The Influence of Smartphones on Children's Brain Development

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Summary

Using a cell phone has become a necessity for most people, however, when children use it unsupervised by adults it can seriously affect their cognitive and brain development. The objective of the research was to analyze the influence of smartphones on children's brain development. The mixed approach, non-experimental design of descriptive level, was used through a survey structured in 24 questions on the use and control of the cell phone to infants, carried out to a sample of 41 parents of the Federico González Suárez Educational Unit in the city of Santo Domingo, Ecuador; The documentary review of scientific articles and postgraduate theses was applied to substantiate the consequences of electronic devices on the brain plasticity of children. As results, 64% of children use the telephone from the age of 9, on a regular basis, more than one hour a day and outside the school environment; parents observed risks of family and social isolation, poor school performance, access to inappropriate content, addition and change in family relationships in an average of 24%; Documented evidence shows severe consequences on brain plasticity with minors addicted to the internet similar to those who use drugs, decreased head circumference, atrophy or loss of gray matter volume, frontal lobe involvement that governs executive functions of doing things, insula damage , fundamental in feelings for others. It concludes in raising awareness from the home, from the role they have as parents, caregivers or responsible for children, to manage the proper use of mobile phones or other electromagnetic devices, avoiding damage that can be irreversible if measures are not taken now.

Keywords: internet addiction, brain development, child development, family relationships, smartphone.

Introduction

Technology plays an essential role in the development of today's society, after being used in a few spaces such as science, academia and industry, today it is present in most of the homes on the planet, being one of the instruments of interconnectivity, the smartphone, designed with a basic purpose of communication, saving time and distances. however, as technology advances, this device is being used for numerous purposes that do not exactly contribute to effective communication (Giler et al., 2020).). .(Giler, Macías, Mera, Álvarez, & Meza, 2020)

Smartphones occupy a prominent place within every home due to their varied uses, including the large storage they offer, allowing a variety of applications to be installed; A small device can perform many functions, work activities, leisure, entertainment, among others, an ideal alternative for infant caregivers who have found in the mobile phone the ideal tool to distract and occupy the children in their care, through videos, games, cartoons and the like (Díaz, et al., .(Villalba, 2012)(2019)

Article 17 of the Convention on the Rights of the Child in 1989 establishes the balance that must exist between minors and the media, children have the right to have a full childhood, in which their integral security is not affected. Early childhood is key in the individual, the environment begins to be explored and known, several changes occur in the physical, emotional, psychological and social, the process of brain development begins, brain functions are shaped, the child is exposed, and if caregivers do not exercise their control role, they can be seriously affected (Council on Communications and Media et al., 2011). (Media, y otros, 2011).

Various studies reveal the negative consequences of smartphones for the brain development of children and adolescents; Fletcher explains that the infant brain is much more plastic and makes infants learn much faster, in addition to the fact that some brain functions take years to fully develop so it can undergo modifications in the face of highly influential activities, unlike the adult brain that has less plasticity, therefore, the smartphone cannot affect brain development significantly. (1997)

One of the negative consequences of uncontrolled cell phone use is known as Internet Addiction Disorder (IAD) (*internet addiction disorder*) which affects approximately 1.5% of adolescents between 12 and 17 years of age in Spain, a figure lower compared to countries such as Korea, China and Taiwan that is equivalent to 30%. IAD is an imperative need that the person feels to use electronic devices that keep them connected to the internet and experience content on social networks, video games, various pages, which they access through Smartphone, apps and computers.(Varela, 2019)(Carrillo, 2019)

The IAD it generates impulsive behaviors to use the mobile phone at all times, which are constantly repeated throughout the day and night (Vera García, 2018); prevents the person from leading a satisfying life (Varela, 2019), but also, from the biological perspective of the human being, "these behavioural addictions act through neuronal receptors and neurotransmission systems very similar to those that generate addiction to toxic drugs". (Carrillo, 2019)

