10 A Longitudinal Study of Psychophysiological Indicators in Pupils Users of Mobile Communications in Russia (2006–2017)

Children Are in the Group of Risk

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10.1 INTRODUCTION

We would start this paper by asking several principle questions. **WHY** does mankind allow, for the first time in the history of civilization, the child's brain to be exposed daily to radio frequency electromagnetic fields, **why** are devices that are potential sources of electromagnetic radiation sold in stores and are

freely accessible to children, **why** do children use sources of radio frequency electromagnetic fields without control and at their sole discretion (Grigoriev and Khorseva, 2014)? **Why** do the international forums need to return to school cable links and to abandon Wi-Fi (Reykjavik Appeal on wireless technology in schools, 2017)? **Why** has an international group of experts of the European Cancer and Environment Research Institute (ECERI) proposed to create an international group of scientists and lawyers to discuss the possibility that the deliberation of the electromagnetic pollution may be considered by the International Criminal Court (ICC) as a true crime against the health of the population? (ECERI Newsletter. No. 6, June 2017)? **Why** has the lack of real action aimed at reducing electromagnetic effects on the children been replaced by endless years of fruitless discussions? (Grigoriev and Grigoriev, 2013).

10.2 THE REAL SITUATION CAN BE ASSESSED AS THE PERFORMANCE OF A GLOBAL, UNRESTRAINED EXPERIMENT INVOLVING CHILDREN

We should admit the fact that the largest group of users of mobile communication is small children and teens who "must" have a connection almost 24 hours a day. If in 2009 in the work of Khurana and coworkers, the fact that the use of a mobile phone starts at the age of three looked sensational (Khurana et al., 2009), the studies that Kabali and coworkers conducted in the US showed that more than a third of ***babies*** six months old start to use computerized toys, including smartphones and tablets, and by the age of two years, the mobile devices are in use by the vast majority of children (Kabali et al., 2015).

However, there is still no way to evaluate and predict the potential damage to the brain of children by this early exposure to EMF. In this regard, the precautionary principle and WHO IARC classification should apply in discussing the potential dangers for children with the "use today and tomorrow of the cellular communication device."

10.2.1 Sources of Exposure to RF EMF Children

First of all, the base stations represent a constant source of technogenic environmental pollution. They generate RF EMF round the clock almost during the entire life of the human population, including children.

Next is the impact on children's health of the number of sources of WiFi as well as many varieties of gadgets. Even if one considers this irradiation to be of less intensity, we have the case of absorbed radiation energy from different sources acting together and initiating various effects which are difficult to predict and assess.

There are publications that WiFi affects the brain activity of children and can reduce working memory (Maganioti et al., 2010; Papageorgiou et al., 2011). From our view point, the authors' assumption requires additional confirmation.

In 2015, Lukyanova compiled and analyzed studies published during the last 40 years on changes in bioelectrical activity of brain and other reactions of the central

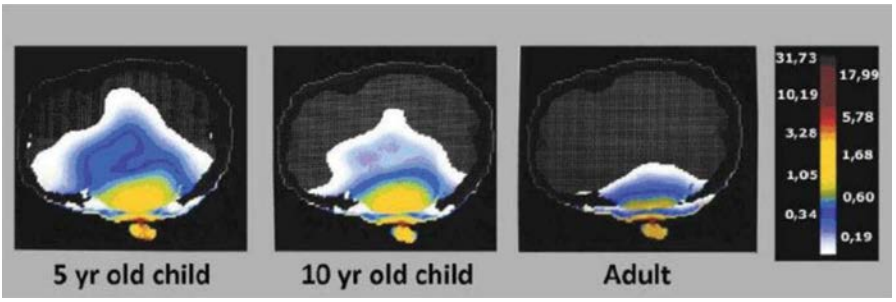


FIGURE 10.1 Distribution of absorbed energy in the brains of adults and children of different ages (5 and 10 years) using mobile phone. (From Gandhi O P et al. 1996. *IEEE Trans Microw Theory Tech*. 44(10): 1884–1897.)

nervous system to RF electromagnetic fields with nonthermal intensity (Lukyanova, 2015). The author came to the conclusion that nonthermal RF EMF at the short-term exposure may be characterized as a weak nonspecific irritant. In addition, WiFi can affect the brain of children in cases where it comes from laptops on their knees (Findlay and Dimbylow, 2010).

