The Importance of Vision

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Introduction

Why is the vision so important? What special role does it play in learning and guiding development from the moment of birth? What is the value of good visual functioning? How does vision affect and impact the development and activities of daily living of children and adolescents?

The peripheral organs responsible for vision in humans are the eyes. Through a complex pathway that begins with focusing of the image by the eye, reception and transformation of light rays into neurological information is transmitted to the brain where we "see". The information is then stored in the occipital lobe (the brain's visual processing center) and is in turn transferred to other regions of the brain, where interpretation and use for motor (movement), cognition (thinking), learning and social interactions take place. Taste via the tongue's gustatory pathways, smell through the nose's olfactory pathways, hearing from the ears' auditory pathways, and touch from the skin's somatosensory pathways are the other peripheral senses that gather information from the environment and ultimately may rely on vision for interpretation. All this information is transported via complex biochemical and electrochemical pathways through the body, and integrated it into a meaningful context in the brain that is eventually acted upon by the person.

Vision, as experienced through the visual system and visual perception, allows us to observe and extract information from the outside environment. Vision provides information that is not available through the other senses, and works in conjunction with different systems to help orient us in the environment, in time and space and at different ages and stages.

This paper will provide details about how vision contributes to development, and then share significant factors of the impact of eye diseases/conditions and visual impairment on child/adolescent development and quality of life.

1. **How does vision contribute to development?**

Vision impacts every area of development. Visual impairment in children is a term that describes many types of eye conditions and brain conditions (since we "see" in the brain, and is unique in each child, depending on the timing of the impairment (congenital or acquired), what part of the visual system is affected, and what additional impairments are associated. The impairment can interfere with the reception and the transmission of the light passing through the eye, the focusing of the light rays on the retina, the processing of the light in the retinal layers, and then transmission along the complex visual pathways to

the visual cortex in the back of the brain, and further on to higher brain levels where there is storage of information in the temporal and parietal lobes, and ultimately in the frontal lobe executive thinking occurs. Even with the same diagnosis, no two children "see" the same.

Infants and toddlers (0-3 years of age): Critical Window of Development

Vision facilitates attachment between infant and caregivers, as well as the development of social, communication, cognitive, and motor skills. Enhancement/development of the use of vision in a child with visual impairment is not simply showing an object only to "stimulate his/her vision", but rather as an integrated, natural approach that uses visually-related senses as well as motor, cognition, language and play. Visual enhancement by parents and caretakers, through responsive, active, playful and attuned caregiving[1], foster the development and use of vision. A baby learns through observation, imitation, and visual experiences that give meaning to what is experienced by their other senses (hearing, touch, taste, smell, and others).

Parents or caregivers may not be aware of the meaning of certain visual behaviours, and this may delay diagnosis and treatment of eye conditions that can lead to further visual impairment and developmental delays. Visual behaviours are surrogate indicators of the acquisition of certain visual skills[2]. These behaviours can be divided into four cognitive domains: visual attention, visual communication, visual-motor coordination, and visual processing [2] and can be measured by the validated Preverbal Visual Assessment (PreVias) questionnaire for under 24 months.[2,3]

Just by keeping their eyes open, through incidental learning, an infant starts to make sense of the world – they see where things come from, what they are used for, and make associations between the objects and its sound (e.g., the telephone rings and adult answers, someone knocking on the door, visitor at door appears). Very early in life, infants will smile at a familiar face, leading us to spontaneously respond (e.g., reach out and touch or talk to the baby). This response from the child lays the foundation of intimacy and caring between infants and those adults that care for them. Another example of the role of vision in development is evident in how children learn to move in the first place. Usually, infants are fascinated with things that they can see – a flapping curtain, a toy or a person. At first, they move their entire body, wriggling and kicking in an uncoordinated way as they keep their eyes on the object. Over time, they see their hands, learn that they are part of their own bodies and try to use them to reach out to the object. Soon, they gain strength and after a lot of practice, they get better at reaching the target. As they gain better control over their limbs, and as they grow in strength, they begin to master the world around them.

