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Vision! The educator & parent guide to children's vision in the learning environment

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Abstract

The purpose of this thesis is to provide a user-friendly educator's resource, which identifies vision problems related to the learning task. Access to this resource will be facilitated by its placement on the internet system. At present, the information on the world wide web regarding vision in learning is inconsistent and cumbersome, if one's effort is to retrieve specific information in one learning problem area. It is our hope that this web page is more straightforward and captivating to the layperson seeking answers to questions about vision. The web page will secondarily serve as a positive marketing tool for the college, and for Pacific University at large.

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VISION!
The Educator & Parent Guide to Children's Vision in the Learning Environment

PRESENTED BY:

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ABSTRACT

The purpose of this thesis is to provide a user-friendly educator's resource, which identifies vision problems related to the learning task. Access to this resource will be facilitated by its placement on the internet system. At present, the information on the world wide web regarding vision in learning is inconsistent and cumbersome, if one's effort is to retrieve specific information in one learning problem area. It is our hope that this web page is more straightforward and captivating to the layperson seeking answers to questions about vision. The web page will secondarily serve as a positive marketing tool for the college, and for Pacific University at large.

ACKNOWLEDGMENTS

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I would like to extend a heartfelt thank you to my faculty advisors on this project: Dr. Anita McClain and Dr. Alan W. Reichow. Your constructive ideas are invaluable for the comprehensive quality of this work. Thank you for your patience, as well as for your superior mentorship.

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VISION!

YOUR STUDENT'S VISION: A Key to Efficient Learning

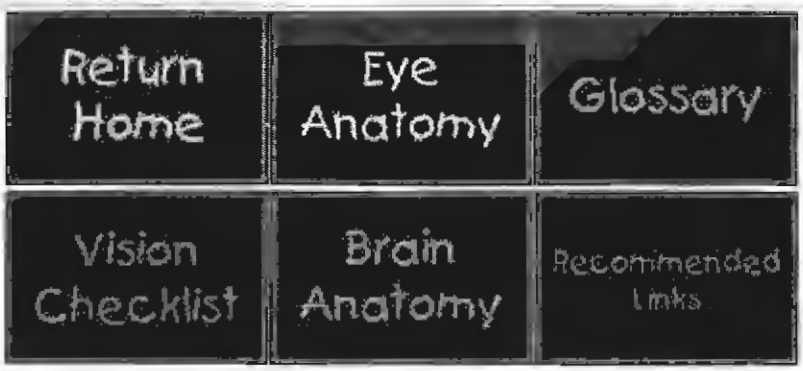
INTRODUCTION

Welcome!

This web page is intended to provide insight into the amazing sense we call "vision." Most of the time, and in most people, vision is our most utilized sense for taking in our environment and extracting information from it. Many of us have the luxury to learn information perceived correctly by our visual systems; but students with underlying vision problems may stumble with a vision system that is inefficient and deceiving.

This site will flag potential warning signs of a disorganized visual system, signs you might see in your child or your student. The subject merits attention, because a poorly organized vision system will require more energy to decipher what the eyes are seeing--energy which is taken away from learning the material at hand. We also hope to answer some commonly asked questions about vision, vision remediation, and eye care practitioners.

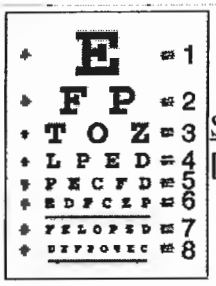
The"Student's Vision" problem checklist provides a good overview for topics covered at this site; the glossary may also be a good point of reference for specific questions on vision terminology. The "Reference" page provides recommendations for further reading.



YOUR STUDENT'S VISION: A Problem Checklist

Appearance of Eyes

- Reddened eyes and / or eyelids
- Turned eye: up / down / in / out
- Watering eyes



Signs Related to Nearsightedness / Farsightedness / Astigmatism / Anisometropia [REFRACTIVE STATUS]

A. Physical Observations

- **B**linking: to clear letters on chalkboard or on page
- **C**lose reading / working distance
- **C**losing / covering one eye
- **H**eadache
- **R**ubbing of eyes: during short periods of reading
- **S**quinting: to view reading materials and / or chalkboard

B. Performance Observations

- **A**voidance: of near tasks
- **C**opying errors
- **D**iscomfort complaints: with tasks requiring visual analysis
- **F**atigue: occurs early in task
- **S**ubstitution: of similar words while reading

Signs Related to Eye Movement Abilities

A. READING

- **A**ttention span: short
- **C**lose reading distance
- **C**omprehension problems
- **E**fficiency: reduced
- **F**inger / marker to keep placc
- **F**luency: decreased
- **H**ead movement: excessive
- **L**ine skipping
- **L**oses place
- **O**mission of words: frequent
- **R**e-reading
- **R**eversals: letters or words
- **S**peed: reduced
- **S**ustainability: short

B. WRITING

- **A**ttention span, copying: short
- **C**halkboard-to-desk copying: poor
- **D**rawing orientation on page: disorganized
- **F**luency: decreased
- **R**eversals: letters or words
- **S**lanted writing on paper: "uphill" / "downhill"
- **S**peed: reduced

Signs Related to Eye Teaming Abilities [BINOCULARITY]

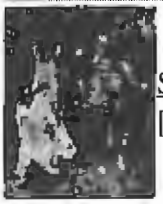
A. Physical Observations

- **B**urning eyes: post-near work
- **C**losing / covering one eye
- **D**izziness
- **D**rowsiness
- **H**ead tilt: during desk work
- **H**eadache
- **I**tching eyes: post-near work
- **L**ight sensitivity
- **N**ausea
- **P**osture deviations at desk
- **S**quinting

B. Performance Observations

- **B**lur of print: after reading a short time
- **D**epth / relative distance perception: poor
- **D**igit misalignment in columns

- **D**ouble vision complaints
- **O**mission: of letters, numbers, and phrases
- **P**aper placement: holds paper at an angle
- **R**epetition: of letters in words



Signs of Visual Form Perception Problems
[VISUAL MATCHING, VISUAL IMAGERY, VISUAL MEMORY]

- **A**uditory integration usage: in reading tasks
- **C**opying difficulty
- **I**nstruction set execution: difficult carrying out set in correct order
- **L**eft / right confusion
- "**S**ames / differences" confusion
- **S**ight word encoding (spelling): difficulty in spelling words he can read
- **S**ight word decoding (reading) vocabulary: limited
- **S**ubstitution
- **R**eversals: letters / words
- **T**actile integration usage: in reading / writing tasks
- **V**isual imagery failure: with silent or oral reading
- **W**ord recognition difficulty: from one sentence to the next

Signs of Eye-Hand (Foot, Body) Coordination Problems

A. Gross Motor

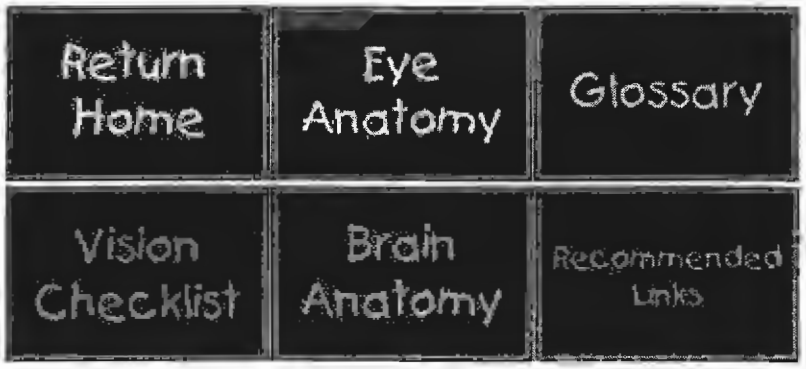
TASKS = Walking, Dancing, Sports

- **C**lumsiness: bump into objects
- **D**ominance, of hand or foot: extreme
- **G**ait while walking: uncoordinated
- **L**eft / right confusion
- "**M**issing the ball"
- **P**osture deviations

B. Fine Motor

TASKS = Writing, Drawing, Model-Building

- **A**uditory integration usage: in reading / writing tasks
- **H**ead movement: excessive
- **L**eft / right confusion
- **O**rganization of written page: poor
- **S**pacing of characters: poor
- **T**actile integration usage: in reading / writing tasks



Appearance of the Eyes

Eye Turning In [STRABISMUS]

An eye which turns in toward the nose, giving the student a cross-eyed appearance, can be indicative of an overfocusing problem--if the eye turns in during near work and is then relatively straight when looking away from near work.

An eye turning in can also be attributed to an eye muscle [EXTRAOCULAR MUSCLE] imbalance, in which the eye muscle pulling the eye inward is relatively unopposed by the eye muscle pulling the eye outward. In this case the eyes may appear crossed most of the time, regardless to what distance the student is looking.

Eye Turning Out [STRABISMUS]

An eye turning out, toward the ear, usually points to an eye muscle [EXTRAOCULAR MUSCLE] imbalance. The eye muscle pulling the eye out is relatively stronger than the muscle which should pull the eye in.

As observers, we can often see a difference in the eye drift outward with the fatigue of the student. As the student's attention or concentration wanes, we may see the eye turning out. Over time, the student must expend greater energy to keep the eyes aligned on the working material--often at the expense of energy used to comprehend subject matter.

Eye Turning Up / Down [STRABISMUS]

Similarly, an eye turning upward or downward is most often attributed to an eye muscle [EXTRAOCULAR MUSCLE] imbalance or palsy.

If the vertical deviation between the eyes is small, often the student will be able to keep the eyes in alignment. However, as more demand is placed on the visual system, we may see the eyes "decompensate," or fall out of alignment.

