REFINEMENTS

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VISION ASSESSMENT OF THE PEDIATRIC PATIENT

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Module 001

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Vision assessment of the pediatric patient

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Introduction

Vision testing of the pediatric patient can be challenging, requiring the use of skills not needed for vision testing of adults. In this module, we present an overview of visual system development and vision testing techniques for use in patients from birth to the teenage years. Amblyopia is of particular concern during childhood. Amblyopia is the presence of poor vision in an eye that is structurally normal and may occur due to the presence of strabismus, an uncorrected refractive error, or occlusion of the visual axis, as may occur with a cataract or upper eyelid ptosis. The incidence of amblyopia or an eye disease that may lead to the development of amblyopia has been estimated in up to 3.5% of preschool age children.[1] The importance of healthy vision cannot be overstated, and significant visual impairment in the first one to two years of life should be considered a developmental emergency.[2] The presence of active vision screening programs in most U.S. public school districts underscores the importance of vision in the learning process.

Patience is always required when testing vision, but it is particularly important in the pediatric population, where flexibility and understanding of a broad range of testing tools are essential. When testing a child's vision, the examiner must not only determine how well the child sees but must also assess the child's ability to cooperate and assess his or her understanding of the test. Flexibility is the key, and using a "one-size-fits-all" approach is rarely successful.

Objectives

Upon completion of this module, the reader should be able to:

(1) explain the importance and purpose of vision testing in the pediatric population.
(2) explain the importance of historical factors in assessing the visual function of a child.
(3) explain basic techniques of vision testing based on the age of the child.
(4) describe the difference between a test of visual behavior and a test of visual performance.
(5) identify special obstacles to vision testing in the pediatric population (e.g., crowding phenomenon, latent nystagmus, etc.,).
(6) describe the signs of severe visual dysfunction.

Visual System Maturation

All children are born with low vision. The visual acuity of a newborn child has been estimated at less than 20/400, but this improves rapidly during the first several weeks of life as the retina, optic nerves, and visual cortex mature.[3] The optic nerves become increasingly more myelinated, and the visual cortex in the occipital lobes of the brain continues to develop. The lateral geniculate body grows during the first two years of life,[4] whereas the fovea, the most sensitive part of the retina, undergoes a process of growth and development that reaches an adult-like state by the age of approximately four years.

In the majority of infants, an easily-detectable fixation and follow response is present by three months of age. In fact, visual fixation can be demonstrated in most infants shortly after birth if appropriate targets, such as the human face, are used.[5] Binocular visual function and stereopsis develop between the ages of three and seven months,[6] and vision reaches an adult level of 20/20 by 3–5 years of age. Table 1 (page 3) outlines normal visual behavior during the first year of life.

Taking a History

The importance of obtaining a history prior to testing vision cannot be overemphasized. Parents often detect a vision abnormality before a problem is easily discernible in the ophthalmologist's office. Ask important questions such as: Does your child see well? Do the eyes appear to cross or wander? Have you noticed anything unusual about your child's vision? With older children, important questions include: Does your child hold things close? Does your child squint? Do you think your child sees well? The answers to these questions may suggest the presence of a vision abnormality.

The examiner should inquire if there is a family history of serious eye disease in childhood, including childhood cataracts, strabismus, amblyopia (lazy eye), glaucoma, retinal problems, and nystagmus. Many conditions are familial, and their presence in other family members increases the likelihood that a child may have similar problems. The child's past medical history should also be reviewed. Many non-ophthalmic medical conditions have associated ophthalmological problems. Premature children, for example, are at higher risk for developing amblyopia, high myopia (near-sightedness), and strabismus. Seventy percent (70%) of severely visually-impaired children have other concurrent handicaps and 10% have impaired hearing.[3]

While taking history, it is also important to record any medications the child may be taking, including ophthalmic drops or ointment.

Overview of Pediatric Vision Testing

Meeting the Child

Many children, particularly younger children, have a difficult time with vision testing due to apprehension, lack of understanding, lack of interest, or a combination of the three. The examiner must work to overcome these constraints. The office environment should be relaxed, friendly, and pleasing to the child. The examiner should develop a rapport with the child before beginning the examination. Talking with older children about school activities, sports, play, and other topics of interest is a good way to "break the ice." Smiling at a child, even an infant, can go a long way toward making the child feel more comfortable. The examiner who ignores the child and immediately begins talking to the parent is often faced with an uncooperative or frightened child, who becomes more difficult to handle as the examination progresses. Infants and small children should sit on their parent's lap during the examination. Even older children who appear particularly uncomfortable or frightened may benefit from sitting on a parent's lap.