The most dangerous source of RF EMF is the mobile phone because the brain of the individual is directly exposed to the microwave radiation: the cerebral cortex, subcortical structures, receptor nerve structures of the vestibular, and auditory and visual analyzers. In 1996, Gandhi showed that the maximum value of the absorbed dose (SAR) in a child's brain is almost 2 times higher than that of an adult and there is a greater depth of penetration into the brain structures (Gandhi, 1996) (Figure 10.1).

This is because the child has a smaller head size, thinner skull, and brain tissue has a larger specific conductivity than that of adults (Ghandhi and Kang, 2002). Moreover, the child holds the phone more tightly to his ear, due to the lack of cartilage in the ear. The domestic measurements showed that during the use of mobile telephone (MT) in adults the heating of the external auditory canal occurs (Berezina, 2015).

During the postnatal development of human tissues, the number and size of cells increase, and the proportion of water content decreases. Such changes generally lead to significant changes in the dielectric properties of tissues. The results show that the maximum SAR levels in the brain tissues of small children (3 months) are 61% and 78% higher than in adults (Mohammed et al., 2017).

It is necessary to remember that children' organisms are in the process of constant development, and no one can predict the problem of remote consequences which may be the result of exposure to RF EMF at an early age.

In 2003, the WHO formulated a conclusion that children are more vulnerable to environmental factors than adults: "Children differ from adults. Children have unique vulnerabilities when they grow and develop; there are 'Windows of susceptibility': periods when their organs and system may acquire a special sensitivity to the effects of certain environmental threats." (WHO, Backgrounder N 3, 2003, 5p.).

This should be considered in the hazard assessment and the availability of a cumulative process in conditions of chronic and repeated impacts.

10.2.2 Radiobiological Evaluation of the Potential Health Effects of RF EMFs on Children

Even before the wide spread use of mobile communication, during the 1970s–1980s in the USSR, experimental studies to characterize the age-related sensitivity to EMFs were carried out. The results of these studies showed that the organisms of young animals are more sensitive to RF radiation (Chernova, 1982; Chernova and Kuzminskya, 1979; Kazarin and Shvaiko, 1983, 1988; Pol'ka, 1989).

Further studies by Russian scientists demonstrated that chronic RF EMF exposure comparable by intensity with the MT irradiation disturbed the creation of conditioned reflexes and consolidation of memory trace, and also revealed changes in neurons in many brain structures, including the cerebral cortex, hippocampus, and basal ganglia (Navakatikyan, 1988, 1992; Pryakhin et al., 2007).

Similar studies outside the USSR have registered in young rats the increase in the permeability of the blood-brain barrier (BBB) to the albumin and as a consequence, histochemical changes in the nerve cells of the brain (Salford et al., 2003a,b).

Recently published data suggests that the cells of the hippocampus of the adult brain maintain the ability to divide, that is, continuing neurogenesis, and this process serves as the neurobiological basis for the formation of new memory. It was also found that the hippocampus, which retains the ability for neurogenesis, plays a key role in the formation of long-term memory, in the integration of the obtained memory by brain information, and its distribution in the higher parts of the brain. As a result, the constantly dividing cells of the hippocampus may have a unique susceptibility to physical factors of the environment, including the radiation from mobile phones (Choi and Choi, 2016; Li et al., 2012; Narayanan et al., 2010; O'Connor et al., 2010), although not all researchers adhere to these conclusions (O'Connor et al., 2010).

The existence of the accumulation of changes/effects during repeated or long-term chronic exposure is one of the most important criteria for assessing the risk of exposure to RF EMF from mobile phones for the population when developing appropriate standards. This was facilitated by the results of a cycle of long-term epidemiological studies of Swedish scientists led by Hardell.