Level of Concern: IV (Urgent)

Student Complaints:

- blur: of printed page
- disappearing print on the page
- double vision
- headaches
- moving print on the page
- no complaints: one eye is suppressing

Physical Observations:

- Eye Turn: intermittent or constant
- Blinking: in attempt to bring the eyes back into alignment
- Head Tilt / Turn:

A student may hold the head in one set position when that position gives him the ability to point his eyes to the same place in space. For "normals," this position is straight ahead. With an eye turn, the head may be consequently turned to compensate for the eye posture. For example: a right eye turning inward may result in a head turn to the right, so that the right eye may then point "straight ahead" and the left eye will compensate by moving slightly outward.

- Redness:

The white part of the eye [SCLERA] may appear red, where the muscles that move the eye nasally and temporally [EXTRAOCULAR MUSCLE] attach to the white part and overlying tissues. This muscle attachment area is located just behind the visible white area of the eye (behind the orbital rim).

- Fatigue:

As the student tires from a given task, one may notice the eye turning in or out more frequently (see Eye Turning Out for explanation).

Relief:

1. The child should be referred as soon as possible to an eye doctor, preferably to one that specializes in functional vision. The functional vision care specialist will test the child's visual system accordingly.

A. Eye Turning In:

⇒ The vision specialist will determine if the eye turning is linked to an overfocusing problem. If this scenario is the case, the child may be prescribed glasses to help him focus, thereby reducing the focusing effort of the child and helping to keep the eyes aligned.

⇒ If glasses (to help the child focus) are not indicated and a muscle imbalance is presumed, the child may be referred to a strabismus surgeon for eye muscle surgery.

⇒ Other possibility: The student may appear to have an eye turning in, when in fact the eyes are aligned straight ahead by visual measurements. The eyes may appear to be crossed if the student has a wide nasal bridge of the nose, prominent epicanthal folds, or a small separation of the eyes [interpupillary distance].

Serious (yet rare) causes of an eye turn in:

- cataract
- congenital syndromes
- corneal opacity
- nerve inflammations
- trauma to nerve system
- optic neuropathy

- retinal scarring
- tumors

B. Eye Turning Out, Up, or Down:

⇒ The vision specialist will determine the severity of the eye turn problem. The severity depends on several factors:

- degree of eye turn
- degree of head tilt / turn
- fusion: the student's ability to regain eye alignment from an eye-out position
- percent of time the eye turns out during waking hours

⇒ Glasses are usually not indicated for an eye-turning-out problem, but may be helpful for an eye turning up or down.

⇒ Often, an intermittent eye turn can be trained to stay in alignment with vision therapy. The functional vision care specialist may institute a program of therapy or may refer out to a vision care practitioner specializing in vision therapy or rehabilitative optometry.

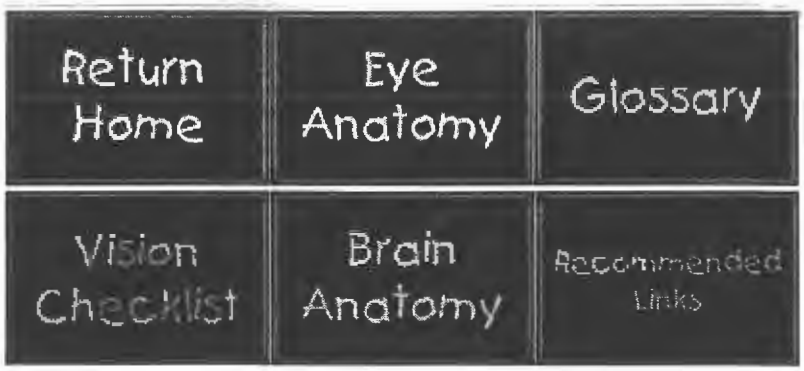
⇒ The student may be referred to a strabismus surgeon for eye muscle surgery, particularly if cosmesis is important to the student or the parent/ guardian.

⇒ Other possibility: The student may appear to have an eye turning out, yet there is no measurement of such a turn during a vision exam. The student may have a wide separation of the eyes [interpupillary distance], which gives the appearance of an eye pointing slightly outward from straight ahead.

Serious (rare) causes of an eye turn out:

- congenital syndromes
- nerve palsy
- tumor
- myasthenia gravis

2. The student may gain temporary relief from an eye turn with rest. Most students who have intermittent eye turns can hold the eyes straight in the morning hours (after a good night's rest), but begin to show signs of eye-turning in the afternoon, with fatigue.



Appearance of the Eyes

When an individual is under visual stress, the physical appearance of the person's eyes can reflect this.

Reddened Eyes or Eyelids

Eyestrain is usually brought about by the combined efforts of focusing, eye teaming, and an effort to comprehend the visual information being presented. Redness of the eyes can be a result of general eyestrain.

Level of Concern: I (Mild)

Student Complaints:

- blurry print
- burning eyes
- double vision
- eye pain / soreness
- headache
- itching eyes
- tired eyes
- watering eyes

Physical Observations:

- Generalized redness on the white part of the eye [SCLERA]. The blood vessels covering the sclera are actually enlarged and engorged with blood, thus causing the eye to appear "red."
- Redness of the eyelids. This redness may be secondary to eye rubbing, in an attempt to alleviate a burning sensation or in attempt to bring about a clear image from a blurry one.

Relief:

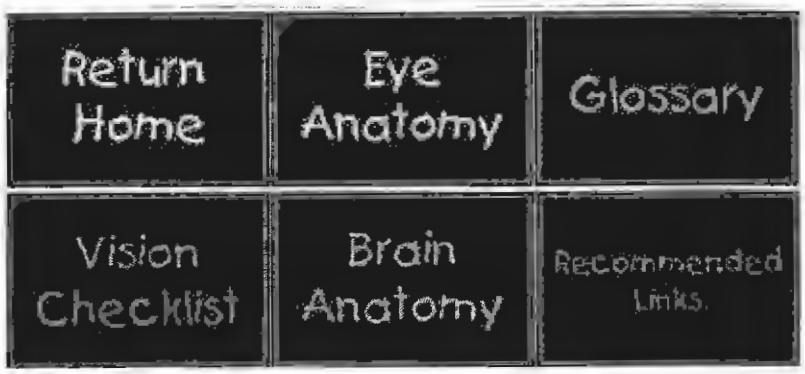
1. As a precaution, the student should see an eye doctor to rule out any other irritation causing the redness. Examples of other irritations include:

- allergies in the eye
- dryness of the eye
- foreign body (eyelash, metal, etc.) in the eye
- infection, viral ("pink eye") or bacterial

- injury to the eye

2. The student should take frequent breaks from learning materials (once every 15 minutes) and rest with eyes closed for one minute.

3. A cold compress (clean washcloth soaked in cold water) held over the closed eyelids may soothe the redness and burning / itching sensation(s).



Appearance of the Eyes

When an individual is under visual stress, the physical appearance of a person's eyes can reflect this.

Watering Eyes

Eyestrain is usually brought about by the combined efforts of focusing, eye teaming, and an effort to comprehend the visual information being presented. Watering eyes can be a result of general eyestrain.

Level of Concern: I (Mild)

Student Complaints:

- blur: of printed page
- burning eyes
- eye pain / soreness
- headache
- itching eyes
- tired eyes
- watering eyes

Physical Observations:

- Eyes water when working at desk

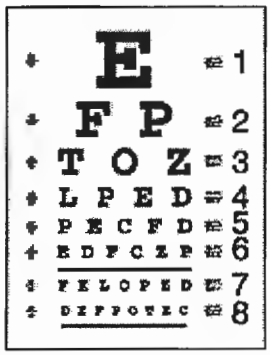
Students in concentration have a tendency to stare, with less frequent blinking, at near work material. The eye's response to staring is to provide a flush of watery tears to the eye surface.

These water-based tears are a "band-aid" reaction to the eye dryness; in fact, the eye would be better served by a lubricating tear. The eye doesn't have the capacity to distinguish the tear types, so it continues with the "water works." The result is a chronic, watering eye.

The subset of students with an eye-watering problem are generally farsighted [Hyperopia]. These students must exert focusing energy and concentration, just to see distant objects clearly. Their focusing requirement is further increased when concentrating on near work material. The result of this concentration effort is often watering eyes.

Relief:

Refractive Status



Refractive status--nearsightedness, farsightedness, and astigmatism--is determined anatomically by the sum of the eye's parts, but can also be affected by the student's environment. Ideally, incoming light would be directed in the eye by the CORNEA and the LENS to coincide exactly at the fovea on the RETINA. More often than not, however, the collective power of these refractive components of the eye is either too great or too weak to match the length of the eye. The result is a blurry or fuzzy image--one that is not pinpointed exactly at the fovea.

Nearsightedness [MYOPIA]

A person who is nearsighted has better ability to see nearer objects; distant objects usually appear blurry. For example, a nearsighted student may be able to see the print on a page much clearer than print on the chalkboard across the classroom.

Demo

Anatomically, the eye has too much focusing power, so light is focused at some point before the fovea on the RETINA. The image that reaches the retina, as a result, is out of focus.

Development Milestone: No definite cutoff period exists for nearsightedness. Most nearsighted people observe the first signs of distance blur between ages 7 to 15. Girls generally precede boys in becoming nearsighted. Nearsighted changes have been shown to occur as late as the 20's and after (mostly in a college population).