Infants with visual impairments often do not learn to hold their heads steady, crawl, or walk as quickly as other children, unless you help them understand and interact with their

environment. Many among them may learn to sit or stand at the age we expect these skills to emerge, but do not know how to move from one position to the other by themselves. Similarly, babies may not seem interested in toys, and when older, if given something in their hands, may only play with it only by banging it, shaking it, or putting it in their mouths, rather than to imitate more purposeful motor actions. Many children may show understanding of language, especially commands – take this, touch your nose, clap your hands – but do not speak or may use words in a repetitive and meaningless manner. Often, children can become very passive, not moving around, not picking up things they drop or searching for toys when bored. They may play with their own bodies, or simply bang or suck on objects they come across. While they recognize their parents or other adults who care for them, some children may not respond to them with the smiles and affection that mark typical parent-child relationships. [4]

Motor

Vision provides early motivation to move. By 2 months of age, the baby can follow a moving object. Around 3 months, eye and arm control begin to allow movements, such as hitting a nearby object. At this stage, the child is beginning to establish object recognition, as well as cause and effect. This brings the infant the experience of the world, luring him outside of the comfort zone of his body. A critical age for visual and motor development is around 4-6 months. They can reach, grasp, manipulate objects, and because of ability to focus on objects at varying distances, infants notice both near and far as relative measurements. [5] Around 8 months, the infant begins to crawl, further developing eye-hand coordination. By 9 to 12 months old, they can pull themselves to stand and judge distance well enough to grasp between thumb and forefinger. They desire the ability to walk and to gain further access to the now very interesting world outside of themselves. Vision drives this motivation to move and walk. Vision allows infants to access incidental event or clues from the environment, providing anticipatory cues that prepare their nervous systems for responding through motor actions such as eating, grooming, and playing .[5] Visual- motor skills (eye-hand coordination) and cognition enable infants to discover new things about the world around them.

If an infant has visual impairment, they move less, and the natural development of musculature can be interrupted. This is seen all the way through childhood as reduced active play and sports that ultimately can affect posture and health in adulthood. Vision gives feedback that guides developing children to develop strategies and fine tune their movements. In its absence, they are more hesitant and seek stability. The rough and tumble jumping around play of children, teach them concepts of space and distance, shapes and estimations and all kinds of geometry that these children must learn in abstract ways in school.[4]

Cognition

Vision provides experience, and without experience, concept development and cognition can be limited without proper interventions. Without vision a child may have what has been called "empty language" where they talk about things or events without much of an actual idea of what it really is. They may develop egocentric language largely because their experience is so small and fragmented. They may have trouble with social aspects of language.

Early or congenital visual dysfunctions impair neurocognitive development in infants and interfere with related functions such as attention, sequential memory, motor development, communication, and learning.[3] Different cues such as sound, tactile (touch), or olfactory (smelling) cues are used to determine appropriate interaction with the world around us. Visual cues play a critical role in attention. With intact vision, visual cues typically determine out-of-attentive focus. Visual attention is closely tied to cognitive development.[5] Vision motivates us to stay awake, alert and attentive to people, objects, and events critical to our happiness and well-being. It allows infants to imitate the actions and behaviours of important people in their lives and allow them to learn about appropriate behaviour within natural context. Cognitive vision plays an important role in the development of communication, interaction and bonding. Visual developmental delays may negatively impact the child's emotional and cognitive development.

Social-emotional

Infants' ability to see caregivers' faces and respond to smiles facilitates bonding, attachment, and reciprocal interactions. Around 10 months, vision is used to establish joint attention, which is a very important social development; it brings the infant into conversation with others, leading to theory of mind. Gestures or nonverbal communications comprise half of the communication between individuals, with verbal communication compromising the other half. Play is important to development, and children need vision to help get interested and explore things and later people in the world around them.

Without vision, children learn to play with their own bodies and in repeated ways with things near them, focusing on how it makes them feel (turning inward) rather than the object itself. This can lead to stereotypical behaviours.[4]

Activities of daily life, such as feeding, dressing, bathing, playing, sleeping, reading, writing, etc., may be affected by a vision loss. Daily activities can be evaluated by tools such as the Preverbal Visual Assessment (PreViAs) questionnaire for infants younger than 24 months. This test assesses various visual difficulties in patients by means of a behavioural assessment. [2,3]

Preschool (3-6 years)
Play is important for learning in this age group as it is in toddlers. Access to toys and persons to play with help them learn about sense in space and time, and relevance in the family and community. Literacy skills begin to develop.