Some warning signs of internet addiction include: a) Chronic and progressive failure to resist the urge to perform the activity. The subject loses freedom and behavior becomes a priority need that alters the functioning of all areas of his life; b) Irresistible and priority need to carry out the activity and the need to increase it; c) Lack of concern for the consequences that this activity may cause; the conduct continues even if it has consequences in the personal, interpersonal, social, economic and even legal spheres; d) Denial of the problem and attempts to hide or justify it through lies about the frequency and intensity of the activity, and e) Restlessness, mood disturbances, irritability or anxiety when the particular behavior is interrupted or reduced.(Sosa, 2019)

Also, these addictions range from video games to pornography, in addition to the following:

Video game addiction. Excessive use of video games and computer games. Games such as *World or Warcraft* (WoW), *League of Legends* (LoL), *Fornite*, *Minecraft*, Pokemon Go, *Mario Kart* or *Candy Crash* are the ones that are most addictive for teenagers lately.

Addiction to social networks. Excessive use of social networks such as Facebook, Twitter or Instagram. People with this problem constantly check the "wall," post updates, comment on photos, or read updates from others. Social interactions over the internet can become more common and important than in-person relationships.

Gambling addiction. Unlike video games, the main motivation of people with gambling addiction is to make money.

Addiction to online entertainment. It is defined by excessive visits to web pages or the viewing of online videos (YouTube). It can often be seen as a way to occupy free time or to delay obligations.

Addiction to pornography or. It involves compulsive viewing and collection of online pornography and/or excessive use of chat or adult video services (Varela, 2019).

Consequently, the most common affectations are those related to headaches, epilepsy due to photosensitivity, language delay, irritability, among other conditions whose background is the misuse of mobile devices (Figueroa & y Campbell, 2020). The frontal lobe of the brain is one of the most affected by these devices, as shown by comparative studies that show the difference between children who exceed 4 hours in front of a cell phone and those who do not; In the first case, there is a decrease in the executive functions of the brain to make decisions, control impulses, some language functions and self-regulation of emotions.(Zachos, 2015)

Within these functions, attention is significantly affected; being in front of a screen affects the processing of information, when a video is watched it is only interpreted immediately and the process of acquiring information is not carried out completely; Excess electromagnetic waves from smartphones aggressively disrupt the brain causing it to weaken, unable to effectively filter information, and act as an enhancer of delays in the performance of childhood skills.(Restak, 2012)(Vera, 2018)

When children and adolescents exceed 4 hours in front of a screen, dependence can be caused, which directly affects brain neuroplasticity, causing a low cognitive level, affecting executive functions revealed in slower learning compared to children of the same age. Excessive exposure to electronic screens for children aged 0 to 6 years has a negative impact on brain development, leading to modifications in the brain sulci, head circumference and grey matter, which affect their cognitive, emotional and behavioural development. (Seoul-Kee & y Hang-Bong, 2018)(Hernández, 2019)

Dependence on smartphones is associated with structural and functional changes in certain regions of the brain, these effects occur specifically in the emotional aspect, executive functions and cognitive processing. All this has resulted in modifications in gray matter, gradually reducing cortical thickness, so all this causes children to be unable to control their impulses, and dopamine transporters, revealed by neuroimaging, are affected (Paik et al., 2019). (Dunckley, 2014)(Paik, y otros, 2019)

Smartphones affect the dopamine neurotransmitter, because there is an overstimulation of dopaminergic neurons in children, affecting the mesolimbic system as responsible for emotions, ecstasy, pleasure or celebration of achievements; making them act impulsively, with difficulties in processing frustration when they are restricted and prevented from using it (Chun et al., 2018). (Chun, y otros, 2018).

As is evident, technology has contributed significantly to social communication in all parts of the world, but it has also brought with it, adverse effects that have escaped people's control and that, for reasons of work and time shared with children and adolescents, many are the parents who allow the use of smartphones for a long time. without family supervision and supervision, without taking into account the risk they put their children at risk, or the consequences they cause in the development of brain plasticity (Navarro & Durán, 2020). (Navarro & Durán, 2020)

At the level of basic education, one of the most frequent problems is the uncontrolled use of cell phones by children, which goes from home to school; spaces such as recess time are the ones used by them to use them, however, depending on the internal rules of the educational centers, they can be used as a support mechanism within classes, in some subjects, however, many students use it as a distraction to browse the web, which is beyond the control of the teacher, when the number of students in the classroom is high.

