NCC Pediatrics Continuity Clinic Curriculum: **Health Maintenance II**

Overall Goal:

To understand the recommended screening procedures utilized in the health maintenance of children.

Overall Objectives:

Over last week's and the next two weeks' modules, residents will become familiar with the AAP Recommendations for Preventive Pediatric Health Care, as outlined in the Periodicity Schedule © 2008.

The Periodicity Schedule includes the following screening procedures, some of which was covered in these 3 consecutive modules, and some of which will be covered in upcoming continuity modules:

1) Measurements:
    a. Length, Height, Weight, HC, BMI: *Health Maintenance I*
    b. Blood Pressure: *Hypertension Module (spring)*
2) Sensory Screening:
    a.* Vision: *Health Maintenance II
    b.* Hearing: *Health Maintenance II
3) Developmental/Behavioral Assessment:
    Behavior I, II, III & Development I, II, III (29 Aug-17 Oct)
4) Procedures:
    a. Newborn Metabolic/Hemoglobin: *Health Maintenance I*
    b. Immunization: *Immunizations Module (8 Aug)*
    c. Hematocrit or Hemoglobin: *Health Maintenance III*
    d. Lead: *Health Maintenance III*
    e. Tuberculosis: *Health Maintenance III*
    f. Dyslipidemia: *Health Maintenance III*
    g. STIs: *Adolescence I & II (28 Nov, 5 Dec)*
5) Oral Health: *Dental Health Module (7 Nov)*

NCC Pediatrics Continuity Clinic Curriculum:
Health Maintenance II

Pre-Meeting Preparation:

Please read the following enclosures, corresponding to the screening procedures:

1) Sensory Screening:
    - ***a.*** Vision: **"Vision Screening Essentials" (Peds-in-Review)**
    - ***b.*** Hearing: **"Pediatric Hearing Screening"**

*** Please bring a hand-held ophthalmoscope to clinic if you have one.**

Conference Agenda:

Objective: *To recognize the most common procedures used in pediatrics for Sensory Screening. Please note that residents will receive dedicated lectures on pediatric ophthalmology and pediatric audiology. The purpose of this module is to become familiar with the main modalities.*

- Review **Health-Maintenance II Quiz**
- Complete the following activities, corresponding to the screening procedures:
    1) Vision Screening:
        a. Snellen Eye-Chart
        b. Corneal light reflex
        c. Cover-Uncover
    2) Hearing Screening:
        a. Conventional audiometer
        b. Tympanometry
- Review additional questions or comments from the Pre-Meeting Prep Materials.

Extra-Credit:

Review these AAP clinical practice guidelines, corresponding to the listed screening procedures:

1) Sensory Screening:
    - ***a.*** Vision: Red Reflex Testing; Vision Screening
    - b. Hearing: Hearing Screening Clinical Report; Hearing Screening Policy Statement

Article eye

Vision Screening Essentials:
Screening Today for Eye Disorders in the Pediatric Patient

Donald H. Tingley, MD*

Author Disclosure
Dr Tingley did not disclose any financial relationships relevant to this article.

Learning Objectives
After completing this article, readers should be able to:

1. Discuss the role of early intervention for vision-threatening problems.
2. Explain how to screen patients for the most common vision problems.
3. Recognize when to screen for vision problems.
4. Describe who should be screened for vision problems.

Introduction

Screening for eye disorders and vision problems is essential in preparing pediatric patients for the future. For this reason, regular vision evaluations are recommended by the American Academy of Pediatrics (AAP).

Significant problems affecting vision are common in children. Vision problems occur in 5% to 10% of all preschoolers and include refractive error, strabismus, and amblyopia. Strabismus is present in 4% of preschool-age children, and amblyopia affects up to 40% of those having strabismus. Major refractive errors requiring correction occur in 5% to 7% of preschool-age children. Cataracts in children are far less common (0.1% incidence), but vision can be affected seriously without early treatment. A simple screening can check effectively for such problems during a time when treatment is most critical without requiring all patients to have a "gold standard" complete eye evaluation at every age, saving both time and health-care resources.

Screening improves visual acuity. In a randomized, longitudinal study, intensive early screening led to a 60% decreased prevalence of amblyopia and improved visual acuity compared with a one-time screening at 37 months of age. (1) Amblyopia responds to therapy, and results are best when treatment is started early in life. The same study showed a 70% lower prevalence of residual amblyopia after treatment when therapy was initiated before age 3 years. The single most effective screening test for the presence of amblyopia is the determination of visual acuity via noninvasive screening.

The consequences of not finding vision-related problems can include adverse effects on school and social performance as well as adult self-image. Further, uncorrected amblyopia is a risk factor for total blindness if the better eye is injured later.

Common Vision Problems

Refractive error is a term describing focusing problems that usually can be treated with glasses or other optical intervention. Such problems include myopia (nearsightedness), hyperopia (farsightedness), and astigmatism. Most children normally have mild hyperopia and can focus their eyes with minimal accommodative effort. High amounts of hyperopia can make eye alignment difficult when significant focusing effort is required, resulting in accommodative esotropia, a common form of strabismus (Fig. 1).

Strabismus is defined as a misalignment of the eyes, either as a full-time occurrence (tropia) or as a tendency to become misaligned (phoria). Various prefixes are used to describe the relative direction of the misaligned eye's deviation, such as "eso" for an adducting (inward) tendency (Fig. 2) and "exo" for an abducting (outward) tendency. Strabismus often must be differentiated from pseudostrabismus, which is the appearance of a misalignment of the eyes without actual strabismus present (Fig. 3). Pseudostrabismus occurs most commonly when a broad nasal bridge covers the nasal sclera of one or both eyes, resulting in an appearance of esotropia.

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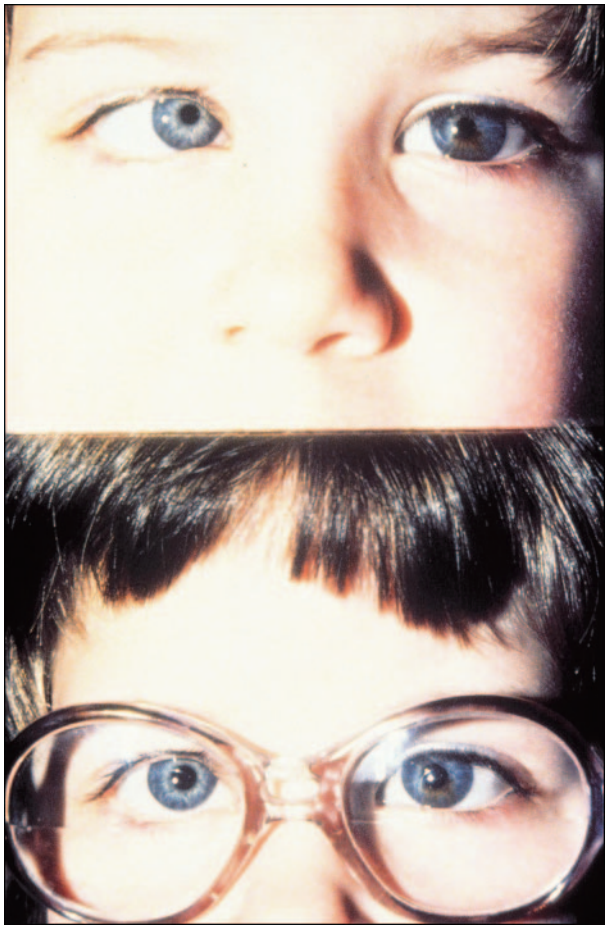

Figure 1. Accommodative esotropia in a child who has a high hyperopia (top). The use of glasses relieves the accommodative effort of focusing, particularly at near objects, resulting in improvement of the induced esotropia (bottom). Photo courtesy of the American Academy of Ophthalmology.