With increasing the time of active use of mobile phones by the population, there is very strong evidence, presented as publications and documents of a number of authoritative agencies and scientific forums, about the possibility of the development of brain tumors among users of MT (Hardell et al., 2004, 2009, 2013; Hardell and Carlberg, 2015; IARC, 2011; Lahkola et al., 2008; US NPCR, 2015). The authors concluded that for the users of cellular phones, the risk of brain tumor development increases with a "waiting period" of 10 years having a risk value of 1.3–1.8. An increased risk of developing astrocytomas and acoustic neuromas on the ipsilateral side of the brain was discovered. The risk of developing brain tumors increases up to 5 times in people who began using cell and portable phones at the age of 8–10 years, and the development of the tumor depends on the duration of cell phone usage.

In 2011, the International Agency for Research on Cancer (IARC) classified radio frequency electromagnetic fields in group 2B as a possible carcinogen based on an increased risk for glioma (IARC WHO. Classifying radio frequency electromagnetic fields as possibly carcinogenic to humans (Press release No. 208, 31 May 2011, 3 p.),

IARC specifically noted that this decision is of great importance for the population, especially for users of mobile phones among young people and children.

In 2015, the results of three national programs of the United States (National Program of Cancer Registries (NPCR), a program of the National Cancer Institute (NCI) and the program for epidemiological observations (SER)) for the assessment of brain cancer in the populations of different age groups for the period 2000–2010 were published (de Salles et al., 2006; Ghandhi and Kang, 2002; Gittleman et al., 2015; Ostrom et al., 2015). A significant increase in the incidence of primary malignant brain tumors and central nervous system (CNS) in American children (0–14 years) was found between 2000 and 2010, with an annual percent change (APC) of 0.6%. In adolescents (15–19 years), there was a significant increase in the incidence of primary malignant brain tumors.

Doubts in the possibility of the development of brain tumors among users of MT forced Swedish scientists to publish two papers in 2017, which reanalysed previously obtained results, with the consideration of many possible methodological errors (Carlberg and Hardell, 2017a,b). It evaluated the power of scientific data to determine whether there is a causal relationship between a risk factor and the associated development of gliomas of the brain and using a wireless phone (Hardell and Carlberg, 2015). The authors present convincing arguments in favor of the conclusion that glioma is caused by RF radiation. The authors strongly recommended a review of current regulatory guidelines for RF exposure in order to protect the population from the effects of low frequency radiation.

Also in 2016, a preliminary report on the results of a two year large-scale experiment on rats conducted under the National Toxicology Program of the United States (NTP) was published (Microwave News, May 2016; http://bit.ly/WSJsaferemr) and performed by the National Institute of Environmental Health United States (US NIEHS). This program was funded by the US Government with the costs amounting to 25 million dollars.

Male rats were exposed to RF EMFs of cell phones every 10 minutes with a subsequent 10-minute break for 18 hours, resulting in nine hours a day for two years. Two standards from GSM and CDMA with a frequency of 900 MHz were used.

For each type of standard cell phone, there were four groups: three experimental groups of 180 rats and the control group for sham exposure (90 rats). The lowest intensity of exposure amounted to SAR 1.5 W/kg, and the remaining two experimental groups were exposed to SAR 3 and 6 W/kg, which excluded the heating of tissue, that is, the "thermal effect."

The study showed a significant increase in cancer rates among rats that were subjected to the electromagnetic influence of GSM or CDMA signals for two years. In the control group, the development of tumors was not found.

These results clearly demonstrate that nonthermal levels of RF EMFs can cause development of tumors in the brain. It should be noted that epidemiological observations are used not only to predict the occurrence of brain tumors when children use MT, but also to investigate the possible development of other somatic disorders. The authors state that there is a correlation between the registered violations and the mode of use of MT. However, these publications raise a lot of questions because their results are not based on the experience of the authors themselves, and the methodology of individual observations was not used (Anttila et al., 2006; Carter et al., 2016; Chernenkov and

Gumenyuk, 2009; George et al., 2015; Huss et al., 2015; Hysing et al., 2015; Inyang et al., 2010a,b; Kheifets and Repacholi, 2005; Sillanpaa and Anttila, 1996; Sudan et al., 2012, 2013; Tomas, 2010; Van den Bulck, 2007; Zheng et al., 2015).

