The Effects of Digital Technology Usage on Children's Development and Health

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Abstract

Globalization has changed our lives in multiple ways, but the most important change in our lives, is due to our way of communication. The recent technological advancements include the innovation in computers and mobile phones and their multi-functions such as voice calls, messaging, data use, games (online and offline) and use of social media apps. Mobile phones have almost become an essential part of our daily lives.

In total, the number of people who own a smart and feature phone is 4.88 Billion, making up 62.17% of the world's population. (Source: https://www.bankmycell.com/blog/how-many-phones-are-in-the-world)

It seems that children's inappropriate use of such technological devices in terms of content, duration, frequency, and the posture they adopt while using them pose a variety of health risks, including developmental problems, musculoskeletal problems, physical inactivity, obesity, and inadequate sleep quality and Leads to multiple learning difficulties and behavior disorders, emotional, moral and social development disorders of young children. It has eventually affected the academic performance of young children. The positive and negative effects of the mobile gadgets are affecting the overall development of young children.

In order for children to avoid harm it is important to monitor the time, frequency, and content viewed while using technological devices and to ensure that children have or develop adequate physical activity opportunities, healthy eating habits, proper sleep cycles, and a nurturing social environment.

Key words: digital technology, children

Introduction

Brain development in children.
Differences in cognition, behavior, and emotions between children, adolescents, and adults have been noted for millennia. Characterizing the neuroanatomical substrates of these differences has been more elusive. Data from animal and post-mortem studies has been able to tell us much about the basic processes underlying the development of the brain, but these types of studies are limited in what they can tell us about how individuals change over time, the extent of variability between individuals, and what factors may impact that change.

Key events in brain development
The development of the nervous system occurs through the interaction of several synchronized processes, some of which are complete before birth, while others continue into adulthood. The first key event in the development of the central nervous system is the formation of a specialized fold of ectodermal tissue called the neural tube. The neural tube nears completion by 3–4 weeks of gestation and is the basis for all further nervous system development. Birth defects such as spina bifida and meningomyelocele arise from abnormalities in neural tube formation (1).

From 4 to 12 weeks the neural tube differentiates into what will become various components of the nervous system. The forebrain and facial structures develop at one end, and the spinal cord at the other.

Myelination occurs regionally beginning with the brain stem at 29 weeks (2) and generally proceeds from inferior to superior and posterior to anterior.

A third major developmental process is the proliferation and organization of synapses, which begins slightly later, around the 20th week of gestation. Synaptic density increases rapidly after birth, reaching by 2-years of age a level approximately 50% greater than that typically seen in adults (3). This is followed by a regionally specific loss of synaptic connections. For example, maximum synaptic density occurs in the visual cortex at 4 months postnatally, but it does not typically peak in the prefrontal cortex until 4 years of age (see Figures 1, 2)

Electromagnetic field (EMF) exposure in children

In today's world, most children are exposed to various manmade electromagnetic fields (EMFs). EMFs are electromagnetic waves less than 300 GHz. A developing child's brain is vulnerable to electromagnetic radiation; their caregivers' concerns about the health effects of EMFs are increasing.

EMF exposure is divided into 2 categories (5-4):

1- Extremely low frequencies:
(ELFs; 3–3,000 Hz), involving high-voltage transmission lines and in-house wiring; and radiofrequencies (RFs; 30 kHz to 300 GHz), involving mobile phones, smart devices, base stations, WiFi, and 5G technologies.

ELF-EMFs are generated from electrical machines, transmission towers, and high-voltage lines. In Korea, electric power is operated at 60 Hz. More EMFs are absorbed with the use of appliances that are close to the body (e.g., hair dryers, bidets, massagers, and electric blankets). The general recommendation is that electrical appliances should be used at least 30 cm away from the body.(http://www.emf.or.kr/general/html/life/guideline.pdf).

2-Radiofrequency EMFs
RF-EMFs are generated from mobile phones, smart devices, WiFi, base stations, and radars. Radio or television transmitters and base stations can be large sources of RF exposure. Mobile phones generate more electromagnetic waves when used in a fast-moving subway or train or when searching for a base station before the ring back tone (6)

The effects of EMFs

1- Biological effects
The main effects of EMFs on the human body are stimulation, thermal, and non-thermal. Stimulation effects involve the nerves and muscles at a high EMF, can be used for medical devices, and can cause electrical shock at very high stimulation levels. Thermal effects involve an increase in body temperature. Hot senses of the ear or body during mobile phone or laptop use are some examples. Non-thermal effects result from recurrent long-term exposure and may be related to the so-called electromagnetic hypersensitivity syndrome or neurodevelopmental disorders (7).

