

Eye and brain of children and adolescents under the light of screens.

Press release from the French National Academy of Medicine (*)

February 8, 2023

After the age of three, screens prove to be a remarkable tool for training and awakening children, provided that they are supervised by parents or educators, and that the priority is placed on its interactivity and playful nature. However, its abusive use exposes to adverse effects, especially in adolescence. One of these adverse health effects is due to the nature of the light generated by these screens.

Since the invention of the incandescent light bulb (Thomas Edison, 1878), new light sources were sought to improve their energy performance and the quality of the light emitted, and to extend the possibility of using them for screens. If misused, the beneficent light can turn out to be a formidable pollutant (1). The eyes and the brain of children and adolescents become the victims.

The eye. Light is an electromagnetic radiation that carries energy capable, by interacting with ocular tissues, regardless of age, of damaging retinal photoreceptors. Exposure to light-emitting diodes (LEDs), which are, in candela per square meter, a thousand times brighter than incandescent lamps, is a source of glare and can be phototoxic to the retina. While sunlight and old sources of artificial lighting have a homogeneous energy in the visible spectrum band, the LEDs currently available emit a peak of blue light, close to ultraviolet rays, whose deleterious effects on retina are known (1). This retinal phototoxicity is not an acute burn, as after careless viewing of a solar eclipse or accidental manipulation of a laser beam. Chronic exposure to LEDs induces photochemical cell damage that is particularly harmful to the macular retina located in its center and ensuring fine vision, reading, writing and colored vision. The photo-protection by anti-UV and anti-blue light lenses is crucial, especially for children and adolescents whose lens is very translucent. This exposure is, moreover, harmful at night, because it inhibits the nocturnal physiological regeneration of the retinal photo-pigments contained in the photoreceptors. These pigments are consumed during the day to initiate vision and regenerate at night in a darkness that must be total. Man is indeed a being with diurnal activity and nocturnal rest.

The brain. The internal clock, located in the hypothalamus, drives cyclical biological processes lasting approximately 24 hours. It is under the control of genetic (clock genes), physiological sleep-wake alternation and environmental (light-dark alternation) factors. The blue band of the light spectrum is the most active on the clock. The light signal is transmitted to the clock and then, after numerous relays, to the pineal gland which secretes melatonin, a key hormone considered as the “clock hand”. The organism is synchronized when these networks are in harmony with the environment, i.e. when it is exposed to light during the day and to darkness at night, humans being a diurnal animal. During chronic exposure to light during the night, including screens (smartphones, tablets, computers), sleep-wake rhythm disorders appear in connection with a desynchronization of the internal clock.

Many teenagers expose themselves to screens, including late at night. Data on the health, school experiences and health-damaging behaviors of pupils aged 11, 12 and 15 old from 45 countries in the WHO European region (2) found that 30% of adolescents communicate online, including late at night with, for some, a real internet video game addiction (3). In these adolescents, the result is late sleep, linked to an increase in alertness generated by a delay in the clock phase and an inhibition of melatonin secretion, involved in falling asleep.

In France, while the sleep needs of adolescents are around 9 hours per night, 14% of middle school students and 29% of high school students sleep less than 7 hours on school days (4). Sleep debt which is observed in 26% of middle school students and 43% of high school student raises a lot of disorders: fatigue in the morning when getting up, reported by 30% of middle school pupils and 40% of high school students, and impaired learning abilities linked to a decrease in alertness and attention, resulting in a drop in schoolwork that can go as far as academic delay, with schoolwork being considered stressful by 31% of them. In addition, mood disorders (stress, anxiety and depression) and behavioral disorders

with violence and hyperactivity are frequent, as well as metabolic disturbances (17% of boys and 11% of girls are overweight or obese at 11 years old), linked to physical inactivity and consumption of sugary foods (2).

These children and adolescents are thus in a state of desynchronization, called "social jet-lag", characterized by a dissociation in which biological time (the internal clock) and astronomical time (the watch) are dissociated from social life. The recovery of sleep during the weekend only reinforces the desynchronization of the adolescents.

Due to the size of the population concerned and the resulting pathologies, the chronic exposure of children and adolescents to screen light at night is a public health problem (1, 3). By inducing retinal phototoxicity and dysregulation of the sleep-wake rhythm, a source of sleep disturbances, cognitive and mood disorders, the misuse of screens (smartphones, tablets) leads to an increased light pollution, harmful to the teenager, who is a big user.

For the health of children and adolescents, the National Academy of Medicine recommends:

- to promote the use of protective glasses against blue light, in the event of prolonged exposure to screens;
- to restrict, or even ban, the use of screens at night;
- to ensure the regularity of bed and wake-up times for children and adolescents to avoid desynchronization of the internal clock;
- to introduce, into the school curriculum, an awareness of pupils on the risks associated with screens and on the importance of sleep;
- to make parents aware of the risks associated with the misuse of screens, the decline in school performance and their children withdrawal being the two essential warning signs they need to watch out.

References

1. Dufier J.L., Touitou Y., Chauvaud D., Torriglia A., Light pollution, insidious pollution. Bull. Acad. Natl. Med., 204, 3, March 2020, p. 201-203.
2. Inchley J, Currie D, Budisavljevic S, Torsheim T, Jåstad A, Cosma A et al, editors. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behavior in School-aged Children (HBSC) survey in Europe and Canada. International report. Volume 1. Key findings. Copenhagen: WHO Regional Office for Europe; 2020.
3. World Health Organization. WHO Releases New International Classification of Diseases (ICD 11), 2018 ([https://www.who.int/news/item/18-06-2018-who-releases-new-international-classification-of-diseases-\(icd-11\)](https://www.who.int/news/item/18-06-2018-who-releases-new-international-classification-of-diseases-(icd-11))).
4. Touitou Y, Point S. 2020. Effects and mechanisms of action of light-emitting diodes on the human retina and internal clock. About Res. 2020 Nov; 190:109942 (doi: 10.1016/j.envres.2020.109942. Epub 2020 Jul 19. PMID: 32758719).

(*) Press release from the Academy's Rapid Communication Platform