Problems:

- Blur in the distance
- Convergence excess [see **Convergence**]

Level of Concern: I (Mild)

Cause of Problems:

⇒ Genetic predisposition: a majority of students have a tendency to inherit the refractive status of their parents

⇒ Nearpoint stress: this theory on myopia development postulates that the following chain of events lead to nearsightedness--

- In evolutionary terms, the eye is unsuited for prolonged near work tasks.
- Historically, the sight of an individual was engineered to see clearly far away for purposes of hunting and to spot danger.
- With the advent of higher learning, more time is spent focusing and pointing the eyes [Eye Teaming] at a 30 cm to 50 cm proximal distance.
- This situation induces physiological stress on the focusing and eye teaming mechanisms of vision, thus inducing an adaptation to the near work environment in order to relieve the stress.
- The eye then responds by placing the nearpoint of the visual system coincident with the fovea, thereby making the individual "nearsighted."

⇒ Premature birth

Results of Problems:

- Close reading / working distance
- Closing / covering one eye
- Copying errors
- Squinting: to view reading materials and/or chalkboard

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist will determine the extent of nearsightedness by performing tests which probe the need for prescription lenses [refraction]. The functional vision care specialist and the student will determine if a glasses prescription is warranted at the present time. Glasses warranted for nearsightedness diverge light rays going into the eye, to make the light rays coincident with the fovea. This type of eyeglass lens renders clear vision.

The specialist may also suggest the following as adjunct treatment with glasses or as intermediate treatment until a time when glasses may become necessary:

- sitting closer to the chalkboard
- a reading prescription, low magnification lens (either in single-vision lens or bifocal lens form) for the specific purpose of relieving nearpoint visual stress. This mode of treatment aims at slowing the rate of nearsightedness in the student. To illustrate, it is interesting to note that nearsightedness develops more rapidly during the school months than it does during summer break for most students.
- good visual hygeine:

* lighting: good nearpoint light in addition to ambient room lighting
* 15/15 rule: for 15 minutes of near work, take a 15 second break to look far away
* posture: sit upright while reading; avoid lying on back or sides (eyes should be pointed perpendicular to the page)
* working distance: hold reading materials at a distance approximately equal to the distance between the middle knuckle of a clenched fist and the elbow (14 to 16 inches for adults).

NOTE: Students who present with nearsightedness are often "discovered" by means of the 20-foot Snellen Test (eye chart) at school screenings. Ironically, this subset of students tend to be the better students in the classroom than their farsighted counterparts, who usually demonstrate the much sought-after 20/20 on the Snellen test. Remember that the eyes of nearsighted students are designed to see well at near distances; near-centered tasks, therefore, are usually comfortable and may be preferred to farsighted tasks, like sports-playing.

Use of the 20-foot Snellen test solely as a means of identifying students with a vision problem is not adequate to identify those students who are farsighted and may have difficulty or may show avoidance of near-centered tasks. See the description below of Farsightedness for further information.

Farsightedness
[HYPEROPIA

The farsighted individual has an ability to see very well far away, but may have difficulty viewing nearer. This difficulty does not necessarily mean poorer sight at near distances; rather, it usually means discomfort or signs of eyestrain after prolonged near viewing. The farsighted student may be able to see both the 20 foot Snellen Test and the near vision chart equally well, but this same student may not be able to read for long periods of time without experiencing discomfort or acquiring adaptations (such as covering one eye) to ease the eyestrain.

Anatomically, the eye has too little focusing power; it is not able to focus light at the fovea on the RETINA. Light is "focused" at an imaginary point behind the eye. The resulting image on the RETINA is out of focus, or blurry. [See diagram above.]

Demo

NOTE: Hyperopes, unlike myopes, have the unique ability to focus the LENS of the eye to make distant objects appear clear. This shifts the point of focus from "behind" the eye onto the fovea on the RETINA. However, this ability to focus creates a dubious situation when trying to identify a student in need of visual assistance. The student is most often able to focus the eyes to see the **20/20** line clearly in a school screening. Even if a near Snellen test is performed, the farsighted student can most often exert more focus to see the reading card clearly, as he or she is only required to read for a short duration. Of all the refractive conditions, hyperopia is the most difficult to detect in a school vision screening. The Snellen Test provides a false sense of security to those responsible for screening students, as it fails to identify the farsighted subset of students who are under stress. It is the farsighted group who tend to have more problems and who show more avoidance with reading in the classroom.

Development Milestone: As with nearsightedness, no cutoff point exists for farsightedness development. In fact, younger people who are mildly farsighted survive quite well by focusing the LENS of their eyes until age 45-50, when they slowly lose the ability to focus the LENS due to inelasticity of this eye component. People in this age bracket may begin wearing their very first pair of glasses, to assist with near vision and / or distance vision.

Problems:

- **B**lur at distance and / or near: usually intermittent
- **E**ye strain
- **E**ye turn: possible
- **E**sophoria [See Convergence]
- **E**xophoria [See Divergence]

Level of Concern: II (Moderate)

Cause of Problems:

- **G**enetic predisposition

Results of Problems:

- **A**voidance: of near tasks
- **B**linking: to clear letters on chalkboard or on the page
- **C**losing / covering one eye
- **D**iscomfort complaints: with tasks requiring visual analysis
- **F**atigue: occurs early in task
- **H**eadache
- **R**ubbing of eyes: during short periods of reading
- **S**ubstitution: of similar words while reading

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist will determine the amount of farsightedness by performing tests which probe the need for prescription lenses [Refraction]. The functional vision care specialist may sugggest a glasses prescription to be worn part-time or full-time, depending on the degree of vision disturbance from farsightedness. For the young student, the purpose of the glasses prescription is not so much to provide clear vision (as most farsighted students already exhibit clear vision for near and distant targets), but rather to relieve eyestrain.

In some instances, glasses also help alleviate an eye turn inward. The focusing system of an individual is linked to the eye pointing system; when the eye focuses more, the normal response is for the eyes to turn relatively inward. If a student has to focus a great deal to bring the point of light to the fovea on the RETINA, his or her eyes will most likely be pointing inward from the straight-ahead position.

In fact, the eye(s) can turn in to the point where one eye essentially gives up depth perception and

points inward toward the nose [see diagram below]. In this case, glasses would be helpful to relieve most of the focusing effort of the eye. When the focus of the eye is relaxed, the eye posture can also be relaxed, and the eyes then point relatively more outward (or straight ahead, from an eye-turning-in position).

NOTE: An eye-turning-in is not always related to a high focusing demand. An eye turn inward can be caused by an EXTRAOCULAR MUSCLE imbalance. See Eye Turning In for more information.

Astigmatism

A person who has astigmatism has impaired ability to see clearly both at distance and up close. If a significant astigmatism is present, a student's environment may appear blurry at all distances.

Anatomically, eye components [CORNEA and LENS] in an eye with astigmatism cause light to be focused into two linear points--if looking at the eye from front to back. The difficulty with two points of light focus in the eye is that the LENS cannot be "focused" to bring the two points into one. The interval of space between the two points always exists, and in the same magnitude, unless corrected for in glasses or contact lenses by an astigmatism prescription (see diagram above).

Demo

Development Milestone: 80% of 6-year-olds have a slight amount of astigmatism

Problems:

- Amblyopia
- Blur at all distances
- Eye strain

Level of Concern: II (Moderate)

Cause of Problems:

- Genetic predisposition
- Posture effects: a skewed reading posture (one eye closer to the page or extreme page tilt) has been correlated with astigmatism development

Results of Problems:

- Avoidance: of near work
- Closing / covering one eye

- Copying errors
- Discomfort complaints
- Fatigue
- Headaches
- Redness of eyes
- Squinting
- Watering eyes

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist will determine the extent of the astigmatism by performing tests which probe the need for prescription lenses [Refraction]. Depending on the degree of the astigmatism prescription, glasses and contact lenses may be the best option for remediation of the astigmatism. Astigmatism may be so slight, though, that it does not require a correction; however, the doctor may want to monitor the student for changes over time.

The doctor may also emphasize the importance of good posture for optimal reading comfort and in attempt to prevent astigmatic eyes from worsening.

NOTE: If a student's astigmatism is significant but remains undiagnosed when the student is young (age 6 and under), the result may be an amblyopia of one or both astigmatism meridians. This condition is diagnosed when an eye cannot achieve optimal vision (20/20) with correction, and in the absence of any disease of the eye. That is, the eye was not provided adequate visual stimulation during its development (other than blur), and as a result it has decreased sensitivity and lacks the ability for crisp vision. This condition can happen with any type of refractive condition of the eye: extreme nearsightedness, extreme farsightedness, moderate to extreme astigmatism, and moderate to extreme anisometropia.

Anisometropia

Demo

A person with anisometropia has a significant difference in the refractive status between the two eyes. For example, one eye may be nearsighted and the other farsighted, as in the diagram above. However, both eyes can be nearsighted (with one significantly moreso) or both eyes can be farsighted (with one eye significantly moreso).

Anatomically, one eye has more focusing power built in to the CORNEA and LENS than does the other eye. Alternatively, one eye may actually be longer from front to back than the other (the longer eye would be the relatively nearsighted eye). This means that each eye is actually focused for a different distance. The two eyes are not focused for the same point in space.

Development Milestone: Anisometropia may be present at birth. It can worsen, however. If the child

becomes proficient at using one eye more than the other, the discrepancy in nearsightedness or farsightedness may grow--with a potential to cause further problems, such as amblyopia or depth perception difficulties.

Level of Concern: III (Severe)

Problems:

- Amblyopia
- **D**epth perception: poor
- **T**urned eye

Cause of Problems:

- **D**evelopmental difference between eyes
- **G**enetic predisposition: inherited tendency from biological parents

Results of Problems:

- **C**lose / cover one eye
- **F**atigue
- **H**eadache
- **H**ead tilt
- **P**erformance with pointing tasks or aiming (e.g. baseball): poor
- **P**osture deviations during deskwork
- Suppression

Remediation:

1. Referral to an eye doctor, preferably to a **functional vision care specialist**.

A functional vision care specialist will determine the extent of a prescription difference between the the two eyes and will prescribe appropriately to let the eyes focus at the same point in space. If amblyopia is a concern, the doctor may prescribe vision therapy to enhance the function of the disadvantaged eye.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Eye Movement Abilities

The eyes are designed to move together. Each receives a signal from the brain, requiring it to move fast or slow, up, down, left, or right. The eye is "wired" to move the same amount as its counterpart.

