All you need to know about

Vision

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All you need to know about

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Contents

1. Vision

Vision or sight is the most dominant sense in humans (Valenti, 2006). The American Optometric Association (2011) indicates that up to 80% of what we learn we learn through vision. Visual development influences the way we learn and interact socially. Van den Boomen, van der Smagt and Kemner (2012) postulate that abnormal visual processing underlies several developmental disorders (e.g. dyslexia, attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder), since brain areas involved in social and cognitive functions depend on input from brain areas involved in visual processing.

Visual perception involves visual stimuli or stimuli that we see. Therefore, visual acuity is a prerequisite for visual perception (Van den Boomen et al., 2012). Many other areas of development, including social and emotional skills, motor skills, cognition and language development, are dependent on visual development (Valenti, 2006).

2. Some concepts for understanding vision

- Vision – sight;
- Distal stimulus – the actual or real object that you are looking at (Matlin, 2009);
- Proximal stimulus – the photon/light particles that are absorbed by the rod and cone cells of the retina or receptor surface at the back of the eye (Sternberg, 2009; Matlin, 2009). This is the information that your eyes receive.

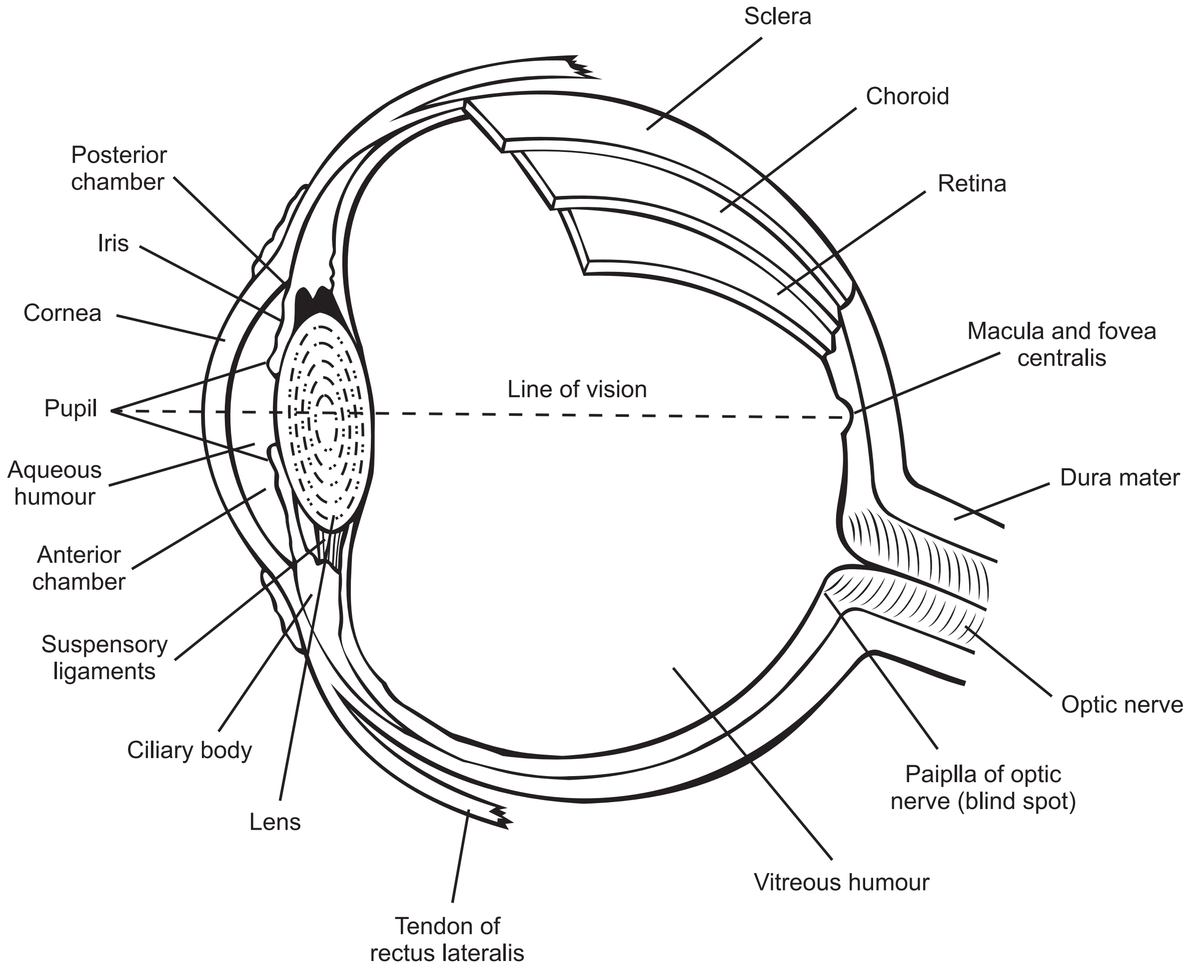
2.1 Vision system

Vaughn, Bos and Schumm (2014) indicate that the visual system consists of three sets of structures:

- The surrounding structures, e.g. the eyelids and facial structure;
- The eye;
- The neurological system, e.g. the optic nerves and vision centres in the brain.

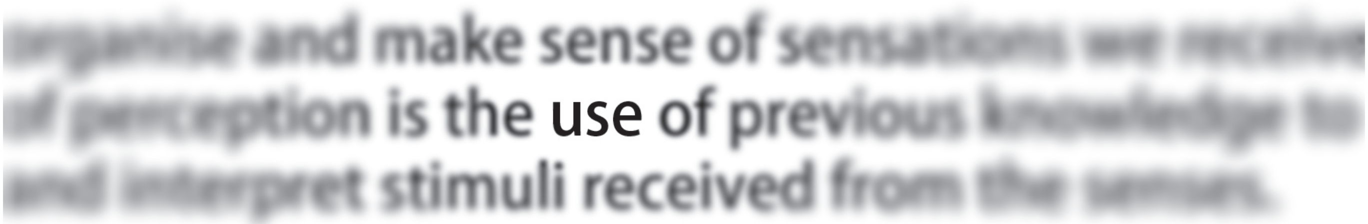
2.2 The eye

The eye is a spherical structure approximately 25 mm in diameter (Landsberg, Krüger & Swart, 2011). The sclera is the tough outer layer of the eye which protects the two inner layers, i.e. the choroid and retina (Landsberg et al., 2011). The part of the sclera that is visible appears white. The choroid is connected to the ciliary body and is rich in blood vessels that deliver oxygen and nutrients to the retina (Landsberg et al., 2011).