Amblyopia is a loss of visual acuity due to active cortical suppression of the vision of an eye and can occur from a variety of causes. Strabismic amblyopia occurs with misalignment of an eye and suppression of one eye to avoid diplopia. Anisometropic amblyopia occurs when one eye has a different length from the other, resulting in a different focusing ability, that limits the ability of the eye to provide appropriate visual information to the brain. Deprivational amblyopia is a result of not using an eye, as from an extended eyelid closure from a hemangioma or a dense congenital cataract.

Cataract is an opacification of the eye lens. Cataracts affect the clarity and interpretation of the image in the developing eye and can have a significant impact on future visual potential by causing deprivational amblyopia.

Figure 2. Esotropia in a child. Covering the fixing right eye can detect if the left eye is being used equally as well as the right eye. If the left eye holds fixation as well as the right eye, no significant amblyopia is yet present. Additional evaluation as to the cause of the strabismus is warranted. Photo courtesy of the American Academy of Ophthalmology.

Screening for the Common Problems

The AAP's vision screening guidelines provide a basis for detecting vision problems at a time when improvement is possible. The methods for screening have been well presented in published sources and are described here briefly. (2)(3) Photoscreening, automated refraction, and electrophysiologic testing may offer opportunities to improve screening methods in the future. (4)(5)

Evaluation of visual function is best initiated at birth with the use of an ophthalmoscope to check if the light reflex in each eye is equal in brightness and color. If a defect in the light reflex is present, the baby might have a cataract, one of the most significant problems with vision that can be detected readily at birth. Variations between the eyes in color or brightness can indicate refractive error in one or both eyes and the need to correct the eyes with glasses early in life (Fig. 4). Retinoblastoma classically causes a white reflex on evaluation (Fig. 5), and this tumor must be considered on any evaluation of the red reflex. However, it is far less common than other causes of a white reflex, including refractive error. Referral to an ophthalmologist for additional evaluation is appropriate if findings are abnormal.

The red reflex test uses the ophthalmoscope with the lens selection on "0" diopters. This device provides illumination directly in line, or coaxial, with the line of sight. Thus, when viewing a normal eye, an orange-to-red light reflection from the fundus is seen filling the

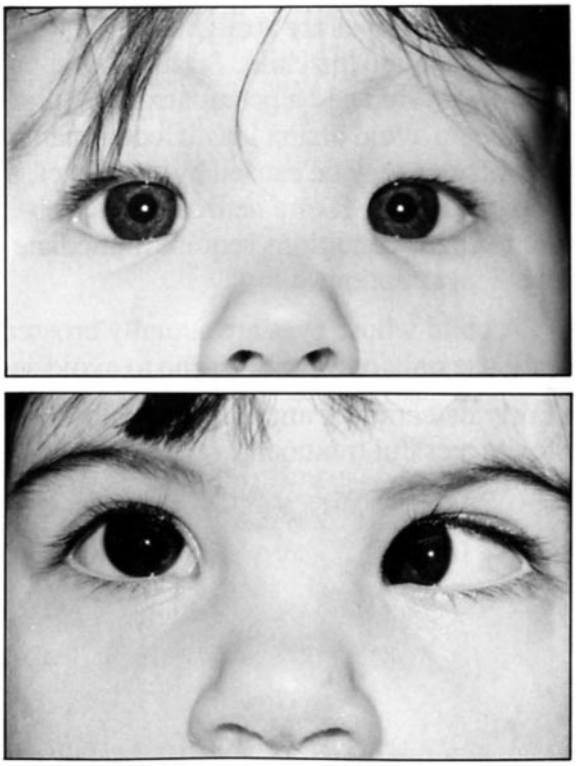

Figure 3. Pseudostrabismus (top) versus true strabismus (bottom). Although the eyes appear misaligned in pseudostrabismus, the light reflection is symmetric in both eyes. In true strabismus, the light reflection is asymmetric. Photos courtesy of the American Academy of Ophthalmology.

Figure 4. Asymmetric red reflexes. This patient shows a variation in color between the eyes, and evaluation revealed a difference between the eyes in focusing, a condition known as anisometropia. In the author's clinical experience, anisometropia is the most common cause of red reflex asymmetry. Anisometropia can cause a significant amblyopia if not detected early by either red reflex testing or visual acuity testing. This child did well with glasses correction. Photo courtesy of the American Academy of Ophthalmology.

pupil. The light should be equal in color and brightness from each eye and fill the pupil completely. Variation between the eyes in any of these aspects is a reason for referral to an ophthalmologist.

Funduscopic evaluation can be difficult to perform without patient cooperation and can be performed more reliably around the age of 3 years per AAP recommendations. Nevertheless, funduscopy can be undertaken in a somnolent infant after the rapid red reflex evaluation is completed.

Ophthalmoscopic evaluations can detect congenital glaucoma, nystagmus, and other visually significant disorders. Direct ophthalmoscopy uses the light on the dimmest setting that still allows visibility for the examiner and requires the examiner to be close enough to the eye so his or her fingers graze the patient's cheek. The clinician should evaluate the structures that are visible throughout the range of lenses from the high plus lenses (black or green numbers) to evaluate anterior structures of the eye to the progressively more minus lenses (increasing red numbers). This procedure allows evaluation of eye structures from anterior to posterior (Fig. 6). Direct ophthalmoscopy can evaluate the retina well and determine the presence of dilated disc vessels of active retinopathy of prematurity (ROP) (Fig. 7). Referral for additional evaluation is recommended for preterm infants to determine the presence of significant ROP and also is needed for patients who have a family history of amblyopia, strabismus, retinoblastoma, retinal degeneration, or systemic disease affecting the eye.

Vision Testing Methods

Defects in visual function may be found at the first evaluation. Ideally, a vision test should allow an examiner to confirm the resolution achieved at the cortical level at any age when the visual system is in use in regular activities, allowing determination of whether each eye is working well. However, technology in visual science has not yet reached that level of sophistication. Currently, clinicians can judge the response of each eye to the same visual stimulus, evaluating for any asymmetry.

A light stimulus should elicit equal wincing behavior from each eye in an alert infant. Infants occasionally fixate

Figure 5. Asymmetric red reflexes, with a yellow right eye reflex and red left eye reflex. This finding led to the early diagnosis of retinoblastoma growing in the right eye. Photo courtesy of the American Academy of Ophthalmology.

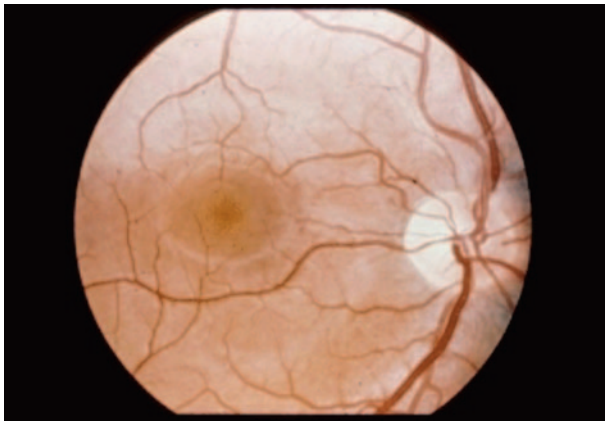

Figure 6. Normal anatomy of the right fundus. Photo courtesy of the American Academy of Ophthalmology.

