The child's vision system is dynamic, constantly changing and adapting to both the body's programmed growth and development cycle as well as the visual world outside.

The examination of a child's eyes and visual-motor system is different than that of an adult. There are a number of tests for sensory integration, motor coordination, acuity development as well as anatomical growth and development specific for children.

This article discusses the development of the vision system and will focus on what is involved in a child's vision examination, the benefits of early detection and prevention and recommended guidelines for pediatric vision care. It is eight pages in length.

The Need for Early Childhood Vision Examinations

The vision system is vitally important to learning and the early detection and treatment of vision problems can help a child reach their potential in school. School vision screenings, although valuable, may not reveal some specific problems and misses testing the child in the earlier developmental periods. Although instrumentation is available that would allow school vision screenings to provide an accurate assessment of a child's vision, it is seldom utilized due to cost and time constraints. School vision screening effectiveness in identifying children with vision system issues varies tremendously among schools in different communities. School vision screenings should not be relied upon as the primary source of vision care in children.

The pediatrician or nurse practitioner might be the first health professional a child might with encounter for vision system examination. From birth through age 3 they should be examining the child for anatomical, neurologic and motor/muscle developmental concerns.

As a general guideline, and in the absence of known birth or genetic risk factors, a child should have an examination by an optometrist at age 3, age 5 or just prior to the start of school, around 7 or 8 and 12-14. If there are risk factors for eye disorders, a different, proactive plan should be considered.

Following is important and more detailed information relating to development, testing and treatment of the children’s vision system.
Children's Vision Development

The human vision system at birth is somewhat poorly developed, but rapidly becomes the remarkable combination of nerve tissue, muscles and optical lenses that provide us with the sense of vision. The information processed by the eyes is sent directly to the brain and is interpreted as vision. That information is also used to provide us with the awareness of space and location. The eyes learn to move and scan across the visual world, sensing time and space. Colors and shapes become valuable clues to help us understand our environment.

Until a few years ago, it was thought that newborns, even early infants do not see very well. We know now that those old assumptions are not at all true.

During the first few weeks, the child sees mostly shapes, lines and boundaries between objects. There is evidence that some degree of true vision, at least for larger objects held near to the eyes, is achieved by the third week. The child's visual world is most usable within about eight to fourteen inches (20-35cm) of his/her eyes, perfect for concentrating on the mother's and father's faces! During this time, the eyes may appear to wander almost randomly, but soon, often by the end of the first month, they appear far more coordinated and the child may show some interest in looking at more distant objects. But they still do not really follow objects in motion. They may be able to fixate upon and follow a larger object for a short distance, from the side to the midline. The ability to track an object across the entire field, from one side to the other may not occur until around the beginning of the third month. Shortly thereafter, you will notice that your child begins to search his/her visual world, intently watches your face and may mimic your facial expressions! By six months of age, most of these systems are nearly fully developed, allowing the infant to cognitively perceive his/her surroundings. But even though the system has developed to this level, there's still a lot of fine tuning and structural changes going on which need to be monitored as the child grows into adolescence and adulthood.

The First 6 Months of Life: Expected Development

What the doctor looks for:

The pediatrician should be observing the eyes for anatomical, functional and perceptual development. The eye structures are examined. The eyelids are checked to be sure they are opening and closing, the ocular surface is checked to see if there is adequate tear fluid production, the pupil/iris observed for normal formation and we test eye-muscle coordination. We also look at psycho-sensory perception and preferential looking. This is a test protocol for determining if the child fixates upon, or, pays attention to objects in the his/her visual space, and to what degree he/she recognizes and understands what is being seen.

The parents should also be the examiners of their children. Report any unusual findings to your primary care provider or eye doctor.
What the parents should look for:

With very young infants, it is normal to notice one eyelid not working in coordination with the other, or see the eyes misaligned at times. By the end of the first month, most babies will have their eyes pretty much aligned---but not necessarily all the time. Around three months, he/she should be able to follow moving objects crossing the visual field and be able to maintain fixation of an object held between 8 and 24 inches (20-60cm). By six months the neurological and motor development should reach the level at which the system works pretty well. Parents should report any obvious problems, such as one eye more often than not "stuck" in one position or apparently operating independently of the other, an eyelid not blinking, cloudiness of the eyes, dark brown areas on the otherwise light colored iris, one pupil much larger than the other, one eye "bulging out" or more prominent than the other, or the infant rubbing his/her eyes. If the parents have significant vision problems, sometime between 6 months and 1 year of age, the child should have a complete eye health and vision examination.

