Navigating the Path of Children's Vision Screening:

Visual Acuity, Instruments, & Occluders

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Contents

INTRODUCTION:

Thank you for downloading "Navigating the Path of Children's Vision: Visual acuity, Instruments, & Occluders". The information contained in this resource applies to screening the vision of children from early childhood through high school. Our mission is to provide a resource that answers a wide range of vision screening questions and provides education relevant to the majority of children's vision screening programs.

Common early childhood vision disorders that affect at least 1 in 20 young children include amblyopia, strabismus, and significant refractive error, disorders that can lead to permanent vision impairment if not detected and treated early. Vision screening – using recommended tools, protocols, and procedures – is a cost-effective method to identify those children who should continue on for a follow-up comprehensive eye examination to determine whether vision disorders exist and treatment should occur. Early detection and timely treatment will likely result in long-term improvements in children's vision and eye health.

Head Start requires vision screening to be conducted or results to be collected from other vision screening venues, such as the child's medical home, within 45 days of enrollment into the federal program. Decisions about how vision screening occurs and which tools to use are left to local program level interpretation. This vision screening autonomy results in a wide variation of vision screening tools, protocols, and procedures.

This e-Book (1) describes screening the vision of typically developing young children with instruments and optotypes (letters, pictures, and numbers), (2) lists children who should bypass vision screening and go directly to eye examination, and (3) describes why a child's hand is not a preferred occluder for optotype-based screening. This resource does not provide information about color vision deficiency screening, stereoacuity screening, or whether or not to include near screening tests of visual acuity in your vision screening program.

AUTHORS:

P. Kay Nottingham Chaplin, EdD, helped Geoffrey E. Bradford, MD, Pediatric Ophthalmologist at West Virginia University (WVU) Eye Institute, to create the Vision Initiative for Children (VIC), a program that trained and equipped individuals to screen the vision of preschoolers.

Between Valentine's Day 2001 and Halloween 2008, Dr. Chaplin directed the VIC program, conducted 178 workshops, and trained more than 1,600 individuals – including Head Start staff, school nurses, pediatricians, and pediatric primary care staff – to screen the vision of preschoolers. In her current role as Director of Vision and Eye Health Initiatives at Good-Lite and School Health Corporation, Dr. Chaplin educates and assists individuals who screen the vision of children and adults, nationally and internationally.

Dr. Chaplin is a member of the Advisory Committee and Education Subcommittee to the National Center for Children's Vision and Eye Health at Prevent Blindness. In that role she assists in implementing recommendations of the National Expert Panel for a universal preschool vision screening strategy, developing a vision screening training and certification program, and contributing to stakeholder education.

She is also associated with two of the partners for the Year of Children's Vision (Good-Lite and School Health Corporation), along with the National Head Start Association, the National Center for Children's Vision and Eye Health at Prevent Blindness, and the American Association for Pediatric Ophthalmology and Strabismus. Supporters of this initiative include the American Academy of Optometry's Binocular Vision, Perception & Pediatric Optometry Section. The goal of YOCV is to (1) provide national guidance to staff of Head Start programs and other early childhood educators to standardize approaches to vision screening, (2) improve follow-up for eye care for children who do not pass vision screening, (3) provide family friendly educational information, and (4) consult with some of the nation's leading pediatric eye care providers to ensure best practices.

Dr. Chaplin is a member of the Healthy Tomorrows Partnership for Children Program Developmental Questionnaire Work Group, a Children's Vision Massachusetts coalition project funded by HRSA/AAP through an award to Prevent Blindness to look at screening children from birth to age 3 years.

Dr. Chaplin is also assisting a Prevent Blindness work group looking at school-aged vision screening guidelines.

Dr. Chaplin is a Consultant to the Vision Screening Committee of the American Association for Pediatric Ophthalmology and Strabismus.

Dr. Chaplin has lectured, trained, and consulted at more than 120 international, national, state, and local venues, including conferences for the:

1. National Association of School Nurses,
2. National Head Start Association,
3. National Association of Pediatric Nurse Practitioners,
4. Society for Physician Assistants in Pediatrics, and
5. National Assembly on School-Based Health Care.

As a hobby, Dr. Chaplin studies eye chart history and design.

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Wendy Marsh-Tootle, OD, MS, is an Associate Professor of Optometry at the UAB School of Optometry. Dr. Marsh-Tootle also is a member of the National Expert Panel for the National Center for Children's Vision and Eye Health, housed at Prevent Blindness America.

Dr. Marsh-Tootle was principal investigator of a study, funded by the National Institutes of Health, to improve the detection of amblyopia (lazy eye) and its risk factors in primary care settings. Along with a panel of experts in pediatrics, family practice, optometry, vision science, and ophthalmology, she developed online training and showed a sustained improvement in knowledge and vision screening practices among participating primary care physicians. With collaboration from Medicaid agencies in Alabama, Illinois, and South Carolina, Dr. Marsh-Tootle showed low rates of quantitative vision screening at preschool ages, when treatment for amblyopia is most effective. She also showed that some providers achieve high rates of vision screening in real-world settings; thus, establishing the feasibility of achieving the overarching goal – to reduce the prevalence of preventable vision loss from amblyopia by improving preschool vision screening in the medical home.

Dr. Marsh-Tootle participates in studies conducted through the Pediatric Eye Disease Investigator Group to determine better methods to treat amblyopia and myopia. These studies have allowed practitioners to prescribe fewer hours of patching and to offer eye drops as an equally effective treatment for amblyopia, as well as to establish the importance of wearing glasses as an important first step in the treatment of strabismus and amblyopia.

In her spare time, Dr. Marsh-Tootle is an active member of VOSH (Volunteers for Optometric Service to Humanity) International.

AUTHORS:

Geoffrey E Bradford, MS, MD, is a professor of Ophthalmology and Pediatrics at West Virginia University. He is in clinical practice and specializes in pediatric eye diseases, trains residents in ophthalmology and pediatrics, and, along with Dr Chaplin, has a research interest in developing ways to enhance early childhood vision screening.