Examination Room Setup

The examination environment should have minimal distractions. If there is a lot of activity in the hallways, the examination room door should be closed. Toys and other fun items should be kept out of the child's sight until they are used for vision testing. An eye chart projection system without mirrors is easier for children to use than a mirrored system. Children may be confused by a mirrored system, or may become interested in how the system works, constantly turning around to see where the letters are coming from. The standard testing distance in the United States is 20 feet. Some children, however, perform better when the test target is placed at 10 feet instead of the usual 20 feet.[7,8,9] Of course, if a 10-foot testing distance is used, an eye chart calibrated for a 10-foot testing distance must be utilized.

Improving Vision Testing Results

The attention span of most children is short, and therefore the examiner should develop an expedient means of obtaining the needed information. Keep the child on task, and do not allow his or her attention to be redirected to other activities. If the child becomes fussy, encourage and reward him. Never become angry or frustrated. Anger and frustration are the two most rapid ways to lose control of the examination. Other siblings should be quietly reminded to remain silent if they are distracting or if they are trying to "help" their brother or sister during the vision test. Approaching vision testing as a game can convert a potentially unpleasant event into a fun experience for both the child and examiner. Coaching and encouragement are critical, particularly with the shy child. Expressing excitement and pride when the child makes a correct response (or even a failed attempt) can put a stalled examination back on track.

Basic Techniques

Evaluation of fixation behavior and other visual mannerisms is the most common method of assessing preverbal children in the typical office setting. Fixation tests are not actually tests of visual acuity, but instead are tests of visual behavior. Verbal children who are able to cooperate for formal visual acuity testing should undergo psychophysical testing. Psychophysical tests determine the child's ability to identify targets or optotypes that are presented on a fixed chart, projection chart, computer chart, or on handheld cards. Optotypes are letters or figures on an eye chart that are used to determine the child's visual activity. The tumbling E game and the Snellen letter chart are examples of psychophysical tests.

Vision Testing of Preverbal Children

In preverbal children (up to 2–3 years of age), vision is usually evaluated by assessing visual behavior, not visual acuity. The goal of vision testing in a preverbal child is to determine if the child's visual behavior is normal for his or her age and to determine if vision is equal between the two eyes. Despite many misconceptions to the contrary, visual fixation reflexes can be demonstrated even in newborn children, provided that an appropriate target, such as a human face, is utilized.[5] It is never appropriate, therefore, to state that a child is "too young to test."

Table 1
NORMAL VISUAL BEHAVIOR OF INFANTS[2]

Age (months)	Behavior
0-1	- Turns eyes and head to look at light sources - Horizontal tracking - Eye contact at 6-8 weeks
2-3	- Intense eye contact - Vertical and circular tracking - Interested in mobiles - Interested in "lip reading"
3-6	- Watches own hands - Reaches toward, later grasps, hanging objects - Observes toys falling and rolling away - Shifts fixation across midline - Visual sphere of attention widens gradually
7-10	- Notices small bread crumbs - First touches them, then develops pincer grasp - Interested in pictures - Recognizes partially hidden objects
11-12	- Visual orientation at home - Looks through window and recognizes people - Recognizes pictures, plays hide-and-seek

Observation

Vision testing of the preverbal child should begin as soon as the examiner enters the examination room. The examiner should observe the child's reaction as he or she enters the child's visual space. Does the child appear to see you come in? Does he or she visually track you as you move across the room? Does he or she smile when you smile? Visual behavior varies depending on the age of the child, and the examiner will begin to recognize normal behavior as he or she gains experience (Table 1). A 1-month-old infant, for example, may make good eye contact. The child will usually begin looking at objects close to his face during the first month of life. An infant in the first month of life appears serious as he fixates, but during the second month of life, as he begins using facial expressions, he becomes animated. During the second and third month of life, he may smile when you smile, or mimic other facial expressions. During the third month of life, the child may be seen observing his hands while holding them close to his face. Most infants will begin watching activities around themselves during the third to fourth month of life. At around six months of age, an infant will carefully observe his surroundings and will be able to recognize a favorite toy or food at a distance.

The Fixation Reflex

The quality of the fixation and following reflex provides a good estimate of visual function in most preverbal children. The human face is an ideal fixation target for children 3–4 months of age or younger. There may actually be a genetic fixation preference for the human face.[10] Even newborn babies may show a fixation response to a human face. When testing fixation reflexes, the examiner should move his or her face to and fro and observe the child's ability to fixate on and follow that movement. Infant fixation movements will not be smooth, but instead will appear somewhat uncoordinated. Vertical movements are not usually present during the first few months of life, so visual targets should be moved horizontally. A common testing mistake is for the examiner to pick the child up and rotate her to and fro. Upon seeing the child's eyes readily move as the child is rotated, the examiner mistakenly believes he or she has witnessed a fixation and follow reflex. In reality, the examiner has merely stimulated the child's semicircular canals, which, when stimulated by rotation of the body, causes the eyes to move. This phenomenon is called the vestibulo-ocular reflex, and it is not a measure of visual behavior. The child must remain still while the fixation target is moved to and fro. The examiner should first assess both eyes together and then test each eye separately, by occluding one eye at a time. Testing the fixation reflex several times will improve accuracy.