Otherwise, the pediatrician skilled in vision developmental testing should be able to determine if a referral to an eye doctor is necessary.

The Vision System at Three Years of Age

Assuming that there have been no previously detected problems, the next time the child should be evaluated is at three years. At this examination, once again neurological and developmental tests are performed, but now, additionally, the optometrist or ophthalmologist will also fully evaluate the quality and clarity of the child's vision.

The First Comprehensive Exam

The child ideally should be examined in the morning, following a nap and small meal. She/he will be more alert and responsive.

Family History: We need to learn about possible genetic tendencies towards vision system problems, especially in siblings and parents. We also ask about systemic conditions, including diabetes, thyroid dysfunction and others.

Patient History: What is the presenting complaint or is this a routine evaluation? We also need to know about the child's general health history, including pre-, peri- and postnatal health and development.

Visual Acuity, the testing of the clearness of vision.

The assessment of visual acuity is achieved with special cards and images which the child matches to target images presented at various distances. Sometimes we use a chart with pictures and symbols or the "tumbling E or hand" chart. Here, the child points his/her hand in the same direction as the standardized image.
The External Anatomical Examination

The eyes are observed for structural anomalies, including the eyelids, position of the eye in the orbit (eye socket), tearing and lubrication, and the neurological assessment of the pupil (for constriction and dilation in response to light and focusing). We also sometimes test for peripheral vision awareness.

Internal Examination

We look through the pupil with an instrument called an ophthalmoscope, providing a clear view of the structures inside the eye. We also assess the intraocular fluid pressure, usually by touch, or if glaucoma is suspected, with appropriate instrumentation.

Ocular Motility and Binocular Function

We test the ability of the eye to perform a number of simple motor and complex integrated visual functions:

Fixation: the ability to maintain attention on an object

Convergence/divergence: the ability for the eyes to turn in and turn out so they are aimed at the same place in space

Accommodation: tests the focusing/de-focusing optical system in the eye

Cover Test: observations to determine if the eyes are properly aligned for a given distance

Rotations and versions: testing the eye muscles tracking (following) a moving object

Saccades: the ability of the eyes to uniformly track, stop at an indicated position, resume movement and return to a preset position. This is one of the skills critical to the process of learning to read.

Stereopsis: examination to determine if the eyes and brain interpret the presented information as a three dimensional image

Color Vision: Testing to determine the ability to interpret color information and to recognize foreground/background images.
Refraction, The Measurement of Optical Error

Using a retinascope or automated refractors, we can measure the optical power of the eye without the observer's interaction and feedback. Sometimes we may use cycloplegic drops, which block the vision system's focusing mechanisms, allowing a more accurate assessment of the refractive error in some specific cases.

Examination of the Older Child

For the most part, the same tests as previously mentioned are repeated. In addition, the refractive part of the examination is modified to include subjective feedback from the child, much like an adult examination. Some of the basic developmental tests may be deleted from the routine exam and some tests may be altered to test at higher levels of sensitivity.

Early Detection and Prevention

There are certain situations where early detection of problems can facilitate the treatment of the condition, thereby helping the vision system to develop more normally. Sometimes, intervention can prevent a problem from having a more significant impact later on in the child's development.

Errors in the development of the human vision system include:

Eye Muscles: Improper position or incorrect length can result in one or both eyes being misaligned or unable to track. This is called strabismus. This type of problem can be a cause of poor spatial perception, clumsiness, and reading disabilities. Also, there can be eyelid blink reflex problems, which can result in dry eyes, irritation and infection.

Neurological Development: Often, the symptoms and outcomes are similar to the problems outlined above. Additionally, acuity non-development from misalignment or solely as a neurological anomaly, is called amblyopia. Also, there may be fixation, attention deficits, and binocular vision (3-D, stereopsis) defects.