2- Carcinogenicity of ELF-EMF
The WHO task group referenced the IARC monograph evaluating the carcinogenic risks in humans in 2002 that classified ELF as a possible carcinogen (8). However, the task group commented that the epidemiological evidence of carcinogenicity was weakened by methodological problems such as potential selection bias.

In the part about the effects on children, it stated that "pooled analyses showed 2-fold excess risk for exposure to ELF magnetic fields above 0.4 μT and a relative risk of 1.7 for exposure above 0.3 μT.". The IARC concluded that ELF magnetic fields were possibly carcinogenic to humans (Group 2B) and that the association between child leukemia and a high magnetic field was unlikely to be due to chance. In contrast to ELF magnetic fields, evidence on the association between ELF electric fields and leukemia was inadequate, and the associations between other childhood brain tumors or cancers and ELF were inconsistent (8).

Figure 1: The pruning trajectory of brain synapses

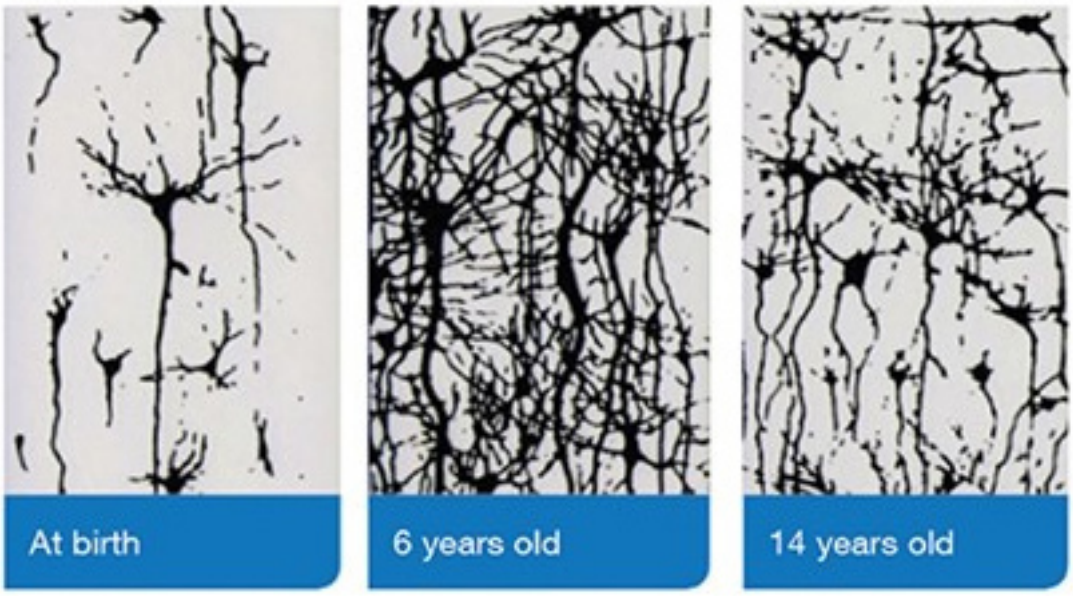
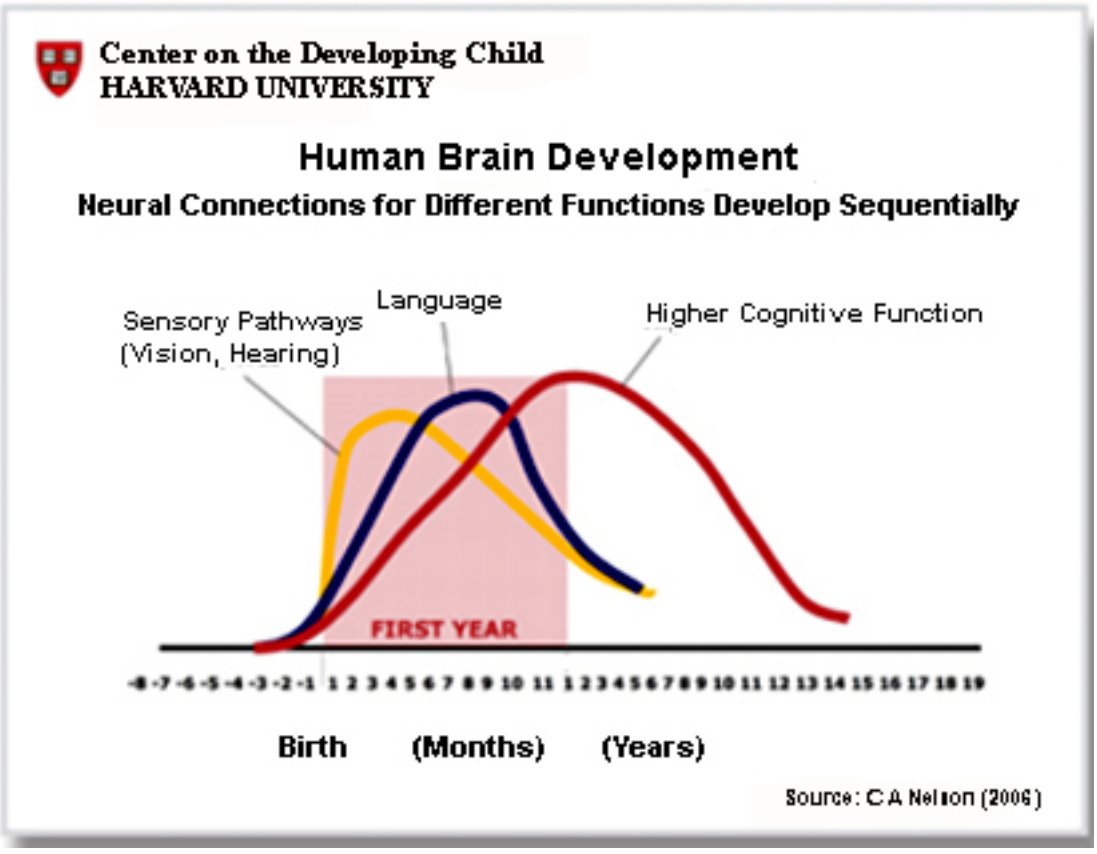