Students use two types of eye movements constantly while scanning their environment for visual information. These two types are PURSUITS and SACCADES. Another reflex important to the stable vision required in learning is the VESTIBULO-OCULAR REFLEX.

Pursuits

Definition = holds the image of a moving target on the finest point of the retina, the FOVEA.

More often than not, learning materials are stationary, while the eyes are the moving component in the learning task--moving smoothly as they follow a line of print or scan the blackboard or page for information.

Demo

Function in Learning:

- Fixate a point of interest
- Follow a line of print, horizontal or vertical
- Scan for information

Development Milestone: The first pursuits are evident at 8 weeks of age, but aren't fully developed until 5 - 6 months of age. Horizontal pursuits develop before vertical pursuits.

Problems:

Jerkiness - may result in lack of ability to keep place on the page. Eyes may jump up, down, or over to an adjacent line.

Head movement - if eyes do not move properly, the student may try to compensate by moving the head (as eyes stay relatively stationary). See **Saccades** for more information.

Level of Concern: II (Moderate)

Cause of Problems:

MORE COMMON LESS COMMON

- Developmental delay
- Fatigue
- Motor system inefficiency
- Brainstem disorders
- Cerebellar disorders (e.g. Multiple Sclerosis)
- Cerebral disorders
- Sedative drug use

Results of Problems:

- Attention span: short
- Chalkboard-to-desk copying: poor
- Comprehension difficult
- Drawing orientation on page: poor
- Efficiency loss
- Fatigue increase
- Line skipping
- Loses place
- Omission of words: frequent
- Re-reading
- Reversals: letters or words
- Slanted writing: uphill or downhill

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist can quantify the extent of the pursuit eye movement problem, as compared with "normals," given the student's age. The functional vision care specialist may wish to monitor the student's progress over time. If the pursuit dysfunction is more debilitating, the specialist may offer vision therapy as a treatment option.

2. Do nothing.

If the pursuit eye movement problem is due to a developmental delay or to fatigue, the pursuit movement problem may resolve by itself as the student becomes an established reader. As a caution, however, pursuits can sometimes hinder a student's ability to become a proficient reader. When in question, refer to a functional vision care specialist.

Saccades

Definition = a rapid eye movement, issued by the visual system to accurately pinpoint the object of interest on the fovea.

Saccades are eye movements which bring the eye to look at an auditory or visual point of interest with one's keep central vision, when said object stimulates initial interest in the student's peripheral vision. The saccade movement precedes the actual learning experience, by leading the eyes to the information. Saccades are essential to the reading task; in terms of chunking information, the saccade leads the eye to the next "chunk" in sequence.

Demo

Function in Learning:

- Centrally view an object of interest: word, illustration, educator
- Lead the eyes to the next information: reading

Development Milestone: Present at birth. Saccades are the most mature of the eye movements at birth.

Problems:

Delayed Saccade - saccades which are slower to be initiated are most often seen in elderly, inattentive, or intoxicated patients. This effect is also seen in Parkinson's disease and with Oculomotor Apraxia.

Head Movement - if the eyes do not move properly, the student may try to compensate by moving the head from place to place (as eyes stay relatively stationary).

Oculomotor Apraxia - this condition is caused by a paralysis of the saccade mechanism. At the initiation stage of the saccade movement, the mechanism is suppressed, and the saccade does not proceed. A rare condition, oculomotor apraxia is usually caused by **FRONTAL LOBE** damage.

Overshooting - the saccade movement that lacks accuracy may result in an eye movement past the target of interest. As an example, a target on the right is passed over as the eyes, in left gaze, move to extreme right gaze. If the eye jumps past the point of interest, the student may lose his or her place and may be required to re-read or go back to the initial point of reference.

Slowing - the normal, fast movement of the saccade is altered so as to appear slower.

Undershooting - the saccade movement that lacks accuracy may result in an eye movement which doesn't succeed to the next point of interest. As with overshooting, an eye movement which does not bring the eyes to the desired target may result in re-reading to gain a familiar reference point.

Level of Concern: II (Moderate)

Cause of Problems:

MORE COMMON	LESS COMMON
• Elderly age	• Cerebellar disorders
• Fatigue	• Extraocular muscle dysfunction
• Inattention	• Huntington's chorea
• Intoxication	• Multiple Sclerosis
	• Paralysis of an oculomotor nerve
	• Parkinson's disease

Results of Problems:

- Attention span: short
- Chalkboard to desk copying: poor
- Finger / marker to keep place
- Head movement: excessive
- Loses place
- Omission of words: frequent
- Re-reading
- Reversals

- Line skipping
- Writing: disorganized

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

The functional vision care specialist will determine the extent of the saccade problem and may initiate vision therapy to remediate poor saccades. If there is a question as to the cause of the saccade difficulty, the student may be referred to a neuro-ophthalmologist for further neurologic testing. Developmental delays may or may not require therapy, depending on the age of the student and the severity of the saccade dysfunction.

Vestibulo-Ocular Reflex

Definition = keeps images steady on the RETINA during head movements

This eye movement is important when the student is performing activities of a physical nature. When the child is turning circles, dancing, or swinging the body or head, the eyes respond to that body movement in an equal and opposite manner, to hold an image steady and to prevent the world from "spinning."

The semicircular canals of the inner ear alert gaze centers in the visual system when head rotation is occurring. They also tell which direction the head is turning. The visual system can then respond appropriately to the head movement.

Demo

Function in Learning:

Steadies visual images: when looking from chalkboard to desk and vice versa; in physical activity when head movement is common

Development Milestone: The vestibulo-ocular reflex is present at birth, but may be uncoordinated between the eyes until six months of age.

Problems:

Nystagmus - this eye motion appears as a repetitive beating of the eyes, usually side to side. The student has no control over this involuntary eye movement.

Level of Concern: III (Severe)

Cause of Problems:

MORE COMMON	LESS COMMON
Infections	Acoustic neuroma - tumor in the auditory/ vestibular nerve
Inflammation	Demyelinating disease - loss of outer protective nerve conduction layer
Toxic reactions	Ischemia - loss of blood supply to nerve

Results of Problems:

Deafness

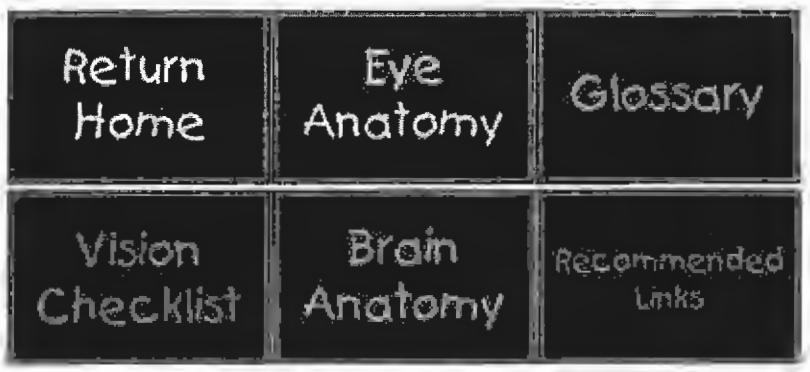
Dizziness

Imbalance

Remediation:

1. Referral to an eye doctor, preferably to a neuro-ophthalmologist.

A neuro-ophthalmologist can quantify the extent of the vestibular-related eye movement problem and provide insight into the possible cause of the nystagmus. The neuro-ophthalmologist may or may not begin treatment for the condition, depending on its cause or the function(s) lost.



Eye Teaming Abilities

Unlike eye movements, which involve both eyes moving in the same direction (e.g. to the right, left, up, or down), eye teaming involves the eyes moving in opposite fashion, toward the body or away from it. For example, if you hold your index finger four inches away from your nose and look at it with your eyes, each eye is pointing relatively inward from a straight-ahead position. The right eye is pointing slightly left from a straight-ahead position; the left eye is pointing slightly to the right from a straight ahead position. Like eye movements, eye teaming is hardwired in the brain. Each eye receives a signal from the brain; the signal causes each eye to move an equal amount, but an opposite direction, as outlined in the example above.

The two outcomes of eye teaming, which are important to learning, are CONVERGENCE and DIVERGENCE. Difficulties with eye teaming lead to double vision [DIPLOPIA], loss of binocular vision [SUPPRESSION], and AMBLYOPIA.

Demo

Convergence

Definition = the relative inward turn of each eye for purposes of seeing a near object as single.

In learning, a student often looks from the chalkboard to his or her desk. The eye movement used inthis shift of attention is a convergent eye movement. Why do the eyes need to point inward when we are looking up close at an object? If the eyes were to maintain a straight-ahead gaze on a clock on the far wall, for instance, any object in front of that clock will appear fuzzy or even double.

Demo

Function in Learning:

- Depth perception
- Single vision (vs. double vision): at near tasks
- Summation: overall quality of vision is improved with two eyes vs. one eye

Development Milestone: At six months, the infant has a gross ability to converge. This ability is refined by twelve months.

Problems:

Convergence insufficiency - the student is unable to maintain a converged eye posture over a period of time. Most often, the result is fatigue.

Convergence excess - the student overconverges, to a point where he/ she may see double vision.