A small, colorful toy makes a good fixation target for children older than 3–4 months of age. Frequently, more than one fixation toy is needed because children often rapidly lose interest in a single toy. Stickers on the end of tongue depressors also make good fixation targets. A toy that makes a noise should not be used because it is difficult to tell if the child actually sees the object or is merely following the noise. White light, such as a penlight, should also be avoided. Light merely represents "visual noise" and is a poor fixation object. Instead, an object with spatial orientation, such as a human face or small toy is essential (Figure 1).

Figure 1. Examples of good fixation toys for vision testing of infants and preverbal children.

Any asymmetry or any abnormality in the fixation reflex (even a small abnormality) is important and may indicate the presence of a serious visual disorder. It should be noted that one is using the presence of a motor function (eye movement) to assess the presence or absence of vision; therefore, if the child has a disease or problem that prevents her from moving her eyes, an erroneous assumption of poor vision may be made in spite of the fact that the child has normal vision.

Documentation

Two common methods are used for documenting fixation reflex testing results. These two notations are the central-steady-maintained (CSM) method and the fix-and-follow (F+F) method. The F+F notation means that under monocular conditions (i.e., the opposite eye is covered), the child is able to fixate on and follow a target with his eye as it is slowly moved through his visual space. Each eye should be tested separately. In children with strabismus, notation should also be made of the child's ability to hold fixation with either eye while both eyes are open. The CSM notation provides essentially the same information as the F+F notation. The C refers to the child's ability to fixate under monocular conditions with central (C) fixation or with eccentric/noncentral fixation (UC). The S refers to how well the child is able to hold fixation on the target as it is held still and as it is moved slowly through his visual space. If he is able to steadily fixate on and follow a target, his fixation is steady (S); if not, his fixation is recorded as unsteady (US). Unsteady vision generally refers to the presence of nystagmus. It is reported as maintained (M) or not maintained (NM). The M refers to the strabismic child's ability to maintain fixation with the viewing eye when the other eye is uncovered. It also indicates that the eye will hold fixation through a blink. Both methods of documenting the child's response are useful, and choice depends on personal preference.

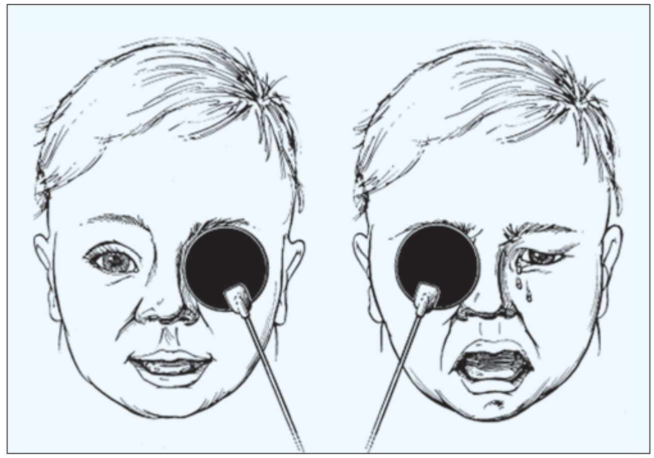

Figure 2. Differential occlusion objection test: Child is not bothered when amblyopic left eye is covered, but becomes fussy when normal right eye is covered.

Amblyopia Detection

In addition to determining if each eye is able to fixate and follow an object, the examiner must determine if the vision is equal in the two eyes. If vision is not equal, amblyopia should be suspected. Several simple tests can be used to detect an inequality of vision between the eyes. If strabismus is present, the child's ability to maintain fixation with either eye should be tested as described in the preceding paragraph. A child with equal vision in both eyes can maintain fixation with either eye and usually has alternating strabismus. A child with amblyopia will not maintain fixation with the poorer seeing eye when both eyes are uncovered and will always prefer to use the better seeing eye. A strong preference for one eye indicates the presence of amblyopia in the opposite eye.