Dr. Bradford founded the West Virginia Vision Initiative for Children in 2001 in which he and Dr Chaplin worked to train, equip, and support vision screeners across the state from Head Start, school nursing, practices in Pediatrics and Family Medicine, and preschool groups.

Dr. Bradford serves on the Section of Ophthalmology Executive Committee for the AAP and is the next Chair of the Vision Screening Committee of the American Association for Pediatric Ophthalmology and Strabismus.

In his spare time, Dr. Bradford enjoys time with his family, travel, wine tasting, chocolate, and relaxing on the deck!

The authors wish to acknowledge and thank the following individuals for reviewing this document or for their assistance and time in answering questions about instrument-based screening:

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Section 1

OPTOTYPE-BASED SCREENING and INSTRUMENT-BASED SCREENING: HOW DO THEY DIFFER AND WHAT DO THEY MEASURE?

Two approaches are available to individuals screening the vision of children in school, Head Start, and community-based settings. The two approaches are optotype-based screening – or tests of visual acuity – and instrument-based screening – or automated devices. The approaches differ in how they are used and what they measure.

Before continuing the conversation about the two vision screening approaches, we need to discuss a subset of children who should bypass vision screening and, instead, be referred for a comprehensive eye examination from an ophthalmologist or optometrist. These children have an increased risk for vision abnormalities.

CHILDREN WHO SHOULD BYPASS VISION SCREENING AND RECEIVE A REFERRAL FOR A COMPREHENSIVE EYE EXAMINATION

The National Expert Panel to the National Center for Children's Vision and Eye Health at Prevent Blindness (NCCVEH) published papers in January 2015[1-2] describing children who should bypass vision screening and go directly to an optometrist or ophthalmologist for a comprehensive eye examination. The National Expert Panel of the NCCVEH is comprised of nationally recognized leaders in children's vision and eye health, including those in ophthalmology, optometry, and public health.

Examples of children who should bypass vision screening and be referred to an optometrist or ophthalmologist for a comprehensive eye examination include those with[1-2]:

- Readily observable ocular abnormalities;
- Neurodevelopmental disorders;
- Systemic conditions that have associated ocular abnormalities;
- First-degree relatives with strabismus or amblyopia;
- A history of prematurity (<32 completed weeks);
- Parents who believe their child has a vision problem;
- Hearing impairments;
- Motor abnormalities, such as Cerebral Palsy;
- Down Syndrome;
- Cognitive impairment;
- Speech/language delays; and
- Autism spectrum disorders.

Children with the above conditions can be included in the screening for social reasons, but feedback to parents should emphasize seeking care from optometrists or ophthalmologists regardless of screening results.

We will now continue the conversation about the two approaches to vision screening.

WHAT IS THE DIFFERENCE BETWEEN OPTOTYPE-BASED AND INSTRUMENT-BASED VISION SCREENING?

Optotype-Based Screening:

Optotype-based screening refers to tests of visual acuity that use pictures, letters, or numbers, which children identify to determine visual acuity. Tests of visual acuity include eye charts with full lines; flipbooks with single, crowded optotypes; flipbooks with full lines of optotypes for critical line screening (the critical line the child should pass according to the child's age), iPad apps, and screening software. The child's task in optotype-based screening is to identify the optotypes on the test of visual acuity at a prescribed distance.

In this e-Book, "tests of visual acuity" includes both standard threshold charts (those with several lines of optotypes decreasing in size on one chart) and flipbooks or other formats with single, isolated optotypes surrounded with bars.

Optotype-based screening provides a subjective measure of recognition visual acuity, or the clearness or clarity of vision when identifying pictures, letters, or numbers at a specific distance. Optotype-based screening provides visual acuity values, such as 20/20. Visual acuity provides information about the presence, or absence, of refractive error and pathology within the visual pathway.[3]

Optotype-based screening requires a child's attentiveness and responses; instrument-based screening does not need as much cooperation from the child. Some of you have asked whether vision screening machines that use cards or slides, and require child responses to measure vision, are instruments. Machines that require child responses are not included in the "instrument" category for this discussion.

Instrument-Based Screening:

Instrument-based screening pertains to automated devices that measure amblyogenic risk factors, such as refractive error, media opacities, and eye misalignment. Instrument-based screening includes photoscreeners and portable, handheld autorefractors. Instruments are often called "devices", "automated screening instruments", "automated vision screening devices", or similar terms.

Photoscreeners use optical images of the eye's red reflex to provide a numerical estimate of refractive error; some also provide information about eye alignment and media opacities, such as cataract.[1] Photoscreeners measure both eyes simultaneously. Handheld, portable autorefractors analyze light reflected from the retina to provide an estimate of refractive error and usually screen one eye at a time.

Instruments do not measure visual acuity. Most of the currently commercially available instruments assess for the presence of amblyopia risk factors, such as:

- Significant refractive errors (hyperopia, myopia, and astigmatism),
- Asymmetry of the refractive error from one eye to the other (anisometropia),
- Misalignment of the eyes (strabismus), and the
- Presence of media opacities, such as cataract.[4]

Let's look at a scenario to help clarify this difference. Vision screening results on a child using an instrument indicate that this child may have an eye condition that can cause defocused and blurred vision. However, vision screening results using a test of visual acuity on this same child show that vision and eye function are actually normal.

During instrument-based screening for many devices, the screener points the device toward the child's eyes at a prescribed distance (often 14 inches or 3.3 feet) for the device in a dimly lit room. The child's task is to sit or stand quietly and look at the device. The front of many instruments display lights and emit sounds to engage the child's interest as the device captures the measurement. Some devices will alert the screener if the instrument is too close or too far away from the child's eyes to achieve a reading and whether or not the child's pupils are too small to permit measurement.

Some instruments can be preloaded with child demographics for faster screening and export vision screening results to printers to share with parents, eye care providers, and pediatric primary care providers. Instrument-based screening usually has three outcomes:

1. The child passed the screening,
2. The child should be referred for an eye exam, or
3. A reading could not be achieved.