Eye turn in / out - see Eye Turn

Level of Concern: III (Severe)

Cause of Problems:

MORE COMMON

- Congenital
- Idiopathic

LESS COMMON

- Demyelinating disease: Multiple Sclerosis
- Head trauma: car accident, blow to head, stroke
- Viral infection

Results of Problems:

- Avoidance: of near work
- Blur of print: after reading a short time
- Burning eyes: post near work
- Closing / covering one eye
- Depth perception: poor or absent
- Digit misalignment in columns
- Dizziness
- Double vision complaints
- Drowsiness
- Head tilt: during desk work
- Itching eyes: post near work
- "Lazy eye:" [Amblyopia]
- Light sensitivity
- Nausea
- Paper placement: holds paper at an angle
- Posture deviations at desk
- Repetition: of letters in words
- Omission: of letters, numbers, and phrases

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist will assess how well the eyes team together to see single and clear at different distances. If a student over-converges, as in Convergence Excess, glasses may be prescribed to relax the eye posture and to make reading tasks more comfortable. The Convergence Insufficiency case requires vision therapy to remediate the lack of ability for the eyes to hold their position during near work. This type of student vision problem is actually one of the easienst to re-train, and the increased flexibility and endurance available as a result of training helps the student perform longer and more comfortably at deskwork tasks.

Demo

Divergence

Definition = the relative outward turn of each eye, from a nearpoint position, for purposes of seeing a distant object as single.

As with convergence, a student with divergence problems will have difficulty seeing distant objects single and clearly. As the student looks from near work to a place in the classroom more distant, the student's eyes must make the transition so chalkboard writing won't be blurry or double.

Function in Learning:

Single vision (vs. double vision): for far distances

Summation: overall quality of vision is improved, with two eyes vs. one eye

Development Milestone: as for Convergence

Problems:

Divergence excess - the student's eyes point slightly outward from a straight-ahead position, so much so that double vision may be the student's observation

Divergence insufficiency - the student's eyes do not return to a straight-ahead position when the student is looking at a distant target. The result is blurry or double vision.

Eye turn out - see Eye Turn

Level of Concern: IV (Urgent)

Cause of Problems:

MORE COMMON

- Congenital
- Idiopathic

LESS COMMON

- Brain tumor

Results of Problems:

- Aim: poor
- Blur of chalkboard print
- Closing / covering one eye
- Dizziness
- Double vision complaints
- Drowsiness
- Headache

- Head tilt
- Light sensitivity
- Nausea

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

As with convergence problems, the functional vision care specialist will analyze how well the eyes team together. For the case of Divergence Excess, vision therapy may be helpful. Also possible are glasses to minimize the extent of double vision seen in the distance. The case of Divergence Insufficiency may indicate something more serious is at fault, such as a brain tumor. Students with eye teaming problems should be seen for this reason--to rule out causes of double vision or eye turns of a more serious nature. If ever in doubt, refer the student for a complete vision and eye health exam.

Demo

 **Concerns with Eye Teaming**

1. **DIPLOPIA**

   Diplopia, or "double vision," normally occurs when the eyes point to a single target it space. Our brain usually does not pay attention to the points in space before or behind the target of interest—yet it is these points that we perceive as "double." This is a completely normal phenomenon. In fact, if a student does not notice this phenomenon, one of the eyes may be SUPPRESSING.

   Double vision becomes a concern when one eye is not pointing to the target of interest. In this case, a person perceives double because the eyes are pointed unequally toward the target. Double vision is noticed when a person has a relatively new eye turn. If an eye turn persists, the double vision may be "remedied" by the brain's refusal to pay attention to the images from both eyes. This is referred to as "suppression."

2. **SUPPRESSION**

   In normal conditions, the eyes send electrical impulses to the brain, conveying a representation of the environment. The brain usually merges the similar images from the eyes into one image. With double vision, the brain is unable to merge the images because light falls on the eye on non-corresponding points.

   The brain dislikes processing double images; it would prefer to pay attention to just one of them. It achieves this by ignoring the information from one of the eyes (usually from the eye that is turning in or out). If the brain develops a pattern of shutting off the information from one eye, the brain may continue to do so out of habit. Suppression becomes a convenient adaptation to relieve the symptoms of an eye turn (headaches, covering one eye, etc.). Unfortunately, suppression leads to direct loss of depth perception, as well as to a loss in the

quality of the student's overall vision. The student becomes "one-eyed" as a result of suppression. Suppression usually begins as a temporary phenomenon, but it becomes more ingrained over time.

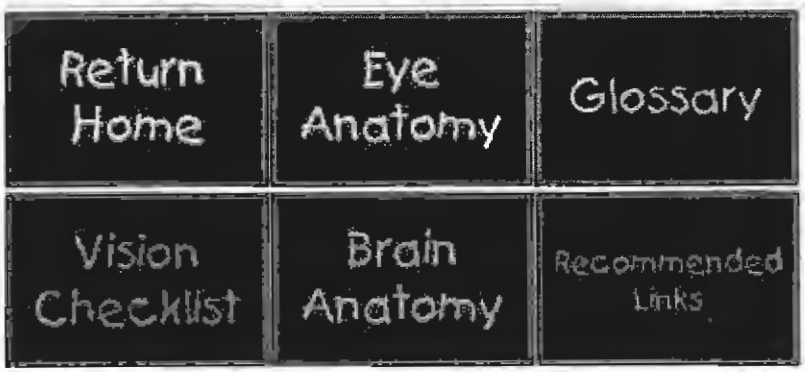
3. **AMBLYOPIA**

- "Law of Disuse"

As the brain continues to suppress the image from one eye, the brain acknowledges that the suppressed eye is not contributing to the perception of the student's environment. It learns to ignore the fine-detail function of that particular eye (as it causes confusion). The brain may still use the eye's input for gross observations of the environment (large movement, perceiving large forms). In general, though, the eye is not functioning at the level of its partner. The eye becomes less sensitive to environmental stimuli over time.

The definition of amblyopia is the following: "one eye cannot achieve optimal vision ("20/20") with correction, in the absence of any eye disease. This definition reveals the status of the eye with poorer function, but it does not delineate the process of how amblyopia happens. Basically, the eye can become amblyopic in the following situations: 1). if it requires a greater prescription than the fellow eye; 2). if an eye turn is present; 3). If it is deprived of light stimulus from the environment due to matter blocking the path of light to the fovea on the RETINA. In all of these cases, the RETINA tissue is normal and without signs of disease. Yet the function of the poorer eye is decreased secondary to the brain's response to that eye's situation.

Amblyopia can be treated with vision therapy. Therapy is generally easier if the amblyopia is of recent onset (i.e. when the student is very young). With therapy, the eye regains function that was suppressed by the brain.



Eye Focusing

The term "focusing" is used extensively when we speak of eyes, and for different purposes:

• The CORNEA and LENS focus, or bend, light rays to bring them to a sharp point near the back of the eye [fovea on the RETINA];

• The eyes focus on, or pay attention to, various objects between near and far distances when we speak of eye teaming and eye movements;

• The eyes, depending on their refractive status, have a built-in focus, which determines how far in linear space they can see clearly;

• And the eyes can change focus, or make images clear, via a muscle inside the eye that corrects the blurry image initially seen to bring it to a sharp view.

This last scenario is what we reference when we speak of "eye focusing." As mentioned above, the eye contains a muscle called the CILIARY MUSCLE, which changes the actual shape of the LENS of the eye, to bring light rays of varying distance to a sharp point at the fovea on the RETINA. We lose our ability to focus the eye when we reach the age of 45 to 50 years. Due to LENS rigidity, the CILIARY MUSCLE is unable to exert enough force to change the LENS shape. We then are required to use "help" in the form of magnifying lenses, often in bifocal form (in glasses or contact lenses). The magnifying lenses we use work to bring light rays from nearer objects to a sharp point at the fovea on the RETINA. Sometimes we must vary the distance of the magnifying lens from the object of regard, to get the sharp point exactly where it needs to be at the back of our eye. The eye has an ability to change the shape of the lens, or in other words, to accommodate.

The function of accommodation in learning is, simply put, to bring words, pictures and other images into sharp focus--to make those images less blurry. Eye focusing then, is a fundamental condition for learning.

Demo

Function in Learning:

Clear images, at all distances

Development Milestone: adult-like by three months of age

Problems:

Lazy focusing response - the eyes tend not to focus the full amount required, for the distance being viewed. For example, if a student is viewing an item at 16 inches, his focusing response may only make objects clear if placed out to one meter.

No focusing response - the eyes do not respond to any target nearer than 20 feet or so. This condition is the most rare of the problems presented here.

Overfocusing - the eyes tend to focus the full amount required and more; if a student is viewing an item at 16 inches, the eyes focus to 8 inches. This situation would make the 16-inch target appear blurry.

Slow focusing response - the focusing response is not immediate. Therefore, a page being viewed will appear blurry for the first few seconds, and then it will become clear. Conversely, if the blackboard appears blurry after doing near work, then the student's focusing can't relax. The blackboard should slowly become clear if the blurring is due to a focusing problem.