Detection of unequal vision is more difficult when the eyes are straight, but tests can and should still be done. There are several simple tests to help make this determination. The differential occlusion objection (DOO) test is particularly helpful. The child in Figure 2 has amblyopia in his left eye but his eyes are straight. How can the examiner determine if his vision is equal or unequal? When his left eye is covered, he remains happy. He still sees well out of his right eye, and patching or covering his amblyopic left eye is not bothersome. When his right eye (the normal seeing eye) is covered, he becomes fussy and agitated. This happens because he depends on the vision of his right eye to see properly, and he is not able to use the full potential of his amblyopic left eye. In other words, if there is a difference in response to occlusion of either eye, a problem should be suspected. A child who has equal vision in both eyes will react proportionately when either eye is occluded or will not react at all. Sometimes children become agitated when approached and resist all attempts to cover either eye, rendering the DOO test unhelpful. The test should be repeated several times to improve accuracy.

Two other tests for unequal vision in children with straight eyes involve the use of a prism. One test, described by Wright, uses a 10-prism-diopter vertical prism and is called the vertical prism test (VPT).[11] The other test is a horizontal 25-prism-diopter test described by Cassin.[12] In the first test, the VPT, a 10-diopter prism is held base down in front of a child's right eye. This induces a vertical tropia that can then aid in the detection of unequal vision. The eye under the prism is then simultaneously covered, forcing the child to take up fixation with his uncovered left eye. The cover is then removed. If the child switches fixation back to his right eye (i.e., the eye under the prism), that eye will move upward and the examiner will see this movement. What does this tell the examiner? The child has a right eye fixation preference and may have amblyopia in his left eye. The test is then done for the left eye by placing the prism over that eye. The test is repeated for each eye and should be redone several times to improve accuracy. If the child is able to maintain fixation with either eye and no shift occurs when the cover is removed, vision is equal. The horizontal prism test described by Cassin is performed in a similar manner, with the prism placed at base IN. A visually normal child would likely be able to converge on jump amplitudes with this amount of horizontal prism if it were placed base out. The VPT is actually the preferred method for amblyopia testing; the horizontal prism is more commonly used to assess amplitudes of convergence or divergence.

Forced Preferential Looking

Grating (Teller) acuity cards can be used to assess vision by the forced-preferential-looking method. This test depends on the fact that children prefer to look at a pattern of alternating contrast over a homogeneous target. Grating acuity cards typically have two target areas: one with alternating light and dark stripes, the other homogeneously gray. The examiner watches the child through a small hole in the center of the test card and notes the direction the child's eyes move as each card is presented to the child. As long as the child is able to discern the difference between the striped area and the homogeneous area, she will prefer to look at the striped target. Targets with thinner and thinner lines are presented to the child until she no longer has a preference. Visual acuity is determined by the thinnest target the child was able to detect. Grating test methods are accurate, but they are not directly comparable to optotype testing methods, and tend to overestimate vision.[13] The skill level of the examiner is critical to accurate grating acuity testing and much practice is needed. Also, the grating acuity determined by various examiners may differ due to variations in testing methods. Because of this, it is probably reasonable for a single tester to be assigned to a given child when longitudinal visual data are important.[14] The limitations of this type of testing include false negative results due to lack of cooperation or large visual field defects. False positive results are also possible due to observer bias and difficulty in assessing fixation movements due to the presence of nystagmus or ocular motility abnormalities. The grating card systems are time consuming, require the skill of a well-trained and experienced examiner, and are not practical for routine use with every child.

Vision Testing in Verbal Children

For the purpose of vision testing, verbal children fall into two categories: (1) preliterate and (2) literate. An accurate assessment of visual acuity can be made in almost all cooperative verbal children, and an attempt should be made to formally test the visual acuity of any child who is three years of age or older. Optotype recognition tests are known as psychophysical tests and are designed to test the vision in each eye individually. If a child wears glasses, vision should be assessed with and without them.

Testing Literate Children

Psychophysical tests involve the subjective assessment of a child's ability to see and recognize an optotype and communicate his or her recognition to the examiner. There are many psychophysical tests, and Figure 3 demonstrates some of the more commonly-used tests. The Snellen acuity test (standard letter test) should be used for children who are old enough to identify the letters of the alphabet. Preteaching children how to do a vision test can improve vision testing performance.[15] When introducing any new test to a child, it is wise to start with the test targets close to the child or to start with the larger optotypes while teaching the child what you want him to do.[6] It is often less threatening for the child to learn how to do the test while both eyes are open. Once the child understands the process, monocular testing can be done.