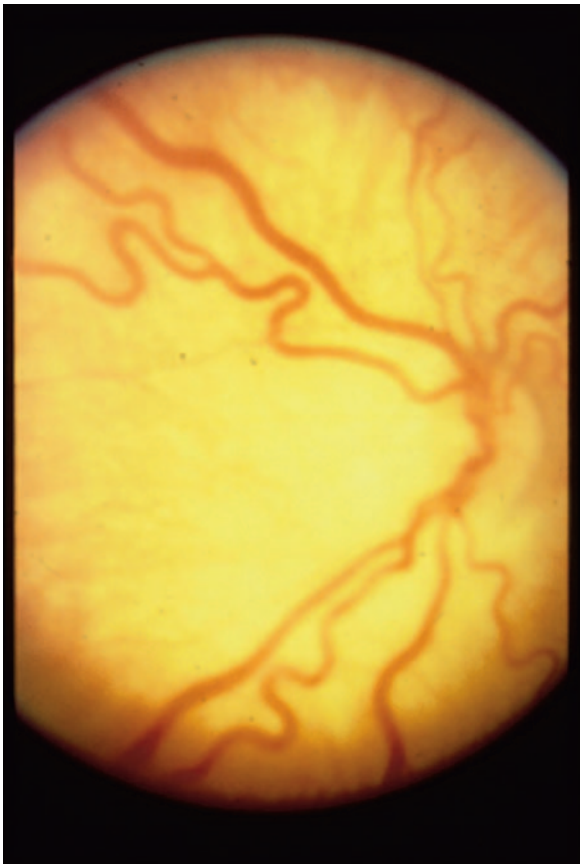

Figure 7. Retinopathy of prematurity (ROP). Note the dilated veins and tortuous arteries in this right eye of an infant who has active ROP. This is known as plus disease and is associated with rapid disease progression. Photo courtesy of the American Academy of Ophthalmology.

momentarily on a high-contrast object or a human face and should do so equally well from either eye. Unfortunately, newborn visual ability is difficult to determine with accuracy. Current understanding of visual acuity in healthy newborns, based on a variety of techniques, suggests acuity of 20/400 at 1 month of age. (6) Mean visual development milestones are listed in Table 1. (7) Both eyes begin to work to fixate together on the same

Table 1. Normal Vision Development

Function	Age
Visual fixation present	Birth
Fixation well developed	6 to 9 wk
Visual following	3 mo
Accommodation	4 mo
Stereopsis	4 mo

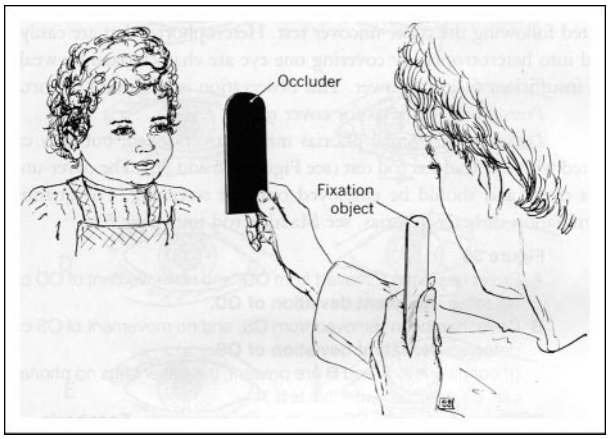

Figure 8. Cover test examination. Reprinted with permission from von Noorden G, ed. *Atlas of Strabismus*. 4th ed. Philadelphia, Pa: Elsevier; 1983.

object at 6 to 9 weeks. Tracking or visual following with both eyes can occur earlier but should be present by 3 months age.

Age-appropriate acuity testing uses instruments that require increasing cognitive ability, ranging from recognizable cartoon pictures (Allen test) or symbols of readily identifiable shapes (LH test) for ages up to 3 years, to choosing which of four letter shapes are presented (HOTV test) or which direction a letter E is pointing (tumbling E test) for ages up to 5 years, to Snellen letters or numbers for ages 5 years and older. The best test for checking acuity is the highest level that the child can complete. Testing is performed at the appropriate distance for the chart used (usually 10 ft), with a line of figures presented at one time. One eye is tested, with the examiner making all efforts to occlude by a patch or wide eye cover the opposite eye at all times, thus avoiding inadvertent "peeks." Differences of two lines of visual acuity between the eyes or vision less than 20/40 acuity in either eye require referral for additional evaluation.

Cover Testing: Identifying Tropias and Phorias

The terms tropia and phoria refer to degree of eye deviations. Tropias define a condition of full-time eye misdirection; phorias define a tendency for the eye to turn when disturbances in binocularity occur, such as when one eye is covered. The cover test is used to distinguish the two conditions. Cover testing one eye at a time can detect a tropia in the other eye because by definition, a tropia is present at all times and does not allow simultaneous alignment of both eyes on the same target. A phoria is detected by observing the covered eye just as it is uncovered; a phoria is present only when binocularity is disturbed.

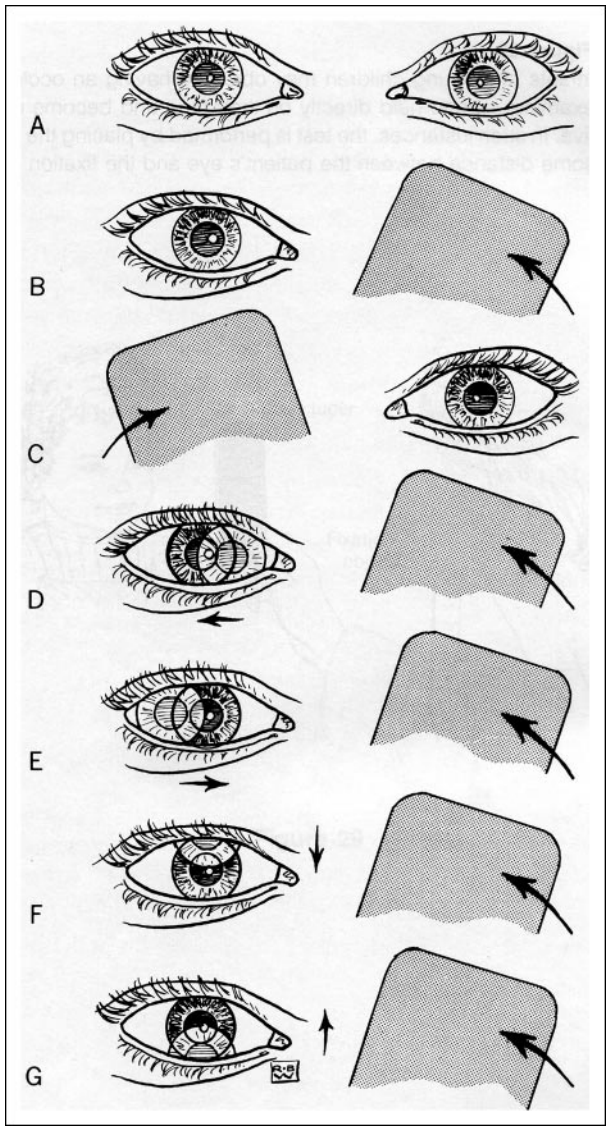

Figure 9. Cover test findings. A. Normal, B. Normal, C. Normal, D. Right esotropia, E. Right exotropia, F. Right hypertropia, G. Right hypotropia. Reprinted with permission from von Noorden G, ed. *Atlas of Strabismus*. 4th ed. Philadelphia, Pa: Elsevier; 1983.