Optical Errors: Farsighted optics (hyperopia) sometimes cause the eyes to turn in, causing esotropia, a form of strabismus. High degrees of hyperopia can cause eye fatigue and blurred near vision. Nearsighted optics (myopia) cause distance vision to be blurred. And a significant difference between the two eyes (anisometropia) can result in a condition which causes amblyopia and mis-coordination.
The Treatment of Vision System Conditions

There are a number of different methods used in the treatment of childhood vision system problems. Treatments may be optical or surgical, include behavioral modification, neuro-motor and sensory integration exercises or combinations of the above. Eyecare professionals, both optometrists (O.D.s) and ophthalmologist (M.D.s) sometimes differ in their approach to vision care, and some forms of therapy might be considered controversial. The presentation below reflects this writer's wholistic approach, accepting the validity of all currently available treatment modalities.

**Neurological and Developmental Problems:**

Sometimes we just monitor the situation and normal growth and development ultimately achieves normal function. We may at times need to intervene and assist the development of the vision system. This may mean prescribing exercises or lenses to train the eyes muscles and exercises or other therapies to stimulate the nerves to operate more normally.

**Motor/muscle problems:**

If the eye muscles are malformed, surgical intervention can re-position the attachments to the eyeball and muscles may be lengthened or shortened to achieve proper alignment of the eyes. Sometimes the eye muscles can be exercised to overcome anatomical errors and there are situations where both surgery and exercises are combined to facilitate normal vision system function.

**Optical Errors**

**Hyperopia**

If there is sufficient power error that causes the eyes to cross, or to cause blurred vision, lens correction is the standard treatment. Otherwise, many practitioners would recommend no therapy, in the hope that the developing vision system would correct itself. It is normal for children to be born with some degree of hyperopic refractive error. As the eyeball grows and develops, there is a biological tendency to adjust this optical error towards perfect distance focus. Sometimes doing nothing is the appropriate treatment.

**Myopia**

Again, if there is sufficient error to affect vision perception, lenses would be prescribed. Some "behavioral optometrists" and similar thinking ophthalmologists might recommend minimal prescription for distance and even near vision lenses to help "relax" the focusing system. There some evidence that the reverse is true, that the vision system should be optimally corrected. Some doctors may prescribe exercises to help train the eyes to grow towards normal optics. The theory is that controlling the factors that may influence the growth of the eye can assist the body
in normalizing and even correcting the optical error. Even when there is a genetic predisposition to develop an optical error, some practitioners subscribe to the theory that we can manipulate the system to grow towards more perfect vision.

Some recent studies seem to show that treatment with pharmaceutical agents that suppress the focusing system might reduce the progression of myopia. Another study indicates that specially designed lenses with aspherics optics may affect the development of the eye’s optical system.

I believe this simply confirms the belief that the growth of the eye is a dynamic process, influenced by genetics and the environment. Controversy remains as to just how much we can interfere and how effective our intervention is in the long term.

In any event, the consequences of disorders such as strabismus, amblyopia, poor vision and perception can be avoided or minimized if we provide proper examinations, emphasizing early detection and treatment.

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**When Should Children Be Examined?**

Below are the guidelines based upon recommendations from vision care specialists and practiced by this author:

Age Birth to 2 years: By six months of age, by a capable pediatrician or by eye doctor if there are risk factors. Basic neurological and motor functions should be checked at every infant visit. A more comprehensive exam should be considered between age 1 and 2.

2-5 years: Optometric examination at age 3 or as recommended if there are risk factors.

6-18 years: Before entering the first grade and every two years thereafter. Annually or as recommended if there are risk factors.

**Factors placing an infant or toddler at risk include:**

1. Prematurity, low birth weight, oxygen given at birth, grade III or higher intraventricular hemorrhage

2. Family history of retinoblastoma, congenital cataracts, or metabolic or genetic diseases, including hyperthyroid, diabetes and heart disease

3. Infection during pregnancy, especially rubella, toxoplasmosis, syphilis, gonorrhea, herpes, cytomegalovirus, HIV
4. Difficult or assisted labor, low Apgar scores

5. Known or suspected central nervous system dysfunction, e.g. developmental delays, cerebral palsy, seizure disorder, hydrocephalus

6. High refractive errors

7. Strabismus (crossed, uncrossed eye position)

8. Anisometropia (large difference in refractive errors of the two eye

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