Developing interest in children and social interactions is visually based, and with visual impairment, the child gets less information from such interactions. A child with VI may form relationships with older kids and adults and more able to handle one on one interactions rather than groups early in life. They may not be able to find their friends in the classroom, playground, or lunchroom. Unless encouraged and guided, these early failures and preferences affect their emotional development, social maturity and overall patterns of interaction.

Primary school
Vision becomes very important for the development of reading. Amblyopia or "lazy eye" is a condition where the nerve pathways between one of the eyeballs and brain are not properly developed, (causes may be eye turning or strabismus, or unequal vision in each eye) which causes the brain to favour the other eye. The condition may be undetected if proper vision screening not carried out during the preschool or early primary school period. This is a common cause for monocular visual loss. Amblyopia is now being pointed to as a cause of poor reading speed.[6,7,8] Uncorrected refractive errors (need for corrective eyeglasses) may lead to an inability to access distance information (myopia) or cause difficulty with reading (astigmatism, hyperopia, poor accommodation or focus).[8]
This is the time for social maturity, motor maturity and friendships.
To access academics to acquire fundamental literacy and numeracy, a child with a visual impairment my need to learn compensatory skills to access their curriculum (i.e., braille, abacus, low vision aids, orientation and mobility training to travel independently and safely, etc.)

Secondary school (adolescence)
Vision is important for accessing high school curriculum - science and math and specialized materials may need to be created. People around the student need to have high expectations and not be prejudiced about what is possible.
Friendships and exclusions are increasing challenges as children move into an age where non-verbal language is key to successful social interactions. How do you see a smile if you are visually impaired? Negotiating the move from childhood to adulthood can be harder for kids with VI. There are many concerns at this age of "fitting in", self esteem, body awareness that can be compromised if there is eye turning, thick glasses, or visual impairment that interferes with the student's sense of being part of the peer group. Social interaction with

peers may become more challenging. A student with visual impairment may not make eye contact with peers, and be perceived as not being social. Access to core curriculum in school may be compromised, and this may affect learning. Participation in sports may be affected, not only because of limits from the visual impairment, but the child may not be asked by peers or coaches to be a part of a team, because of the difficulty with performance. The child may also be at risk for injury.

2. The **impact of eye diseases/conditions and vision impairment on child development**, **and quality of life**

Mounting evidence indicates that successful treatment of visual disability sustains or improves quality of life.[9] In infancy; this is achieved through early detection of eye disease, early treatment, early childhood care and education. The rising cause of visual impairment in the United States and many other developed countries in the birth to age 3 population is thought to be cerebral/cortical visual impairment, followed by optic nerve hypoplasia, then retinopathy of prematurity.

Knowledge of visual developmental milestones is important for the parents and providers of primary health care to understand. Failed eye contact at 6-8 weeks of age is the first warning sign there may be a visual impairment. Without proper intervention, this may interfere with the child's ability to bond with his/her family members. Early intervention for the baby and family can minimize the effect of the delay or disability. Goal directed hand and arm movement (putting hands in mouth, hands in midline, reaching for toys, mother's hair, etc.) begins in the 3rd to 5th months. Recognition of facial features should be present around 7-10 months.

During the second year, development of motor function allows for increased exploration of the world, which facilitates the concepts of form and "same". Matching is an important concept for later literacy. Quality of life outcome studies in in the area eye conditions such as pediatric glaucoma[10], amblyopia[8], uveitis[11], and cataract[12] help us to understand the impact of visual impairment on child and family quality of life. *The Impact of Vision Impairment on Children (IVI-C) questionnaire* is directed toward children age 8-18, and was developed to identify the support needs of children with low vision. School/specialist support (for example teacher knowledge, access to curriculum, technology, and specialist support for identifying individual needs, independence and fulfilling potential) and social interaction (fitting in, peer acceptance, social skills) were the most common areas identified as concerns for the students with visual impairment. Low communication skills and low self-confidence inhibited successful social interaction.[13]

Some specific examples:

Preschool (3-6 y.o)

Motor

Motor skills have been reported to be poorer in children with infantile esotropia (in turning of eyes from birth) prior to and after surgery.[14]

Primary education

Most countries even in emerging economies have primary education for children. Inclusion into not only life, but also education is considered a right of the child. However, integration in the classroom does not guarantee the child has access to the curriculum. At school age, the number of vision related tasks and activities increases rapidly.[9]

In a study in an Australian population, the most common causes of visual impairment qualifying children 4-18 for educational services were retinal dystrophies, optic nerve atrophy/hypoplasia, albinism, and infantile motor nystagmus.[15] These conditions are non-preventable, and not reversible. Treatable or potentially preventable causes such as retinopathy of prematurity or pediatric cataract makeup less than 10% of vision impairment.[15] The type of visual impairment, and whether it is stationary, progressive, or can be improved with treatment make a difference in the educational and habilitation approach for the child.

