The infant's vision and light - The role of prevention in preserving visual capacity

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The eyes of infants are permeable to both ultraviolet radiation and blue light, and extremely sensitive to glare. Although light is essential for the proper development of visual function in children, surveillance and protection are particularly important in the first months of life. Moreover, medical surveillance and early screening help prevent risks associated with possible anomalies of the visual system.

The newborn child can see from the moment of birth, and even before. When we laterally illuminate a pregnant woman’s womb around the sixth month of pregnancy, we can see under ultrasound that the foetus turns its head away from the light source. This is also the case after birth. If newborns quite often keep their eyes closed, it may be because they are asleep. But if they are awakened in a low-light environment, they will look at us. This enables us to measure their acuity, which is about 1/20. Depending on their complexion (very light or more pigmented), they are dazzled by light up to the age of about six months. For their comfort, strong light should be avoided. At the age of six months, their acuity reaches 2/10, and then 4/10 at one year and 10/10 at about five years of age, remembering that in preverbal children we measure detection acuity with acuity cards and then the more demanding morphoscopic acuity. The field of vision is complete at one year but the child needs to learn to use it, a process that will continue more or less successfully throughout life, depending on motivation. This is evidenced by the large proportion of motorists who do not use the rear-view mirror.

Colour and contrast vision is good at three months, but will continue to improve until adolescence. Stereoscopic vision appears at four months and rapidly becomes excellent. Focusing becomes precise at about eight months with the development of the fovea in which the cones are gradually concentrated, enabling a reliable orthoptic examination. Ocular motor control, including saccades and pursuit, is precise at one year, although latency or reaction time is characterized by a certain slowness up to the age of about ten. This relative slowness facilitates examination.
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**The role of light**

Light plays a fundamental role in this visual performance. Numerous visual deprivation experiments conducted in baby monkeys and kittens show attrition of visual pathways due to vision deprivation, making it possible to define a “deprivation-sensitive period”. The existence of this sensitive period in humans is now widely recognized. A baby presenting early lens opacity should be operated on during the first months of life to prevent severe amblyopia. Fitting aphakic infants with contact lenses allows them to acquire normal vision. Similarly, strabismic amblyopia can be easily treated at nine months with temporary occlusion of short duration and an appropriate optical correction. But the duration of occlusion required lengthens with age and if treatment begins at age 5, recovery will be incomplete and fragile, despite prolonged occlusion.

Light is therefore essential to the development of visual function. It conveys signals which are converted by the brain into information. The information influences the development of neural connections, especially during childhood. What must we guard against?

**The sun is the villain**

The eyes should be protected from the sun for reasons of visual health and comfort from a very early age, and this practice must become routine.

People of my generation (born in 1942) did not protect themselves from the sun, except on snow. If we are seeing more and more cases of AMD and other age-related pathologies, how much of that is due to the increase in life expectancy as compared with time spent at seaside and ski resorts, where we are subjected to cumulative sun exposure? As regards AMD, the POLA study (on age-related ocular pathologies) [1] was unable to show a significant correlation of disease with sun exposure, which was also the case for the Chesapeake Bay and Blue Mountains Eye studies [2]. It was subsequently shown that a balanced diet reduced the incidence of AMD. However, new studies show increased onset of early AMD. In addition, the significant risk of sun exposure after cataract surgery is well known in clinical practice. It is crucial for this population to wear fit-over sunglasses.

**Good and bad blue light**

The obsolescence of incandescent bulbs has paved the way for various categories of illuminants whose effects on ocular physiology are still poorly understood. The main concern is the high level of energy in the blue spectrum, narrowly speaking between 450 and 500 nm in wavelength, and more broadly speaking, between 400 and 510 nm. This range has been shown to cause damage to the retina of rodents. Since the ocular media of infants are permeable to UV and blue wavelengths, logically speaking, we should all be blind. But the strength of the infant’s retinal physiology protects him, especially since it is the accumulation of exposure over a lifetime that may cause irreversible damage. These hypotheses have not yet been completely verified, but numerous experiments currently being conducted on animals implicate “bad blue” light. A real dilemma.

But if anything, the dilemma has worsened with the discovery of a new class of photoreceptor, melanopsin ganglion cells, whose axons leave the visual pathways at the optic chiasm and are projected into the hypothalamus. This is the regulatory pathway of our biological clock that synchronizes a number hormonal activities, as well as our sleep-wake rhythm. This is corroborated by the blind, who frequently complain of sleep disorders. The irony is that the pigment in these cells is wavelength sensitive with a peak at around 480 nm, hence the name “good blue” light.