Children have a very short attention span and become disinterested quickly. It is usually futile to begin testing with the largest row of optotypes on the chart and asking the child to read every letter on every row until he or she fails. By the time the child gets to the smaller optotypes, he may have become bored or disinterested. Instead, the examiner should start with a smaller row—the 20/40 line, for example . If the child has trouble with the 20/40 row, the examiner should move to larger rows. If the child easily reads the 20/40 line, the examiner can immediately skip down two or three lines, perhaps to the 20/25 or 20/20 line. Often a child's visual acuity can be determined by carefully selecting as few as two or three rows of optotypes. If one eye has significantly better vision than the other, the eye that performed poorly should be retested. A child's visual acuity will vary with age, but if acuity differs by more than one row between eyes, amblyopia should be suspected. A 4-to 5-year-old child should have at least 20/30 acuity or its equivalent.[8] Younger children may not be able to see better than the 20/40 or 20/50 row, but the vision should be the same in each eye. The examiner should encourage and coax the child if he gives up early. If a child is known to have amblyopia in one eye, the amblyopic eye should be tested first to minimize poor performance due to boredom and lack of interest, and avoid artifact due to memorization.[6]

It is not necessary for the child to get all optotypes on a line correct, but he should identify a majority of them correctly. The examiner should listen for consistency in misnaming optotypes. If the child consistently confuses E with F, for example, this may indicate that the child actually sees the optotype but does not know the name of the character—not that the child is unable to see the letter.[6]

Testing Preliterate Children

Verbal but preliterate children can still undergo psychophysical vision testing, but special optotypes are needed. Useful tests include picture optotypes such as Allen figures, LEA figures, and directional optotype tests such as the tumbling E game and Landolt rings (see Figure 3). Other special charts, such as the HOTV chart (a modification of the STYCAR test, a distance vision test), use a limited number of test letters that the child can easily learn and then identify by matching or by verbalizing.

Picture Optotype Tests

Picture optotypes are available both as a wall chart and on handheld cards (i.e., Allen cards or LEA charts). They are useful in preliterate children but have several drawbacks. First, they depend on the child's familiarity with the pictured objects. Second, some of the tests require a verbal response. If a child does not recognize the object or is too shy to respond, the test may be impossible. Third, cultural and social factors have been shown to play a role such that patients of some cultural or social backgrounds perform less well on certain tests.[8] Fourth, the tests may actually overestimate visual acuity in patients with amblyopia.

Figure 3. Psychophysical tests: (a) Snellen letters, (b) tumbling E game, (c) HOTV test, (d) Landolt ring test, (e) LEA figures, (f) Allen figures, (g) single optotypes surrounded by crowding bars.

With Allen card testing, the child is presented with a single picture optotype, typically of 20/30 size. The examiner starts at a close distance to the child and progressively moves farther away until the child can no longer identify the figures that are shown to her. Visual acuity is recorded as the maximum distance the examiner is from the child when she is last able to identify the Allen figures over the denominator of the optotype. If the child is able to identify the 20/30 optotype at 6 feet with her right eye, for example, her vision would be recorded as: "Allen Card Vision" 6/30, right eye.

Directional Optotype Tests

The tumbling E game is a very accurate test, but many children have difficulty with the E game due to a poor understanding of laterality (i.e., right versus left) and/or poor coordination because the test requires the child to point in the direction that the E is pointing.[6,8] An excellent way to overcome childhood problems of laterality and coordination is to change the E game from a 4-choice test to a 3-choice test. Fewer children have a problem determining if the E points "up," "down," or "to the side."[13] Using a 3-choice test not only avoids the problem of laterality, but allows the child to verbalize his response more easily, instead of pointing. Despite having only three alternatives, the test is still very accurate. If three consecutive correct responses are given, there is less than a 1 in 20 chance that the child was guessing. If four consecutive correct responses are given, the chance is less than 1 in 100 that he was guessing.[13] Landolt rings and other psychophysical tests that use a directional optotype may also be converted to a 3-choice test.

Matching Tests

Sometimes children are unwilling or unable to communicate verbally. When this problem is encountered, a matching test may be utilized. An example of a matching test is the HOTV chart, in which the child points to the correct letter on a sample page containing the four test letters. The tumbling E game, Landolt rings, Allen chart, and LEA chart can also be used in a matching mode. Matching tests are particularly useful for shy children or children with a speech problem. It is helpful to give the parents directions for teaching the test to the child, along with a copy of the test optotypes to use for practice at home. This allows the child to become familiar with the test before he returns for a follow-up vision evaluation.

Figure 4. Child being tested with occluder.

Interacting With Parents

Parents are often apprehensive during the vision testing process. Relieving parental fear and apprehension will make the testing process easier for the examiner and more comfortable for the child. Parents should be asked not to critique their child or to get worried during vision testing. Let parents know ahead of time what you will be doing, and tell them why you are doing it. Parents should be discouraged from making comments such as "Why can't you see that?" "He can't see those big letters?" Such statements are discouraging for the child and complicate the testing process. Parents should praise and encourage their child as you do. If your office uses a mirrored lane system, parents are often positioned so they can see the reverse image of the projected eye chart on the back wall. The letters look large from the parents' perspective, and they often become very concerned when their child is having difficulty reading these seemingly large letters. When you sense discomfort, explain to the parents that the image their child sees is much smaller than the image they see, thus relieving their anxiety. Avoid overexplaining vision testing results to parents. Interpretation should be left to the ophthalmologist. Premature interpretation of vision testing results can cause great discomfort for everyone involved, particularly if the interpretation turns out to be wrong.