(Landsberg et al., 2011)

The retina is the inner layer of the eye and is covered in nerve cells, also known as the rods and cones (Landsberg et al., 2011). The cones found around the macula (central point of focus) are responsible for distinction of colour and function in bright light (Landsberg et al., 2011). The central 15 degrees of the retina, or fovea, is covered in high-resolution cells (Dehaene, 2009). The resolution of the rest of the retina is coarser (Dehaene, 2009). The eyes use saccades or jerky motions to focus text on the fovea which has the necessary resolution to determine letters (Dehaene, 2009). Whilst reading the eyes perform four of five of these saccades per second (Dehaene, 2009). At any given time only one or two words close to the point of fixation are clear, while the rest of the words becomes increasingly blurry (as can be seen below).



Interestingly, even when the size of the font differs, saccades are usually eight to nine letters long and tend to fixate on the centre of a word (Dehaene, 2009).

Resolution – degree of visual precision (Dehaene, 2009). A high resolution allows a finer distinction of visual stimuli. A low resolution allows only coarser distinction. Visual precision decreases as one moves further away from the central gaze (Dehaene, 2009).

The rods further away from the macula are responsible for peripheral vision and function in low light, e.g. during night time (Landsberg et al., 2011). The pigment in the rods and cones absorbs light and converts it into electrical pulses (Landsberg et al., 2011). The eye is connected via the optical nerve to the brain (Landsberg et al., 2011). The electrical pulses travel down the optical nerve to the brain. Damage to the optical nerve might lead to low vision or even cortical blindness (Landsberg et al., 2011).

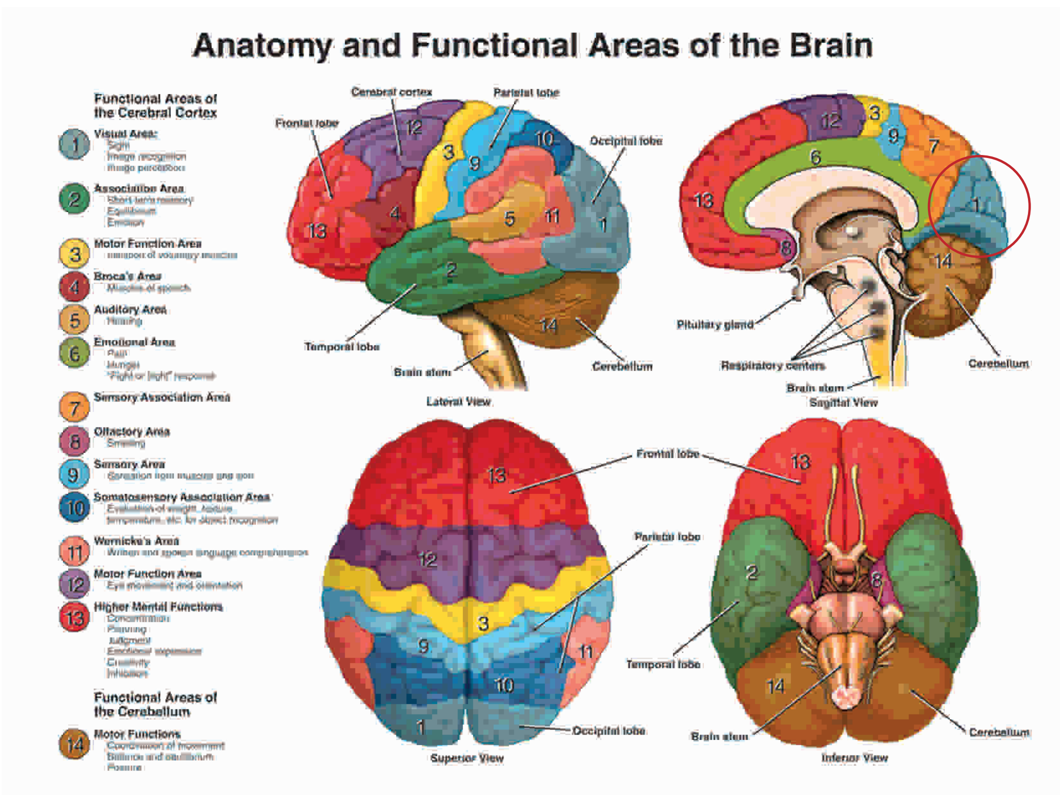
The eye muscles control eye movement (Landsberg et al., 2011). Poor or uncoordinated eye movements can have a negative effect on visual perceptual development. Therefore, as Vlok, Smit and Bester (2011) indicate, intervention programmes for learners with visual perceptual deficits should include eye movement exercises.

The cornea is completely transparent and allows light into the eye (Landsberg et al., 2011). The nerve cells in the cornea trigger the blink response when an object approaches the eye (Landsberg et al., 2011). The iris, the coloured part of the eye which rests on the lens, controls the size of the pupil in order to regulate the amount of light allowed into the eye (Landsberg et al., 2011). The spaces between the cornea and the iris as well as between the iris and the lens are filled with a watery fluid (or aqueous humour) which regulates the pressure in the eye (Landsberg et al., 2011). The lens is connected by ligaments to the ciliary body (Landsberg et al., 2011). By tightening or relaxing the ligaments, the shape of the lens can be changed to allow light to focus on the macula (Landsberg et al., 2011). The changing of the shape of the lens in order to ensure light is focused on the macula is called accommodation.