Photo: Andrew Sikorski

Figure 2: Human Brain Development



In 2014, the WHO also published the following fact sheet on mobile phone EMF and public health. Similar to ELF, the WHO opinion was undetermined. It referenced the IARC's classification of mobile phone use as possibly carcinogenic to humans (9).

Studies of mobile phone RF exposure in children
The skull thickness of adults is approximately 2 mm. However, the skull thickness of a 5-year-old child is approximately 0.5 mm and 1 mm at10 years (10). Therefore, radiation penetration is larger in children than in adults(10,11). As a child's head diameter is smaller, the energy-absorbing "hot spots", the most sensitive parts of RF, are more pronounced.

The results of the study that assessed the associations between RF exposure and cell phone use, residential RF-EMF levels, and cognitive function tests were inconsistent(12,13).

Children may be more vulnerable to EMF than any other age groups.

The vulnerability of children to electromagnetic field exposure according to the UK Independent Expert Group on Mobile Phones. EMF, electromagnetic field; RF, radiofrequency:

Children are exposed to electromagnetic waves over a longer life time than adults

Their nervous systems are in the process of development

The conductivity of the children is higher due to higher moisture and ionic content than adults

Children's head absorbs a lot of RF energy more than adults

From Stewart report" by the UK Independent Expert Group on Mobile Phiens (2000)

Technological Tools and Their Effects
Digital technology's integration into the daily lives of children and its influence on their cognitive, emotional, and social development continues to increase day by day. Technology offers many opportunities for children to play, explore, and learn (15).

Since children's brains are extremely flexible in this period, these learning opportunities constitute a critical developmental point in children and through the natural exploration and discovery of their own world, new connections between neurons are formed and existing connections are strengthened (16).

Television
Television plays an active role in children's world due to its visually and auditory captivating and entertaining nature. Watching an excessive amount of television and videos by children less than two years of age has been reported to significantly influence language development and behavioral disturbances (17_.

Computer
Similar to television, computers have become an indispensable element in children's lives. Spending too much time on the computer from an early age can negatively affect academic success due to the low concentration, lack of attention and disorganization, undeveloped language skills, creativity, and imagination seen in children as a result of excess computer use (18).

Internet
Studies on the internet's possible effects on early literacy activities have explored whether the internet offers intentional and unintentional learning opportunities, and the impact of the internet on early literacy is still not fully understood (19).
Easy access to illegal, violent, and sexual content, communication with dangerous people, and excessive dependence on games constitute only a few of these significant risks (20).

Video games
Although much has been written about the effects of video games on children and adolescents, there has been little work done on the effects of video games on young children (21).

Violent video games can lead children to aggressive behavior and inhibit creative game play (22).

Studies have shown that there is a strong link between violence in video games and real life violence, and that these games lead to social isolation and lack of communication and communication with other children (23)

Smart phones.
An increased use of smartphones has been reported to be associated with passive aggressive, unprotected, socially incompatibility, obsession, addiction, and anxiety traits. It has been reported that those children engaged with their smartphone during school negatively affects both own and their classmates' attention (24).

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Developmental and Health Risks of Digital Technology Usage
The use of digital technology has been associated with lack of attention, aggressive behaviors, physical inactivity, obesity, and sleep problems in preschool and school age children. The overuse of digital technology causes children to use their time inefficiently. Concern should also be paid to the cognitive and emotional effects that these technologies have on the development of children (25).