Avoiding Testing Artifacts

Peeking

Children are motivated to do a good job, and in an effort to do so, they often squint, peek, or memorize. Peeking is a common problem and can be easily overlooked if the examiner is not cautious. If a handheld occluder is used to cover the nontested eye, when the examiner turns his or her head to check the eye chart, the child may peek around the occluder. The examiner can be easily fooled into thinking the child sees better than he actually does. Great care should be taken to ensure that the occluder stays in place. Do not let the child use his hand as the occluder, but the palm of a parent's hand can be used if all else fails. The surest method to ensure that the child does not peek is to simply place a patch over the eye that is not being tested.

Memorization

The examiner cannot prevent a child from memorizing a row of optotypes, and it does little good to ask a child not to memorize. In fact, asking may seed the idea in the child's head. Several simple maneuvers can be used to help overcome memorization artifact.

For example, the child can be asked to read the optotypes backward, and most of the time this will thwart his memorization effort. Another method is to cover the first optotype on the row so that the row starts with a different letter, thus fooling the child into believing that a new row of optotypes has appeared. Currently, there are several computer generated eye chart systems that help prevent memorization. The Mentor® BVAT, the M&S Vision Testing System®, and the Haag-Streit® Machine are all effective systems that completely eliminate the possibility of memorization.

Crowding Phenomenon

It is important to be sure that all patients seen in your clinic are examined the same way by all physicians and staff. Systematic differences in vision assessment between examiners can influence the interpretation of clinical exam findings and treatment. It is recommended that all clinic staff use the Amblyopia Treatment Study (ATS) protocol* which outlines a prescribed, proven method for examining children and minimizes differences in vision assessment due to interexaminer variability.

One of the most important reasons for testing vision in young children is to detect the presence of amblyopia at an age when treatment can be successfully instituted. Amblyopia can be easily overlooked if the examiner is not cautious. An amblyopic eye will achieve a better visual acuity when tested using isolated optotypes than when tested using a full row of optotypes.[13] For example, a child with amblyopia may be able to read the 20/25 line when presented with isolated optotypes, but only achieve 20/70 vision when a full row of optotypes is used. This is known as the crowding phenomenon. Obviously, this testing artifact can be eliminated by presenting a full row of optotypes. The advantage, however, of presenting an isolated optotype is that the test is easier for some children to understand. Isolated optotypes can still be useful provided that special adaptations are utilized. The use of contour interaction bars (crowding bars), for example, induces the crowding phenomenon while still allowing the examiner the advantage of presenting a single optotype[8] (Figure 3). To induce the crowding phenomenon when testing with Allen cards, three cards can be held in a row, and the examiner can point to the center card for identification.

Nystagmus Artifact

Nystagmus is a rhythmic to and fro movement of the eyes that can be horizontal, vertical, rotary, or a combination of these. Nystagmus can be manifest (present all the time) or latent (present only when one eye is covered). Vision is always decreased when nystagmus is present. Interestingly, near vision may be better than the distance vision in children with nystagmus. Therefore, in patients with nystagmus, near vision, as well as distance acuity, should always be tested. Many children with manifest nystagmus can improve their vision by adopting an abnormal head posture. The improvement occurs because the child's nystagmus may be dampened when the eyes are directed in a particular field of gaze (i.e., up gaze, side gaze, and so on). This quiet eye position is known as the null point. Patients with manifest nystagmus should have visual acuity tested with both eyes open and with each eye individually. Vision should be assessed with the child's head erect and with the child's head in the preferred abnormal head posture. For a patient with a left face turn, for example, vision might be recorded as follows:

Vision tested with both eyes open:

With head straight:	20/80
With head turned to left:	20/25

Vision should then be tested with each eye separately, and the head posture that the patient automatically uses should be noted.

With latent nystagmus, the eyes are quiet and motionless when both eyes are open. When one eye is covered, nystagmus develops and visual acuity worsens. Patients with latent nystagmus should first have visual acuity tested with both eyes open, and any abnormal head posture should be noted. Vision should then be tested with each eye separately, by using a +10.00 lens instead of an occluder or patch. This technique is known as fogging. Fogging blurs the image in the nontested eye but does not induce latent nystagmus, thus allowing monocular acuity to be more accurately assessed.