The inside of the eye is filled with a jellylike fluid (vitreous humour) which ensures the eye keeps its shape (Landsberg et al., 2011).

2.3 Visual cortex

Processing of visual information or stimuli takes place in the primary visual cortex in the occipital lobe of the brain (Sternberg, 2009). Processing happens extremely fast - recognition of an object takes one tenth of a second (Matlin, 2009).



[Adapted from www.neuroanatomy.org, 2014]

3. Vision development

Vision development begins before birth in the womb (Valenti, 2006).

The visual processing system is immature at birth (Van den Boomen et al., 2012). Farroni and Menon (2008) go as far as saying that visual sensory experience influences the way the brain wires itself after birth. The visual processing system undergoes changes that are both structural and functional in nature (Van den Boomen et al., 2012). Structural changes include the folding of the brain and the myelinisation of the axons of the visual nerve cells (Van den Boomen et al., 2012). These changes allow better conduction of electrical impulses along the nerve cells. The functional changes involve the tuning of neurons to specific characteristics of visual stimuli (Van den Boomen et al., 2012).

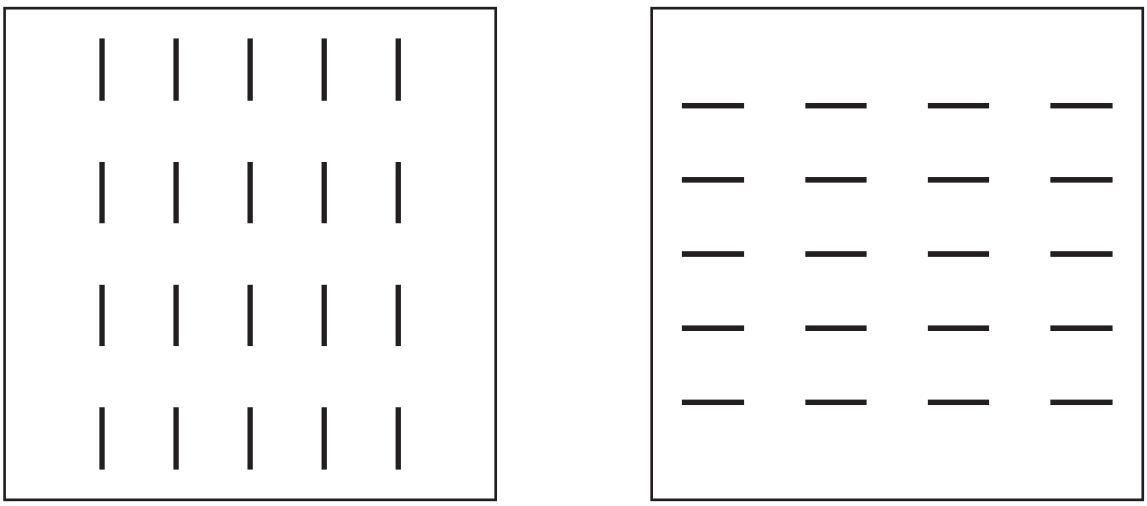
3.1 Stages in visual development

3.1.1 New born infants

As can be seen in the figure that follows, the new born infant has limited visual acuity and contrast sensitivity (Braddick & Atkinson, 2011). This is partly due to weak ocular muscles (Berk, 1997), reduced density of cones in the retina, small eye diameter and cortical immaturity (Braddick & Atkinson, 2011).

Acuity - the sharpness or clarity of vision.

New-born infants can, nonetheless, distinguish between sets of lines orientated differently as in the figure below (Atkinson, Hood, Wattam-Bell, Anker & Tricklebank, 1988).



3.1.2 One to two months

At seven weeks an infant develops the ability to process motion from visual stimuli (Van den Boomen et al., 2012).

3.1.3 Two months

At the age of two months infants can discriminate between blue and yellow (Van den Boomen et al., 2012).

3.1.4 Three months

Infants can distinguish between blue, yellow, red and green by the age of three months (Goulart, Bandeira, Tsubota, Oiwa, Costa & Ventura, 2008).

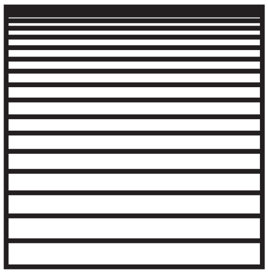
3.1.5 Three to four months

Braddick and Atkinson (2011) report that binocular interaction develops around the third or fourth month of life. Even though infants have the ability to fixate on objects from birth, the ability to shift their focus from an object to a newly appearing target only emerges at three months of age (Braddick & Atkinson, 2011).

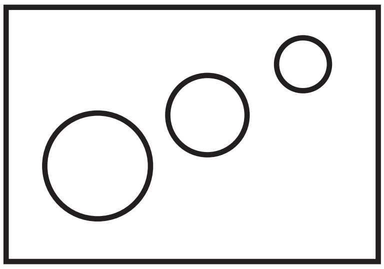
3.1.6 Five months

Depth perception using pictorial cues emerges at around five months of age (Kavsek, Granrud & Yonas, 2009). These pictorial cues are monocular. Monocular depth cues can be shown in two dimensions and perceived by just one eye (Sternberg, 2009). Sternberg describes monocular depth cues as follows:

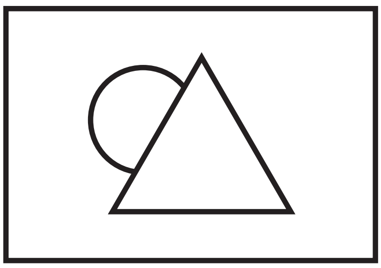
- Texture gradients: larger gradients that are further apart appear closer and smaller gradients that are closer together appear to be farther away;