Vision screening results are determined by the instrument's automated image analysis system or interpreted by trained individuals at a central reading location. Some devices will report the reason for referral, such as myopia, hyperopia, or astigmatism.

Four factors may impact whether or not a reading could be achieved:

1. Pupil size,
2. Pupil color,
3. Child's ability to fixate on the device, and
4. Environmental lighting.

You may want a test of visual acuity as a backup if a reading cannot be achieved.

Instruments detect eye conditions that can lead to poor vision but do not measure visual acuity. Consequently, most experts in the field of vision screening believe that instrument-based screening results cannot be directly translated to a specific Snellen notation, such as 20/20.

WHY MIGHT I WANT TO SCREEN VISION WITH AN INSTRUMENT?

Instrument-based screening is quick, requires minimal cooperation of the child, and is especially useful in preverbal and preliterate children, according to the 2012 Instrument-Based Pediatric Vision Screening Policy Statement from the American Academy of Pediatrics, the American Academy of Ophthalmology, the American Association for Pediatric Ophthalmology and Strabismus (AAPOS), and the American Association of Certified Orthoptists.[5]

This instrument-based policy statement is geared toward the medical home and does not provide recommendations for mass screening. Table 1 provides suggested ages for tests of visual acuity or instruments.[5]

Table 1: Child Ages for Optotypes and Instruments

AGE	OPTOTYPE	INSTRUMENT
Preverbal children		✓
Preliterate children		✓
6 months to 3 years		✓
3 to 5 years	✓	✓
>5 years	✓	

HOW DO INSTRUMENTS DIFFER?

Two devices you will commonly see on the market for instrument-based vision screening are:

- Welch Allyn SureSight®, and
- Welch Allyn Spot™ Vision Screener™.

*These instruments are examples and do not represent an exhaustive list of commercially available products or endorsements of effectiveness of one product over another.

The National Expert Panel to the NCCVEH[1] provides recommendations for instrument-based screening in three categories for children ages 3 through 5 years: Best Practice, Acceptable Practice, and Unacceptable. Placement in one of the three categories is based on high-quality, published, peer-reviewed data. Best Practice indicates the instrument has high-quality published performance data for the targeted age group. Acceptable Practice indicates the device has fewer high-quality published performance articles for the targeted age group, but available data suggest the instrument will perform as well as, or even outperform, Best Practice instruments. A systematic process is available at the NCCVEH for instrument manufacturers and can be accessed at http://nationalcenter.preventblindness.org/vision-screening-device-review

For children in the targeted age group of 3 through 5 years, the National Expert Panel[1] categorizes the Retinomax and Welch Allyn SureSight® Vision Screener Version 2.25 as Best Practice. The Plusoptix S12C and the Welch Allyn Spot™ Vision Screener are classified as Acceptable Practice instruments. The NCCVEH web site lists instruments and classifications, and will provide updated information on instrument recommendations: http://visionsystems.preventblindness.org/screening/instrument-based-vision-screening.html

The two instruments described in this section differ in (1) whether they screen monocularly or binocularly, (2) the distance from the child at which they screen, (3) referral criteria, and (4) purchase cost.

Monocular and Binocular Screening:

It is easy to assume that screening monocularly would miss detecting eye alignment and strabismus because such a device reads only one eye at a time. This is not necessarily true.

"Claims for instruments that they do a better job of detecting strabismus because they test both eyes simultaneously are not necessarily correct," said Lynn Cyert, PhD, OD, Vision in Preschoolers (VIP) Study Group member representing the Oklahoma Northeastern State University College of Optometry, one of the five clinical sites in the Vision in Preschoolers study (personal communication, February 17, 2014).

"Instruments or VA (visual acuity) tests that test monocularly do a very good job of detecting strabismus, presumably because in most cases strabismus is associated either with decreased visual acuity in one or both eyes or is associated with a high refractive error in one or both eyes." Dr. Cyert said. "So it is not necessary to test binocularly to screen for strabismus, even though monocular tests do not DIRECTLY test for strabismus."

Screening Distance:

The screening distance for the Welch Allyn Spot™ Vision Screener is around 3 feet or 1 meter. The distance for the Welch Allyn SureSight® Vision Screener is 14 inches. Table 2 describes screening distance and conditions measured:

Table 2: Instument Screening Distances and Conditions Measured

INSTRUMENT		DISTANCE	1 EYE AT A TIME	BOTH EYES AT SAME TIME	REFRACTIVE ERRORS	EYE ALIGNMENT	ANISCORIA
Welch Allyn Spot™ Vision Screener		3.3 feet		✓	✓	✓	✓
Welch Allyn SureSight® Vision Screener		14 inches	✓		✓	Indirectly	

Referral Criteria:

The sensitivity and specificity of your device for detecting vision disorders will depend on the referral criteria for your device.[5] Before moving forward, let us review sensitivity and specificity.

- Sensitivity refers to the percentage of children with a vision disorder who were correctly identified and were referred for an eye exam.
- Specificity is the percentage of children without a vision disorder who appropriately passed.

If sensitivity is 80%, the screening test:

- Correctly identified and referred 80 of 100 children with a vision disorder, and
- Failed to identify and refer 20 of 100 children with a vision disorder.
  - The 20 children passed the vision screening although they had a vision disorder. This is also known as under-referring.

If specificity is 80%, the screening test:

- Correctly passed 80 of 100 children without a vision disorder, and
- Incorrectly referred 20 of 100 children without a vision disorder.
  - The 20 children did not pass the vision screening even though they did not have a vision disorder. This scenario is also known as over-referring.

It is important to remember, Dr. Cyert said, that "health screening over-refers some of the people who do not have the target condition and misses some of the people in the screening who have the targeted condition."

Some instruments contain preprogrammed referral criteria thresholds and others permit you to select referral criteria. When you select referral criteria, you are basically determining whether you want to over- or under-refer children for eye exams. Changing referral criteria often results in a trade-off between sensitivity and specificity. High sensitivity risks excessive over-referrals. High specificity risks under-referring children with vision disorders.[5]

Until evidence-based refractive error criteria are determined, you can consult with pediatric optometrists or ophthalmologists for the best referral criteria settings to use for targeted age groups.