Vision testing results should be recorded in the medical record as in the following example:

Both eyes open:	20/20
Right eye:	20/30 (+10.00 fogging lens)
Left eye:	20/30 (+10.00 fogging lens)

Near Vision Testing

Near vision is not routinely tested in the pediatric population; however, anytime there has been a decline in educational or school performance, a near vision evaluation should be performed. Other complaints that should trigger testing of near vision include complaints of reading difficulties, asthenopia (eye train), headaches, double vision, blepharospasm, and complaints of blurred or distorted near vision. Testing of near vision is done in a manner similar to distance vision testing. A near vision testing card is used to present optotypes that have been scaled down in size. In preliterate children, a card with pictures or multidirectional optotypes such as the tumbling E game or Landolt rings can be used, whereas a letter or number card can be used with literate children. When testing near vision, it is important to hold the card at the appropriate testing distance. This distance will be printed on the card itself and is usually 14 inches from the eye. Testing near visual acuity at any point other than the proper test distance yields uninterpretable data unless the distance at which the test was actually performed is stated in the medical record. Generally, near vision should be tested first with both eyes open, then with each eye individually. A strategy similar to that discussed for distance vision testing is utilized, and the child should not be asked to read every row of optotypes on the card. Fogging techniques, instead of occlusion, will be needed if latent nystagmus is present.

Vision Testing in Children With Special Needs

"Children with special-needs," for the purposes of this module, include children with known or suspected visual impairment and children with concurrent neurological abnormalities such as cerebral palsy and developmental delay. When such a child is brought to the office for ophthalmological examination, there is often great parental anxiety that the child may be severely visually impaired or even blind. The examiner should be aware of these concerns. The goals of vision testing in this special group of children is to determine first if the child sees, and then to attempt to estimate the level of vision present. A team approach with involvement of the child's parents, teachers, primary-care physician, neurologist, ophthalmologist, counselor, and others who can provide information about the child's past visual performance is important. Multiple measures of visual function are usually necessary, and may include assessment of visual acuity at distance and near, contrast sensitivity, visual fields, color vision, accommodation, oculomotor function, and refraction.[16]

A "one-size-fits-all" approach is rarely successful with special-needs children. The examiner should have an understanding of the child's basic medical disorder and its effect on behavior. A child with attention deficit disorder, for example, will require special handling if an accurate vision assessment is to be made. If the child is on medications, the effect of the medications should be kept in mind and the examination done during the child's peak functional time of day. Knowing the child's previous experience with vision testing and ophthalmological examination is also useful, allowing the examiner to take advantage of previously-successful techniques while avoiding unsuccessful ones.

Observation

There are several important clinical signs that indicate the possibility of severe visual impairment. Manifest nystagmus always indicates the presence of a visual disorder and may occur because of abnormalities of the eyes, optic nerves, or brain. Nystagmus, therefore, provides an immediate clue that the child has a vision problem. In severely visually impaired children, certain behaviors, known as blindisms, may be seen.

Examples of blindisms include repeated poking of the eyes (oculo-digital reflex), repetitive rocking of the head or trunk, and repetitive hand waving. Blindisms tend to be monotonous and repetitive and are most common in very young children who are severely visually impaired.

Testing

Several rudimentary tests of vision can be used to screen special children when other measures fail. A bright penlight, for example, can be directed into either eye. The child should close his eyes and/or withdraw. If the child ignores the light, there may be cause for concern. An indirect indication that the anterior portion of the visual system is working is the presence of a normal pupillary light response. If the pupil constricts to light, this indicates that the afferent and efferent anterior visual pathways are intact, and increases the likelihood that the child sees. However, it should be noted that children with cortical blindness may have normal pupillary responses, so the test must be interpreted with caution. The threat response is very useful in selected children. The threat response is a learned reflex in which a child withdraws when an object such as the examiner's hand is rapidly moved into the child's visual space. This test can be helpful in children older than six months and indicates the presence of at least rudimentary vision. The test is not reliable in younger children.

The vestibulo-ocular reflex (VOR) is a normal reflex in all humans with an intact neurological system. Spinning a child stimulates the semicircular canals in the inner ear and causes a temporary nystagmus to develop. The presence of this normal reflex can be used to help assess the presence or absence of vision.

A child with vision will inhibit VOR nystagmus within 3 to 5 seconds after body rotation has ceased. A blind child, on the other hand, will often continue to have nystagmus for 15 to 30 seconds following cessation of body movement. The presence of prolonged nystagmus following a VOR test indicates the possibility of severe visual impairment.[17]

An optokinetic drum is a simple device with a recurring pattern of white and black stripes. The drum can be rotated in the child's visual space and should stimulate the development of nystagmus. An optokinetic drum with thick stripes tests for the presence of gross vision (i.e., 20/400). Accurate assessment of more refined visual acuity can be done by using drums with thinner stripes. A negative test can occur in a child who lacks interest or in a child who does not have normal ocular motor function.[18] In addition, some children may develop optokinetic nystagmus even in the absence of a normal visual cortex, presumably due to the presence of other vision-related neural pathways.[18]