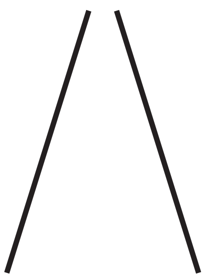
- Relative size: bigger objects appear to be closer and smaller objects appear to be farther away;



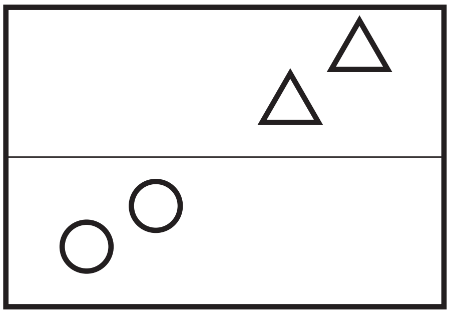
- Interposition: an object obscuring another object appears to be closer and the object being obscured appears to be farther away;



- Linear perspective: parallel lines converging appear to be farther away;



- Location in the picture plane: objects below the horizon and lower down appear to be closer and objects above the horizon and higher up appear to be farther away; and



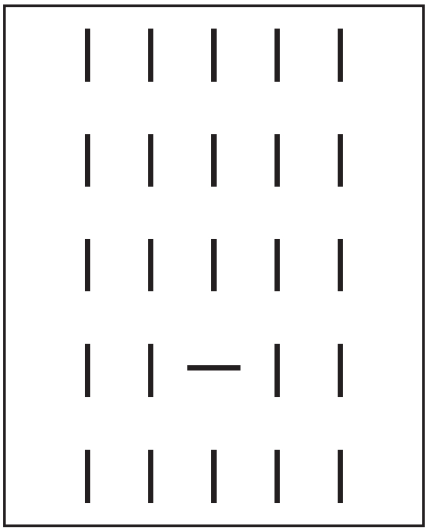
- Motion parallax: an object coming closer appears to get larger and move with increasing speed and an object moving away appears to get smaller and move with decreasing speed.

Binocular depth cues are made possible by the slightly different sensory information received simultaneously by both eyes (Sternberg, 2009). The closer the observed object is, the more disparate or different the two images perceived by the eyes are (Sternberg, 2009). Furthermore, as an object approaches more closely, the more the eyes turn inward to observe the object clearly. This is called binocular convergence.

The ability to process binocular depth cues emerges between three and five months of age and develops rapidly between four and six months (Duckman & Du, 2006).

3.1.7 Nine months

The ability to detect a single line which is oriented differently within a set of lines, as shown below, emerges around the age of nine months (Rieth & Sireteanu, 1994).



3.1.8 Four to six years

Adult-like acuity is reached between the ages of four and six years (Almoqbel, Leat & Irving, 2008). This implies that the school beginner has the prerequisite visual acuity for the finer visual discrimination involved in reading and writing.

3.1.9 Adolescence

Colour vision reaches maturity in the teenage years (Goulart et al., 2008).

By the age of 12 years depth perception reaches adult-like levels (Takai, Sato, Tan & Hirai, 2005).

By the age of 13 years the ability to detect a single line that is differently orientated within a set of lines is fully developed (Rieth & Sireteanu, 1994).

3.2 Visual deprivation and cortical plasticity

Valenti (2006) explains that vision development requires both self-guided movement and varied, interesting visual input. Judge (2003) reports a study of orphans who spent most of their days alone in cribs in colourless, quiet rooms without toys. The orphans showed delayed sensory-motor development, including poor balance, laterality and crossing of the midline (Judge, 2003). After the introduction of a stimulating visual environment these developmental delays started to normalise (Judge, 2003). This indicates a degree of plasticity of the visual cortex and related brain areas.

> Plasticity - refers to the ability of a brain area to take over the functions of damaged or injured brain areas.
>
> Cortex - the outer shell of the brain that surrounds the other brain structures.

3.3 Interaction of vision development and learning

Valenti (2006) reports that many aspects of vision are learned through movement and experience. He further states that there is a higher incidence of children with poorly developed visual skills among children struggling in school than among the so-called "achievers" (Valenti, 2006). Interestingly, he notes that most of the visual deficiencies involve subtle visual skills and not major eye diseases or defects such as cataracts, glaucoma or myopia (Valenti, 2006).

4. Stimulation of visual development

In his vision development programme for infants Valenti (2006) specifies that the activities must be done when the infant is happy and relaxed, with a focus on creating interest through variation and enjoyment rather than on rigid and forced activity. Like infants, children are most likely to engage and learn when they enjoy the activities in a safe and caring environment.

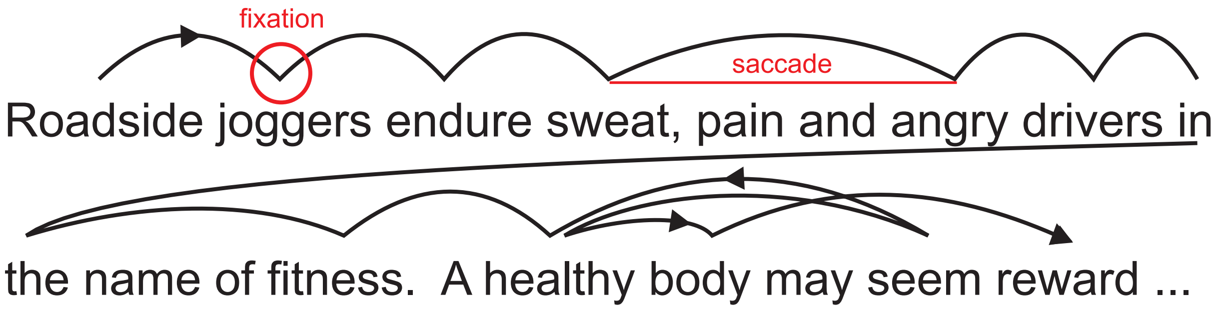
4.1 Convergence

Convergence refers to the ability of both eyes to move inward (or to converge) as an object approaches (Valenti, 2006). This allows for binocular alignment (Valenti, 2006) which becomes increasingly important when children start to engage in reading and writing as well as sports.

