Children’s Vision

Vicki Vivian-Cooper
Elaine Salina
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Normal refractive development in children

College of Optometrist Guidelines

Practical tips on getting the most from the examination

Know what and when to prescribe
PRENATAL CORTICAL DEVELOPMENT

- **3-8 WKS** – Germ layer derivation: Mesoderm, Endoderm, Ectoderm
- **1st month** – Formation of Brain, Spinal chord & Neural system from neural plate & neural tube
- **2nd month** – Formation of Cerebral Hemispheres & Cranial nuclei
- **8-16 wks** – Proliferation of Glial tissue
- **12-20 wks** – Migration of neurones
- **3-4 months** – Neurones in ventricular zones proliferate & migrate to cortical plates
- **24 wks-term** – Cortical Organisation occurs
- **24 wks – 2 yrs** – Myelination of nerves occur
Prenatal Ocular Development

- Optic vesicle forms from Optic Groove by 2 wks
- Lens forms from surface ectoderm by 7 wks
- Optic nerve with central retinal artery develops by 9 wks
- Iris Sphincter formed from smooth muscle from neural ectoderm around 4/12
- Iris Dilator formed from pigmented myoepithelium from outer layer of optic cup at 7/12
- Neonate has miosed pupils. Pupillary light reflex present from 30/52
- Blink to light reflex seen around 30/52
- Rods & Cones are distinguishable around 35 wks
- N.B Foveal cones do not reach adult dimensions until 4 months after birth
- **Birth** – Vestibular-ocular response is well developed. Central retina more functionally complete than peripheral retina.

- **1/12** – Myelination of Anterior Visual Pathway completed – this is delayed in cases of Delayed Visual Maturation. Myelination is accelerated by light. Therefore, process completed earlier in premature babies.

- **1/12** – Gain alignment of Visual axes
  Able to follow moving target with a saccadic type movement.
  Smooth pursuit movement not apparent until later.

- **8/52** – Functioning Vergence system

- Refixation saccade not present until **6/12** of age
### EYE VITAL STATISTICS

- The structures within the eye undergo rapid growth throughout the first 18 months of life. An eye reaches adult size by age 13.

- Between age 3-13 yrs the axial length of the eye only increases by 1mm

<table>
<thead>
<tr>
<th></th>
<th>BIRTH</th>
<th>6 months</th>
<th>12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axial length</td>
<td>16.8 mm</td>
<td></td>
<td>20mm</td>
</tr>
<tr>
<td>Cornea</td>
<td>51 dioptries</td>
<td>44 dioptries</td>
<td></td>
</tr>
<tr>
<td>Lens Power</td>
<td>34.4 dioptries</td>
<td>28 dioptries</td>
<td></td>
</tr>
</tbody>
</table>
This occurs with normal growth of the eye. The refractive error tends to decrease during the first year of life in a 'passive' way. As the eye develops and increases in size, the power of the optical components decreases reducing the refractive power.

Emmetopisation has an active visual feedback mechanism which is dependant on normal visual experience. Normal development does not occur where there is visual deprivation during infancy.

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**Table 1: Age norms and tests used (measurements are all approximate) (adapted from A. Grounds by C. Rushen and L. Speedwell)**