If you use the Welch Allyn SureSight® Vision Screener, ensure the device is calibrated every 18 months, set in "child mode" (see Figure 1) when used with children before age 7 years, and updated to Version 2.25, which matches Vision In Preschoolers Study screening criteria.[6-7] Child mode is the top "person" of the two "people" on the left button above the "Go" button see (Figure 1). If you are not using Version 2.25, ensure the device is set in minus cylinder. Check with the company where you purchased the device for assistance in setting the device to minus cylinder. If the device is not set in minus cylinder, the refractive error is expressed with slightly different numbers and the results may not be as accurate. A printout of vision screening results will display your software version. Welch Allyn SureSight® Vision Screener Version 2.25 includes referral criteria (0.90 specificity) that align with the recommendations of the National Expert Panel to the NCCVEH.

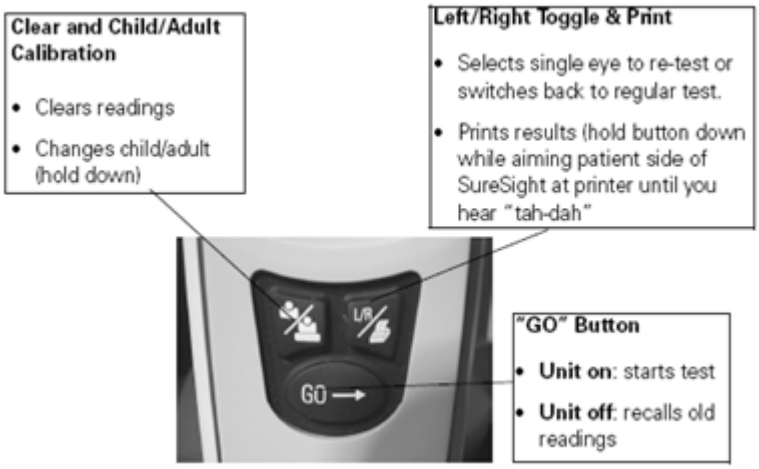


Figure 1

If you have access to eye exam results for your vision screening referrals, compare the eye exam results with your vision screening results to ensure appropriate referral rates and use of updated, age-appropriate criteria. If you believe this comparison suggests you may be referring too many children, adjust your referral criteria. It is a balancing act, if you will, between over- and under-referring children. Your local ophthalmologists and optometrists can help you with this decision.

Purchase Cost:

The two instruments described in this section cost around $4,000 to $8,000.

SHOULD I USE AN INSTRUMENT OR A TEST OF VISUAL ACUITY?

The following information may help you with this decision:

- The 2012 Instrument-Based Pediatric Vision Screening Policy Statement provides recommendations for the medical home but not for mass screening.[5]
  This document:
  - States that photoscreeners and handheld autorefractors may be electively performed with children ages 6 months to 3 years to permit earlier detection of disorders that could lead to amblyopia.
  - States that photoscreeners and handheld autorefractors may be electively performed with older children who are unable or unwilling to participate in optotype-based screening.
  - Recommends photoscreeners and handheld autorefractors as an alternative to tests of visual acuity for children ages 3 through 5 years.
  - States that tests of visual acuity to assess amblyopia in children ages 3 to 5 years remains a viable practice.
  - States that tests of visual acuity are more efficient and less expensive for children aged 6 years and older.
- Instrument-based screening has not been shown to be superior or inferior to tests of visual acuity in children ages 3 to 5 years.[6-7]

Daniel E. Neely, MD, Pediatric Ophthalmologist, Professor of Ophthalmology at the Indiana University School of Medicine, and past Chair of the AAPOS Vision Screening Committee, provided this summary:[4]

- Instrument-based screening has advantages in children under the age of 3 years.
- Children ages 3 to 5 years can be screened with equal efficacy with either an instrument or a test of visual acuity.
- Children ages 5 years and older should be screened with an acuity chart to document the visual acuity of each eye.

Choosing whether to use optotype- or instrument-based screening as your primary vision screening tool – or even a mixture of both – depends on at least six factors:

1. Your preference,
2. Number of children to screen[1],
3. Time allotted for screening[1],
4. Screening environment,
5. Reporting requirements[1], and
6. Funding resources[1].

IF I CHOOSE TO USE AN INSTRUMENT AS MY PRIMARY VISION SCREENING TOOL, SHOULD I ALSO HAVE A TEST OF VISUAL ACUITY IN MY TOOLBOX?

If you choose to use an instrument as your primary vision screening tool, you will want an age-appropriate, evidence-based, and scientifically valid test of visual acuity (discussed in Section 2) as a backup in case:

- You forgot to charge the battery and an electrical outlet is inaccessible in your screening area,
- The device malfunctions,
- You cannot achieve a reading with the instrument, or
- A child is untestable with the instrument.

The Vision in Preschoolers Study[7] found that children who were unable to participate in vision screening with a handheld autorefractor were nearly always able to participate in vision screening with a test of visual acuity. Children who were unable to participate in vision screening with a test of visual acuity were nearly always able to participate in vision screening with a handheld autorefractor.

Tests of visual acuity are described in Section 2 of this e-Book.

VISION SCREENING AS 1 PIECE OF A 12-COMPONENT STRONG VISION HEALTH SYSTEM OF CARE

Whether you choose optotype-based screening, instrument-based screening, or a combination of both, vision screening is only one piece of a 12-Component Strong Vision Health System of Care. Three additional components include:

1. Ensuring that all parents/caregivers receive educational material, which respects cultural and literacy needs, about the importance of good vision for their child now and in the future, and scheduling and attending an eye exam when their child does not pass vision screening.
2. Rescreening or referring difficult-to-screen (untestable or unable) children.
   a. The Vision in Preschoolers Study Group[8] found that untestable children were nearly twice as likely to have a vision problem than children who passed vision screening.
   b. The National Expert Panel of the NCCVEH[1] recommends that children ages 3 through 5 years be rescreened either the same day or at least within 6 months of the initial screening.
3. Receiving formal vision screening training that leads to certification and recertification in evidence-based vision screening procedures.
   a. The World Health Organization[9] says the skill of the screener significantly affects the validity and variability of the screening outcome.