Level of Concern: III (Severe)

Cause of Problems:

- Eye teaming skills: poor
- Refractive condition (Nearsightedness, Farsightedness, Astigmatism)
- Spasm of the focusing muscle

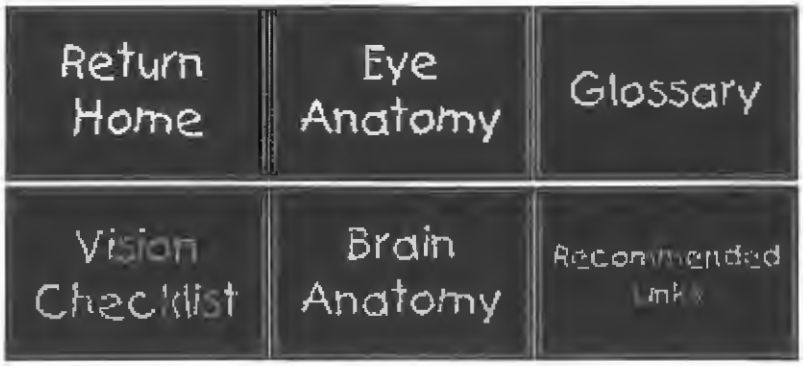
Results of Problems:

- Attention span: short
- Blinking: to clear an image
- Blur: of printed page after short time reading
- Blur: of chalkboard print after period of near work
- Burning eyes: post-near work
- Drowsiness
- Fatigue
- Headache
- Itching eyes: post-near work
- Redness of eyes: post-near work
- Rubbing of eyes: post-near work

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

A functional vision care specialist can quantify the extent of the focusing problem, and determine if a link exists to the student's refractive condition or to his eye teaming skills. The problem may be remedied by a glasses prescription to be worn during desk work, but often these students must undergo vision therapy to increase the flexibility and response of this important visual system.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Vision Perception Skills

"Vision" does not occur within the eyes; it occurs after light is transferred to electrical energy and passed to the OCCIPITAL LOBE of the brain. There, the electrical input is processed; as a result of processing, we can then visually perceive what is in our environment. Visual perception is a result of brain processing.

The processing does not end there; in fact, the OCCIPITAL LOBE has many connections with other parts of the brain: auditory centers, identification centers, touch centers, and proprioceptive centers. The interaction of information received from these centers allows us to identify things in our environment many different ways. When one or more of our senses fail us, we can still rely on the others to "get by." One might think, then, that visual perceptual problems should not be such an issue in learning. However, due to high visual demand of the learning environment, students have difficulty getting by when they have visual perception difficulties.

Demo

Function in Learning:

- Detail / shape discrimination: e.g., "b" from "d"
- Distance discrimination: e.g., object "a" is further from me than object "b"
- Location identification: e.g., the pencil is to the left of the eraser
- Recall: of letters, numbers, words, symbols
- Size judgments
- Velocity judgments

Development Milestone: 1st - 2nd grade level

Problems:

Lack visual imagery skills - The student is unable to make pictures (of a story, for instance) in his mind. He may have difficulty imagining how a scene looks.

Lack visual constancy - The student has difficulty matching similar shapes / symbols, particularly if they differ in size, color, or texture.

Lack visual form recognition - The student has difficulty recalling what a "b" looks like, or what a square looks like.

Lack visual memory - The student has difficulty remembering shapes / symbols by sight, whether they stand alone or are in a sequence.

Level of Concern: III (Severe)

Cause of Problems:

- Brain injury
- Developmental delay
- Lack experience with visual information

Results of Problems:

- Auditory integration usage (whispering, mouthing, read aloud): in reading tasks
- Copying difficulty
- Instruction set execution: difficult carrying out set in correct order
- Left / right confusion
- Reversals: letters / words
- Sight word encoding (spelling) difficulty: in spelling words he can read
- Sight word decoding (reading) difficulty: limited
- Sames / differences confusion
- Substitution: of similar words while reading
- Tactile integration usage (tracing letters with finger, counting fingers): in reading / writing tasks
- Visualization failure: with silent or oral reading
- Word recognition difficulty: from one sentence to another

Remediation:

1. Referral to an eye doctor, preferably to a functional vision care specialist.

The functional vision care specialist will determine the specific areas of visual perception which are giving the child difficulty. The difficulties may be found in one or more of the following areas:

Visual Imagery: imagining how a scene appears

Visual Closure: correct identification of a partially-completed symbol

Visual Constancy: matching two identical symbols from a composite of similar symbols with a variant characteristic

Visual Figure-Ground Relationships: identifying the subject (figure) from distracting background information (ground)

Visual Form Recognition: matching identical symbols from a composite of several different symbols

Visual Memory: retaining the mental image of a single symbol

Visual Motor Integration: copying printed symbols without distortion, or major error

Visual Sequential Memory: retaining the mental image of multiple symbols, in a specific sequence

If the student lacks readiness, performance in these areas may be improved in a few practice sessions. More serious deficits persist if the student is unable to acknowledge that continual mistakes are recurrent in nature. Vision therapy, combined with multisensory techniques (Visual-Auditory-Kinesthetic-Tactile feedback), can carry a student a great distance toward the

remediation of vision perception difficulties.

2. Do nothing.

The student may lack readiness to do classroom tasks of this nature; if so, the student will soon begin correcting errors without assistance and may soon perform up to speed with the work of his peers. If questions persist about the student's aptitude, or if he continually falls behind his peers, it may be in the best interest of the student to refer him to a functional vision care specialist.

Eye-Hand (Foot, Body) Coordination Skills

The eyes do not stand alone from the rest of the body. They are connected to the body via a complex network of nerves; what information the eyes take in dictates how the body will respond to its environment.

Demo

Eye-hand coordination can then best be thought of as "eyes leading the hands." Very seldom do our hands lead our eyes. Our eyes are the watchdogs of our environment. If our eye movements and eye teaming skills are uncoordinated, how well do you think the eyes will be able to save us from hazard or from making mistakes?

When we are very young, we learn about our world through sense of touch: by object manipulation or by placing objects into our mouths. As babies, we are required to learn about our world through touch, because our eye skills are not well-developed. As vision becomes our dominant sense, children make the connection between how the object feels and how it is visually perceived. The successful transition enables the child to observe with the eyes; "feeling" one's world is no longer required. The UN-successful transition leaves the child with visual frustration, so he relies on touch to gain information about the environment.

Demo

Function in Learning:

- Fine motor control mastery: coloring within lines, character reproduction
- Gross motor control mastery: making spatial judgments in sports, penmanship coordination
- Posture: control of head and hand placement in paper / pencil tasks
- Space characters on a page using vision

Problems:

Head movement - The student who is uncomfortable processing information visually may fall back on earlier ways of gathering information: turning the head at a response to sound or touch. This is also incorporated in the writing task; the "head" keeps the place on the page, rather than the eyes doing so.

Judgment of space - The student with eye-hand coordination problems has difficulty relating what is seen visually to what is felt, or heard, or smelled. The senses are disconnected. As a result, the student cannot estimate space according to how it is "felt." He has little idea of how the two-thumb-width spacing rule, in writing, is visually represented.

Level of Concern: III (Severe)

Cause of Problems:

- Eye teaming: poor (see Eye Teaming)
- Eye movements: poor (see Eye Movements)
- Lack readiness for writing, reading

Results of Problems:

- Art capability: poor
- Clumsiness
- Computer skills (e.g. moving mouse): slow
- Left / right confusion
- Organization of written page: poor
- Penmanship: poor
- Playground / Sports teams: last one to be picked
- Tactile integration usage: in reading / writing tasks

Remediation:

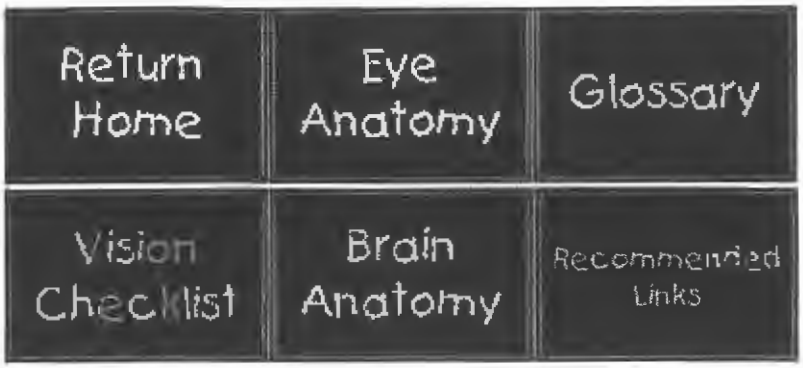
1. Referral to an eye doctor, preferably to a functional vision care specialist.

The functional vision care specialist assesses eye-hand coordination tasks with a series of pencil / paper tests that reveal the degree of difficulty. Depending on test performance, the doctor may advise to wait and give the student time to further develop in this area. If a serious deficit is present, the doctor may prescribe vision therapy to address the eye-hand coordination difficulty and associated eye teaming / eye movement problems.

2. Referral to an occupational therapist for gross motor coordination difficulties / concerns. The occupational therapist is the most qualified health professional to deal with gross motor function; they tailor therapy to work toward better performance--in the classroom, on the playground, or in the athletic arena.

