Adverse Biologic Effects of Digital Technology on Memory and Learning in Children

Wireless Radiation Acts as a Biologic Toxin to the Nervous System



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Abstract:

Wireless Technology has rapidly expanded into our culture giving us immediate access to information, communications for emergencies, personal connection and the ability to purchase items instantaneously. More uses for wireless technology are being developed in schools, the workplace and in medicine. Cell tower expansion is being rapidly deployed in cities, schools and hospitals. The population is now experiencing higher and more constant exposures, now beginning in utero for the newest generations. See Figure 3.

Current standards for radiofrequency radiation emitted from wireless devices and cell towers is based only on heat effects, despite numerous studies showing harmful biological effects at much lower non-thermal levels. Adverse effects on the interrelated immune system, nervous system and reproductive systems are being demonstrated in the laboratory and clinically. (Pall 2018) For children, evidence is accumulating that digital technology may hamper learning, behavior and memory as well as contributing to many other disease states. (Leach 2018)

Schools and daycares are now commonly using wireless devices placed close to the body and allowing cell towers to be placed on or near schools. Wireless devices are being marketed for babies. Educators and administrators may not be aware of recent literature or policies that call for precaution due to direct acute and long term effects of radiofrequency radiation on children's health.
There are also adverse psychosocial effects related to overuse of digital technology, including addiction, increased social pressure, lack of privacy, distraction, loss of patience and loss of empathy.



NASA Image of Wireless Radiation from Devices

Are observed cognitive effects psychosocial due to overexposure or is non-ionizing wireless radiation causing direct injury to neurologic processes, with long term exposure and/or at critical windows of development?

Normal Brain Development Crucial for Behavior, Memory and Learning Through Adolescence

Human brain development is a non-linear process both structurally and functionally. (Taki 2012)
Gray matter increases in childhood then decreases in adolescence, with the exception of the hippocampus and amygdala, which showed volume increases. (Orsby 2009) White matter maturation, especially in the frontoparietal area is responsible for cognitive functioning, such as increased working memory capacity. (Klingberg 1999; Edmond 2009; Khadka 2016) The hippocampus mediates numerous cognitive functions, including spatial memory and synchronized sensory processing over many circuits with brain wide functional connectivity.(Chan 2017) Anomalous white matter development is noted in ADHD (Silk 2009)

Gray Matter: Synapses per neuron increase differentially in anatomic parts of the developing brain

White Matter: Synaptic connections and myelination increase linearly in all parts of the brain though development. (Klingberg T 1999)

The Developing Brain and Nervous System Are More Vulnerable to Toxic Exposures

Brain development begins in the womb and continues through the early adult years. The complex biology of neurodevelopment can be easily disrupted by toxic exposures depending on the type of substance, the level of exposure, the duration of exposure, and most critically, on the timing of exposure during the developmental process. Genetics are also a factor. Toxic influences can alter the foundational structure of the brain, resulting in lifelong impairment of learning, behavior, and general health as the nervous system, immune system and reproductive systems are interrelated in development and function. (Shonkoff JP 2006)

Wireless Radiofrequency Radiation Acts as a Toxic Exposure

Wireless radiation passes through and is absorbed by the water contained in all organisms. Although physicists have stated that the energy in non-ionizing radiation is not high enough to move electrons, several mechanisms of harm from wireless non-ionizing radiation have been well documented including alteration of membrane calcium channels and oxidative stress. These are common mechanisms of toxicity from chemicals.
Yakymenko (2016) examined 100 currently available peer-reviewed studies on oxidative effects of low-intensity microwave radio frequencies. He found that 93 of the 100 studies confirmed that wireless radio frequencies induced oxidative effects in biological systems. Many research studies have also highlighted the protective effects of melatonin, vitamins C and E and other antioxidants with exposure to radio frequencies.

Absorption of Radiofrequency Radiation is Higher in Children

Children have thinner skulls and higher brain water content, thus the brain tissue absorbs higher doses of radiation (Deniel 2014; Morgan 2014). The eye also has a high water content and thus absorbs more radiofrequency radiation.