<table>
<thead>
<tr>
<th>Age</th>
<th>Stereo (secs of arc)</th>
<th>Visual acuity test</th>
<th>VA term/6wks prem (6/6)</th>
<th>VA 5-9/52 prem (6/6)</th>
<th>VA &gt;9/52 prem (6/6)</th>
<th>Near VA test @ 25cm</th>
<th>Near VA @ 25cm</th>
<th>Average Rx</th>
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</thead>
<tbody>
<tr>
<td>Birth</td>
<td></td>
<td>Keeler PL cards</td>
<td>300</td>
<td></td>
<td></td>
<td>+ 3.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One month</td>
<td></td>
<td>Keeler PL cards</td>
<td>200-90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Three months</td>
<td></td>
<td>Keeler PL cards</td>
<td>90-60</td>
<td>90-75</td>
<td>130-90</td>
<td>+ 2.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six months</td>
<td>600 Frisby</td>
<td>Keeler PL or Cardiff</td>
<td>36-30</td>
<td>60-50</td>
<td>75</td>
<td>+ 2.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nine months</td>
<td>300 Frisby</td>
<td>Keeler PL or Cardiff</td>
<td>24</td>
<td>36</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One year</td>
<td>210-170 Frisby</td>
<td>Cardiff cards</td>
<td>18</td>
<td>24</td>
<td>36-30</td>
<td>+ 2.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 months</td>
<td>170-150 Frisby</td>
<td>Cardiff cards</td>
<td>12</td>
<td>18</td>
<td>24-18</td>
<td>+ 1.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two years</td>
<td>100-85 Frisby</td>
<td>Cardiff or SG singles @ 3m</td>
<td>12-9</td>
<td>12</td>
<td>15-12</td>
<td>Red Keys (reduced)</td>
<td>6/12-6/9</td>
<td>+1.25</td>
</tr>
<tr>
<td>Three years</td>
<td>85-55 Frisby</td>
<td>SG, Keys or logMAR singles @ 3m</td>
<td>9-6 singles</td>
<td>9-6 singles</td>
<td>9 singles</td>
<td>Red Keys or SG/Red Snellen singles</td>
<td>6/9-6/6</td>
<td>+1.00</td>
</tr>
<tr>
<td>Four years</td>
<td>40-30 Frisby</td>
<td>SG, Snellen or logMAR singles or Morph</td>
<td>9-6 Morph</td>
<td>6 Morph</td>
<td>9-6 singles</td>
<td>Red Keys or SG/Red Snellen singles</td>
<td>6/6 or N5</td>
<td>+0.50</td>
</tr>
<tr>
<td>Five years</td>
<td>30-20 Frisby / Mallett</td>
<td>SG, Snellen or logMAR singles or Morph</td>
<td>6-5</td>
<td>6-5</td>
<td>6 Morph</td>
<td>SG/Red Snellen, Red Snellen or MacMure</td>
<td>6/6 or N5</td>
<td>+0.50</td>
</tr>
<tr>
<td>Six years</td>
<td>10-5 Frisby / Mallett</td>
<td>Snellen or logMAR Morph</td>
<td>6-5</td>
<td>6-5</td>
<td>6-5</td>
<td>Red Snellen or MacMure</td>
<td>6/6 or N5</td>
<td>+0.50</td>
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**About the author**

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BINOCULAR SINGLE VISION (BSV)

BSV is the ability to use both eyes simultaneously so that each eye contributes to a common single perception.

Normal BSV occurs with bifoveal fixation & normal retinal correspondence.

Abnormal BSV occurs in the absence of bifoveal fixation usually with abnormal retinal correspondence.
COMPONENTS OF BSV

- **SENSORY FUSION** – Is the ability to appreciate two similar images, one with each eye & interpret them as one. Developed by **3 months of age**. Prior to this, there is a form of superimposition between the 2 eyes.

- **MOTOR FUSION** – Is the ability to maintain a single fused image during a range of vergence movements.

- **STEREOPSIS** - Is the ability to fuse images which stimulate horizontally different retinal points within Panum’s area. It develops abruptly between **3-5 months of age**. Females develop it 4 wks before males. **60 ’’** of arc can be attained by **6 months of age**.
N.B. SENSORY & MOTOR fusion are normal in patients with Normal Retinal correspondence. Weak Sensory fusion usually present in Abnormal Retinal Correspondence.

If Fusion is absent, BSV can not be restored. Sensory fusion is insufficient to maintain stable eye position.
What can affect vision & BSV?

- Squint – misalignment of the eyes
- Amblyopia – lazy eye
- Hypermetropia – longsighted
- Myopia – shortsighted
- Astigmatism – rugby ball shaped eye
- Other conditions – cataract, nystagmus, glaucoma, retinal detachment and other pathological conditions
SUPPRESSION

Defined as the mental inhibition of visual sensations of one eye in favour of those of the other eye when both eyes are open. Can occur in BSV and manifest strabismus.

Suppression develops rapidly in early childhood during the critical period of cortical development. Suppression of the fovea develops to prevent confusion & diplopia.
Amblyopia

- This is the term for a “lazy eye”
- Vision is impaired
- Results from poor development of the brain cells & connections in the vision areas of the brain during maturation of the visual pathways
- Can only be treated while the brain pathways are still maturing (up to age 8)
When examining a younger child, the optometrist has a duty to use a range of tests suitable for the age of the patient being assessed and in all cases to obtain as much information as possible about vision and/or visual acuity, oculomotor balance, refractive error and the health of the eyes.