In addition, the research of the influence of the EMF RF mobile phones on the psychophysiological parameters of children and adolescents and the results obtained are highly ambiguous (Calvente et al., 2016; Curcio et al., 2008; Schoeni et al., 2015a,b; Thomas et al., 2010).

We have data from our own experience of the long-term monitoring of children as users of MT, where we were in constant personal contact with children, their parents, and teachers. The results of these studies are presented below.

10.3 PSYCHOPHYSIOLOGICAL INDICATORS AS MARKERS OF THE IMPACT OF EMF RF MOBILE PHONES TO THE CENTRAL NERVOUS SYSTEM OF CHILDREN AND ADOLESCENTS

In our studies, we used psychophysiological indicators, because in this situation, the "critical organ" is the child's brain. Previously, on a large amount of statistical material (more than 3500 children and adolescents), it was shown that psychophysiological indicators, along with other medical indicators, are very sensitive markers in other exposures to a number of unfavorable environmental factors (Khorseva, 2004). The study was conducted in the Lyceum 10 and 17, in the city of Khimki, Moskow region. It is important to note that in addition to the main group of children who used MT (1161), a control group of children and adolescents not using MT (370 people) was formed. ***The presence of a control group is an undeniable advantage of our studies.***

10.3.1 The Main Results of Our Ten-Year Study

The psychophysiological parameters were recorded both with the use of the automated workplace of the psychophysiologist and with the help of a computer program developed by us, LUM (Local Universal Monitoring).

10.3.1.1 Hearing Analyzer

For studying the effect of mobile phone electromagnetic radiation on the auditory system, we used the parameters of a simple audiomotor reaction, since it was established that the determination of the time of simple sensorimotor reactions quite clearly reflects the functional relationships in the cerebral cortex. In our studies, we applied a complex of characteristics of a simple audiomotor reaction. It included recording the change in reaction time and the degree of its instability (variability, in the stereo- and mono-presentation of the audio signal), as well as the level of violations of phonemic perception. The latter parameter was developed by Khorseva. The index is obtained empirically and reflects the wrong perception of similar sounding or similar in articulation speech sounds, manifested in the pass/substitution of letters, the permutation of the syllables, the wrong reading or uttering words, etc. (Khorseva and Zakharova, 2011a,b).

We described for the first time the effects of changing the phonemic perception, the laterality of their changes, the number of missed signals, and the time change

of a simple audiomotor reaction in MT child users. The effect of increasing the time of a simple audiomotor reaction in comparison with the age dynamics in both stereo and mono-presentation of the sound signal was manifested only when it achieved a certain total time of use of the child of MT. In our study, this total time is 360 minutes, provided that the child started using a mobile phone at the age of 7. For children older than 9 years, the effect of slowing the age-related dynamics of the audiomotor reaction is observed at a higher total exposure to 750 min (Grigoriev and Khorseva, 2014).

It is shown that for all children, MT users increased the number of violations of phonemic perception. In 79.3% of cases, we registered a contralateral effect, that is, an increase in the number of disorders recorded on the side opposite the impact of EMF RF of the mobile phone.

Next, we traced the age characteristics of this effect. It has been established that with age, the frequency of manifestations of the contralateral effect of changes in the number of violations of phonemic perception as a whole for each age group decreases.

Our results are in good agreement with the work of the otolaryngologists Panda et al. (2007, 2010, 2011), who for several years, conducted a study of the auditory analyzer for mobile phone users. It has been shown that if the MT is used more than one hour a day for more than four years, dysfunction of the auditory analyzer occurs: a decrease in the perception of high-frequency sounds (s, f, h, t, z), which may indicate a violation of the phonemic perception.

10.3.1.2 The Visual Analyzer

Investigations of the effect of electromagnetic radiation from the MT on the visual analyzer were carried out using such indicators as visual acuity in near vision, speed of visual discrimination, and the time of a simple visual-motor reaction (SVMR).

It was found that such indicators as visual acuity and speed of visual discrimination in children users of MT were not different from the control group, that is, apparently these indicators were not sensitive to the radiation of MT.