The aim of this work was to determine the changes that occur in children's brain development due to the excessive use of smartphones.

Materials and methods

The mixed approach, non-experimental design of descriptive level, was used through a survey structured in 24 questions on the use and control of cell phones in infants, based on the questionnaire designed by the Faculty of Pediatrics. (SJD [Sant Joan de Déu], 2019)

The tool was applied to a sample of 41 parents of the fifth grade of basic general education of the Federico González Suárez Educational Unit in the city of Santo Domingo, Ecuador, justified in the non-probabilistic sampling of an intentional type of those parents who agreed to provide the information, from a total population of 282 fathers and/or mothers; The documentary review of scientific articles and postgraduate theses was used to substantiate the consequences of electronic devices on the brain plasticity of children.

With the synthesis analysis method, the criteria expressed in the discussion of the results were supported, through interpretation and argumentation contrasted with the experiences of authors who previously worked on the object of study.

Results and discussion

As results of the survey applied to parents on the use of cell phones in 48 children in the fifth grade of basic general education between the ages of 9 and 10, 36% are girls and 64% are boys, 64% began to use the mobile phone at the age of 9. 33% use their mobile phone regularly, more than one hour a day and outside the school environment, 27% do not, 20% use a tablet and another percentage use other devices.

No child has their own cell phone, 87% ask permission to use their parents' cell phones, which have rules of use in 93%, although they are complied with in 87%, receiving supervision in 67% at the time of installing them and using them in 73%. 40% of children have the security code of their parents' phone, 33% of them have argued with their children about the use of the device, however, 67% understand and accept the prohibition of using and playing with it. During the week, 33% use it for 1 to 3 hours a day, 27% very sporadically, another 27% less than 1 hour a day, 13% do not use it. During the weekend, 27% use it very sporadically, another percentage do it from 1 to 3 hours a day, 20% use it less than 1 hour a day, another percentage does not use it on the weekend, and 7% use it more than 3 hours a day.

60% believe they always use their mobile phone responsibly in the presence of their child, 53% of them have put aside some responsibility for using it, according to their opinion 47% of children make responsible and correct use of the mobile phone. 67% of parents believe that they should talk about cyberbullying with children, 80% are convinced that their child has not participated as a victim, observer, aggressor in these issues, although 7% have been a victim and observer. 100% of parents do not consider it convenient for children to bring phones to class, since for 53% their use causes behavioral changes such as bad character, aggressiveness, laziness, distraction, isolation, bad behavior, bad vocabulary and questioning orders.

Figure 1 shows the risks and benefits, according to parents, that the mobile phone causes in their children.