The cover test is performed by covering one eye at a time and observing the eyes for movement as the eye is being covered while the patient observes a fixation target, such as a human face, a small toy, or an attractive picture (Fig. 8). When a child is observing the target and the cover is placed, the uncovered eye should not move; it should not have to move to look directly at the object of

Figure 10. Pseudostrabismus. The light is centered in the pupil of each eye. This is normal eye alignment regardless of the asymmetry in the white sclera visible. Photo courtesy of the American Academy of Ophthalmology.

regard. If the uncovered eye does have to move to look at the target, a tropia is present and is named according to the position of the original deviated position. However, if only the covered eye moves back from a deviated position when uncovered to fixate again on the target, a phoria is present. If the affected eye is deviated toward the nose, an esotropia or esophoria is present. If the eye is deviated away from the nose, it is manifesting an exotropia or exophoria. If the eye is deviated upward, a hypertropia or hyperphoria is present, and if the eye is deviated downward, it is affected by a hypotropia or hypophoria (Fig. 9).

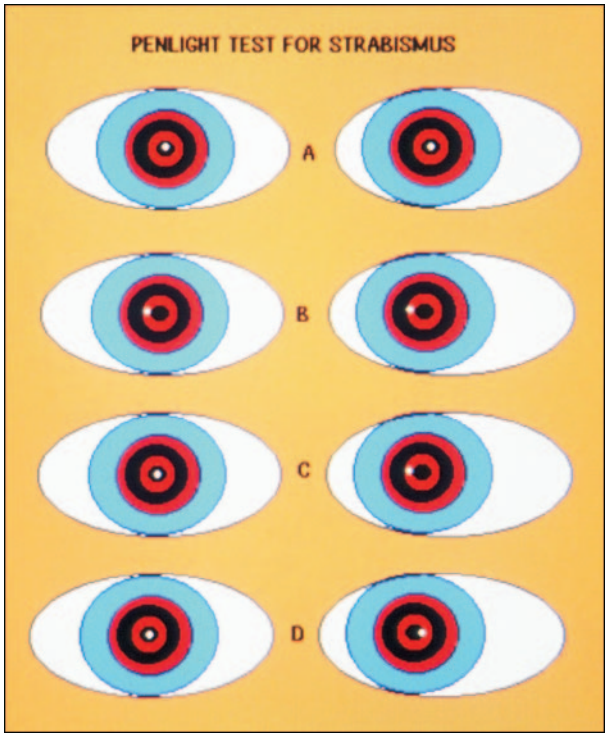

Figure 11. Corneal reflex test. A. Normal, B. Normal, examining light is directed from patient's right side. C. Left exotropia. D. Left esotropia.

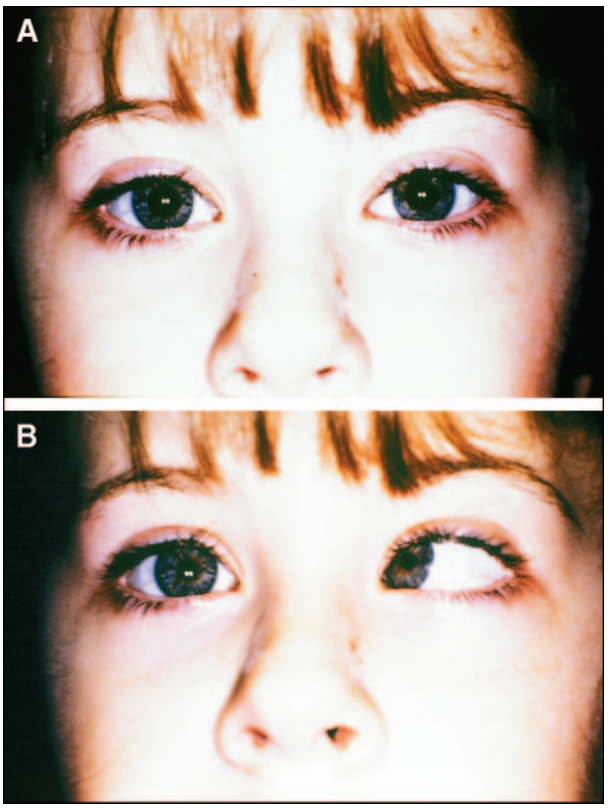

Figure 12. A. Patient evaluated for strabismus by using a penlight at near exhibits a normal corneal reflex test result. B. By using a small target that requires effort to focus, accommodative esotropia becomes apparent. Photo courtesy of the American Academy of Ophthalmology.

The biggest difficulty in preforming a cover test occurs when fixation cannot be sustained reliably for the duration of the test. A visually attractive target is essential to obtaining reliable fixation, and the appropriate object varies by the age of the patient. The face of the examiner can be most attractive to an infant, whereas a small finger puppet or interesting picture might be more attractive to an older child. Results can be interpreted only when fixation is present; a voluntary change in fixation while the eye is covered can be interpreted falsely as either a tropia or a phoria.

Distinguishing Pseudostrabismus

As mentioned, an infant's facial anatomy can be misleading when evaluating the eyes for alignment. The immature nasal bridge often is broad enough to cover the nasal sclera of either eye, and parents may interpret such asymmetry of the amount of white visible about either eye as

Table 2. Pediatric Eye Evaluation Screening Recommendations for Primary Care Providers, Nurses, Physician's Assistants, and Trained Lay Personnel*

Recommended Age for Screening	Screening Method	Criteria for Referral to an Ophthalmologist
Newborn	Red reflex†	Abnormal or asymmetric
To 3 mo	Inspection	Structural abnormality
6 mo to 1 year	Fix and follow with each eye	Failure to fix and follow in cooperative infant
	Alternate occlusion	Failure to object equally to covering each eye
	Corneal light reflex	Asymmetric
	Red reflex	Abnormal or asymmetric
	Inspection	Structural abnormality
3 y (approximately)	Visual acuity‡	20/50 or worse or 2 lines difference between the eyes
	Corneal light reflex cover-uncover	Asymmetric/ocular refixation movements
	Red reflex	Abnormal or asymmetric
	Inspection	Structural abnormality
5 y (approximately)	Visual acuity	20/40 or worse or 2 lines of difference between the eyes
	Corneal light reflex	Abnormal or asymmetric
	Stereoacuity	Failure to appreciate stereopsis
	Red reflex	Abnormal or asymmetric
	Inspection	Structural abnormality
Older than 5 y	Visual acuity	20/30 or worse or 2 lines of difference between the eyes
	Corneal light reflex/ cover-uncover	Asymmetric/ocular refixation movements
	Stereoacuity§	Failure to appreciate stereopsis
	Red reflex	Abnormal or asymmetric
	Inspection	Structural abnormality

* From American Academy of Ophthalmology Preferred Practice Pattern.
† Physician or nurse responsibility.
‡ Figures, letters, "tumbling E" or optotypes.
§ Optional: Random Dot E Game, Titmus Stereograms (Titmus Optical, Inc, Petersburg, Va.), Randot Sterograms (Stereo Optical Company, Inc, Chicago, Ill.).

evidence of eye misalignment. Pseudostrabismus is the appearance of eye misalignment when, in fact, no strabismus is present (Fig. 10). There is no strabismus if a cover test does not detect any, although sufficient fixation can be problematic when evaluating an infant.