Cognition

Reading is a major life activity, as recognized by the US Congress in the Americans with Disabilities Act Amendments Act of 2008.[7] Reading promotes imagination and learning, is fundamental to academic achievement, and relies on a complex interplay of visual and motor capabilities.[7] Slow reading has been documented in children with anisometric amblyopia (the eyes have significantly different refractions leading to suppression in one eye), strabismic amblyopia (suppression of one eye because of misalignment)[6]. The slow reading is due to amblyopia and ocular motor dysfunction (not learning disability)[6] Treatment of the amblyopia may remediate reading speed.[6]

Secondary Education

Secondary education is still not universal.

Quality of life tools like VRQol confirm sharper visual acuity in the better seeing eye associated with better VRQoL in children with glaucoma in older children.[10] A children's quality of life with children reporting directly identified six themes important to children age 10-15. [16] There are complex issues with child, family, and peers if a child does not have typical vision.

These included:

a. social relationships, participation and acceptance
b. independence and autonomy

c. psychological and emotional well-being
d. aspirations and concerns about the future
e. functioning at home, school, leisure
f. treatment of eye condition

3. Inclusive development initiatives are worldwide. Legislation in many countries guarantees the right of the child to a safe environment to learn, and access to core curriculum. However, if the human resources don't support the interventions, integration in a classroom may not necessarily allow integration into life.

4. **Treatment** of visual disabilities may sustain or improve quality of life. One example is amblyopia. [17] Amblyopia results in permanent visual loss without treatment, and this can affect educational achievement, sports participation, psychosocial well-being, and occupational selection if not treated in early childhood.[17]

Cultural Differences
Even in high-income countries, there are becoming more diverse populations and there may be differences in care-seeking attitudes.[15] If services are "free", someone still pays. Whether it is a government by taxes from the general population, a nongovernmental organization (NGO) who pays, or the family who pays in lost time from work, travel expenses, etc.

Gender differences are still under study. For example there was a predominance of males with visual impairment in the study from Australia, which may be because of the visual impairment from retinal dystrophies, which may be x-linked, or a gender-based disparity in the health care-seeking behaviour of parents.

Rural and urban differences may be significant as in the myopia studies in China where it was found that urban children had a higher rate of myopia than rural children (need reference). Access may be difficult for education resources for a child with visual impairment in remote rural areas, but also in urban areas where travel might be difficult, or funding limited.

Refugees and internally displaced children may be struggling with survival, food, shelter, and it is difficult to bring preventive, restorative eye care in these situations. Vision may be an important survival tool in this case.

Effective coordination and integration of eye care services with other areas of care
Vision Screening can help detect visual condition that can lead to interventions. Vision screening with low-tech methods are being evaluated against newer instrument based screening, and compared with the gold standard of an eye exam by a trained

ophthalmologist. This will help us to learn the most effective and efficient ways to detect treatable visual impairments (example Nigeria).
Screening may be carried out in day-care settings (India), immunization clinics, or other ways.

Technology and innovative practice include cell-phone technology that has opened up communication for persons with low vision, and also access of families and students for information in regards to visual impairment. Most tablets have audio and other accessible features. There are newer technologies that are too costly for most families including eye-gaze with machines. Low-tech devices like magnifiers still have a place in the classroom, as do telescopes for accessing distance information.

Conclusion

Much of visual development happens in the early months and years of life, in direct response to a child's experience of the world. If we do not identify and intervene early, and provide comprehensive support at the right time, we lose an opportunity to create fundamental change in the life path of a child. We deprive children of the opportunity to utilize a powerful way of learning and interaction and place them at risk of deprivation and delay in the absence of rehabilitation support.

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