* **Cell Phone Radiation**: 2-fold increase in head and 10-fold increase in bone marrow absorption in 5 and 10 year old children (Ghandi 1996 and 2012) See Figure 1.
* **Virtual Reality Radiation**: 2 to 3-fold increase in radiation to the hippocampus and cerebellum with cell phones. 2 to 5 fold increase in radiation absorption to eyes. (Fernandez 2018) See Figure 2.

Direct Cellular Harm to the Nervous System From Radiofrequency Radiation

The brain and nervous system are considered to be the most sensitive target organs for radiofrequency radiation. Research has shown direct harm to cellular processes from non-thermal exposures to wireless radiofrequency radiation. These include:

* **Damage to hippocampus** (spatial memory) (Shahain 2018; Fragopoulou 2018; Sahin 2015)
* **Decreased neurotransmitter concentrations** (mood) (Ismail 2015; Aboulezz 2013)
* **Demyelination** (white matter) (Kim 2017)
* **Oxidative stress** and inflammation (headaches, sleep disturbance, fatigue, memory) (Yakymenko 2016 : Shahin 2015; Fragopoulou 2012)
* **DNA damage** (Deshmukh 2013; Lai & Singh 1996)
* **Aptosis /autophagy** in neurons (Gupta 2018; Kim 2018; Varghese 2018)

Neurobehavioral Effects of Radiofrequency Radiation

Scientists have observed a variety of adverse neurologic effects with exposure to wireless radiation including

* **Cognitive impairment** (Deshmukh 2015; Deshmukh 2016; Hassanshahi 2017; Megha 2012)
* **Memory** (Foerster 2018; Schoeni 2015)
* **Learning** (Shahain 2018; Wang 2000)
* **Depression** (Pall 2015)
* **Social behavior/ADHD** (Divan 2012)
* **Ill health/fatigue/anxiety** (Schoeni 2017; Shehu 2016; Pall 2015)
* **Prenatal effects** (Birks 2017; Othman 2017; Zhang 2015; Aldid 2013)

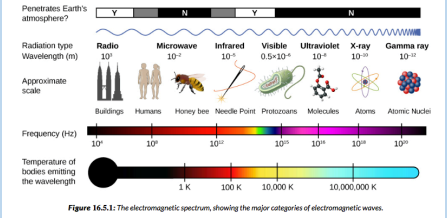


Figure 16.5.1: The electromagnetic spectrum, showing the major categories of electromagnetic waves.

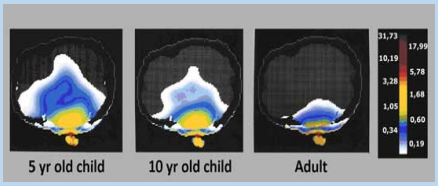


Figure 1: SAR distribution into 5 year old, 10 year old and adult skull.
*Electromagnetic Absorption in the Human Head and Neck for Mobile Telephones at 835 and 1900 MHz. Gandhi, Lazzi and Furse, published in IEEE Transactions MTT, 1996 with permission.

U.S. NTP Study Showed Carcinogenicity of Cell Phone Radiation

The 10 year, $25 million National Toxicology Program (NTP 2018) Chronic Carcinogenicity Studies of Cell Phone Radiofrequency Radiation demonstrated a significant increase in cardiac and brain tumors as well as DNA damage and cardiomyopathy from radio frequency radiation from cell phone radiation.

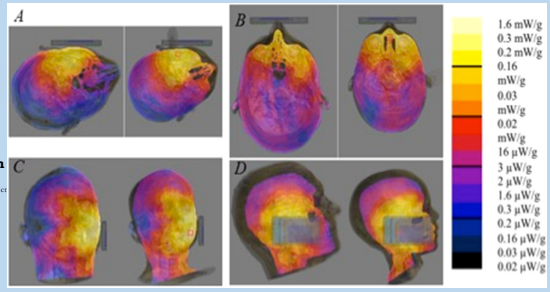
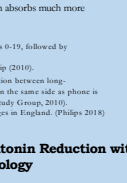


Figure 2: Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality. Fernandez C et al. (2018) Environmental Research. June 5, 2018. Reprinted with permission. Adult images on left in all frames.