The corneal reflex test is helpful to differentiate strabismus from pseudostrabismus if fixation is poor. The corneal reflex test is performed with an ordinary penlight held more than 18 inches from the child while the child either is observing the light or looking in its general direction. The light reflecting off the cornea, known as the corneal reflex, should be essentially central in the pupil. If the reflex does not appear to be central in the pupil, but is deviated to the periphery of the pupil or further, a strabismus is present until proven otherwise (Fig. 11).

Problems with a penlight test include missing a small or intermittent strabismus and the procedure not being helpful if a child is not alert enough to allow any fixation. Most actual eye deviations in a preverbal child are large, allowing differentiation with this method. Intermittent strabismus can be present, but this phenomenon occurs most commonly in children 2 to 4 years of age, when accommodative effort starts to cause esotropia with near fixation effort, known as accommodative esotropia. Accommodative esotropia can be detected with a corneal reflex test by using a small target for fixation, such as the eyes of a finger puppet or the number on a pencil, while determining the corneal light reflex position (Fig. 12).

When to Screen

Guidelines endorsed by the AAP recommend visual assessment at birth and at all subsequent routine health supervision visits. Anatomy and gross visual assessments should be checked from birth to 3 years of age, about the age when visual acuity can be measured reliably and ophthalmoscopy can be attempted. Vision should be assessed whenever there is a complaint about vision (Table 2).

Who Should Be Screened

All patients should be evaluated at the youngest possible age. Frequent assessments in those younger than age 3 years result in improved visual outcomes. Patients who have a family history of strabismus, amblyopia, congenital glaucoma, or retinal diseases clearly benefit from close observation and referral if screening warrants it. Patients who have developmental delay are at high risk of having a coexistent visual difficulty. Patients who have Down syndrome are at higher risk for vision-related difficulties, including refractive error, strabismus, and cataract. Preterm infants are at risk for ROP, requiring retinal evaluations at 4 to 6 weeks after delivery, as well as at higher risk for strabismus and refractive error later in childhood.

Summary

Vision screening provides children with their best possible vision for a lifetime of use. Screening can be performed in the office and can determine which patients are in need of additional evaluation. Screening is good medicine!

References

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PIR Quiz

Quiz also available online at www.pedsinreview.org.

Match the clinical situation with the *most* likely diagnosis.

5. The tendency toward inward deviation of the eye when that eye is covered.
6. The refractive state most likely to be found in a 3-year-old child.
7. The most likely result of pronounced ptosis of the right eyelid in a 4-year-old child.
8. Active cortical suppression of the vision of one eye.

A. Amblyopia.
B. Esophoria.
C. Esotropia.
D. Hyperopia.
E. Myopia.

9. The parents of a 1-month-old infant ask you what she can see. You tell them that their daughter's visual acuity is *most* likely:

A. 20/30.
B. 20/80.
C. 20/100.
D. 20/200.
E. 20/400.

Pediatric Hearing Screening (Adapted from http://www.entcolumbia.org/childscrn.html)

I. Newborns and Infants

Hearing screening for newborns before they leave the hospital or maternity center is now becoming a common practice. Without such programs, the average age of hearing loss identification is between 12-25 months. When hearing loss is detected late, language development is already delayed.

Screening Techniques for Newborns and Infants
The screening of newborns and infants involves use of non-invasive, objective physiologic measures that include otoacoustic emissions (OAEs) and/or auditory brainstem response (ABR). Both procedures can be done painlessly while the infant is resting quietly.

- *Otoacoustic emissions* (OAEs) are inaudible sounds from the cochlea when audible sound stimulates the cochlea. The outer hair cells of the cochlea vibrate, and the vibration produces an inaudible sound that echoes back into the middle ear. This sound can be measured with a small probe inserted into the ear canal. Persons with normal hearing produce emissions. Those with hearing loss greater than 25-30 dB do not. OAEs can detect blockage in the outer ear canal, middle ear fluid, and damage to the outer hair cells in the cochlea.
- *Auditory brainstem response* (ABRs) is an auditory evoked potential that originates from the auditory nerve. It is often used with babies. Electrodes are placed on the head, and brain wave activity in response to sound is recorded. ABR can detect damage to the cochlea, the auditory nerve and the auditory pathways in the stem of the brain.

What happens if an infant does not pass the screening?
Infants who do not pass a screening are often given a second screening to confirm findings and then referred for follow-up audiological and medical evaluations that should occur no later than 3 months of age. These evaluations confirm the presence of hearing loss; determine the type, nature, and (whenever possible) the cause of the hearing loss; and help identify options for treatment. Even if the infant passes screening, certain conditions do not produce immediate hearing loss. Rather, the hearing loss occurs later in the child's development.

II. Older Infants and Toddlers

Infants and toddlers (7 months through 2 years) should be screened for hearing loss as needed, requested, mandated, or when conditions place them at risk for hearing disability. Infants not tested as newborns should be screened before three months of age. Other infants should be screened who received neonatal intensive care or special care, or who display other indicators that place them at risk for hearing loss.

Screening Techniques for Infants, Toddlers and Children
Two screening methods are suggested as the most appropriate tools for children who are functioning at a development age of 7 months to 3 years, visual reinforcement audiometry (VRA) and conditioned play audiometry (CPA). Both of these methods are behavioral techniques that require involvement and cooperation of the child.

- *Visual reinforcement audiometry* (VRA) is the method of choice for children between 6 months and 2 years of age. The child is trained to look toward (localize) a sound source. When the child gives a correct response, e.g., looking to a source of sound when it is presented, the child is "rewarded" through a visual reinforcement such as a toy that moves or a flashing light.

- *Conditioned play audiometry* (CPA) can be used as the child matures. It is widely used between 2 and 3 years of age. The child is trained to perform an activity each time a sound is heard. The activity may be putting a block in a box, placing pegs in a hole, putting a ring on a cone, etc. The child is taught to wait, listen, and respond.

With both of these methods, sounds of different frequencies are presented at a sound level that children with normal hearing can hear. It is ideal if the child will allow earphones to be placed on his or her head so that independent information can be obtained for each ear. If the child refuses earphone placement or earphone placement is otherwise not possible, sounds are presented through speakers inside a sound booth. Since sound field screening does not give ear specific information, a unilateral hearing loss (hearing loss in only one ear) may be missed.

Alternative procedures, such as otoacoustic emissions (OAEs) or auditory brainstem response (ABR) may be used if the child is unable to be conditioned.

What happens if a toddler does not pass the screening?
A toddler who does not pass the screening should be rescreened or referred for audiologic evaluation. Confirmation of hearing status should be obtained within 1 month, but no later than 3 months, after the initial screening.