Any activity in which an object (e.g. a ball) approaches and recedes from the child will assist in the development of convergence.

4.2 Saccades

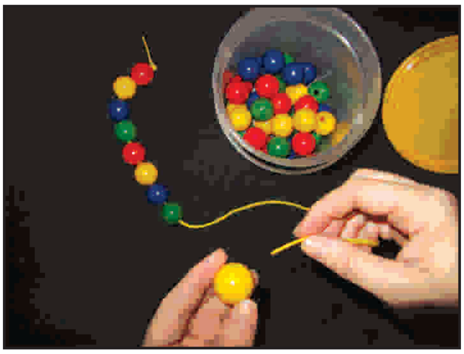
Saccades refer to the movement of the eyes from one object to the next (Valenti, 2006). A saccade is a jerky shift in focus, as opposed to the smooth movement involved in tracking. Skill in saccades underlies the ability to perform the eye movements required for reading.



Playing peek-a-boo or doing any activity in which the child needs to shift his/her focus will assist in the development of the ability to perform saccades.

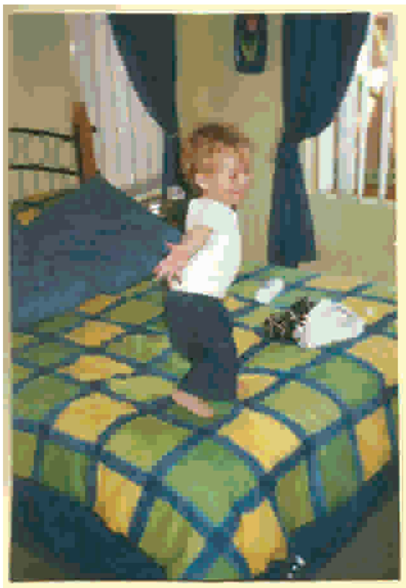
4.3 Fixation and binocular control

Valenti (2006) indicates that vision is guided by hand movements. Activities in which the child has to thread a needle, string beads or place objects in containers assist the child to develop accurate and sustained fixation.



4.4 Binocular coordination

Bilateral balance is the foundation for binocular coordination (Valenti, 2006). Activities such as jumping on a trampoline or any unstable surface (such as a bed!) activate control of muscles on both sides of the body, assisting in later development of the control and coordination of both eyes.



4.5 Ocular muscle range

The control and relaxation of the ocular or eye muscles are essential for vision development (Valenti, 2006). A swinging ball suspended to reach the hand at eye level will draw the child's attention. By increasing the arch of the swing the range of eye movements increases.

5. Visual impairments

According to Landsberg et al. (2011), visual impairments can range from partial sight to blindness. Approximately 90% of children with visual impairments retain some vision (Sattler & Hoge, 2006).

Visual impairment is a low-incidence impairment, but often presents comorbidly with other impairments, e.g. intellectual impairments, cerebral palsy or albinism (Landsberg et al., 2011). Up to 50% of visual impairments are congenital (Sattler & Hoge, 2006). The rest are the result of injury, accidents or illness (Sattler & Hoge, 2006).

5.1 Identifying learners with visual impairments

Sattler and Hoge (2006) list the following as signs that might indicate visual impairments in infants:

- Lack of eye contact at three months;
- Lack of visual tracking and fixation by three months;

- Lack of accurate reaching by six months;
- Squinting after four months;
- Frequent jerky eye movements (nystagmus);
- Haziness of the cornea;
- White pupil;
- Persistent tearing (not due to crying);
- Photophobia;
- Persistent redness of eyes;
- Droopy eyelid;
- Asymmetry of pupil;
- Abnormal shape or structure of the eye.

Hallahan and Kauffman (2006) list the following as signs that might indicate visual impairments in older children:

- Rubs eyes excessively;
- Complains about scratchy or itchy eyes;
- Has red rimmed eyes;
- Has crusty eyes;
- Has recurring styes;
- Has swollen or droopy eyelids;
- Has inflamed or watery eyes;
- Shuts or covers one eye;
- Tilts the head;
- Blinks excessively;
- Complains that light is too bright;
- Cannot see distant objects;
- Complains about blurred or double vision;
- Squints;
- Has clumsy movements;
- Dislikes ball games;
- Loses place when reading;
- Struggles with visual discrimination;
- Holds books very close to eyes;
- Has poor spacing in writing;
- Has excessive eye movements;
- Complains about dizziness, headaches or nausea.

Many of these signs could be due to other things, e.g. nausea could also be due to ear infections and itchy eyes could be due to allergies. Thus, it is important to have a child's eyes tested by an optometrist or an ophthalmologist.

5.2 Making sense of the results of an eye test

A score in the form of a fraction is usually given to indicate the visual acuity of a person compared to a person with normal vision, e.g.:

- Normal vision: 6/6 ;
- Partially sighted: between 6/24 and 6/60;
- Mild low vision: 6/21;
- Moderate low vision: 6/60;
- Severe low vision: 6/121;
- Profound low vision: <6/121;
- Totally blind: no light perception (NLP).

(Adapted to meters from Sattler & Hoge, 2006).

A person with a visual acuity of 6/24 can see objects at a distance of 6m as well as a person with normal vision can see objects at a distance of 24m.

Visual acuity lower than 6/121 but not total blindness is measured as follows:

- Count fingers (CF) – can count fingers at a specified distance;
- Hand motion (HM) – can see hand motions at a specified distance;
- Light perception (LP) – can detect light;
- Light perception and projection (LP&P) – can detect the direction light is coming from.

(Sattler & Hoge, 2006).

A person with normal vision has a 180 degree visual field (Landsberg et al., 2011). Sattler and Hoge (2006) define legal blindness as less than 6/60 acuity or a visual field less than 20 degrees. Thus, a legally blind person may still have the ability to see light or some objects. It is further important to establish the level of visual acuity because it will determine the most appropriate interventions and support.