The overuse of technology in early childhood has been found to be related to cognitive, language, and social/ emotional delays in community-based research (26).

Digital Technology Usage and Musculoskeletal System

A steady increase in the use of digital technology at home and in school environments has been reported to cause an increase in musculoskeletal problems, in addition to psychological factors (27).

Such factors include monitoring anxiety and somatic complaints (headache and abdominal pain) (28). Musculoskeletal disorders are associated with such physical factors as sex, age, body mass index (BMI), and exposure to sedentary activities. For this reason, playing with toys should be encouraged in place of watching screens in order to minimize the risks of potential musculoskeletal disorders and sedentary lifestyles, and conscious instruction manuals for tablets and other technological devices should be provided to parents and caregivers (29).

Digital Technology Usage and Physical Inactivity

Evidence that the use of technology has changed physical activity is doubtful, but it is being investigated as to whether the use of excessive technology, in particular, takes the place of a night's sleep. In a study on children aged 4-11 years, it was found that 37% of the children had a low active play level, 65% had high screening time (television, computer, tablet, etc.),and 26% had a combination of these two (30).

Another study found that only 4 out of 10 children aged 6-11 years met the recommendations of the guidelines for both physical activity and screening duration, further showing that increased age was associated with decreased physical activity in children (31).

Digital Technology Usage and Obesity

The rate of obesity in children has tripled in the last 20 years. For healthy development of children, 3-4 hours of daily physical activity and social interaction are needed (32). Excessive use of technology is linked to lifetime obesity and cardiovascular risk and this relationship is now observed starting from early childhood (33).The excessive use of social media during the pre-school period is associated with low, but significant increases in BMI, laying the groundwork for weight gain in later childhood (34).

Digital Technology Usage and Sleep Quality

Keeping a television, computer, or mobile phone in the bedroom during early childhood is associated with less sleep (35).

Children who make excessive use of social media or who sleep with mobile devices in their bedrooms are at increased risk of experiencing sleep disturbances (36).
Poor sleep quality in adolescents is associated with extreme mobile phone use while the number of devices in a bedroom and poor sleep quality are associated with excessive internet use and duration of digital technology usage prior to sleep in pre-adolescents (37).

The use of electronic devices during the daytime can also affect sleep quality (38).

Precautions to reduce the risk of excessive electromagnetic field (EMF) exposure in children (14)

Children can be exposed to EMF by electronic devices, high-voltage transmission lines, mobile phones, WiFi, etc.

For parents:

- Avoid long-term exposure to strong EMFs in home, school, or other places children spend much of their time.
- Avoid using electrical devices within 30 cm of the body.
- Avoid using smartphones directly against your child's head.
- Keep your child's body from getting hot while using mobile phones.
- Do not allow your child to use smart devices during meals or for the last hour before bed.
- Note that the effects of various devices using virtual reality and WiFi have on the neural development of children remain unknown.
- Most products that claim to reduce EMFs are ineffective or unproven.
- Ask your child's pediatrician for information to guide your child's use of smart devices.

For teachers, policymakers, and commercial companies:

- Teachers: Educate children on how to avoid excessive EMF exposure.
- Policy makers: Create policies to reduce children's EMF exposure from the environment.
- Commercial companies: Create products that reduce children's exposure to EMFs and issue warnings about them.

Conclusion

It is clear that with the development of digital technology, research on these products will continue. Technological developments are largely variable, and the effects also depend on the type of device, the type of use, the amount and extent of use, and the characteristics of the child or adolescent. Since children are currently growing up using highly personalized technology, parents should strive to ensure that they are able to implement and benefit from the principles of balanced nutrition, quality sleep, adequate physical activity, and positive social interaction for healthy growth and development by making plans according to the age, health status, character, and level of development of their children. However, parents should also be aware of their duties and responsibilities in modeling appropriate technology use while also striking a balance between technology usage and other activities.

Parents should be aware that their technological device use may also have negative effects on their children. It should be known that children under the age of four playing games alone rather than being exposed to technological devices will help the child develop creative thinking and

individual problem solving skills. The total technology usage time during the day (e.g., watching television and playing games on computers, tablets, and mobile phones) should be limited to 1-2 hours. Care must be taken that children aged 2 years or younger not be allowed to face the screen.

Television and technological equipment connected to the internet should be kept away from the child's bedroom. If one's children are allowed to use technological devices, the use of these devices must be subject to certain rules. Enforce a mealtime and bedtime "ban" for technological devices, including cell phones. Reasonable, but firm, rules for cell phones, television, computer games, internet, and social media use should be established and these rules should not be compromised.

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