III. Hearing Screening in Preschoolers

The goal of screening for hearing loss in preschoolers (ages 3-5 years) is to identify children most likely to have hearing loss that may interfere with communication, development, health, or future school performance. In addition, because hearing loss in this age range is so often associated with middle ear disease, it is also recommended that children in this age group be screened for outer and middle ear disorders (acoustic emmittance screening).

Screening Techniques for Preschoolers
- *Conditioned play audiometry* (CPA) is the most commonly employed procedure.
- *Acoustic emmittance screening* includes tympanometry, acoustic reflex, & static acoustic impedance:
  - ***Tympanometry*** introduces air pressure into the ear canal making the eardrum move back and forth. A special machine then measures the mobility of the eardrum. Tympanograms, or graphs, are produced which show stiffness, floppiness, or normal eardrum movement. They are classified as type A (normal), type B (flat, clearly abnormal), and type C (indicating a significantly negative pressure in the middle ear, possibly indicative of pathology).
  - *Acoustic reflex testing* measures the response of a tiny ear muscle that contracts when a loud sound occurs. The loudness level at which the acoustic reflex occurs and/or the absence of the acoustic reflex give important diagnostic information.
  - *Static acoustic impedance testing* measures estimate the physical volume of air in the ear canal. This test is useful in identifying a perforated eardrum or whether ear ventilation tubes are still open.

What happens if a preschooler does not pass the screening?
- If the child cannot be conditioned to the play audiometry, the child will be screened using infant-toddler procedures or will be recommended for a more in-depth audiologic assessment.

- If the child did condition and did not pass the screening, then referral for audiological assessment will be made. Hearing status of children referred after screening should be confirmed within 1 month, but no later than 3 months, after the initial screening.

IV. Hearing Screening for School Age Children and Adolescents (5-18 years)

School-age children should be screened for hearing loss as needed, requested, mandated, or when conditions place them at risk for hearing disability. Screening for hearing loss identifies the school-age children most likely to have hearing impairment that may interfere with development, communication, health, and education. School age children with even minimal hearing loss are at risk for academic and communication difficulties.

School age children should be screened at the following times: on first entry into school; every year from kindergarten through 3rd grade; in 7^{th} & 11^{th} grade; upon entrance into special education; upon grade repetition; upon entering a new school system without evidence of having passed a previous screening.

Screening techniques used for school-age students

- ***Conventional audiometry***, in which students are instructed to raise their hand (or point to the appropriate ear) when they hear a tone, is the commonly used procedure. Conditioned play audiometry (CPA) is also used.

What happens if a school-age student does not pass the screening?
The student should be reinstructed, earphones repositioned, and rescreened in the same session.
If the student does not pass the rescreening, he or she should be referred for audiologic assessment.
Hearing status of referred students should be confirmed within one month, and no later than 3 months, after initial screening.

V. Risk Factors for Hearing Loss in Children

- Parental, caregiver and/or health care provider concerns regarding hearing, speech, language, and/or developmental delay based on observation and/or standardized developmental screening.
- Family history of permanent childhood hearing loss.
- Infections associated with sensorineural hearing loss including bacterial meningitis, mumps.
- In utero infections such as cytomegalovirus, herpes, rubella, syphilis, and toxoplasmosis.
- Neonatal indicators - specifically hyperbilirubinemia at a serum level requiring exchange transfusion, persistent pulmonary hypertension of the newborn associated with mechanical ventilation, and conditions requiring the use of extracorporeal membrane oxygenation (ECMO)
- Syndromes associated with progressive hearing loss such as neurofibromatosis, osteopetrosis, and Usher' s syndrome.
- Neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedreich's ataxia and Charcot-Marie-Tooth syndrome.
- Head trauma
- Recurrent or persistent otitis media with effusion for at least 3 months.
- Anatomic disorders that affect eustachian tube function
- Reported exposure to potentially damaging noise levels or to drugs that cause hearing loss.

Health Screening Quiz- Part II:

1. At what ages does the AAP recommend hearing screening? Do we perform hearing screening in the Bethesda Clinic? If so, how?

2. At what ages does the AAP recommend vision screening? Do we perform vision screening in the clinic? If so, how?

3. Please fill in the appropriate sensory screening tests for each of the following age-groups:

Age-Group	Hearing Screen	Vision Screen
Neonate		
Toddler		
Preschool		
School-Age		

4. Please define the following terms:
    a. Myopia

    b. Astigmatism

    c. Strabismus

    d. Esotropia

    e. Exophoria

    f. Amblyopia

    g. 20/40 OU

5. Match the following vision problems in children with the appropriate screening method:

Problem	**Test(s)**
Refractive Error	_____
Strabismus	_____
Cataract	_____

6. Which of the following patients is at increased risk for hearing loss?
    a. 8do former 37+4 week infant, readmitted for bilirubin of 28.5
    b. 3yo with Trisomy 21
    c. 18mo female with OME at 12mo, 15mo, and 18mo well-baby visits
    d. 14yo with Neurofibromatosis Type II

7. Please list the visual acuity criteria for optometry referral for the following age groups:
    a. 3 y.o. _____

    b. 5 y.o. _____

    c. > 5 y.o. _____

Sensory Screening Group Activities

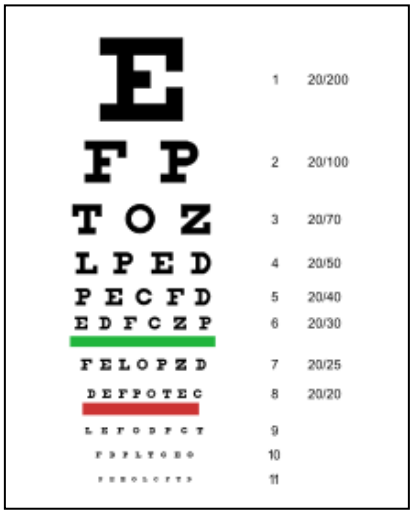
(Adapted from http://www.aafp.org/afp/980901ap/broderic.html)

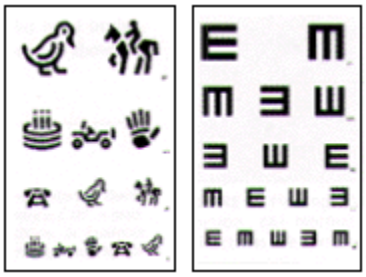
** Remember to add the Snellen chart, audiometer, and tympanometry to your Procedure Log.*

Vision Screening

1. Visual acuity (Snellen chart)

* Ensure that Snellen chart is **10 or 20 ft away** from where the patient stands.
* Have the patient cover one eye and read aloud every letter in the chart. If the patient misses only one letter, have the patient continue reading the next line.
* Record the last line the patient reads accurately, and note what the vision is. (Visual acuity measures are marked on the Snellen Chart)
* Ask the patient to repeat the process with the other eye, and the with both eyes uncovered.
* Record the visual acuity for each eye and with both eyes uncovered. Remember— **OD** = oculus dexter (R eye); **OS** = oculus sinister (L eye); **OU** = oculus uterque (both eyes)

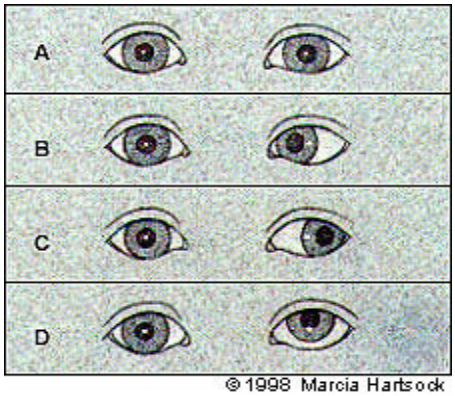




Other Pediatric Vision screen charts, used for preliterate young children or older children with MR. (L) Allen object recognition; (R) Tumbling E chart.