College Guidelines July 2011
Same principles apply to children's examinations as do to adults, with some additional advice as follows:

1. Specific history relating to those conditions that might predispose the child to visual problems (e.g. Family history of Rx, squints, difficult birth, abnormal or delayed development)
2. Vision/visual acuity measured using an age appropriate test. Ideally a crowded test
3. Oculomotor balance using objective or subjective methods
4. Stereo test
5. Refractive error measurement, only objectively in younger children
6. A good view of the fundus should be attempted, at the very least a clear view of ocular media, disc and macula
7. Colour vision test at the first opportunity
Use of Cycloplegia

All under 7’s??

Guidelines state cyclo should be considered to give an accurate assessment of the refractive error, and for the best possible fundus view in a child.

If any of points 1-7 are suspicious you must perform a cyclo.
Gut feeling
Parental concerns
LogMAR Test
Kays Crowded test
Why LogMar is the preferred test

- Equal no. of letters on each line
- Regular spacing between lines and letters
- Letter sizes are in a uniform progression
- Each individual letter is assigned an individual score resulting in a more accurate and consistent measurement of VA
- The test is therefore superior in its scientific principles, clinical accuracy and reproducibility.
Referral Criteria

* LogMAR vision less than 0.2 (6/9.5 Snellen)
* $\geq$ than 0.75 (3 letters) difference between two eyes
* Crowded Kays vision less than 0.1 (6/7.5 Snellen)
* Any squint
* Any abnormal eye movements
Examination Tips

Be Friendly

- Interact with the child on their level & listen to parents’ concerns.
- Make them feel at ease. Try incorporating their interests in to the tests.
- Explain what will happen at each stage of the examination.
- Talk to child constantly to keep their attention / fixation.
- Give child appropriate praise and encouragement. (Stickers work wonders!!)
Be Flexible

- Consider time of appointment
- You will not be able to stick to your normal testing routine.
- Get down to their level (literally)
Be Fast !!!

- Short attention span – you have approximately the same number of minutes as child’s age + 1 before they lose concentration.
- Do tests that require greater concentration first
- Test problem eye first
- If child fed up, try something else & come back to it
- Trial frame not always necessary
- Multi-task
Consider the Refractive Error in the light of:

* Management of Ocular Misalignment
* Management of Amblyopia +/or it’s prevention?
* Age of the Child (Broadly 3 groups: up to 1yr, 1yr-pre school & school age)
Ocular Misalignment and Amblyopia

* Refer to HES for orthoptic assessment and management.

* Confident cycloplegic refractive errors that relate to condition can be given prior to referral.
Consider these questions

1. Is Refractive Error within Normal Range for child’s age?
2. Will this refractive error emmetropise? Will prescribing interfere with this process?
3. Will this level disrupt Normal Visual Development? Or increase visual function?
Natural History of refractive error

**0-1yr** – wide range ref error
* Fast emmetropisation both hyperopia, astigmatism and myopia
* Rate is related to initial amount of refractive error. Higher is faster

**1-5 yr** slower period emmetropisation
* Anisometropia: more common in infants than adults
* Moncularly different rates of emmetropisation – so transient
* >3.00 more likely permanent
HYPEROPIA (nil orthoptically)

* Consider range vs age of child
* <4yrs? partial RX both sph & cyl
* School age Full Rx
* > 0.75DS no signs or symptoms – could affect visual function
ASTIGMATISM

* Consider age of child
* > 15months especially oblique – high risk factor in amblyopia
* ? Give partial cyl up to 3-4yr old
* >4yr old full cyl (reduced initially if high Rx)
* School age > 0.75 DC with no signs or symptoms
ANISOMETROPIA

* Consider amblyopia - give full anisometropic RX

*>3.00 Less likely to be transient anisometropia

* If no amblyopia consider monitoring??
MYOPIA

* Consider age of child
* Under 1 yr if >-5.00DS reduce by 2.00
* 1-4yr >-2.00DS slightly reduced
* 4-6yrs >-1.00 or if VA improved
* School age- full RX
Internal HES Pathway

Assessed by Orthoptist/Optometrist

No defect found

Discharged

Results sent to GP and referrer

Defect found

Any pathology - See Ophthalmologist

Treatment plan agreed and started

Review with Orthoptist – ongoing or Discharged
Thank you!