Further, an analysis was made of the effect of the slowing down of the dynamics of a simple visual-motor reaction with both binocular and monocular presentation of a light signal. In contrast to the parameters of a simple auditory motor reaction (PSRM), for which the effect of slowing dynamics was detected with a total usage time of the mobile phone by the child, 360 min, the total time of use for a simple visual-motor reaction (PZMR) was 730 min. Such effects were found in children aged 7 years.

One more effect, which we observed for both the SSRM and the PZMR, should be especially noted. With short duration of use of MT (up to six months) and intense daily use up to 2 min/day, we noted a decrease in the response time of both auditory and motor-motor reactions, which may be related to the child's central nervous system stress response to a new type of external effect, radiation from an MT. A further increase in the duration of use and the daily load leads to the effects described above. These effects were observed for all age groups.

10.3.1.3 Fatigue and Working Capacity

In our studies, we recorded fatigue indicators (through the index of muscular tension, determined with the help of tremorometry) and working capacity (through

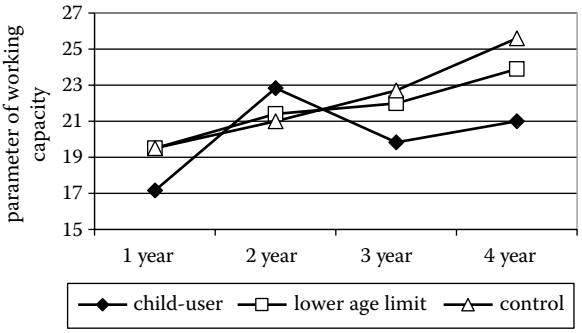


FIGURE 10.2 Comparison of dynamics of individual parameters of working capacity children from the test and control groups (daily time of use: 1 year—2 min; 2 year—5 min; 3 year—15 min; 4 year—10 min).

the parameters of the tapping test), which are objective not subjective methods. In the course of longitudinal studies, it was found that, in comparison with the control group, an increase in fatigue was registered for children in 39.7% of cases, and in 30.3% of cases this increase was significant. Parameters of working capacity for children decreased in 50.7% of cases.

It can be seen that for schoolboy from the test group at the fourth year of observations, an indicator of working capacity has decreased the lower of limit of the age norm, while schoolboy for the control group, parameters of the working capacity are within normal limits (Figure 10.2).

In further studies, we were using the parameters of a ten fingers chaotic tapping test using the computer program LUM (Local Universal Monitoring). This program provides for the registration of more than 20 parameters, including the total number of clicks, and characterizes the level of development of fine motor skills of the hand and working capacity (patent of the Russian Federation No. 2314743). It should be especially emphasized that the data of children and teenage mobile users were processed on the basis of the normative indicators of children and adolescents of the control groups.

In general, only in 8.5% from all data (1364 measurements) is at the level of formation of fine motor skills and working capacity within the limits of the age norm for children and adolescents 7–11 years of age (we examined children and adolescents 7 years old—311 people, 8–348 people, 9–339 people, 10–311 people). This situation already affects the performance of written work, the handwriting of children and adolescents.

Given that the level of motor skills and the formation of cognitive processes are directly dependent, one can expect changes in attention and memory in children and adolescents. In this regard, a special place is occupied by studies of the possible impact on cognitive functions of the RF EMF from mobile phones.

10.3.1.4 Cognitive Functions. Arbitrary Attention and Semantic Memory

Our studies, providing dynamic observations of changes in attention and memory rates, revealed the stress response of a new environmental factor (MT radiation). With

a short duration of MT use (up to six months), and daily intensity up to 2 min/day, we recorded an improvement in the parameters of cognitive processes (increasing productivity and accuracy, reducing the time of the task). We recall that similar effects were also revealed for simple audio and visual motor responses.

Nevertheless, with the increase in the duration and total time of MT use by children, it was noted that not only the stability parameters of arbitrary attention decreased (productivity indicators worsened by 14.3% and accuracy indicators by 19.4%), but semantic memory also decreased (decreased the accuracy factor by 19.4%, increased in time by 30.1%). Below is an example of changing individual indicators of arbitrary attention and semantic memory in a schoolchild for 6 years (Figure 10.3).

As can be seen from the presented data, changes in the mode of using MT leads to changes in the indices of cognitive processes. Decreasing the daily use of MT in the second year of observation leads to an increase in the productivity index (Figure 10.3a); greater accuracy and a significant reduction in the execution time of the task (Figure 10.3b).

