# Vision Development and the Infant/Toddler Examination

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## Standing on the Shoulders of Giants!

- ARNOLD GESELL, M.D.
  - Vision is the key to a child's whole development, therefore;
  - If vision is not working well, the child is not working well
- John W. Streff, O.D.
  - When vision is working well, it guides and leads.
  - When it is not, it interferes.
- Darrell Boyd Harmon, PhD
  - Movement is not just for moving-movement is for action! VISION is not *for* seeing, VISION *is for* discrimination, appraisal, decision and action in a lighted world.

## Factors Impacting Development

- Prenatal
  - Disruption in development leads to difficulties
  - Genetic vs. Environmental
    - Parental lifestyle
- Birth Process
  - APGAR score
- Birth Weight and Prematurity
  - Physical, emotional, cognitive and sensory development

## Newborn

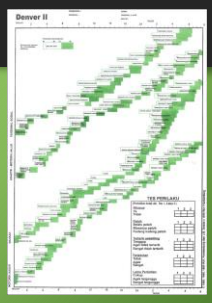
- Birth to Four Months
  - Primary focus is 8-10 inches
    - 20/200-20/400
  - Improving focusing ability
  - Improving eye control
    - Normal vs. abnormal
  - Eye-hand coordination is developing
  - Color vision
    - present but like tones are hard to distinguish
    - Black and white patterns

| Behaviour | Age | | | | |
|---|---|---|---|---|---|
| | Neonate | 6 weeks | 3 months | 4 months | 5 months + |
| Blinks when a light is flashed in their eyes? | Healthy babies will do this. If not, suspect a problem | | | | |
| Turns to a diffuse light, such a light coming from a window? | May do it | Healthy babies will do this. If not, suspect a problem | | | |
| Looks at your face when 10–20 cm away (less than 1 foot)? Any response to silent smiles or eyebrow raising? | Too young | May do it | Healthy babies will do this. If not, suspect a problem | | |
| Eyes fix on, and follow, a dangling ball or toy? | Too young | May do it | Healthy babies will do this. If not, suspect a problem | | |
| Watches an adult at 1.5 metres (5 feet)? | Too young | May do it | | Healthy babies will do this. If not, suspect a problem | |
| Converges accurately? (If you move a toy closer and further away, do the eyes focus on the toy and line up properly?) | Too young | May do it | | Healthy babies will do this. If not, suspect a problem | |
| Blinks in response to a threat? (Any silent, sudden movement close to the face which causes no breeze, e.g., opening your fist very suddenly.) | Too young | Too young | Too young | May do it | Healthy babies will do this. If not, suspect a problem |

## Newborn

- Five to eight months
  - Refinement in eye control
  - Development of stereopsis
  - Fine focusing
  - Movement of body coordinated with vision
    - Motor planning
- Nine to twelve months
  - Refinement of depth perception
  - Integration of fine motor coordination
  - Start of visual processing
  - Vision used to direct walking

## Developmental Milestones




## Developmental Milestones

**TABLE 1.1 Guidelines for Social and Emotional Milestones Expected at 12 Months of Age**

- Shy or anxious with strangers
- Cries when mother or father leaves
- Enjoys imitating people in his play
- Shows specific preferences for certain people and toys
- Tests parental responses to her actions during feedings
- Tests parental responses to his behavior
- May be fearful in some situations
- Prefers mother and/or regular caregiver over all others
- Repeats sounds or gestures for attention
- Finger-feeds herself
- Extends arm or leg to help when being dressed

Used with permission from Shelov SP, et al. Caring for your infant and young child: birth to age 5. 4th ed. Bantam Books; 2005. p. 247.

## Developmental Milestones

**TABLE 1.2 Cognitive Milestones Expected by 12 Months**

- Explores objects in many different ways (shaking, banging, throwing, dropping)
- Finds hidden objects easily
- Looks at correct picture when the image is named
- Imitates gestures
- Begins to use objects correctly (drinking from cup, brushing hair, dialing phone, listening to receiver)

Used with permission from Shelov SP, et al. Caring for your infant and young child: Birth to age 5. 4th ed. Bantam Books; 2005. p. 243.