2. Corneal light reflex (Hirschberg Test)

* Hold a penlight about 3 ft (1m) from both eyes. Note the position of the corneal reflection.
* The reflection should fall in the same location in the cornea of each eye, even when the eyes move. Displacement of the corneal light reflection in one eye suggests strabismus.



How would you interpret these findings?

A_____

B_____

C_____

D_____

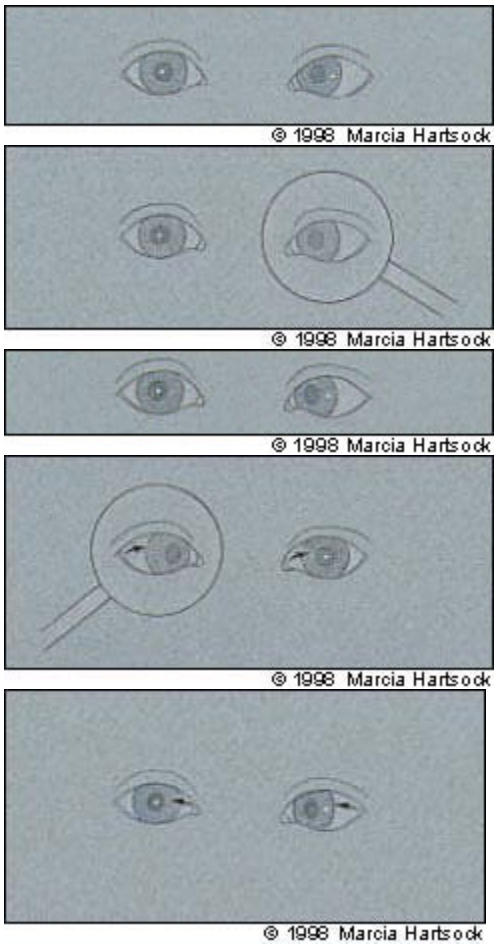
3. Cover-Uncover test

(For demo, see: http://www.youtube.com/watch?v=TxEQWtlXtrI&feature=related)

Example 1: Unilateral Cover-Uncover Test:

* Direct the patient to focus on an interesting object about 10ft (3m) away.
* For testing of the R eye, cover the L eye and observe the R eye for "fixation" movement.
  - If no movement, the patient does NOT have a R eye tropia.
  - If the R eye moves inward after the left is covered, the patient has a R eye EXOtropia.
  - If the R eye moves outward after the left is covered, the patient has a R eye ESOtropia
* For testing of the L eye, cover the R eye and observe the L eye for "fixation" movements.
* Cover each eye for approximately 3-4 sec, and repeat 3x for each eye.

Example 1: Unilateral Cover-Uncover Test for 'Tropias'



A. Observe the corneal light reflex at rest, the L eye shows _____.

B. Cover the L eye. What happens? _____ _____.

C. Uncover the L eye. What happens? ____ _____.

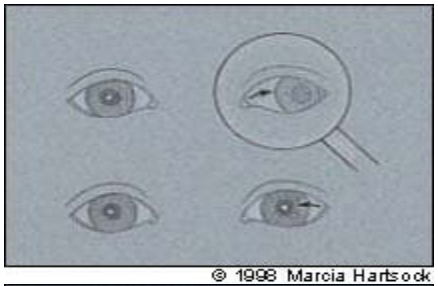
D. Cover the R eye. What happens to the L eye? _____.

E. Uncover the R eye. What happens to the L eye? _____.

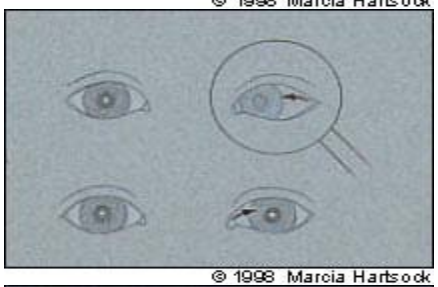
Example 2: Alternating Cover-Uncover Test:

* Direct the patient to focus on an interesting object about 10ft (3m) away.
* For testing of the R eye, cover the R eye for 1-2 sec, then move to cover the L eye for 1-2 sec. Observe the R eye *as it is being uncovered* to detect "re-fixation" movements.
    - If no movement, the patient does NOT have a R eye phoria.
    - If the R eye moves inward, *as it is being uncovered*, the patient has a R eye EXOphoria.
    - If the R eye moves outward, *as it is being uncovered*, the patient has a R eye ESOphoria.
* For testing of the L eye, cover the L eye, then move to cover the R eye. Observe the L eye *as it is being uncovered* to detect "re-fixation" movements.

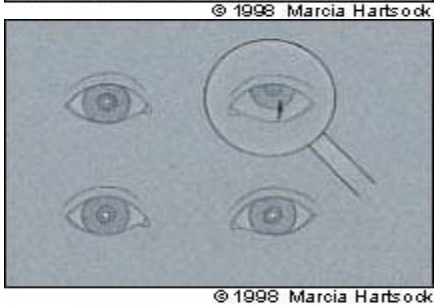
Example 2: Alternating Cover-Uncover Test for 'Phorias'



A. Cover and uncover the L eye. What happens? _____.
This patient has a _____.



B. Cover and uncover the L eye. What happens? _____.
This patient has a _____.



C. Cover and uncover the L eye. What happens? _____.
This patient has a _____.

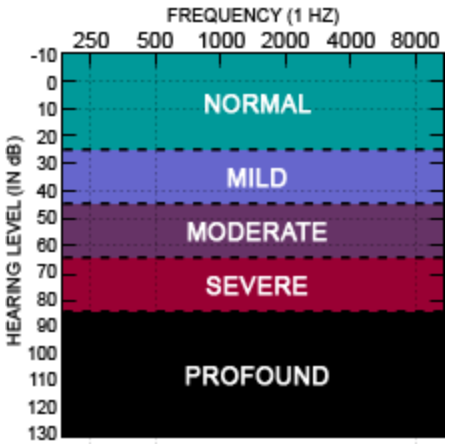
And finally, what's this?

Hearing Screening

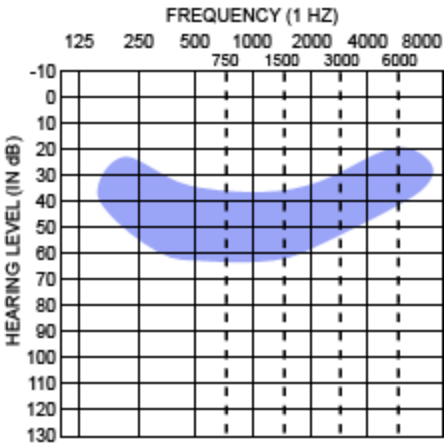
1. Conventional Audiometer

(adapted from: http://www.babyhearing.org/hearingamplification/hearingloss/audiogram.asp)

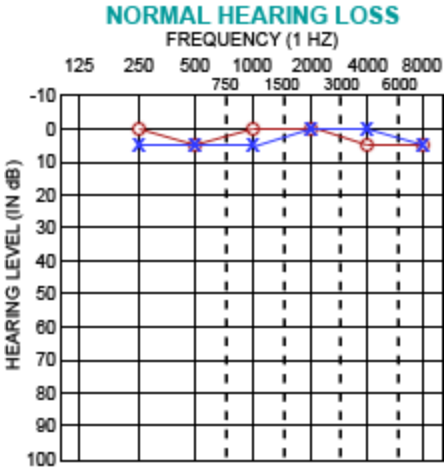
Conventional audiometry uses air conduction testing: different sounds go into the ear canal, through the middle ear, to reach the inner ear. **An audiogram is a graph that shows the softest sounds a person can hear at different pitches or frequencies.** An "O" is used to represent the R ear responses and an "X" for the L ear. The closer the marks are to the TOP of the graph, the softer the sounds that can be heard.