You may visit this link for a description of all 12 recommended components: http://nationalcenter.preventblindness.org/sites/default/files/national/documents/12_component_vision_health_system_of_care%20%282%29.pdf

You may visit this website to evaluate your current vision and eye health system of care: http://nationalcenter.preventblindness.org/sites/default/files/national/documents/VSProgramEvaluationNHSAVersion.pdf

The 12-Component Strong Vision and Eye Health System of Care is part of the Year of Children's Vision[10], a project of various organizations including:

- The National Head Start Association;
- The National Center for Children's Vision and Eye Health at Prevent Blindness;
- The American Association for Pediatric Ophthalmology and Strabismus;
- The American Academy of Optometry's Binocular Vision, Perception & Pediatric Optometry Section;
- Good-Lite; and
- School Health Corporation.

You can visit this link for more information about the Year of Children's Vision, which includes resources and archived webinars: http://nationalcenter.preventblindness.org/year-childrens-vision

The take-home message is this: The decision to use an instrument or a test of visual acuity as your primary vision screening tool, or a combination of both, depends on your preference, your screening environment, what you want to measure, and your budget. If you choose an instrument, add an age-appropriate, evidence-based, and scientifically validated test of visual acuity as a backup in your vision screening toolbox.

SECTION 2

TWO OPTIMAL OPTOTYPES FOR TESTS OF VISUAL ACUITY IN PRESCHOOL AND SCHOOL-AGED CHILDREN

Tests of visual acuity with various optotypes are commercially available and selecting the appropriate tools can be challenging. “Optotype” is the name of the picture, letter, or number you are asking a child to identify at a prescribed distance to receive a visual acuity estimate for each eye. Two optotypes are recommended for children ages 3 through 5 years, as well as older, school-aged children.

WHAT ARE THE PREFERRED OPTOTYPES FOR CHILDREN AGED 36 TO <72 MONTHS?

The National Expert Panel to the National Center for Children's Vision and Eye Health at Prevent Blindness (NCCVEH)[1] recommends two optotypes for children ages 36 to <72 months:

1. LEA Symbols, preferably surrounded with crowding bars.
2. HOTV letters, preferably surrounded with crowding bars.

Many professional organizations also support LEA Symbols and HOTV letters, including the American Academy of Pediatrics,[2] the American Association of Ophthalmology,[2] the American Academy of Ophthalmology Pediatric Ophthalmology/Strabismus Panel,[3] the American Association for Pediatric Ophthalmology and Strabismus (AAPOS),[4] the American Association of Certified Orthoptists,[2] Prevent Blindness[5], and the American Optometric Association.[6]

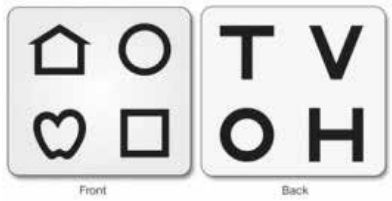
WHAT ARE THE BENEFITS OF THE LEA SYMBOL OPTOTYPES?

LEA Symbol optotypes have three benefits:

1. LEA Symbols are culturally neutral. Children choose a name for what they believe the optotype represents. For example, the circle may be a hula-hoop or the square may be an iPad.
2. LEA Symbols blur equally at threshold, or at the line where children experience difficulty distinguishing one optotype from another.[7-9] When the optotypes blur, they tend to resemble circles. This blurring helps to prevent guessing and encourages the child to keep responding, rather than "shutting down", allowing the tester to obtain a valid visual acuity estimate.
3. The Vision in Preschoolers Study Group10 found that LEA Symbols may be slightly easier than HOTV letters for 3- to 5-year-old children.

WHAT IF YOUNG CHILDREN DO NOT KNOW THEIR SHAPES OR LETTERS?

Young children need not know their shapes or letters to participate in vision screening with tests of visual acuity. Instead, children aged 36 to <72 months, can use "response panels" or "lap cards" in a matching game. Response panels included in many tests of visual acuity have four optotypes with either LEA Symbols or HOTV letters. Children can point to the optotype on the lap card that matches the optotype you want the child to identify. Some tests of visual acuity include four separate cards with one optotype on each small card. You can place those cards in front of the child's feet and ask the child to step on the card that matches the optotype you want the child to identify. The individual cards are for matching only, and should never be used for screening.



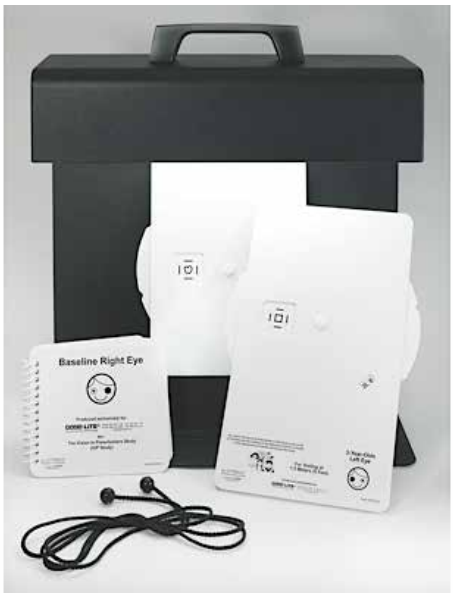
WHAT TEST OF VISUAL ACUITY SHOULD I INCLUDE IN MY TOOLBOX FOR CHILDREN AGED 36 TO <72 MONTHS?

For Best Practice, the National Expert Panel to the NCCVEH[1] recommends monocular visual acuity testing using a simplified test of visual acuity for children aged 3 through 5 years with a single, LEA Symbol or the letters H, O, T, and V surrounded by 4 lines (50% crowding bars) at a 5-foot screening distance.

A 5-foot screening distance has two advantages:

1. You have a greater ability of maintaining the child's attention, and
2. Vision screening can occur in a smaller area to avoid distractions commonly found in a larger screening room.[1]

An example of a 5-foot test of visual acuity is the test designed for the Vision in Preschoolers Study[11-12] to help enhance children's participation in vision screening.