3. Do nothing.

A student may, with practice, develop better eye-hand (foot, body) coordination abilities. If difficulties with writing and visual discrimination persist, it is in the best interest of the student to take an active role (vision therapy) to remediate the problem.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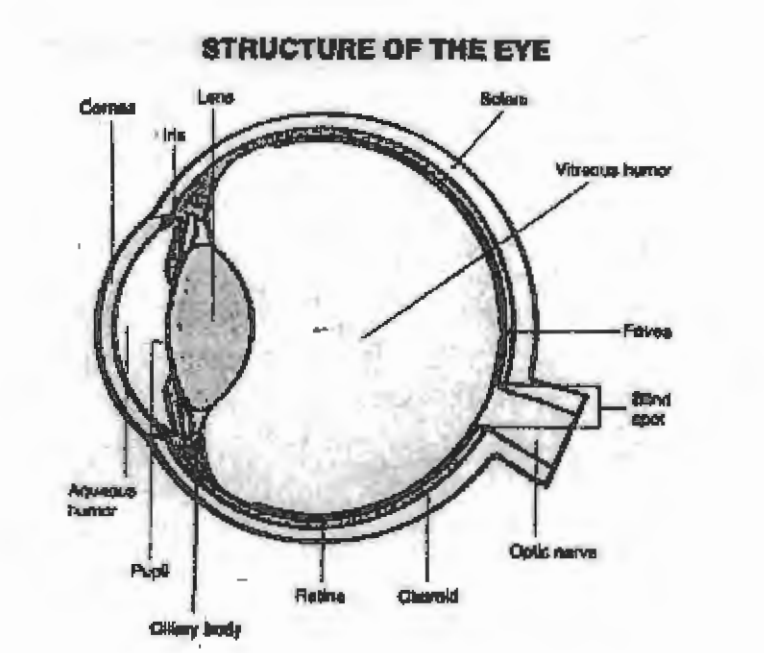


Ciliary Muscle

Function: changes the shape of the LENS to bring near objects into focus at the back of the eye

Cornea

Function: its curve bends light rays from the environment to bring them to focus at the FOVEA

Extraocular Muscles (6)

Function: exert force on the globe ("eyeball") to move the eye up, down, right, left, or diagonally

Fovea on the RETINA

Function: renders the sharpest, most distinct vision

Iris

Function: shades the eye from excess light

Lens

Function:
- bends light rays from the environment to bring them to focus at the FOVEA
- changes shape to make near objects appear clear

Pupil

- controls the amount of light passing from the environment to the RETINA

Function:
- changes size (gets smaller) to protect the retina from the effects of too much light (glare, light sensitivity, photoreceptor bleaching)

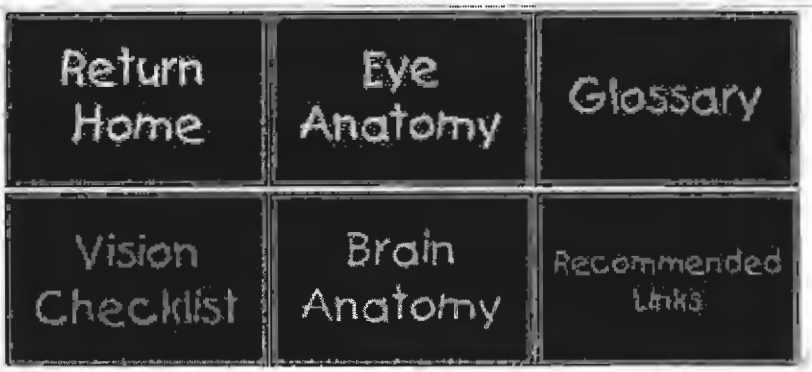
Function:

Retina

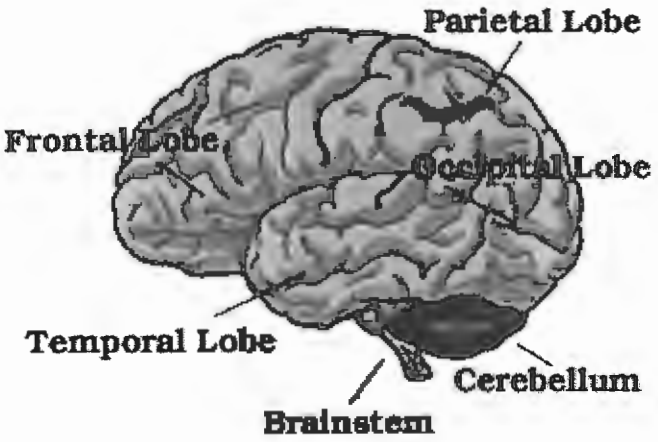
Function: cells in the retina change light energy to electrical energy, which is then transported to the **OCCIPITAL LOBE** to be processed into what we perceive

Sclera

Function: encase and protect the inner contents of the globe ("eyeball")



Brain Anatomy and Function: An Overview



Brainstem

Functions:
- alertness
- blood pressure
- breathing
- digestion
- heart rate

Cerebellum

Functions:
- balance
- muscle coordination

Frontal Lobe

Functions:
- behavior
- emotions
- organizing
- personality
- planning
- problem solve
- select attention

Occipital Lobe

Functions:
- color recognition
- shape recognition
- visual processing

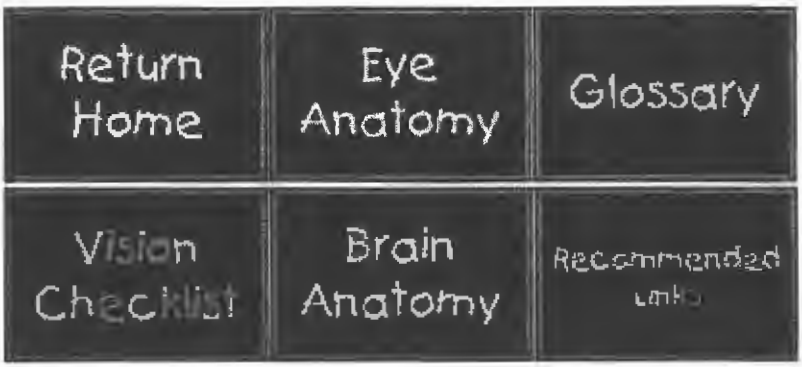
Parietal Lobe

Functions:
- judgments of--
-shape
-size
-texture
-weight
- sensation--
-pressure
-touch
- understand spoken / written language

Temporal Lobe

Functions:
- smell ID
- sound ID
- short-term memory

Rt. Lobe = visual
L. Lobe - verbal



Glossary

20/20 - "optimal" vision; a person can see at twenty feet what the population can see at twenty feet [e.g. A patient with "20/40" has reduced vision--he can only see at 20 feet what the population can see at 40 feet.]

Accommodation - the process by which the **LENS** of the eye changes shape, to allow us to see near objects clearly (without blur)

Amblyopia - one eye (or both) cannot achieve optimal vision ("20/20") with correction, in the absence of any eye disease

Anisometropia - a significant difference in the refractive status between the two eyes

Astigmatism - a variant condition of **CORNEA** shape, in which light is focused in two points near the back of the eye instead of one point. An astigmatism lens brings those two points of focus into one point of focus, to help eliminate blurring at all distances.

Bifocal - a type of spectacle or contact lens which includes both the distance portion of a person's prescription (at the top of the lens), as well as a near vision magnification lens (at the bottom of the lens). These lenses are used for both children and adults, but are more commonly associated with adults over 40 - 45 years of age.

Binocularity - the extent to which both eyes are used to focus and point to an object of interest

Ciliary Muscle - Anatomy: a muscle located inside the eye, behind the iris (colored portion); Function: to change the shape of the **LENS**, so that near objects can be brought into a focus on the **FOVEA**

Cornea - Anatomy: clear window of our eye; lies over the iris (colored portion); Function: bend light rays from environment (with the **LENS**) to bring them to sharp focus on the **FOVEA**

Convergence -the relative inward turn of each eye, for purposes of seeing a close object as single

Depth of Focus - the distance an individual can see clearly, measured from the person toward the horizon

Depth Perception - the ability to see three-dimensionally, and to judge distances in space; requires two eyes to be pointed at about the same place in space

Diplopia - a condition of seeing one object as two; Synonym: "Double Vision"

Divergence - the relative outward turn of each eye, from a nearpoint position, for purposes of seeing a distant object as single

Epicanthal Folds - a fold of skin draping the nasal part of each eye, seen in young children and in individuals of Asian ethnicity

Extraocular Muscles - Anatomy: six muscles--external to the globe, or eyeball; Function: move the eye up, down, left, right, or diagonal

Farsightedness - an ability to see farther objects better than nearer objects

Fine Motor Coordination - the ability to manipulate small objects

Fovea - the center point on the **RETINA**; the part of the retina which renders the sharpest, most distinct vision

Fusion - two-eyed coordination, such that an object seen in space is perceived as one object (e.g. the lack of double vision)

Gross Motor Coordination - the ability to coordinate large groups of muscles for the purpose of walking, dancing, sports accuracy, and maintaining posture

Hyperopia - an ability to see far objects clearer than near objects; synonym: "Farsightedness"

Interpupillary Distance - the distance measured, in millimeters, between the centers of each pupil

Lens - Anatomy: a transparent structure located behind the iris (colored part of eye); Function: to bend light rays from the environment (with the **CORNEA**) to bring them to sharp focus on the **FOVEA**

Myopia - an ability to see nearer objects; distant objects usually appear blurry. Synonym: "Nearsightedness"

Nasal (Nasally) - referring to the movement, part, or visual field of the eye closer to the nose; Antonym: "Temporal"

Nearsightedness - a better ability to see nearer objects; distant objects usually appear blurry

Nystagmus - an abnormal eye movement, in which the eyes beat repetitively (usually side to side)

Occupational Therapy - a health profession which specializes in remediating those functions affecting the work and / or play of the individual

THE THREE "O's:" OPHTHALMOLOGY, OPTICIANRY, OPTOMETRY

Ophthalmology - Degree; "M.D." Medical Doctor; Training: 4 years college, 4 years medical school, 1 year general clinic training, 3+ years ophthalmology residency, optional 1 year subspecialist training. Emphasis: disease, surgery of the eye, refraction

> **Neuro-ophthalmologist** - specialty in neurologic and eye diseases; pathology expert in dealing with intracranial lesions (tumors, aneurysms, strokes) and their effect on the visual system
>
> **Strabismus Surgeon** - often a pediatric ophthalmologist, strabismus surgeons specialize in the surgical treatment of eye turns and eye muscle entrapment (which may cause a "pseudo-eye turn")

Opticianry - Certification: optional 2 year degree program. Emphasis: recommendation, production, and verification of spectacle eyewear; contact lens fitting; refraction.

