# INFANT VISUAL BEHAVIOR IN THE DIGITAL AGE.

## THOUGHTS ON THE DESIGN OF OPHTHALMIC LENSES.

The challenges posed by the digitization of all aspects of life are particularly relevant when it comes to addressing the impact the use of mobile devices-both for leisure and school activities- may have on children. In this article, we approach this problem from the unique challenges children present as spectacle users, and we propose the need to design specific ophthalmic lenses that take these challenges into account.

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## ACRONYMS USED

- **FVA** Far visual acuity
- **NVA** Near visual acuity
- **DES** Digital Eye Strain
- **P/NRA** Positive/negative Relative Accommodation
- **ANSBDs** Accommodative and Non-Strabismic Binocular Dysfunctions
- **VA** Visual acuity
- **AA** Accommodative amplitude
- **URE** Uncorrected refractive error

**KEYWORDS:**
Working distance, gaze position, ophthalmic lenses, digital devices.

### INFANT VISUAL BEHAVIOR IN THE DIGITAL AGE. THOUGHTS ON THE DESIGN OF OPHTHALMIC LENSES.

Throughout this series of articles on the existence of possible differences in reading and academic performance associated with the use of digital devices in schools (link to the 3 article-series done before), we have tangentially touched on certain questions which we believe deserve more extensive and profound attention:

- The unique characteristics of children as users of digital devices
- How children use digital devices
- How children see: what are their postures and characteristics

And, lastly,

- What solutions can we prescribe for the specific visual needs of children?

Before we start, we must take a few things into consideration. First of all, we have to bear in mind that children are not miniature copies of adults. We share with Sharma et al (1) two basic insights, and in our opinion, on the management of the paediatric patient:

1. Their visual needs are different
2. A very important part of the prescription is selecting the right frame and contact lenses.

An additional point needs to be discussed. As some guides on paediatric prescription (2) point out, the decision to dispense a correction once the presence of a refractive error is detected is determined by a series of factors that are already widely recognized and that offer little discussion. Among those are:

- The age of the patient
- The process of emmetropization
- Risks of amblyopia
- Possibility of strabismus

(3) The **child's visual needs** also need to be taken into account. We believe that this last factor should refer to the presence of symptoms that are unequivocally related to the visual activities performed by each child both in school and during leisure time, which deserve special attention. This means a refractive error may need to be corrected in one child but not in another. This is a result of the particular considerations related to visual performance and activities of each, as well as the specific visual needs of the child as a subject, **who has a viso-postural behavior with some characteristics that differentiate them from adults.**

### *Some peculiarities of children as users of digital devices.*

**It is safe to say that** today's children live in an environment in which technology is deeply embedded in their lives. Kabali et al. (4) and others found children have rapidly adopted digital devices, same as almost all of society as a whole. The phenomenon is global. It is clear that the mobility of these devices were the driving force of their success and popularity. Many studies suggest tablets and mobile phones are progressively replacing the TV as a preferred format for consuming visual content, primarily in the digital native (younger) cohorts. Additionally, tablets and smartphones provide an immediate interactive experience and they are easy to use intuitively, even for the youngest children (7). Many studies found that **many pre-school children (under 4/5 years old) regularly use screens in their activities** and that this **behaviour** has become completely **ingrained in the habits of children when they start primary school** (6). Among all the explanations for this phenomenon, there is one we find particularly relevant: **parents believe that,** since their children will use these devices in schools, **the sooner they acquire the capacities allowing them to sufficiently develop in a digital environment, the better it will be for their school performance** (8). This reasoning appears sufficiently relevant for us, considering the digitization (link to first article of series) of school resources. The ramification being young children will continue to use screens and we can expect an increase in screen use in pre-school (up to 4 or 5 years old) and young (8 years old) children, as well as an increase in the possible resulting repercussions on children's' visual performance.

The clinical studies have established that excessive use of mobile digital devices and computers have various negative implications on health. You can see this in Kwow et al. (9) for a detailed overview. The issues most frequently observed are: reduction in sleep quality, family relationships suffer, development of eating disorders, and musculo-skeletal and joint problems. We must focus on the implications that the use (not necessarily abuse) of digital devices has on ocular and visual health. There is some data on infant use of technology that we think is very interesting. Carson & Kuzik (19) found that for each month of age, the use of digital devices increases by nearly 10 minutes / day for children between 4 and 8 years old. A result which was confirmed in other studies: there is a positive relationship between the age of the child and the number of hours used in mobile phones or tablets, including the early ages—up to 8 years old (11). The time used in reading activities in school and doing homework, which usually requires the use of digital devices, presents a contradiction. Ichhpujani et al (13) points out the difference between the recommended exposure of less than two hours per day for teenagers, which must be considerably less for children, and the actual time spent. Indeed, the use of digital devices is an essential part of the pre-teen lifestyle. Pre-teens use them all the time for both school activities and fun (13), which has implications for health in general and vision in particular (14, 15).