The National Expert Panel[1] considers as acceptable a single line of optotypes with crowding bars surrounding the optotypes to resemble a rectangle.

AAPOS[4] also recommends LEA Symbols or HOTV letters, presented as either a line of optotypes surrounded by a crowding rectangle, or single optotypes surrounded by four crowding bars for preschool-aged children. AAPOS developed a basic vision screening kit featuring LEA Symbols for young children and Sloan Letters for older children. An AAPOS basic kit with HOTV and Sloan Letters is in production.

Notice that the recommended single optotypes are not isolated; they are surrounded with crowding bars. The crowding bars are important because screening vision with a single, isolated optotype (without crowding bars) can miss detecting some vision disorders, such as amblyopia. A single, isolated optotype is easier to identify, which is not what you want to occur during vision screening, no matter how much you want the child to pass your vision screening.

Using a single, isolated optotype without crowding bars will overestimate the chart acuity. A single, isolated optotype without crowding bars will also produce an inaccurately high visual acuity estimate. For example, two studies comparing visual acuity results using single, isolated optotypes with visual acuity results using charts of full lines found that the scores were – on average – three lines better with the single letter compared with charts.[13-14] This means that visual acuity could be 20/32 with a single, isolated optotype and 20/80 on a line chart. The reason for this large difference is explained by the "crowding effect", which is a reduction in acuity when optotypes are presented with neighboring optotypes, such as a line or a chart of letters or pictures.[15-16] Simply put, single optotypes are too easy to identify.

In the Vision in Preschoolers Study (VIP)[11-12], nurses and lay screeners detected more children with strabismus and amblyopia using the VIP Study 5-foot test of visual acuity with single, surrounded LEA Symbols optotypes than they did with a test showing a line of optotypes surrounded by a rectangular box at a 10-foot screening distance. Strabismus is defined as turned or misaligned eyes. Amblyopia is defined as "lazy eye" or preventable loss of vision at the brain level because of defocused, misaligned, or obscured images.

Lay screeners in the VIP study[11-12] found 79% of children with strabismus and 87% of children with amblyopia with the VIP 5-foot test. However, when using a line of optotypes surrounded by a rectangular box at a 10-foot screening distance, lay screeners detected only 39% of preschool-aged children with strabismus and 56% of children with amblyopia.

You may hear the term "simplified screening format" for tests of visual acuity that use these single, surrounded LEA Symbols optotypes.

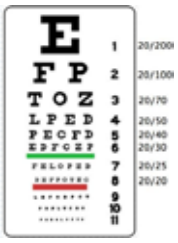
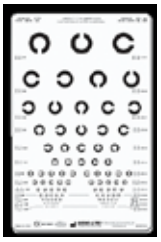
An example of a tool using a simplified screening format is the EyE Check Screener with LEA Symbols. This screening test uses the critical elements of the VIP test, including the surround bars around the optotype and the 5-foot screening distance. Focus groups, including pediatricians and office staff, suggested that acuity tests calibrated for a 5-foot testing distance would work well in pediatric primary care settings.[17]

Another example is EyeSpy 20/20™, a software video game that uses single, surrounded LEA Symbols optotypes. EyeSpy 20/20™ is typically conducted at 10-feet, but has the capability to use at 5 feet.

WHAT TESTS OF VISUAL ACUITY ARE NOT RECOMMENDED FOR CHILDREN AGED 36 TO <72 MONTHS?

The National Expert Panel to the NCCVEH[1] currently considers six tests of visual acuity unacceptable for children ages 36 to <72 months. Table 1 illustrates the six unacceptable tests of visual acuity:

Table 1 Examples of "Unacceptable" Tests of Visual Acuity for Children Ages 36 to <72 Months

					
Snellen	Allen Pictures	Tumbling E	Landolt C	Lighthouse (House, Apple, Umbrella)	Kindergarten "Sailboat"

The six tests of visual acuity are considered unacceptable[1] because some charts require discrimination of up, down, left, and right orientation and direction; do not meet national and international recommendations for standardized eye chart design, and children ages 3 through 5 years typically do not know their letters, as would be required if you used a Snellen chart.

Additional optotypes or tests of visual acuity may be added to the National Expert Panel's current list. Monitor this web site for updates: http://visionsystems.preventblindness.org/screening/recognition-visual-acuity-screening.html

Six additional "Unacceptable" practices from the National Expert Panel[1] for screening children ages 3 through 5 years include:

1. A 20-foot testing distance because a shorter distance enhances your ability to maintain the young child's attention and you are likely to have fewer distractions in a smaller screening environment.
2. Near cards because 3 diopters of myopia (nearsightedness) may be undetected at a 14-inch screening distance.
3. A testing distance less than 5 feet because myopia could be missed.
4. Binocular screening because "unilateral amblyopia is masked by the better-seeing eye when amblyopic children are tested binocularly". (p. 9)
5. Vision testing machines that optically simulate distance vision, such as those used at motor vehicle testing facilities. While developing recommendations, the National Expert Panel concluded that machines optically simulating distance vision have potential and actual methodological problems that preclude their effective use today.
6. When used as part of a vision screening protocol, red reflex testing for media opacity detection and cover testing for eye misalignment should be conducted only by health care personnel who are professionally trained to perform and interpret the tests.

WHAT ARE THE PREFERRED OPTOTYPES FOR OLDER, SCHOOL-AGED CHILDREN?

For older, school-aged children, AAPOS[4] recommends using tests of visual acuity with Sloan Letter optotypes when children can comfortably verbally identify letters.

The American Academy of Ophthalmology Pediatric Ophthalmology/ Strabismus Panel[3] recommends using tests of visual acuity with Sloan Letters or LEA Numbers for older, school-aged children.

Prevent Blindness convened a work group in early 2015 to update its national position statement for tests of visual acuity for school-aged children. Recommendations will be on the Prevent Blindness web site at http://www.preventblindness.org/

WHY SHOULD FULL EYE CHARTS BE STANDARDIZED and HOW DO I KNOW THE DIFFERENCE BETWEEN A STANDARDIZED AND NON-STANDARDIZED FORMAT?