## Just for fun!

- 10 Things Every Child In Memphis Should Experience Before Kindergarten
  - Play at the Children's Museum
  - See Animals at the Zoo
  - Watch the Peabody ducks
  - Ride the Trolley
  - Explore the Botanic Gardens
  - Enjoy Shelby Farms Park
  - Tour Memphis Museums
  - Walk the Mississippi River
  - Get a library card
  - Visit your child's elementary school

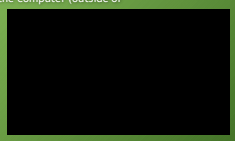
## DEMANDS ON STUDENTS

There seem to be many more kids having difficulty today than ever before! Why???

| 1950 | 1985 | 2003 |
|---|---|---|
| No kindergarten<br>No computer<br>Small number of kids in a class | Kindergarten<br>One computer for each room<br>30 kids in a portable classroom | At least one computer in every classroom<br>Computer classes for many children<br>Summer reading programs<br>Cutting of physical education |

## ADDITIONAL DEMANDS ON KIDS

- Kaiser Family Foundation
  - two-thirds of infants and toddlers watch a screen an average of 2 hours a day
  - kids under age 6 watch an average of about 2 hours of screen media a day, primarily TV and videos or DVDs
  - kids and teens 8 to 18 years spend nearly 4 hours a day in front of a TV screen and almost 2 additional hours on the computer (outside of schoolwork) and playing video games
- Hand-held computer games
- Surfing the net
- Texting
- TV shows
- The issue is not that kids use them
  - it is that they use/play them obsessively



## The Examination

- General observation
- Visual acuity
- Alignment
- Convergence
- Pupils
- Visual fields
- Intraocular pressure measurement
- Anterior & Posterior segment

## The Examination

## The Examination

## Eye Movements

- Fixation
  - Make a red finger
  - Grab the toy
  - Silent targets
- Pursuits
  - Same strategy
- Saccades
  - Attractive targets with motion
  - Puppets dancing in turn
  - Parent holds head stable

## Eye Movements

## Development of Oculomotor Abilities

| Skill | Age* |
|---|---|
| Fixation to: | |
| Lights | 3 months |
| Faces | birth |
| Visual Objects | 3 months |
| Auditory Objects | 3 months |
| Optokinetic Nystagmus | birth |
| Saccadic Movement: | |
| Horizontal | birth |
| Faces | birth |
| Vertical Upgaze | 4-6 weeks |
| Vertical Downgaze | 3 months |
| Penlight | 3 months |
| Pursuits | 6-8 weeks |
| Vestibulo - Ocular Reflex | birth |
| Coordinated Head-Eye Movements | 3 months |

* >50% of infants demonstrate skill

(Scharre '97)

## EOM fields

- Move your face with the target while Mom holds head
- Move head watching you & target
- Surprise noise and target in each position of gaze
- Multi-modality targets best

## EOM fields

## Visual Acuity

Teller Cards

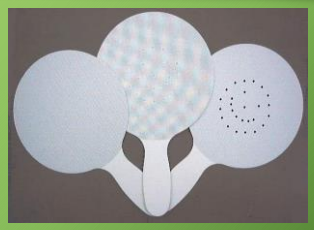
## Teller Card Norms (1986)

| Age | Visual Acuity |
|---|---|
| Newborn | 20/400 - 20/1200 |
| One Month | 20/300 - 20/1200 |
| Two Months | 20/150 - 20/600 |
| Four Months | 20/80 - 20/300 |
| Six Months | 20/50 - 20/200 |
| One Year | 20/50 - 20/200 |
| Three Years | 20/15 - 20/40 |

## Lea Gratings

## Lea Gratings


## The Face Dot Test



## The OKN Drum


## Motor Fusion

- R/O strabismus or pseudostrabismus
- Hirschberg
  - with penlight for gross assessment of binocularity
  - Nasal placement=exotropia
  - Temporal placement=esotropia

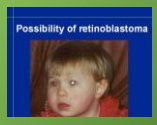

## Motor Fusion

- Cover test
  - observation with occlusion
  - loose prism
  - prism bar
  - with dynamic targets
  - lighted targets best for observing alignment reflex