Ill Health and Electrosensitivity Near Cell Towers

A variety of reports show general health symptoms including headache, insomnia, memory loss, fatigue, dizziness, nausea and irritability when a cell tower, emitting constant radiofrequency radiation exposure, is placed within about 1200 feet of a residence. These are typical symptoms experienced by those with electrosensitivity when in the presence of wireless devices.

* Bogers RP. (2018)
* Belyaev I. (2016)
* Shinjyo T and Shinjyo A. (2014)
* Hutter HP et al. (2007)
* Santina T et al. (2003)
* Navarro, EA et al. (2003)
* Kolodynski AA (1996)



Brain Tumors

Brain tumors are a concern as research shows a child's brain absorbs much more radiation than an adult. (Ghandi 1996)

* Brain tumors are now the most common cancer in youth ages 0-19, followed by testes and leukemia. (Ostrom et al, 2015).
* Increased incidence of brain tumors in 20-29 year olds. (Inskip (2010).
* Independent robust studies demonstrate a consistent association between long-term use of cell phones and increased risk of brain tumors on the same side as phone is used (Coureau et al, 2014; Hardell et al, 2013; Interphone Study Group, 2010).
* Glioblastoma multiforme brain tumors are rising across all ages in England. (Philips 2018)

Sleep, Light at Night and Melatonin Reduction with Digital Technology

Light at night, blue light from LED bulbs, and possibly electromagnetic radiation from wireless devices can reduce melatonin, a potent natural endogenous antioxidant, and alter a person's circadian rhythm, causing insomnia. (Tosini 2016; Bellieni 2012) Sleep is critical for:

* Neurogenesis and synaptic reorganization in the human hippocampus (Taki 2012)
* The hippocampus to store and process information learned during the day, sending this to the neocortex for permanent storage (Urbain 2013).
* Circadian organization. The International Agency for Research on Cancer (IARC) classifies shift work in group 2A of "probable carcinogens to humans" due to its involvement in circadian disorganization. (Touitou 2017)
* To maintain circadian clock and melatonin release, the reduction of which is associated with a number of disease states including cancer, diabetes, cardiovascular risks, obesity, mood disorders, age-related macular degeneration. (Blask 2009: Touitou 2017)

Conclusions:

1. **Multiple studies indicate that wireless radiofrequency radiation acts as a biologic toxin with an oxidative mechanism similar to other environmental toxins. It can cause direct damage to cells and processes in the nervous system that are associated with memory, learning and behavior and can affect all living organisms. (Siddoo-Atwal 2018)**
2. **Wireless radiation can have cumulative long term effects including cancer and neurodevelopmental harm**
3. **Wireless radiation can cause acute and chronic symptoms of electrohypersensitivity in a subpopulation of people who live near cell towers or who use wireless devices.**
4. **EMR exposure can be considered a Modifiable Risk Factor for neurologic as well as psychosocial health and well-being.**

Recommendations:

Precaution in individual and community exposure to wireless radiation is indicated.

1. **Follow 2017 California Department of Public Health Guidelines on Cell Phones; advising adults and children to limit their exposure to wireless radiation (CDPH 2017)**
2. **Strengthen American Academy of Pediatrics recommendations for digital use to include reducing exposure to wireless radiation. (AAP 2016)**
3. **Update 1996 FCC radiofrequency guidelines to consider long term and non-thermal exposures for adequate health protection**
4. **Educate the public about limiting exposure to wireless devices in children and adults, including cell phones, tablets, laptop computers, Wi Fi routers, smart meters, cordless phones, IoT devices**
5. **Use best practices in schools to limit wireless use, including placing wired or fiberoptic connections in preference to wireless systems**
6. **Do not place cell towers near schools, homes or hospitals.**

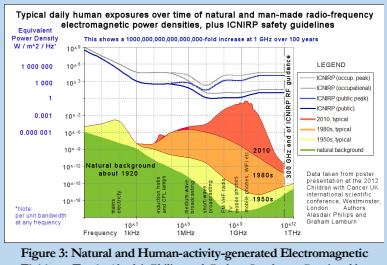


Figure 3: Natural and Human-activity-generated Electromagnetic Fields on Earth. Alasdair Philips and Graham Lamburn . Reprinted by permission.

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Full list of references available at MDSafeTech.org