Evidence has also shown that parental control and supervision on use (in terms of time, content, and ergonomics) is lower in relation to age (12). We will subsequently analyze the consequences this may have on vision.

It is important to note the **limited self-awareness of children - the younger the child, the lower the self-awareness** (16) - as well as their capacity to adapt to adverse visual-ergonomic conditions. The combination of these two characteristics means it is easy for children to overuse digital devices without recognizing the symptoms (eye strain or ocular and physiological issues) digital devices cause, which are ignored or deemed normal by the children.

### *Childhood visual behavior*

Earlier, we stated that "children are not miniature versions of adults". We will now elaborate on this very categoric statement. On the one hand, various studies from different disciplines have indicated that the oculomotor behavior of children and adults differs both when performing focused activities and while gazing freely (17). We would like to point out another basic fact: children who require vision correction tend to move their eyes freely through their lenses and glasses rather than moving their heads (21). This behavior is frequently confirmed in our consultations. It is common in nearsighted children (although not exclusive to them) to display specific behaviors: shorter working distances and a characteristic head/neck tilt (21). It is important to note that this observation on working distance is not exclusive to nearsighted children. Wang et al (22) checked emmetropic children (7 to 12 years) working at a desk completing their tasks at the following distances:

| ACTIVITY | WORKING DISTANCE |
|---|---|
| Reading | 25.4 cm (10 inches) |
| Reading and writing | 20.6 cm (8.1 inches) |

Working distance in emmetropic children *according to Wang et al. (22)*

Note that **these distances tend to be shorter for digital activities.** For example, Haro C. et al (23) found that video-game activities took place at shorter working distances, while non-digital reading distances were close to the Harmon distance. This is a similar process – regardless of reasons – to that observed by Paillé in adults, where the distance at which a smartphone is held is 8-10 cm (3.5 inches) closer than a hard copy (25). In our case, for children, this brings the working distance very close to 20 cm (7.8 inches) (24) when using a portable digital device –the pervasive smartphone.

These distances **decrease further as the task is prolonged and the cognitive workload increases** (23), which is a fundamental issue since reduced working distance is directly related to accommodative and vergence demand, associated visual fatigue load, and the presence and intensity of asthenopic complaints (26) –apart from their link to the development of myopia genesis and myopization– related to the continuous use of screen devices. This is even more important in the context of the increasing digitization in schools, with all the **implications this may have for school performance and academic achievement.**

We have commented on various aspects related to different health problems linked to the use of digital devices, which can be confirmed by taking a quick look at the clinical literature (20). We agree with Ichhpujani et al. (13) that, at the present time, when **children** are **immersed in digital technology** and surrounded by screens from the moment they are born, it is more than reasonable to assume that the **prevalence of asthenopia problems will increase**, although the current rate is already considerably high at 19.7% (27). However, most of these studies tend to analyze these problems from a perspective that is, first of all, "adult" –for lack of a better expression– and, secondly, is related to an excessive use of digital media. This could lead to a certain degree of bias that would invalidate some of the conclusions of the scientific studies. However, in studies in which children themselves are asked about the impact of digital media on their health, the results are quite clear. **Even with moderate use of such devices, children report physical problems associated with their use**, including, unequivocally and prominently, eye problems (18). In fact, when tasks are performed for relatively short periods of time –30 minutes– children complain of **eye pain, irritation, visual fatigue** or diffuse eye discomfort. These problems multiply with longer periods of use and are linked to –and we must emphasize the importance of this data– working with computers in schools (18). This is particularly relevant if we bear in mind that children, as noted by Menon et al. (19), are generally overoptimistic in their perceptions of their health problems.

All these visual-ergonomic considerations (shorter working distances, oculomotor behavior, head and neck angle/declination, duration of use, etc.) suggest that, as stated by Drobe et al. (21), "lenses [...] for children should have shorter corridors (due to lesser eye declination) and larger insets (due to shorter working distances) than lenses for adults". Drobe places particular emphasis on myopic children, but we believe that this can (and should) be generalized further. We clinicians know first-hand the difficulties children have in wearing their prescribed glasses properly every day. This is due to obvious anatomical reasons related to the fit of the frames, such as facial proportions, different nasal bridges and pupillary distances, and also to the demands of children's high level of physical activity". In addition, from the point of view of visual behavior, it is also due to the aforementioned tendency of children to look through areas of their glasses that do not correspond to the optical center or effective power of the lens both at distance –typically through the upper part of their frames– and close up. We must also add to this scenario the positive relationship between older age and the use of mobile phones and tablets in bed (13) –and often with the lights off– with the establishment of abnormal gaze angles and positions that result in (without assessing such behavior from other ergonomic-visual points of view) the development of postural strategies to compensate for the resulting optical aberrations.