A small time of use in the period of 2–5 years of observation leads to the following effects. The productivity index is significantly increased (Figure 10.3a), which corresponds to the age dynamics for the control group pupils; the accuracy rate is very high. The parameters of accuracy and time of the task execution fluctuate depending on the change in the daily load regime (Figure 10.3b). During this period of time, the task was carried out quickly with high accuracy. However, for the 6th year of observation, with a sharp increase in the daily use time of up to 25 min/day, all parameters of arbitrary attention deteriorated: decreased accuracy and productivity, and time of task execution increased.

In addition, the analysis of the indices of arbitrary attention and semantic memory obtained by testing students using our programs LUM allowed us to more thoroughly

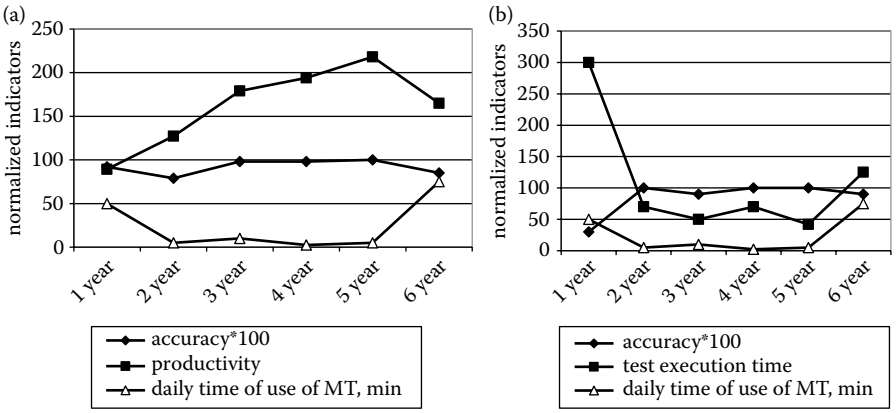


FIGURE 10.3 Example of changing individual performance of arbitary attention (a) and semantic memory (b) (performance and accuracy) during longitudinal observations. The indicators are normalized. Daily load of using MT: 1 year—10 min; 2 year—1 min; 3 year—2 min; 4 year—0.5 min; 5 year—2 min; 6 year—25 min.

assess the change in performance, in particular, semantic memory in groups of 7 years (2012–2014, time observations). It should be noted that, in contrast to the group of first-graders who were under observation in the period 2007–2012, the use of MT in groups of children during the monitoring in 2012–2014 had significantly increased the time use every day and in duration of the use (about 55% of the students started to used MT with 5–6 years).

This immediately influenced the parameters, particularly on the semantic memory: with a duration of MT use for one year with a daily load of no more than 2 minutes/day, a slight change in accuracy was observed, but the task execution time increased by 1.3 compared to the control. However, in the group of users whose daily load exceeded 20 minutes, other patterns were revealed. If the duration of MT use was 0.5 years, the registered accuracy index decreased by 30%, and the time of the task fulfillment increased by 1.4 times. With one year use, there was an increase in the time of the task of 1.69 times and a decrease in the accuracy parameter of 20%. Similar changes were found for school children and other age groups.

10.3.1.4.1 The Statistical Analysis of the Data

The statistical analysis of the data was carried out at the BIOSTASTIKA Center under the leadership of Leonov V.P. The array of data of indicators of voluntary attention and semantic memory on the whole array of data since 2006, which contained 2086 observations, including 25 signs, was analyzed.

Tables 10.1 and 10.2 show the level of formation of arbitrary attention and the semantic memory of children and teenage users of MT at the ages of 5–16.5 years.

From these results, it can be seen that only 41% of measurements can be attributed to a high level of formation of indicators of arbitrary attention (both indicators at the level of high values), while 29.62% of measurements are a combination of medium and high values, 8.3% are at the level of average values, and 21% are a disharmonious combination of indicators (high to average accuracy and lower limit/low/very low productivity and vice versa).