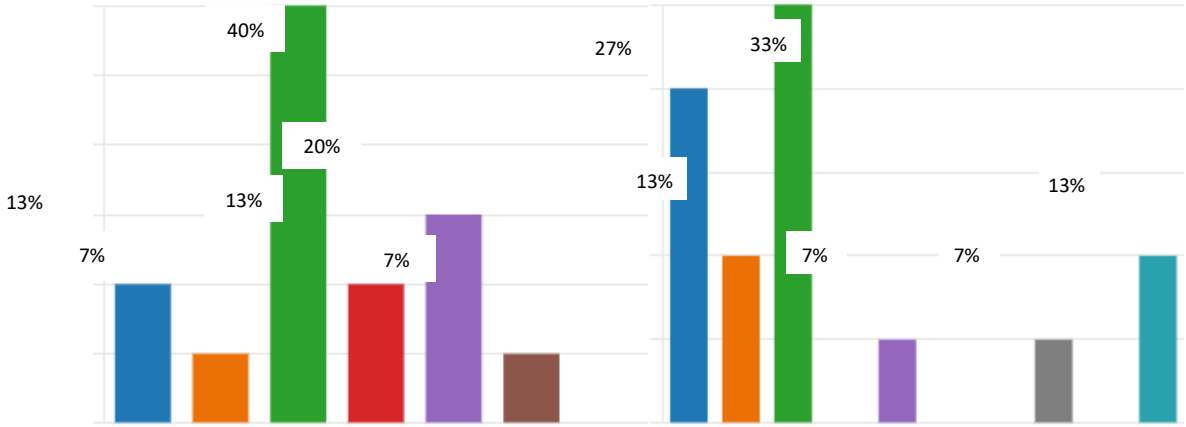

Figure 1

Children's cell phone use: benefits and risks according to parents

Proceeds	Risks
Greater control	Worse school performance
Increased communication	Access to inappropriate content
Access to information and learning	Family/social isolation
Increased socialization	Easier to perform
Useful resources (GPS, dictionary...	Addiction
Entertainment	Economic expenditure
Other	Distorted conception of reality
	Changes in family relationships
	Access to online play
	Other

Note. Data obtained from the survey applied to the parents of the educational unit.

Given the results, the benefits are 40% of access to information and learning, 20% of useful resources such as GPS, dictionary, texts; 13% of greater control, the same percentage of greater socialization, 7% of greater communication and the same percentage of entertainment.

Meanwhile, the risks reflect 33% of family/social isolation, 27% of worse school performance, 13% of access to inappropriate content and the same percentage of other risks related to the innocence of the child, 7% of addiction and the same percentage of changes in family relationships.

As a result of the documentary review on the object of study, smartphones and brain development; Neuroimaging research confirms the fears of the parents surveyed.

Figure 2 reveals the damage caused to the brain caused by excessive time in front of a cell screen.

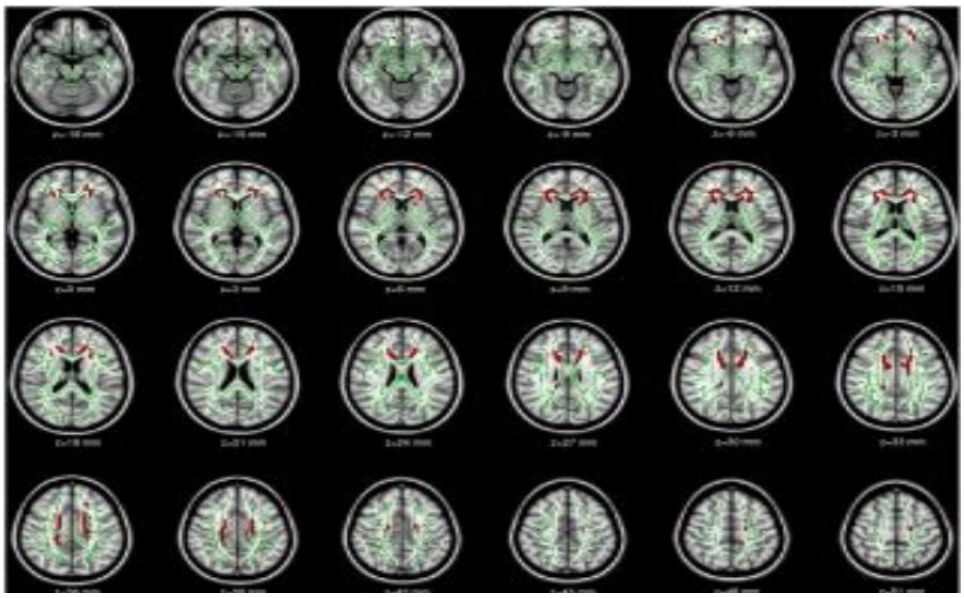

Figure 2

Effects on brain development in children

Note. Taken from Lin et al., (2012). Red areas indicate abnormal white matter in the brains of children and adolescents addicted to cell phones.

According to the study by Lin et al., which summarizes neuroimaging findings in (2012)Internet and gaming addiction, (IAD internet addiction disorder)"Addiction The Internet is associated with structural and functional changes in brain regions that involve emotional processing,AttentionExecutive ,Decision-makingand cognitive control" (p. 7).