The Spring 2013 issue of Points de Vue (no. 68) featured a remarkable series of articles on the proven and potential dangers of blue light. Even though it only considers adults, there is no reason to believe that the deleterious effects would spare children, when we understand that the consequences occur with age. This issue complements and updates the data provided in the earlier issue.

**Display screens**

Since the growing use of all kinds of screens, especially LED screens, which are now commonly used by children as soon as they can point with their hand, at the age of about six months, concern has arisen about their possible impact on vision. In fact, there are no convincing proofs available. In France, a report by the Academy of Sciences (2013) [31], containing several hundred references, points out the positive effects of displays in children, including the awakening of attention, the development of digital learning ability and cognitive agility. The negative effects are minimized. However, the working group did not include any vision professionals. Moreover, this report ignores the work of Michel Desmurget (2011) [4], containing 1,193 references, which advances the risks of addiction to virtual environments with its social consequences, the trivialization of violence, wandering attention and obesity due to lack of exercise and meals on the run. [5, 6]

The two studies agree on recommending limited use. One may only wonder why no impact on the visual system was identified (or it was possibly ignored) in either report.

**Lighting levels**

The introduction of fluorescent lighting, driven by cost concerns and possibly comfort concerns, has significantly impacted luminous power in indoor environments. School children must receive 400 lux on their desks. But one wonders if is this for the teacher’s comfort or the children’s. Sensitivity to light develops rapidly in children, reaching its adult level in adolescence. It then gradually decreases with age. What teenager has not been reprimanded for reading in semi-darkness? But we forget that by age 35, we have already lost half of our sensitivity. “You’ll ruin your eyes... I know dad, speak for yourself.” With the introduction of fluorescent tubes in the 60s along with improvements in lighting and its use for longer periods, concern has spread about possible adverse effects that have not proven justified. So we use lighting generously. Night lights in children’s rooms calm their parents’ anxiety. Studies in this field are fraught with methodological problems. How do we isolate the factors responsible for the increase in the incidence of myopia or other pathologies in a rapidly changing world? Should we blame it on the increase in close work? That remains to be proven. Nutritional changes? Perhaps. On the other hand, the effect of relative confinement on the development of myopia has been clearly demonstrated in urban areas in Asia, among people living in confined, rather than open spaces. Lighting quality and quantity become important for comfort with age, and particularly with advanced age.

Fig. 1: Evolution of sun protective eyewear for children.
The precautionary principle

This term drawn from the fields of theology and law has been increasingly used in the medical field in recent times. It consists in establishing a practice on the basis of a body of knowledge, or even presumptions. It must be weighed against the constraints imposed by the practice, by estimating the benefit-cost ratio. A concern for optimizing living conditions, coupled with longer life expectancies – one in two baby girls born today will live to be 100 – accounts for the widespread implementation of medical and health measures to reduce risk exposure. In the field we are dealing with, what constitutes a reasonable attitude?

Sun protection

One finds spectacles with flat coloured lenses as early as the 18th century, known as “conserves”, which were meant to shield the eyes from glare and protect vision (see the 1759 Richelet and 1902 Larousse dictionaries), but wide-brimmed hats and more recently caps have also come into wide use. Climbers have long worn protective sun goggles. In both cases, the aim was to shield the wearer’s eyes from glare and improve comfort. Sunglasses for babies are a recent development. They have a wide bridge, often featuring a non-slip design and wide temples that provide side protection. But most importantly, they have a wraparound design that covers the eyebrows. In the 1980s, I saw an albino child at the Bébé Vision clinic whose parents lived at a high elevation in the Alps. The optician prescribed the glasses shown in Figure 1. The side shields for adults were supplied by a manufacturer’s representative. A model for babies was not yet available. But times have long since changed. Opticians have developed a wide range of wraparound performance products, including side protection. Today, babies are well protected, if only for comfort reasons (Fig. 2, Fig. 3).

But I was told by certain ophthalmologists that sun protection should only be resorted to in extreme situations in order to allow children’s retinas to develop defence mechanisms to prevent them from becoming dependent on glasses!