Simplified tests of visual acuity using single, surrounded LEA Symbols or HOTV letter optotypes are for children ages 36 to <72 months. You want to use tests of visual acuity with full lines for children aged 6 years and older, and those charts should be in a standardized format, as recommended in national and international guidelines for eye chart design.[18-21]

The design of an eye chart can significantly affect visual acuity scores, according to Ian Bailey, OD, MS, FBCO, FAAO, Professor of Optometry and Vision Science, Berkeley School of Optometry, University of California, Berkeley.[22] Excluding the size of the optotype, "each visual acuity level on a test chart should present an essentially equivalent task".[23] (p. 740) Standardized eye charts provide this equal visual acuity test task during vision screening.

Let's look at an example. In vision screening, visual acuity is defined as the last line where the majority of optotypes are correctly identified. On some eye charts the number of optotypes increases as the line size decreases. This means that, as the child moves down the chart, the child is tasked to identify more optotypes . . . on smaller lines. The number of optotypes to correctly identify increases as the number of optotypes on a line increases. Is this visual acuity test task equal? The answer is . . . no.

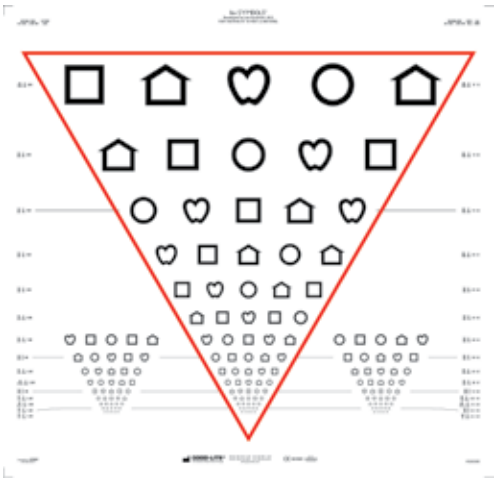
WHAT MAKES A TEST OF VISUAL ACUITY STANDARDIZED?

Four national and international guidelines exist with six similar recommendations to help ensure that eye charts are standardized.[18-21]

The recommendations are:

1. Optotypes should be of approximate equal legibility. One optotype should not be easier to identify than another on the same line.
2. Each line on an eye chart should have the same number of optotypes. Identifying correctly the majority of optotypes on a line will be consistent throughout the chart.
3. Horizontal spacing between optotypes on a line should be equal to the width of the optotypes on that line. Specific optotype spacing helps to ensure that the visual task of identifying optotypes is consistent throughout the chart.
4. Vertical spacing between lines should be the height of the optotypes on the next line down. Uniform spacing ratios help to ensure that the visual task is equal on all lines.
5. The size of the optotypes should progress geometrically up or down the chart by 0.1 log units. You will likely see 20/32 instead of 20/30 on charts that meet this guideline.
6. Optotypes should be black on a white background under good lighting conditions.[18-21]

If you drew a line around the outside of optotypes on a standardized eye chart, the shape of the line would resemble an inverted pyramid or triangle instead of a box or a rectangle. Eye charts meeting spacing requirements will likely be described as "proportional" or "proportionally spaced" in product catalogs and on e-commerce web sites.



Some of you may be asking how the visual acuity test task can be equal when some eye charts have fewer than five optotypes on the top two lines. The answer to that question is: The top two lines on some charts have fewer optotypes to accommodate the size of the chart. Think about a 9 x 14 chart that slides into the grooves of an ESV1200 illuminated cabinet. The chart meets standardization guidelines overall and you, the screener, are more concerned about how the typically developing child performs on the lines from 20/50 down. If a child cannot identify the majority of optotypes on the first two lines, you have an automatic referral.

The national and international guidelines pertain to "regular" or "threshold" eye charts, where children identify optotypes from the top of the chart downward until they can no longer correctly identify the majority of optotypes. Most of the guidelines, such as optotypes of approximate equal legibility, same number of optotypes, and appropriate horizontal spacing between optotypes also apply to "critical line" tests of visual acuity. In this type of test, the child must correctly identify the majority of optotypes on the critical line matching the child's age.

WHAT CAN HAPPEN IF I USE A NON-STANDARDIZED EYE CHART AS A TEST OF VISUAL ACUITY?

Let's answer this question from your perspective as a school nurse, a Head Start or early childhood program staff person, or anyone who screens vision. If a child does not pass vision screening conducted with a non-standardized eye chart, it is likely that the visual acuity measurement will differ when the child is later examined by an eye care professional using a standardized eye chart.[24] In fact, the child could pass the visual acuity part of the exam. At least five problems can occur with this scenario:[24]

1. The over-referral rate of children with normal vision increases.
2. The eye care professional may question the appropriateness of future referrals.
3. The child's parent(s) takes time away from work or household duties for an unnecessary appointment with an eye care professional.
4. Children who actually have vision problems may be under-referred.
5. Over-referrals of children with normal vision increases health care costs.[17]

NOW THAT I KNOW THE PREFERRED OPTOTYPES AND TYPES OF TESTS OF VISUAL ACUITY FOR MY TOOLBOX . . . WHEN DO I REFER CHILDREN FOR A COMPREHENSIVE EYE EXAMINATION WITH AN OPTOTMETRIST OR OPHTHALMOLOGIST?

Different national referral criteria exist. AAPOS[4] recommends:

- 3-year-old children correctly identify the majority of optotypes with each eye on the 20/50 line.
- 4-year-old children correctly identify the majority of optotypes with each eye on the 20/40 line.
- 5-year-old children, and older, correctly identify the majority of optotypes with each eye on the 20/32 line.

The National Expert Panel to the NCCVEH[1] recommends:

- 3-year-old children must correctly identify 3 of 3 or 3 of 4 optotypes with each eye at the 20/50 level.
- 4- and 5-year-old children must correctly identify 3 of 3 or 3 of 4 optotypes with each eye at the 20/40 level.