## Motor Fusion

## Motor Fusion

- Bruckner Test
  - strabismus, amblyopia, & anisometropia
  - 80-100 cm away from child
  - ophthalmoscope light on both eyes simultaneously
  - anisocoria, larger pupil is brighter
  - Anisometropia: higher refractive condition is brighter
  - Strabismus: non-fixating eye is brighter




## Motor Fusion

## Motor Fusion

## Sensory Fusion

- Based upon stereo acuity development during the first 24 months
- A sensitive period for development of binocularity
- 10^ BU prism test

## Sensory Fusion

## Sensory Fusion

Worth Four Dot

## Sensory Fusion

- Stereo tests
  - Lang
    - no filter glasses required
    - change orientation of target to be sure response is valid
    - **Test 1** has disparities of 550", 600", and 1200", with car, star, and cat.
    - **Test 2** has Moon 200", car 400", and elephant 600". Star is visible monocularly, observed.
  - Stereo Fly and
    - 18 - 20 months +
    - gross and fine stereo vision
    - graded circle test (800 to 40 seconds of arc),
    - animal testing for young children (400 to 100 seconds of arc) and stereo glasses
    - fly features 3500 to 40 seconds of arc

## Sensory Fusion

- Stereo tests
  - Frisby Stero test
    - 2 + years of age
    - three plates-6mm, 3mm and 1.5mm.
    - differ distances to further vary the disparity cues.
    - stereo acuity measurement in the range 600-20
  - Random Dot E
    - tests for 500 to 52 seconds of arc by variations in the testing distance.
    - standard acuity (20/90 minimum)
    - new Low Vision Random Dot E version permits resolution to 20/200 acuity.

## Sensory Fusion

- Stereo tests
  - Stereo Smile
    - Forced choice test
      - PASS Test 1: 720 minutes of arc card
      - PASS Test 2: 480 and 240 minutes of arc cards,
      - PASS Test 3: includes the 480, 240, 120 and 60 minutes of arc cards

## Sensory Fusion

- Stereo tests
  - Randot Preschool Stereo
    - Three pages in one booklet:
      Page #1: 200 and 100 seconds of arc
      Page #2: 60 and 40 seconds of arc
      Page #3: 800 and 400 seconds of arc

## Stereo Fly

## The Keystone Basic Binocular Test (KBB)

Excellent for young children, patients with strabismus, amblyopia, and patients who suffer from head injury.


## The Keystone Basic Binocular Test (KBB)

## The Keystone Basic Binocular Test (KBB)

## Refraction

- Myopia, hyperopia and astigmatism can vary measurably throughout the first year.
- Refraction may vary as much as 6.00 - 8.00 diopters.
  - This includes hyperopia, myopia astigmatism, and anisometropia
- Frequent re-assessment is necessary until it is determined that the refraction is stable over a three month period

## Refraction

- Significant refractive conditions in children 12 months and older:
  - > +3.00 D hyperopia in any meridian
  - > -3.50 D myopia
  - > 1.50 to 2.00D astigmatism
  - > 1.00 D anisometropia
    - (esp if higher ametropic eye is > +3.00D)

## When strabismus is present, refractive compensation could be considered for:

| Isometropia | | Anisometropia | |
|---|---|---|---|
| Myopia | >3.50 D | Myopia | >3.00 D |
| Hyperopia | >2.00 D | Hyperopia | >1.00 D |
| Astigmatism | >1.50 D | Astigmatism | >1.00 D |

## Cycloplegia

- Prescribing lenses from the cycloplegic refraction during the first year may delay or offset the emmetropization process
- "Pushing plus" should be reserved for minimization of the angle for ET
- Wet vs. Damp
- Optometry & Visual Performance Vol 1, Issue 1
  - Smith and Laudon-Point/Counterpoint

## Distance Retinoscopy

- Mohindra Retinoscopy
  - non cycloplegic
  - monocular technique
  - infant fixates a dimmed retinoscope light
  - 50 cm working distance
  - totally darkened room
  - Correction factor:
    - 0.75 D for infants
    - 1.25 D after age 2 yrs

## Distance Retinoscopy

## Near Retinoscopy

- Have the baby look at a near target
- MAKE IT AN INTERESTING TARGET!
- Compare right and left eyes before trying to determine a refractive amount
- JUST LOOK-Glen Steele

## Prescribing Pearls

- Allow emmetropization to take place
- Wait on Rx unless esotropia is present
- Wait on Rx if child was a preemie
- Prescribe lenses that positively affect the child's interaction with the environment.
- General guide: be conservative: 1/3rd of what you measure to begin with!