However, for children who are not addicted and who have regular exposure, there is a risk of subtle harm, considering that the average infant spends more than 7 hours per day in front of a cell screen (Rideout et al., 2014). (Rideout, Ulla, & Donald, 2014)

The most common affectations in children exposed to many hours to smartphones or screen syndrome, for Dunckley (2014)Include; lack of restful sleep, sensory overload and hyperactivated nervous system; Infants manifest characteristics of bad mood and attention deficit, however, the involvement of parents to recover their children from this entrapment cannot be justified by their lack of knowledge due to the existing scientific evidence, the consequences are severe when it comes to a developing brain such as that of children.

Table 1 details some findings of the consequences of cell phone use on brain development.

Table 1

Brain Scan Research Findings on Screen Addiction

Find	Researchers	Aftermath
Gray matter atrophy	Zhou et al.; Yuan et al.; Weng et al., (2011) (2011) (2013)	– Atrophy (contraction or loss of tissue volume) in gray matter areas (where "processing" occurs) in internet/gaming addiction Affected areas included the important frontal lobe, which governs executive functions, such as planning, planning, prioritizing, organizing, and impulse control ("getting things done"). – Loss of volume in the striatum, which is involved in reward pathways and the suppression of socially unacceptable impulses. – One finding of particular concern was damage to an area known as the *insula*, which is involved in our ability to develop empathy and compassion for others and our ability to integrate physical cues with emotions. – The obvious link to violent behavior, these skills dictate the depth and quality of personal relationships.
Compromised white matter integrity	Lin et al., ; Soon et al.(2012) (2013); Weng et al. (2013)	– Loss of integrity of the brain's white matter. "Irregular" white matter translates into loss of communication within the brain, including connections to and from various lobes of the same hemisphere, links between the right and left hemispheres, and pathways between the upper (cognitive) and lower (emotional and survival) brain centers. White matter also connects networks from the brain to the body and vice versa. Interrupted connections can slow down signals, "short circuit" them, or cause them to be erratic ("misfires").
Reduced cortical thickness	Soon et al.,; Yuan et al., (2013)(2011)	– Reduced cortical thickness (the outermost part of the brain) in adolescent children addicted to the Internet. – Reduced cortical thickness in the frontal lobe of online gaming addicts (late adolescent males and females) correlated with impairment of a cognitive task.
Impaired cognitive functioning	Dong et al., (2012); Yuan et al., (2011)	– Imaging studies have found less efficient information processing and reduced impulse inhibition.) – Increased sensitivity to rewards and insensitivity to loss. – Abnormal spontaneous brain activity associated with poor task performance.
Cravings and impaired dopamine function	Kuhn et al.; Ko et al.,; Hou et al., (2013)(2014) (2012); Han et al., (2011); Kim et al., (2011)	– Research on video games has shown that dopamine (involved in reward processing and addiction) is released during gameplay. – Cravings or urges to gamble produce brain changes similar to drug cravings. – Other findings on internet addiction include a reduced number of dopamine receptors and transporters

Note. Elaboration based on documentary review.

Figure 3 below shows how gray matter is reduced in adolescents suffering from internet addiction disorder.

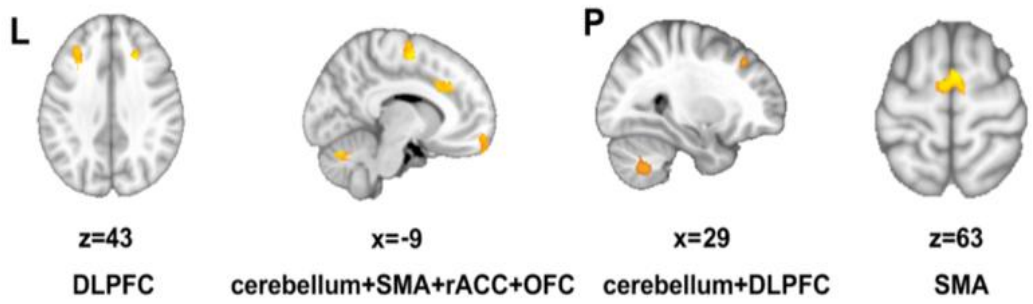

Figure 3

Reduction of gray matter volume in minors with internet addiction disorder

Note. Taken from Yuan et al., . (2011)Dorsolateral prefrontal cortex (*Dorsolateral prefrontal cortex DLPFC*), rostral anterior cingulate cortex (*anterior rostral cingulate cortex rACC*), supplementary motor area (*Supplementary motor area SMA*) were negatively correlated with the duration of internet addiction.