Specialized Tests

The importance of a comprehensive eye examination for every pediatric patient cannot be overemphasized. Sometimes, the office eye examination is not sufficient to determine how well a child sees. A special test, known as a visual evoked potential (VEP) test, can be used when other measures fail to provide the necessary answers. Although a detailed discussion of the VEP is beyond the scope of this module, the test, in general, involves presenting patterned targets (e.g., checkerboards) to the child via a television monitor. Electrodes placed on the child's scalp, over the occipital lobes of the brain, detect electrical changes in the visual cortex that occur in response to the patterned visual stimuli. Analysis of the electrical patterns produced allows an estimation of the child's visual acuity and can be very accurate. When a VEP test is used to estimate visual thresholds in humans and animals, there is close agreement with psychophysical test results.[19] Caution must be used in interpreting the VEP, however, because variation in laboratory technique can alter the results, and because a normal VEP may occasionally occur in the absence of a functioning visual cortex.

Summary

Vision testing in the pediatric population requires patience, understanding, and skill with a variety of testing techniques. An assessment of visual performance can (and should) be made in children of all ages, including newborn babies. Experience and practice allow the examiner to determine if the child's visual response is representative of children of a similar age or if the response is abnormal. Visual acuity can often be assessed accurately even in special children who are visually or neurologically impaired. Experience and careful technique can lead to satisfactory and accurate vision testing results.

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Notes

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Examination Questions

The following self-examination questions were designed to meet the learning objectives for this module. To receive 1 continuing education (CE) credit from JCAHPO for this module, you may have no more than two incorrect answers. Complete the enclosed answer sheet, including the evaluation section and the address block, and return it to JCAHPO in the envelope provided. Those who answer the examination questions successfully will receive a certificate of completion. Fill in the code for this module on the answer sheet in one of the places shown. **Code: 0001**

1 What is the incidence of amblyopia in the preschool age group?

a. 50–60%
b. 10–15%
c. 2–5%
d. Less than 1%

2 Regarding assessment of vision in a normal child less than 6 weeks of age:

a. vision should not be assessed.
b. assessment of fixation behavior is usually possible.
c. Allen figures should be used.
d. a penlight makes a good fixation target.

3 All of the following should raise suspicion for the presence of a vision/eye problem except:

a. a family history of childhood eye diseases.
b. the child's mother is not sure he sees as well as his siblings.
c. the child passed the school vision test.
d. the child squints.

4 Which of the following are important considerations in improving the success of vision testing in pediatric patients?

a. proper office setting
b. proper testing equipment
c. developing a good rapport with the child and allowing the child to have fun
d. maintaining control of the exam and examination environment
e. all of the above

5 Each of the following is a test to detect an inequality of vision between the eyes in a preverbal child except:

a. Differential occlusion test.
b. Prism and cover test.
c. Vertical prism test.
d. Fixation preference test.

6 Which statement regarding infant visual fixation and following reflexes is true?

a. the human face is an ideal target for infants less than 3–4 months old.
b. horizontal following movements are easier to test.
c. infant fixation movements may appear uncoordinated.
d. all of the above.

7 Each of the following is useful in testing the vision of preliterate children except:

a. Tumbling E game
b. Landolt ring chart
c. Snellen chart
d. Allen chart

8 Each of the following statements regarding psychophysical acuity testing is true except:

a. children will avoid memorizing the eye chart if asked not to.
b. children frequently peek during vision testing.
c. testing with isolated optotypes may overestimate visual acuity in children with amblyopia.
d. a fogging lens should beused to test the visual acuity of a child with latent nystagmus.

9 Amblyopia may be associated with each of the following except:

a. decreased vision even when wearing accurate spectacles
b. better visual acuity when using a row of optotypes
c. strabismus
d. better visual acuity when testing with isolated optotypes
e. taking steps to prevent the child from memorizing the eye chart

10 **Special consideration for vision testing in pediatric patients include all of the following except:**

a. Recognizing and understanding the crowding phenomenon.
b. Recognizing the effect of latent nystagmus on vision testing.
c. Using an eye chart with special colors to better attract the child's attention.
d. Recognizing problems with peeking and how to avoid them.
e. Taking steps to prevent the child from memo rizing the eye chart.

11 **Near vision should be tested in any child with one or more of the following:**

a. Decline in educational/school performance
b. Reading problems
c. Asthenopia (eye strain)
d. Blurred vision at near
e. All of the above

12 **All of the following may be signs of severe visual impairment except:**

a. Nystagmus
b. Smiling inappropriately
c. Repetitive hand waving
d. Repetitive poking of eyes (oculo-digital reflex)
e. Repetitive rocking of head or trunk