## Anterior Segment

- Penlight and 20 D lens is your friend.

## Posterior Segment

- However you can get it done!
- Wait for it!
- Baby
  - In mother's arms
  - While feeding
  - While sleeping
- Toddler
  - Standing on your head
  - Laying on the floor
  - Watch out for flying hands and kicking feet!

## The Toddler/Young Child

- **History**
  - Preparation should ideally begin before the patient enters the practice.
  - Intake forms and questionnaires on the patient's medical and ocular history can be sent out beforehand.
  - This information will provide insight about the patient's needs and their level of functioning.

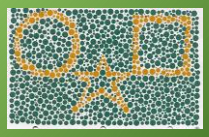
## More History

- Discussion of any occupational and physical therapy services used can also provide background about the patient's developmental level.
- When assessing medical history, note any ocular or systemic medications and the length of time they were taken.
- Be familiar with commonly used medications and their side effects

- Academic
- Social
- Birth

## Color Vision Testing

- **Color Vision Testing Made Easy**
  - For patients who do not know their numbers.
  - If they cannot communicate verbally
    - Ask the patient to trace the shapes with a cotton tipped applicator or a small paint brush.
- **Ishihara Plate Test**
- **Wool/Yarn Test**



## Visual Acuity Assessment

- **HOTV Test**
  - Developmental ages beginning at three or four years old.
  - Four letters (H, O, T and V) are used in the chart.
  - The test is performed at 10 feet
    - Near card for matching
  - Advantage
    - No directional component-good for children with issues of letter reversals
  - Disadvantage
    - Unequal blur-possible for the patient to identify the letters correctly, when they are actually guessing.

## Visual Acuity Assessment

- **Lea Symbols Test**
  - Developmental ages of two to five years old
  - Non-verbal patients.
  - The test is performed at 10 feet
  - Contains four symbols (circle, square, house and apple)
  - The child matches each symbol at distance to a companion card at near
  - Advantage
    - all the symbols blur out evenly to circles.
    - reduces the likelihood of the patient guessing each symbol correctly.
  - Also available in a near visual acuity test.

http://www.nkk.com

## Visual Acuity Assessment

- **Broken Wheel Test**
  - Developmental ages of three to six years.
  - Landolt C symbol-replaces the wheels of the car
  - Performed by placing two pictures side by side.
  - One picture has complete wheels while the other picture has sections missing.
  - The child is asked to point to the car with the 'broken wheel'.
  - Advantages
    - highly sensitive
    - detect subtle differences between the two eyes due to amblyopia or refractive error.

## Visual Acuity Assessment

- **Tumbling E Test**
  - Developmental age beginning at four to five years.
  - Performed at 20 feet
  - The child must tell the orientation of the legs of the letter 'E' (up, down, left, right).
  - Advantage
    - Helpful for non-verbal children
  - Disadvantage
    - May pose a problem to children who have issues with laterality and directionality.

## Visual Acuity Assessment

- **Cardiff Cards**
  - Vanishing optotypes.
  - The targets disappear at the patient's resolution limit.
  - The cards contain pictures of a house, car, fish, train, dog and duck
  - The pictures are in an up/down rather than a right/left separations.
  - Easier to distinguish in cases of congenital nystagmus.
  - Does not use a peephole as in Teller acuity.
  - The practitioner does not know the position of the target.
  - Credit for a particular acuity level
    - correctly identify two out of three presentations.

## Visual Acuity Assessment

- **Optokinetic Nystagmus (OKN)**
  - Used to verify if the patient possess a cortical visual response.
  - Developmental ages between 18 months and seven years
  - Requires little to no effort by the patient.
  - The drum is spun slowly and the examiner observes the patient's eye movements as they follow the rotating drum.
  - The patient should exhibit a nystagmus movement.
- **Visual Evoked Response/Potential**
  - Electrodiagnostic testing is a very precise way to quantify the patient's visual acuity.
  - With Visual Evoked Response (VER), a scalp electrode is used to record electrical signals from the visual cortex while the patient views a grating or checkerboard stimulus.