TABLE 10.1
Analysis of the Level of Development of Voluntary Attention in Children of Mobile Users Across the Dataset (2084 Observations)

	Productivity Indicators				
Accuracy's Indicators	**Tall**	**Average**	**The Lower Limit of Normal**	**Low**	**Very Low**
Tall	41,03	17,1	4,32	3,41	0,77
Average	12,52	8,3	1,73	1,39	0,58
The lower limit of normal	1,78	1,78	0,67	0,48	0,1
Low	1,01	1,01	0,48	0,58	0,24
Very low	0,1	0,1	0,05	0,4	0,38

Data in %.

TABLE 10.2
Analysis of the Level of the Formation of the Semantic Memory in Children Users by Mobile Communication Throughout the Entire Dataset (2083 Measurements)

	Time Indicators for the Test				
Accuracy's Indicators	Tall	Average	The Lower Limit of Normal	Low	Very Low
Tall	33,6	11,95	1,92	3,22	1,2
Average	9,22	8,98	1,58	3,89	2,06
The lower limit of normal	4,27	2,88	0,82	2,5	0,96
Low	2,45	2,4	0,96	0,82	1,2
Very low	0,53	0,53	0	0,29	0,77

Data in %.

It is established that only 33.6% of the measurements can be attributed to a high level of the formation of semantic memory indicators (both indicators at the level of high values), 21.17% of measurements are a combination of medium and high values, 8.98% are at the level of average values, and 36.25% are a disharmonious combination of indicators (high/average accuracy and low limit /low/very low time parameters task execution and vice versa).

However, it should be noted that when comparing the level of development of arbitrary attention and semantic memory, there is some imbalance: high levels of development of arbitrary attention were revealed in 41.03% of children and adolescents against 33.6% for increased semantic (semantic memory); the disharmonious level for indices of arbitrary attention is set for 21%, and for semantic memory it is 36.25%. It is possible that this may reflect the fact that the parameters of semantic memory for children users of mobile communication indicators were reduced to a greater extent than the voluntary attention.

Statistical analysis of data using conjugacy tables showed the following: although the strength of the connection of these qualitative characteristics for both parameters of voluntary attention and semantic memory is not very strong, it is statistically significant ($p < 0.0001$).

So, the longitudinal changes in the psychophysiological indicators of children who use mobile phones convincingly show that chronic exposure to electromagnetic radiation from a mobile phone may negatively affect the central nervous system of the child:

1. The reaction time to sound and light stimuli is increased;
2. There is an increase in the number of violations of phonemic perception and the number of missed signals when a sound stimulus is presented;
3. Indicators of arbitrary attention and semantic memory deteriorate;
4. There are increased parameters of fatigue and decreased parameters of working capacity

It should be especially noted that in most cases in children who are active users of mobile communication, changes in psychophysiological indicators either were within the lower limit of the norm or already go beyond it.

We believe that the changes listed above may and in some cases already do affect the success of the training. However, observance of the elementary rules of a safe mode of using MT can significantly reduce the level of negative effects of electromagnetic radiation from mobile phones. And we already have confirmation of this statement.

Over the past three years, a complex of preventive measures was implemented on the basis of the Lyceum 17 with the participation of all participants of the educational process aimed at reducing the negative impact of the RF EMF of the MT (schoolchildren, parents, teachers, and the Lyceum administration). A series of lectures was organized for parents, teachers, and the administration of the educational institution. During this period, using the program Universal Local Monitoring, the levels of cognitive processes (arbitrary attention and semantic memory), parameters of working capacity, and the level of development of fine motor skills were studied. An individual survey of children on the use of MT was conducted.

It was found that the safe mode of use (headphones, speakerphone, use of SMS, MMS) statistically significantly improve ALL psychophysiological indicators.

We believe that the results of our longitudinal observations clearly show that the RF EMF from mobile phones affects psychophysiological indicators of children and adolescents. Based on our results, it can be confidently affirmed that children are located in the group at risk. It should be recognized and the efforts of the scientific community to reduce the risk of adverse effects on the organisms of children should be made. One of the possible ways of reducing the impact of electromagnetic fields on children is an understanding of the dangers by the parents and children, the use of mobile communication, and a voluntary choice of the form of communication, that is, the introduction of the concept of "voluntary risk."

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