5.3 Age of onset

The age at which the visual impairment occurs play an important role in the development of the child, e.g. a child becoming blind after the age of five years faces different challenges to a child born blind (Sattler & Hoge, 2006).

5.4 Types of visual impairment

According to Vaughn et al. (2014) the types of visual impairments may be grouped according to:

- Structural impairments, e.g. damage to one or more parts of the vision system;
- Refraction errors, e.g. inability to focus adequately;
- Cortical visual impairments, e.g. problems with the neurological pathways in the vision system.

5.4.1 Refraction errors

Refraction errors are due to the way light travels to the retina and are usually caused by structural irregularities (Sattler & Hoge, 2006). Refraction errors can usually be corrected through the use of prescription lenses.

Sattler and Hoge (2006) list the following refraction errors:

- **Astigmatism:** the curvature of the lens or cornea causes blurred vision;
- **Hyperopia or farsightedness:** the light is focused behind the retina;
- **Myopia or near sightedness:** the light is focused in front of the retina.

5.4.2 Central visual field defects

Sattler and Hoge (2006) describe the following defects that affect the central part of the retina (the macula and fovea):

- **Achromatopsia:** a genetic disorder that causes colour blindness, poor visual acuity and photophobia. The use of hats and visors are recommended.
- **Diabetic retinopathy:** an acquired disease associated with diabetes that could lead to blindness. Symptoms include blurred vision and bleeding from blood vessels behind the eye. Laser surgery is sometimes recommended.
- **Juvenile macular degeneration or Stargardt's disease:** an incurable genetic disorder with onset in middle childhood. The disease involves a gradual loss of central vision, but leaves peripheral vision intact. The use of optical aids is recommended.

5.4.3 Peripheral visual field disorders

Two progressive disorders that affect peripheral vision are listed by Sattler and Hoge (2006):

- **Glaucoma:** a genetic disorder or acquired condition that results in the increase of pressure inside the eye due to the excessive production of or inability to drain the aqueous humour. There is a risk of blindness. It is treated through medication and surgery.
- **Retinitis pigmentosa:** a genetic disorder which leads to tunnel vision, the loss of night vision and eventually blindness.

5.4.4 Whole visual field defects

The following disorders that affect the whole visual field are listed by Sattler and Hoge (2006):

- **Albinism:** a genetic disorder in which little or no melatonin is produced. Albinism is characterised by photophobia and low visual acuity. Low illumination and the use of hats or visors are recommended.
- **Aniridia:** a congenital disorder which results in the absence of an iris. The disorder is characterised by photophobia and low visual acuity. There is a risk of developing glaucoma. The use of hats or visors as well as contact lenses with a tinted periphery is recommended.
- **Cataracts:** congenital or acquired opacity of the lens. Cataracts usually require surgical removal. In some cases a lens may be implanted.
- **Retinoblastoma:** a rare but malignant tumour of the retina. Large tumours usually result in the removal of the eye. Smaller tumours are treated with radiation, cryotherapy, laser therapy or chemotherapy.
- **Retinopathy of prematurity:** abnormal development of blood vessels in the back of the eye in premature infants. The condition may result in detachment of the retina. Oxygen treatment of premature infants increases the risk for retinopathy. Laser and cryotherapy are recommended treatments.
- **Retinal detachment:** the retina separates from the choroid leading to seeing flashing lights, dark spots or blurry spots. Injury to the eye, diabetes, a thinning retina due to myopia or cataract surgery may lead to retinal detachment. It can be corrected through surgery; left untreated it might lead to blindness.

5.4.5 Other conditions that affect vision

- **Amblyopia or lazy eye:** no or poor transmission of the visual image to the brain for a sustained period in childhood may lead to amblyopia which is characterised by blurry vision. Treatment includes covering the stronger eye for periods and wearing corrective lenses.
- **Strabismus:** squint resulting in blurry or double vision.
- **Cortical visual impairment:** damage of the visual cortex or neurological pathways as a result of hypoxia (insufficient oxygen) or anoxia (no oxygen) during birth, premature birth, cerebral palsy, meningitis or

- encephalitis or trauma to the brain. Visual stimulation sometimes results in improvements.
- **Foetal alcohol syndrome:** may include vision loss. Treatment includes use of corrective lenses or optical aids and visual stimulation.
- **Optical nerve atrophy:** genetic or acquired damage to the axons of the optic nerve as a result of tumours of the optic nerve, inadequate blood or oxygen supply at birth, trauma, hydrocephalus or genetic abnormalities. Treatment includes visual and motor stimulation as well as the use of large print and high contrast materials.
- **Optical nerve hypoplasia:** underdevelopment of the optic nerve prenatally. The condition is associated with midline brain defects and endocrine deficits. Use of high illumination, large print and high contrast materials is recommended.
- **Toxoplasmosis:** a parasite passed from mother to foetus may cause vision loss, hearing loss, hydrocephalus or mental retardation. Corticosteroids are prescribed to reduce inflammation. Avoiding infection of pregnant women is essential.
- **Nystagmus:** rapid involuntary jerky movements of the eye which reduce the ability to fixate on a visual target. Allowance of extra time for visual tasks is recommended.
- **Trachoma or granular conjunctivitis:** contagious, chronic inflammation of the eyelid that causes swelling of the eyelid, photophobia and scarring of the conjunctiva and cornea. The condition is caused by the chlamydia trachomatis bacteria and is associated with unhygienic and hot, dry conditions.
- **Conjunctivitis or pink eye:** inflammation of the conjunctiva caused by bacteria or viral infections. Conjunctivitis is characterised by red eyes and excessive secretion of pus and is treated with antiseptic eye drops.