In short, we are faced with a **"digital" scenario** in which we believe –and therefore suggest– that the **design of special ophthalmic lenses for the paediatric population should be customized**, **taking into account the postural, visual and**


Looking above the optical center of the lenses, a typical behavior of children who wear glasses.

**ergonomic characteristics unique** to this population group, as it has been done for others, such as emerging or incipient presbyopes and progressive-lens wearers. In other words, **we need new lenses for a new scenario of high visual demands**. In this context, we believe we can contribute to improving children's adaptability to optical prescriptions and, above all, their **visual abilities**, which would in turn have a positive impact on their **academic performance**.

If, in addition, as we mentioned earlier, adult supervision and the shared use of digital devices becomes less frequent with age, this implies that there will also be a reduced ability to monitor visual and ergonomic behavior (posture, breaks, duration). From our point of view, this presents a strong argument for promoting **greater customization of the visual solutions** we offer, and thus ensures that, as far as visual performance is concerned, our **response** to the possible **needs of children** is appropriate to each specific case.

Although this is a separate –albeit interrelated– issue, we would like to point out that, with respect to parental control of use, it has been noted in some studies that there is greater concern about content than about total time of use (which can be considered relatively logical) and that 'abuse' in terms of time is a very loose concept and as such the time restrictions that each family imposes on their children. We believe that as well as solving the visual-ocular issues related to the use of digital devices, pedagogical work is needed in order to establish healthy usage habits for both school and leisure time.

As we have seen in the previous articles "Digital vs. Hard Copy":

- The early school years are very important to carefully nurture and promote healthy vision.
- The period of life from 6 years old is when vision undergoes high visual demands (e.g: learning to read and write) and children's eyes are not fully mature.
- Educational systems are moving towards digitalization. There are more and more digital devices used at school (smart boards, interactive whiteboards...). And at home, children are accustomed to using tablets and computers to do research and homework.
- The differences between digital devices and print cause changes in posture, ergonomics, cognition and visual abilities.
- Children have different visual needs and behaviors than adults: they have different morphology, their eye movements differ and they have shorter arms so their reading distance is closer than adults.
- Furthermore, the multiple characteristics associated with intensive screen usage of digital devices (unwanted reflections, glare, blue light and small and pixelated characters) can have a negative impact on children's vision.
- Having a reduced visual acuity may interfere with their learning abilities and their performance in school.

Children need a lens specially designed for their visual needs. However, standard single vision lenses are not specifically optimized for them.

Essilor has launched EYEZEN® Kids lenses, specially designed for children, taking into account the three children's unique parameters:

1. Morphology: Children have different facial features than adults.
2. Object Distance: They have shorter arm's length meaning that they look at objects at closer distances than adults.
3. Gaze directions: Children are shorter so they see the world from a lower point of view, hence they are often looking up at the world around them. They are eye movers and use all parts of the lens, instead of just the central area.

EYEZEN® Kids lenses are designed with Eyezen® DualOptimTM Kids technology, that takes into account two reference points to optimise the surface of the lens for all children's gaze directions while maintaining their prescription. This brings a wider vision zone in a more comfortable lens:

***EYEZEN® Kids lenses RELAX AND PROTECT CHILDREN'S EYES.***

- Relax: Ensure that children have optimal vision in their different daily activities.
- Protect: Includes a Blue UV Filter to protect the eyes from harmful Blue-Violet and UV light[1]

***EYEZEN® Kids lenses: THEIR MOST COMFORTABLE LENSES[2].***

[1] Harmful Blue light: up to 455nm with the greatest toxicity between 415-455nm.

[2] Eyezen® Kids in-Life consumer study - 2019 - US (n=58) - 3rd independent party - Children have a better level of visual comfort when playing/doing activities indoor with Eyezen Kids compared with their current single vision lenses.

**KEY TAKEAWAYS:**

- Kids have specific visual needs and also a viso-postural behavior with some characteristics, which differentiate them from adults.
- Various studies have indicated that the oculomotor behavior of children and adults differs both when performing focused activities and gazing freely.
- There is a new digital scenario with its own peculiar characteristics related to ocular health. This new framework imposes high visual demands
- We consider that the design of ophthalmic lenses for the paediatric population should be customized, taking into account the postural, visual and ergonomic characteristics unique to them and their digital environment.

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