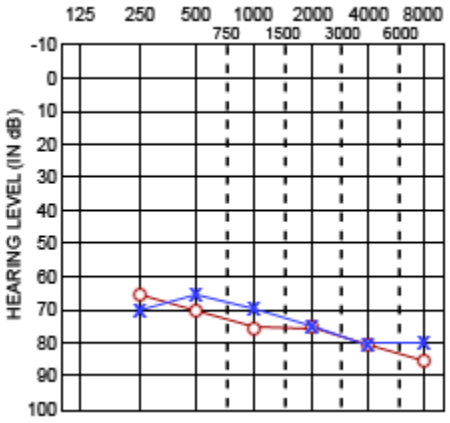
Different degrees of hearing loss



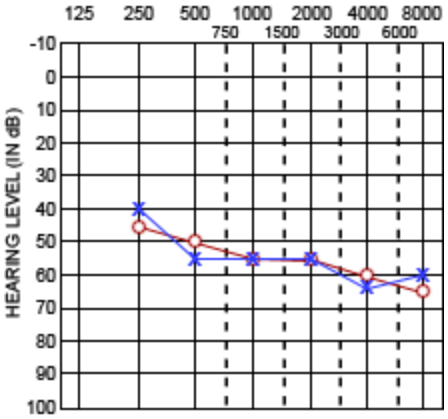
Range of pitch and loloudness for most of the "speech sounds"



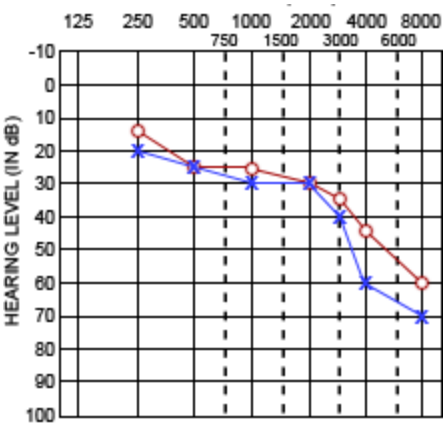
You will receive a hands-on demonstration by one of the audiologists or by your preceptors. Please select 1-2 members of your continuity group to be tested, and complete an audiogram. ***Compare your group's results to the following audiogram examples:***



_____ hearing loss



_____ hearing loss



_____ hearing loss

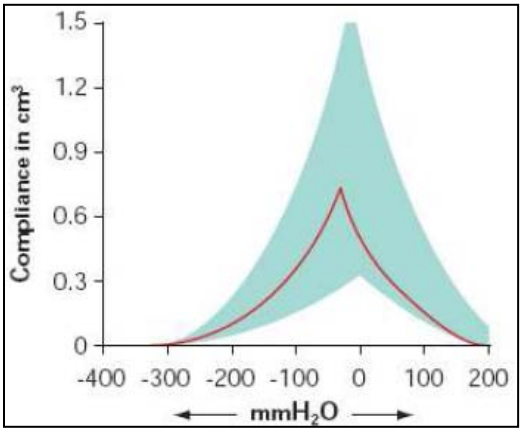
2. Tympanometry (adapted from: http://www.aafp.org/afp/2004/1101/p1713.html)

Tympanometry is an examination used to test the condition of the middle ear and mobility of the tympanic membrane and the conduction bones by creating variations of air pressure in the ear canal. A probe is inserted into the canal, permitting a hermetic seal to form. On the probe tip are 3 small holes. Through the 1st hole, we introduce an 85 dB pure-tone sound; through the 2nd hole we measure the sound pressure in the cavity; through the 3rd hole we create and remove pressure in the cavity to get a dynamic measure of the movement of the TM. We can exert positive pressure, pushing the TM away from us, or negative pressure, creating a partial vacuum and pulling the TM toward us. Most testing instruments use +200 mmH_2O to -200mmH_2O.

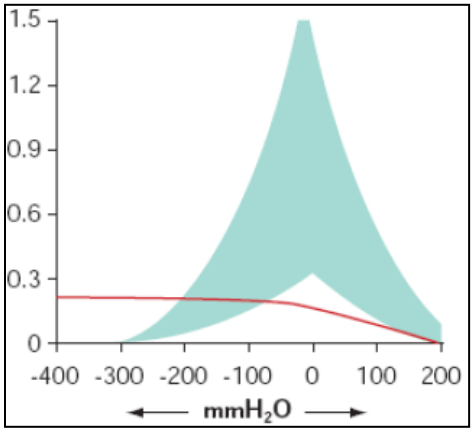
In basic tympanometry, we insert +200 mmH_2O pressure against the TM, effectively pushing it away from us (into the middle ear space). When we do that, we make it "stiffer". As we make it stiffer, it reflects more sound back into the cavity, and this allows less energy ("less sound") through the TM. Then, we begin to remove the pressure in the cavity, a bit at a time. As we do, the TM becomes more compliant, lets more sound through, and the perception is that the sound gets louder. We make a measurement at +200, +100, +50, 0, -50, -100, and -200 mmH_2O. We plot the amount of sound pressure at each of these points to create a tympanogram. The X-axis shows the air pressure, and the Y-axis shows the "static compliance" or mobility of the TM.

There are 5 basic type of tympanograms. **Type A** is normal: there is a normal pressure in the middle ear with normal mobility of the eardrum and the conduction bones. **Type B and C** may reveal fluid in the middle ear, perforation of the TM, scarring of the TM, lack of contact between the conduction bones of the middle ear, or a tumor in the middle ear. **Types A_S** and **A_D** represent variations with decreased (s = shallow, stiff) or increased (d = deep, disarticulated) compliance.

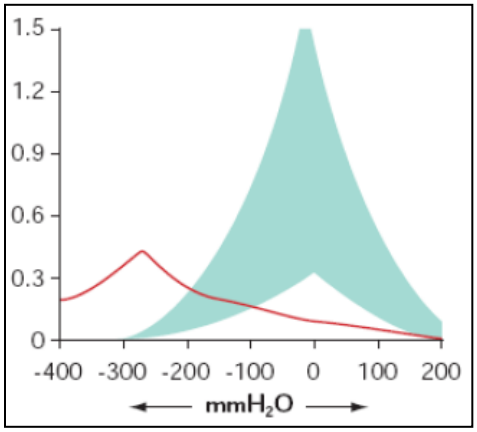
Please identify the following tympanometry tracings as a group:



Type ___
Due to _____
_____
_____
_____
_____



Type ___
Due to _____
_____
_____
_____
_____



Type ___
Due to _____
_____
_____
_____
_____