6. Ideas for supporting learners with visual impairments

The necessity of early identification of learners with visual impairments becomes clear when considering the effects of visual impairment on the child's social, emotional, physical and cognitive development. Landsberg et al . (2011) list the following as some of the effects of visual impairment:

- Blind infants take longer to develop motor control because they do not receive the visual stimulation needed to develop control of their heads, necks and trunks, to establish laterality and directionality, to develop fine and gross motor coordination and to develop balance when walking.
- Children with myopia and cataracts might lag behind in terms of gross motor development because they avoid activities such as running.
- Children with macular degeneration might lag behind in terms of fine motor development and visual-motor integration due to the lack of central vision and the consequent difficulty with close visual activities.
- Blind children do not develop visual perceptual skills.
- Partially sighted children may have difficulty with visual perceptual development due to their limited engagement in spontaneous visual stimulation activities.
- Blind children find time and spatial awareness difficult, since these are abstract concepts that are difficult to discover through hearing and touch.
- Blind children find it difficult to develop conceptual understanding of objects outside their tactile reach, e.g. ephemeral objects such as flames and clouds, moving objects such as a rolling wheel, delicate objects such as bubbles and big objects such as buildings.
- Children with cataracts, hyperopia and macular degeneration may find figure-ground perception particularly difficult.
- Children with visual impairments take longer to master vocabulary that represents concrete experiences or depends on visual input.
- Children with visual impairments have less exposure to facial expressions and physical gestures, which might

- delay their understanding of emotions and social interactions.
- Younger children with visual impairments have limited ability to initiate and imitate play, which influences their social, emotional and cognitive development.
- Children with visual impairments struggle with understanding group dynamics, e.g. waiting their turn.
- Being teased or bullied might lead to social withdrawal or acting out.
- The trauma associated with developing a visual impairment might lead to emotional, social and behavioural problems.

Vaughn et al. (2014) add the following to the above list:

- Children with visual impairments show limited incidental learning, e.g. by watching others and imitating their actions.
- Where adaptive technology is not available, visual impairments might limit the learning of academic skills such as reading and writing.
- Children with visual impairments often struggle with expressing their own emotions non-verbally, since they do not have the opportunities to observe others' expressions.

Sattler & Hoge (2006) mention that congenitally blind children often exhibit autism-like symptoms, including echolalia, late emergence of pretend play, difficulty with abstract language, idiosyncratic vocabulary, perseveration, stereotypic behaviour and poor posture.

Support for learners with visual impairments should be geared towards using their strengths and should address their specific needs. Learners' needs and strengths will be partly determined by the type of visual impairment as well as the age of onset.

6.1 Using community resources

Resources such as the South African National Council for the Blind should be utilised. The Council's website can be accessed at www.sancb.org.za The South African Optometric Association can be contacted through its website, www.saoa.co.za.

Resources from other countries are often also useful and could be adapted for use in the South African context. Such resources include:

- The National Center for Accessible Instructional Materials, which provides resources for teachers on http://aim.cast.org;
- The National Federation of the Blind, which provides a technology resource list on https://nfb.org;
- Learning Ally, which provides audio recordings of educational materials on www.learningally.org;
- The American Printing House for the Blind, which provides a list of special media, tools and materials on www.aph.org.

6.2 Some common sense and general courtesy

Vaughn et al. (2014) list some of the everyday changes that teachers can easily make to accommodate learners with visual impairments, e.g.:

- Announce your arrival and departure.
- Leave doors fully open or closed.

- Leave drawers closed and equipment stored away.
- Provide extra desk and storage space for visually impaired learners to store their equipment.
- Provide access to audio equipment and electrical outlets.
- Provide a reading lamp or ensure good natural lighting or shade, depending on the specific visual impairment.
- Back-lighting reduces visibility, so do not stand in front of a window while teaching.
- Use high contrast between fore- and background to increase visibility, e.g. black writing on yellow paper is easier to see than yellow writing on white paper.

6.3 Auditory perception

Partially sighted and blind learners rely more heavily on their other senses, including hearing (Landsberg et al., 2011). However, auditory perception skills, including listening skills, auditory discrimination and auditory memory, need to be taught and reinforced. This can be done by:

- Encouraging infants to reach and move by placing toys that make sounds just outside their reach;
- Talking to infants and children, describing the world around them;
- Encouraging children to identify sounds, the direction the sound is coming from as well as the distance of the sound;
- Practise auditory memory skills.

(Landsberg et al., 2011)

6.4 Sense of movement (kinaesthetic), direction and orientation

Blind and partially sighted infants should be encouraged to develop head, neck and trunk control by being placed on their stomachs, encouraged to crawl and later to stand and to walk (Landsberg et al., 2011). They should be encouraged to climb, walk and crawl through the use of touch and sound, e.g. by placing ropes on the floor in different shapes. They can be taught to use furniture or tactile indicators to move around in a room (Vaughn et al., 2014). The above activities all involve mobility skills (Vaughn et al., 2014).

Laterality and directionality (orientation) need to be taught using the children's bodies as a point of departure and through the use of brightly coloured toys, e.g. peg boards. Orientation skills include understanding the orientation of one's own body (including laterality), one's position in space and spatial relationships (Guth, Rieser & Ashmead, 2010).

6.4.1 Mobility devices

The most frequently used mobility device is the cane (Vaughn et al., 2014). However, the use of strollers and wheelbarrows are useful guides for movement too (Landsberg et al., 2011).

6.5 Tactile perception

Blind children need to learn to use tactile discrimination to detect texture, shape and form in order to identify and use objects optimally (Landsberg et al., 2011; Vaughn et al., 2014). Tactile and kinaesthetic perception will later be used by blind learners to read and write in braille (Landsberg et al., 2011). In lessons it is useful to have concrete objects available which the visually impaired learner can explore through touch (Vaughn et al., 2014). Tactile or raised and textured diagrams are also very useful.

6.6 Sense of smell and taste

Both blind and partially sighted children should be encouraged to explore tastes and smells and to use these senses to identify objects, e.g. foods and to direct their movements, e.g. the smell of soap indicates the direction of the bathroom (Landsberg et al., 2011).