## Stereo Testing

- Evaluate the degree and presence of stereopsis
  - Suppression check (R+L)
  - Local/Contour Stereopsis
    - Wirt circles, Titmus stereofly and animals
    - Uses two similar targets that are laterally displaced.
    - Contains monocular cues
    - Helps determine if peripheral stereopsis is present
    - What should we shoot for?
  - Global Stereopsis
    - Random dot stereopsis
    - Helps to determine the presence of a constant strabismus

## Stereo Vision

- **Lang Stereo Test**
  - The images vary in disparity, ranging from 600 to 200 arc seconds.
  - Polarized spectacles are not needed.
  - Patient must be able to point to, or describe, the location of the objects.
- **Random Dot E Test**
  - Measures global stereopsis
  - Different distances to evaluate different disparities.
  - useful for nonverbal patients or those with expressive aphasia

## Visual field testing

- To uncover gross peripheral defects, and areas of constriction or neglect.
  - The practitioner should sit in front of the child observing their visual response and holding a target (puppet or noise making toy).
  - The practitioner will need an assistant to stand behind the child and present another toy (hand puppet) in arcs of all meridians.
  - This toy, and the assistant, must not make any noise.
  - The position where the patient first detects the stimulus should be noted.

## Refractive Error Assessment

- General Hints
  - Objective measurements
  - Lens racks
- Static retinoscopy
  - performed out of the phoropter,
  - using lens racks and plus spectacles (+1.50D to
  - +2.00D) to fog the patient.
  - better idea of the patient's fixation and a better chance of holding their attention.
  - Getting the patient to fixate in the distance may be a difficult task. The use of musical toys, bubbles and video players with cartoons may alleviate this problem.
- Mohindra near retinoscopy
  - The patient to fixates on the retinoscope light monocularly at 50cm.
  - The test is performed in complete darkness.
  - The child may be occluded by a patch or the parent's hand.
  - Add -1.25D to the gross sphere power obtained if child is 18 months or older.
  - Add -0.75D to the gross sphere power obtained if child is 18 months or younger

## Refractive Error Assessment

- Autorefraction
  - Should not be used as gospel.
  - Used to confirm the results from retinoscopy,
  - Proper fixation in order to gather measurements.
- Keratometry
  - Used to confirm the amount and axis of the corneal astigmatism.
  - Integrity of the cornea-appearance of the mires.

## Refractive Error Assessment

- Cycloplegic retinoscopy
  - Useful in patients with fluctuations in their accommodative system.
  - Cyclopentolate-cycloplegic refraction
  - Tropicamide-wet refraction
  - Two drops of cyclopentolate (0.5% for infants and 1% for older children), five minutes apart.
  - Retinoscopy should be performed 30 minutes after installation of the last drop.
  - Avoid over dosage of in children with Down's syndrome, cerebral palsy and other central nervous system disorders

## Measuring intraocular pressure

- TonoPen
  - Small, handheld
  - Multiple, quick measurements of IOP
  - Useful for patients in wheelchairs.
  - Disadvantages
    - Anaesthetic is required

## Measuring intraocular pressure

- Non-contact tonometry (NCT)
  - Useful for patients who are uncomfortable with drop installation and having their eyes touched.
  - Stationary or portable
  - Prior to taking a reading, demonstration of the puff of air on the patient's hand should be done.
  - Patient anxiety can be reduced by saying phrases such as "It's going to give you a kiss."

## Measuring intraocular pressure

- Goldmann applanation tonometry (GAT)
  - Gold standard
  - Disadvantages
    - Anesthaesia prior to use
    - Patient must hold proper fixation and posture.
    - Need to get very close and touch the patient's eye
- iCare Tonometer
  - eliminates the need of drops
  - a very light probe is used to make momentary contact with the cornea.
- Digital tension estimation
  - When all else fails!
  - Reliable mean of obtaining IOP- Ficarra *et al*
    - particularly in the range of 6mmHg to 22mmHg.
  - Pressures should be recorded as 'soft to touch,' 'medium to touch,' or 'hard to touch.'

## A good introduction!

## Thank You

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