In Figure 3, Yuan et al., (2011) used VBM (voxel-based morphometry), a neuroimaging analysis technique that allows the investigation of focal differences in brain anatomy using a parametric statistical approach, to demonstrate the reduction of brain gray matter volumes in adolescents with internet addiction disorder (IAD). (Psicología, 2024)

Figure 4 shows a comparison of the head circumference of adolescents with DAI and healthy children.

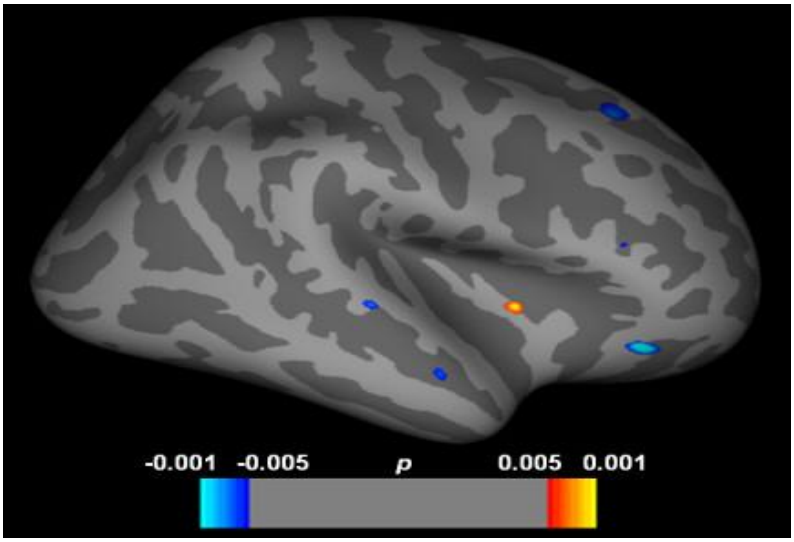

Figure 4

Comparison of head circumference between adolescents with AKI and with healthy control

Note. Taken from Soon-Beom et al., (2013). Red indicates that cortical thickness is lower in adolescents with Internet addiction, and blue indicates that cortical thickness is greater in healthy children.

The image signifies a reduction in the thickness of the head circumference Occipitus frontar circumference *(OFC*) in minors with Internet addiction compared to those adolescents who are healthily controlled in the use of the telephone, the former have addiction disorders, this region of the brain in the right hemisphere is particularly important in brain development, its thinning causes deficits of cognitive flexibility in the genesis of pathological habits, being fundamental in the neurobiological models of obsessive-compulsive disorder (Chamberlain et al., 2008). (Chamberlain, y otros, 2008)

Behavioral addictions have similar characteristics with other known disorders such as difficulties in abstaining from aggressive behaviors, low attention, irritability, among others (Rotge et al., 2008). Zhou et al. found impaired mental flexibility in adolescents with internet addiction along with poor response inhibition, similar neurobehavioral characteristics found in other studies. (2012)(Rotge, y otros, 2008)

Conclusions

Studies on the effects that smartphones have on children and adolescents reveal that excessive screen time affects the structure and function of the brain, causing the frontal lobe of the brain to suffer much of the damage, which undergoes massive changes from puberty to the mid-twenties. This consequence is so worrisome, since the development of the frontal lobe largely determines success in all areas of human life, ranging from the state of well-being to academic or professional success and the skills to relate to peers.

This work carried out with a group of schoolchildren urges awareness from home, from the role they have as parents, caregivers or guardians of children, to manage the proper use of mobile phones or other electromagnetic devices. As fathers and mothers, the desire to be well is a priority for our children, and in this process, imperfection as human beings accompanies us, however, the time to realize the mistakes we have made and take back the reins of family education, comes at the right time and that time is now.

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