Fig. 2: Evolution of sun protective eyewear for children. Wraparound design with wide bridge and wide temples that provide side protection.*

Fig. 3: Evolution of sun protective eyewear for children. Wraparound design that covers the eyebrows.
New parental attitudes

Parental behaviour has evolved considerably, and in a positive direction as regards protective gear for children. The increased average age of parents at the birth of their first child – 30 for women and even older for men – as well as the choice of family planning are factors conducive to a higher level of concern in the care of children. Just consider how often parents run to the doctor at the slightest concern. As for protective gear, parents are proud to show off their babies with sunglasses, helmets and knee pads on their toy scooters. This is quite commendable. Such prudent behaviour has given rise to investments by the protective equipment sectors, including the optical sector, in response to the emerging needs of children and echoing current information provided to paediatricians, general practitioners and, of course, ophthalmologists and opticians.

Screening, surveillance and diagnosis

The founding of the first Bébé Vision clinic in 1982 contributed to raising awareness in professional circles. The publicity given this initiative, devoted to the search for visual anomalies of all kinds, has raised awareness of the visual capabilities of the preverbal child. Infants see better than previously thought, and their vision deserves to be protected. The concept of a “sensitive period” led to recommending a first routine exam at the age of nine months. At this age, the examination is easy, and the child is cooperative and follows the treatment. Opposition begins to appear at approximately 12 months. Once an indication has been identified, whether it is due to heredity, prematurity or an apparent eye disorder – often an epicanthic fold – the medical profession recommends a check-up with a specialist (ophthalmologist or orthoptist). This practice has significantly reduced the number of surgical procedures for strabismus, since most of them can be avoided by early correction of refractive errors. The discovery of amblyopia during the health check performed at the entrance to the first year of primary school (at age 5) has become much less frequent. Consequently, treatment for the most serious ophthalmologic pathologies is provided earlier and remarkable progress has been made in therapeutic regimens.

Determining best practice: screening, surveillance or protection?

Although certain therapeutic ratios still need to be measured, all evidence indicates that protecting the eyes against cumulative sun exposure is the responsible attitude.”

Routine screening of all children would be costly and unproductive, since it would inevitably be cursory. Nevertheless, in the absence of accurate statistics, it is estimated that nearly 15% of infants require follow-up, and more than half of these have a significant refractive error or a more serious disorder. Surveillance consists in referral to a specialist as soon as an indication or risk factor has been identified. This the current practice in France and it is paying off. It is during these visits, but also during visits to the paediatrician or general practitioner, that parents raise the issue of sun protection.

Opticians have also contributed to raising parents’ awareness. The eyes should be protected from the sun for reasons of visual health and comfort from a very early age, and this practice must become routine. There are no contraindications. Although certain therapeutic ratios still need to be measured, all evidence indicates that protecting the eyes against cumulative sun exposure is the responsible attitude.

Conclusion

It is somewhat delicate to propose a hierarchy of factors that have contributed to the increasing acceptance of eye sun protection for infants and children. Much remains to be done, however, to encourage widespread acceptance of the need for children to wear protective eyewear. The dissemination of information on the dangers of exposure to high-energy visible light – particularly blue light and UV radiation – is gaining momentum, spurred on by the introduction of new lighting solutions. But better knowledge about vision in children, coupled with low birth rates, is focusing parents’ attention on their limited number of offspring, leading to a more protective attitude in their regard. Increased life expectancies are also making everyone more aware of the difficulties faced by the elderly as their sight begins to fail, irrespective of the origin of the pathology. Eyewear manufacturers have made a particular effort to provide appropriate solutions at a reasonable cost. Such products are even found in sporting goods stores.

Finally, the medical and paramedical professions have become aware of the need to protect the vision of infants and provide more comfort for this little toddler who is not yet able to express his or her discomfort.

Protective eyewear for infants and children undoubtedly has a bright future.

Key Takeaways

• The visual system is an integral part of the brain and begins to form 18 days after conception. During the sixth or seventh month of pregnancy, the foetus begins to see and react to light.
• Light plays a crucial role in the development of such visual functions as acuity, and colour and contrast vision, from the first days after birth.
• At birth, the newborn’s visual acuity is still very low (1/30); objects can only be detected from a short distance (30 cm), and only in black and white and with little contrast.
• The eyes of infants are highly sensitive to glare and their ocular media are permeable to both ultraviolet light and blue light, due to the fact that their pigmentation is not yet complete.
• The visual system matures gradually: babies develop stereoscopic vision at the age of six months and are able to distinguish all colours at one year, but their visual acuity only begins to function optimally (10/10) when they reach the age of six.
• The paediatrician and ophthalmologist play essential roles in monitoring
and detecting anomalies throughout the process of visual development.

- It is recommended that children be fitted with sun protective eyewear as early as possible for their comfort and visual health.

References


04. Delcourt et al., op. cit.