The take-home message is this: To help children have the best vision possible to grow and develop, your task is to do the best job you can when screening vision. Whatever test of visual acuity you use, ensure you use age-appropriate, evidence-based, and scientifically validated tools.

SECTION 3
THE CHOICE OF OCCLUDER MATTERS

Screening the vision of each eye separately (a.k.a. monocular screening) is preferred over screening with both eyes open (a.k.a. binocular screening) because you could miss detecting unilateral amblyopia when a child compensates by using the better seeing eye.1 Young children, particularly those aged 3 through 5 years, will attempt to peek around an occluder if you cover their better seeing eye during vision screening with a test of visual acuity. To prevent peeking and receiving incorrect visual acuity values, the choice of occluder matters.

WHY IS FULLY OCCUDING ONE EYE WHEN SCREENING THE OTHER EYE IMPORTANT?

The answer to this question is: If a child peeks to use both eyes to identify an optotype, the visual acuity value is not a true visual acuity value and you could under-refer children who have vision problems.

Full occlusion is especially important for young children who will attempt to peek when they have full responsibility for occlusion, meaning a young child will likely try to peek around, over, or under the occluder if it is covering their "good" eye and you are asking the child to identify an optotype with an eye that is defocused or has blurry vision.

IS A CHILD'S HAND AN APPROPRIATE OCCLUDER?

The answer to this question is: No. Occluders run the gamut of the child 's hand or screening partner's hands to tissues to index cards and paper cups. Excluding the assumption that a child might not necessarily appreciate someone holding a hand over their eyes . . . especially a stranger . . . two primary problems occur when using the child's hand or the hand of a parent or partner screener:

1. The heel of the hand can press into the eyeball and you, the screener, must wait for the "stars" to disappear from the child's hand-occluded eye before screening the other eye. Do you have time to wait for the stars to clear when you must screen hundreds of children with 45 days of enrollment in a Head Start program or 200 children before lunch in a school setting?
2. Fingers of the hand cupped over the eye can provide little slits of open space for peeking.

Try this experiment. Cover one eye with your hand. Close the eye that is uncovered and open the eye underneath your hand. Look through the small slits of open space between your fingers. What do you see? Surprising, right? Objects can become clearer when viewed through a small slit, or pinhole – but that's another topic for another day.

If you are using index cards or paper cups, a child can peek around the edges . . . and will try hard to peek if they cannot see well with the uncovered eye. Attempting to peek is a typical reaction, not a naughty child.

WHAT IS AN APPROPRIATE OCCLUDER FOR A YOUNG CHILD?

Because it is unwise to give a young child responsibility for covering an eye during screening, use an adhesive eye patch, medical tape, or an occluder that a young child does not need to hold.

The National Expert Panel to the National Center for Children's Vision and Eye Health at Prevent Blindness[1] prefers adhesive eye patches or 2-inch wide hypoallergenic surgical tape as the first choice for occluders. You could give children the opportunity to decorate the adhesive patches as a prescreening activity to further engage their cooperation during vision screening.

If a child will not tolerate adhesive eye patches or surgical tape, using commercially available occluder glasses designed to prevent peeking is an option. The National Expert Panel[1] considers "specially constructed occluder glasses" (p. 9) as an acceptable occlusion method.

Commercially available occluder glasses, which often include whimsical frames with parrots, tigers, and horses, are available in sets of two, one for screening each eye. In those glasses, one of the openings has a lens to occlude the eye and the other opening has no lens. The opening with no lens is the eye you are screening.

We offer two tips when using commercially available occluder glasses:

1. The cover lens in most commercially available glasses is either dark . . . somewhat similar to sunglasses . . . or frosted. The frosted lens allows more ambient light around the eye and is not as intrusive to the child as the dark lens.
2. Typically the set of occluder glasses with the left eye covered and the right eye open is used first. If you are interrupted during screening, you will know which eye was screened and which eye needs to be screened. If you are wearing clothing with two pockets and are right-handed, you could place the glasses with the right eye open in the right pocket. This will help you to remember which eye to screen first.

Occluder glasses framed with parrots, tigers and horses can also increase participation when children are not interested in playing your vision screening game. Most children like the novelty of the glasses; none have asked to keep the glasses at the conclusion of the screening in our experience.

We do not recommend making your own occluders by purchasing two sets of sunglasses and removing one lens from each set. The commercially available occluder frames have an important benefit in that they include extra material around the frame's outer edges to help prevent peeking.

Another commercially available option for young children—with petite faces—is occluder glasses where each eye piece pops up separately.

You can clean occluder glasses between screenings with alcohol or non-alcohol wipes. Clean all parts of the occluder glasses except occlusive lenses.

WHAT ARE INAPPROPRIATE OCCLUDER GLASSES FOR YOUNG CHILDREN?

The National Expert Panel to the NCCVEH[1] considers the following four types of occluders unacceptable for children ages 3 through 5 years because children can easily peek around them:

1. Hand,
2. Tissues,
3. Paper cup, and
4. Occluder paddle.

WHAT IS AN APPROPRIATE OCCLUDER FOR CHILDREN OLDER THAN 10 YEARS?

Some school nurses use occluder glasses through the fourth grade. An appropriate occluder for children aged 10 years and older (and who are less likely to peek) is the black or gray "lollypop" occluder with a handle.

We have a tip for using a "lollypop" occluder . . . many screeners hold the "lollypop" with the handle toward the chin. If you use this occluder, look at the underside of the occluder. Notice a raised portion? That raised portion has a purpose. Hold the occluder with the handle toward the temple. The raised portion fits in the curve of the nose . . . to prevent peeking, even with these older children.

Another occluder option is a handheld "flip paddle" or "Mardi Gras mask". This occluder has an opening for only one eye. Once screening is completed for one eye, the child "flips" the occluder over to cover the eye previously screened.

The take-home message is this: Screen one eye at a time, typically the right eye first. If you want to do the best vision screening you can possibly do, ensure that the child does not peek when an eye is occluded. And, to ensure the child does not peek, use occluders designed to help prevent peeking.

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