6.7 Language and cognitive development

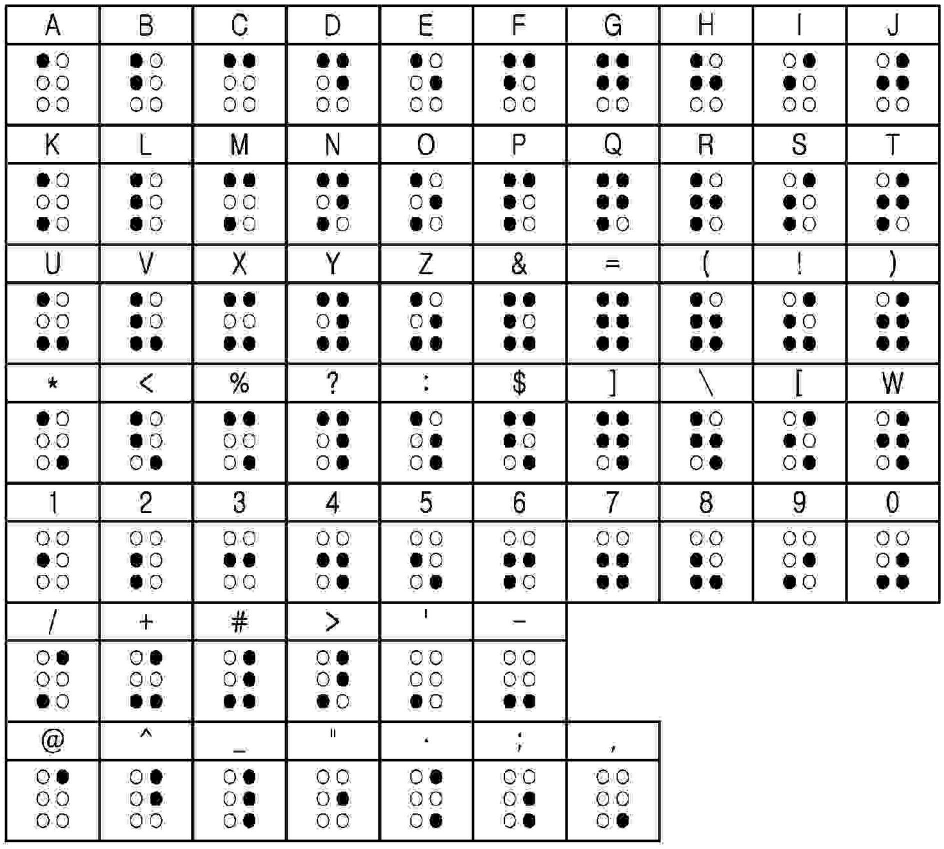
Children with visual impairments learn vocabulary and the meaning of words through verbal explanations (Sattler & Hoge, 2006).

Martelle (1999) emphasised that auditory materials should be used to supplement braille and printed materials, but should not be used as a substitute, since braille and print provide better understanding of the structure of a language than oral language does.

6.8 Assistive devices and aids

6.8.1 Braille and braille devices

Braille is a system of raised dots that can be read using the finger tips (Vaughn et al., 2014). Combinations of the basic six dots represent letters, numbers and contractions. The contractions are shorter versions of words.



For writing in braille, a braillewriter (a machine similar to an old fashioned typewriter), a portable Braille 'n Speak (portable note taker), Braille+ (a mobile application) or a braille slate and stylus can be used.



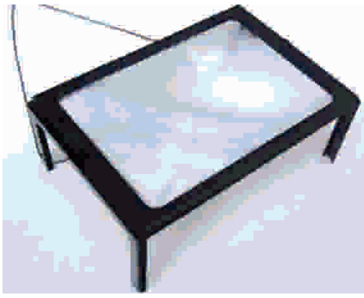
Braille keyboard conversion software converts nine keys on a standard computer keyboard to braille (Sattler & Hoge, 2006). Braille labels can also be glued onto the keys of a keyboard (Sattler & Hoge, 2006).

Clocks, rulers and measuring kits are usually also available in braille (Vaughn et al., 2014).

6.8.2 Optical devices

According to Vaughn et al. (2014) optical aids include the following:

- Monocular device (device that magnifies distant objects);
- Magnifiers (devices used to magnify close objects or print);
- Prescription glasses and contact lenses.




Sattler and Hoge (2006) also include:

- Video magnification through the use of a close circuit television or monitor;
- Screen magnification software for word processing programmes.

Optical aids are ideal since they are usually portable and can be used with any materials (Vaughn et al., 2014).

6.8.3 Non-optical devices and aids

Large print texts can also be used, but often require exaggerated head movements as well as adapted seating positions (Vaughn et al., 2014). Large print is also difficult to accommodate in small spaces. Large print is not suitable for all visual impairments, e.g. learners with a limited visual field may find large print more difficult to read than smaller print.

Vaughn et al. (2014) lists the following as non-optical aids:

- Auditory materials;
- Lamp for additional lighting;
- Reading stand that brings the reading material closer to the eye and reduces back and neck strain from bending forward to read;

- Bold-line or raised line paper to ease writing;
- Hats and visors for photophobic learners;
- Colour acetate (a coloured plastic overlay, usually in yellow) to enhance contrast;
- Cranmer abacus used as an arithmetic aid.

Sattler and Hoge (2006) add:

- Speech synthesiser that is connected to a computer which allows the computer to generate speech;
- Screen readers which read out the text on a computer screen.

6.8.4 Testing or assessment aids and accommodations

- In addition to the use of devices and aids described above, the following accommodations could also be made:
  - Amanuensis – questions are read to the learner whose oral or written answer is then written or copied by a transcriber.
  - Additional time – usually time and a half for large print readers and double time for braille readers.

(Vaughn et al., 2014).

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