Optometry - Degree: "O.D." Doctor of Optometry; Training: 4 years college, 4 years optometry school, optional 1 year specialist residency. Emphasis: refraction; screening and treatment for eye disease; concerned with the coordination of the eyes and function of the visual system.

Functional vision care specialist - specializes in the coordination of the visual system, and the effect its coordination (or lack thereof) has on the individual. Recommends lens prescription and / or therapy to assist the student in becoming more visually comfortable in his environment.

Rehabilitative optometry - the specialty of optometry which remediates visual deficits secondary to trauma (head / neck injury, stroke, etc.); another term for **Vision Therapy**

Orbital Rim - Anatomy: the bony area surrounding each eye; Function: to protect the eye, **EXTRAOCULAR MUSCLES**, and orbital fat from damage

Palsy - "paralysis;" loss of some degree of nerve input to a muscle or to a group of muscles

Pursuits - eye movements which hold the image of a moving target on the fovea

Refraction - the portion of an eye exam which tests the need for prescription lenses

Refractive Status - the degree to which a person is nearsighted, farsighted, or astigmatic

Retina - the sensory portion of the eye; Function: the sensory cells change light energy to electrical energy, which is carried to the brain via a system of nerves

Saccades - a rapid eye movement to an object of interest; it places the image of the object at the **FOVEA**

Sclera - Anatomy: the white part of the eye; Function: to encase and protect the inner contents of the globe, or "eyeball"

Snellen Test - the test in which vision acuity is measured, either with or without correction

Suppression - the brain turns "off" the image coming from one eye, in an attempt to alleviate eye strain or double vision [Diplopia]

Strabismus - a condition in which the two eyes are not aimed to the same point in space; the eyes are out of alignment. Synonym: "Eye Turn"

Temporal (Temporally) - referring to the movement, part, or visual field of the eye that is away from the nose; Antonym: "Nasal"

Vestibulo-Ocular Reflex - an eye reflex which keeps images steady on the retina during head movements.

Vision Therapy - the remediation of the following vision problems: eye movements, eye teaming, amblyopia, eye turn in / out / up / down, visual field neglect, eye-hand coordination, and visual perception. Treatment is aimed at restoring function to the visual system after loss, or refinement of a vision system which is uncoordinated. Vision therapy can also be utilized to for enhancement of adequate vision systems, to enhance sports performance, or to enhance reading / processing pace. Vision therapy is NOT exercising the muscles of the eye; it is better described as retraining how the brain processes visual information.

Visual Imagery - imagining how a scene appears, in absence of physical visual stimuli

Visual Closure - the ability to identify a partially-completed symbol (e.g. a clown figure without the face)

Visual Constancy - the ability to match two identical symbols from a composite of similar symbols with a variant characteristic

Visual Figure-Ground - the ability to identify the subject (figure) from distracting background information (ground)

Visual Form Recognition - the ability to match identical symbols from a composite of several different symbols (e.g. matching the figure of a square from the following choices: triangle, circle, square, trapezoid)

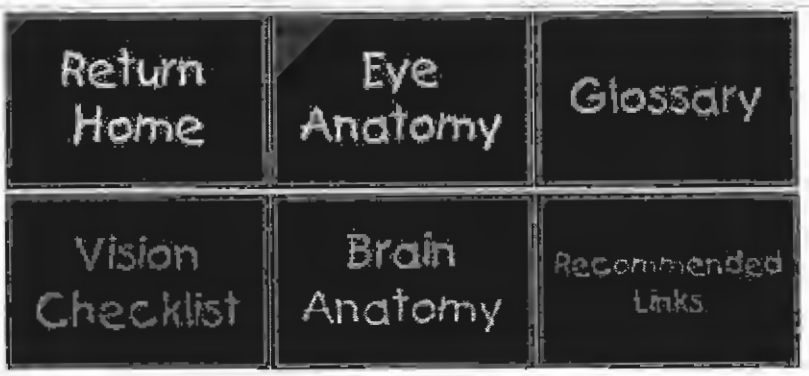
Visual Matching - the ability to pair physical stimuli (e.g. blocks, 2-dimensional pictures) with similar characteristics

Visual Memory - the ability to retain the mental image of a symbol, when the symbol is taken away from view

Visual Motor Integration - the ability to copy printed symbols without distortion nor major error

Visual Perception - the ability of several brain areas to identify and to react to the information taken in by the **RETINA**

Visual Sequential Memory - the ability to retain the mental image of multiple symbols, in a specific sequence, when the symbol sequence is taken away from view



Recommended Links

American Academy of Optometry: http://www.aaopt.org

American Optometric Association http://www.aoanet.org

College of Optometrists in Vision Development http://www.covd.org

Optometric Extension Program: http://www.healthy.net/oep

Pacific University: Master of Education, Visual Function in Learning Program
http://www.pacificu.edu/MED_VFL.html

Pacific University College of Optometry program
http://www.pacificu.edu/academics/index.html

Parents Active for Vision Education: http://www.pave-eye.com/~vision

Recommended Reading

The following materials may be ordered through the:

Optometric Extension Program Foundation, Inc. (OEP)
phone (714) 250-8070
fax (714) 250-8157
CREDIT CARD ONLY: 1-800-424-8070

Customer Service Hours: Monday – Friday, 7:30 a.m. – 4:30 p.m. (Pacific Standard Time)

1. **When Your Child Struggles: The myth of 20/20 vision**
   David L. Cook, O.D.

   "Written for parents about their children's vision, how to detect if their child is struggling unnecessarily and where to turn for help. The author uses case histories to illustrate the various vision disorders described in the book; lists research on vision and vision therapy, additional reading for the layperson, and a glossary of terms."

   Soft-bound, 173 pages.

2. **How to Develop Your Child's Intelligence**
   G.N. Getman, O.D., D.O.S.

   "This book discusses how many children are not ready for the visual demands of school, and can help parents and teachers understand the critical relationship between vision and intelligence." *Includes two charts of intellectual development.*

   Soft-bound, 130 pages.

3. **Thinking Goes to School**
   Hans G. Furth & Harry Wachs, O.D.

"Discusses Piaget's theory and then illustrates activities and strategies to help a child with experiences best designed to develop his/her full potential as a 'thinking' human being." *170 activities are included.*

Soft-bound, 279 pages.

4. **Your Child's Vision**
   Richard S. Kavner, O.D.

   "An excellent guide for understanding visual development from the behavioral point of view. The book was written to educate the public about developing and protecting a child's functional vision. Divided into three parts: Part One describes vision development for early childhood (infant through age 5); Part Two discusses environmental considerations, and reviews visual concepts about play, television, nutrition, and more; Part Three covers specific visual difficulties and the prevention and remediation of these problems."

   Soft-bound, 251 pages.

5. **Developing Your Child for Success**
   Kenneth Lane, O.D.

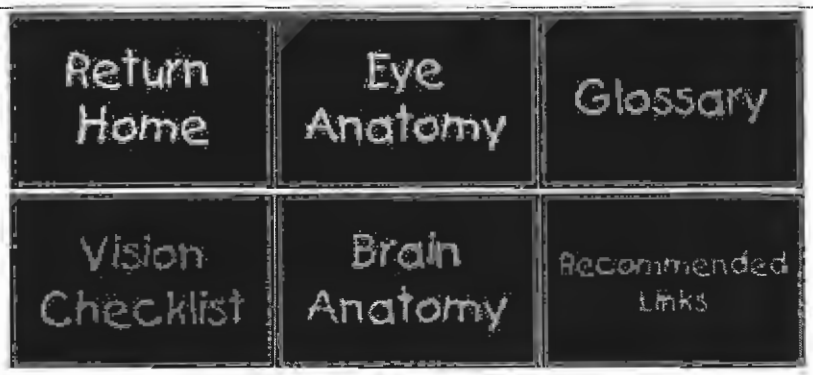
   "Designed for the professional or parent to help children avoid early school failure. The majority of the book is devoted to activities that will help give children the necessary perceptual-motor skills needed to succeed in school. Over 630 activities are described in the book. A list of equipment is also included."

   Soft-bound, 323 pages.

6. **Classroom Visual Activities**
   Regina Richards, M.A. & Kristy Remick, O.D.

   "Classroom activities for all agesto help develop visual skills. Objectives, success criteria, and detailed instructions are included for each activity."

   Soft bound, 80 pages.



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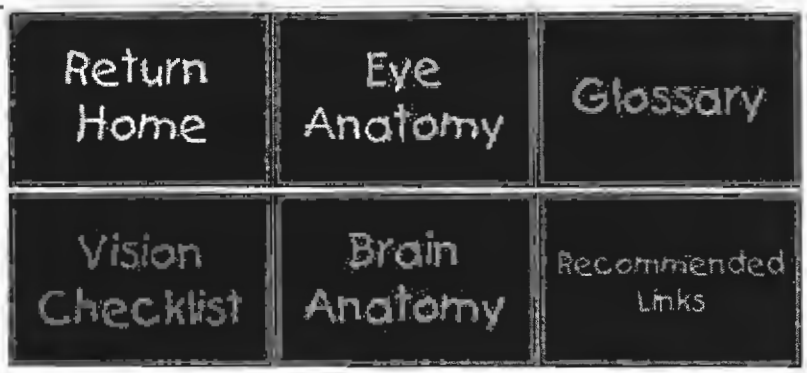

An example of nearsightedness (albeit extreme) can be demonstrated with the aid of a magnifying glass. Hold a magnifying glass close to your eye. Next, observe your ability to see clearly at close distances. Now try to look far away across the room, at a clock, for example. Can you make out any details on the clock? Can you find the clock on the wall?

This demonstrates the sight of a highly nearsighted person. Most young students are not this nearsighted. But now you may be able to appreciate why a student squints to see a chalkboard or an object across a street clearly. By squinting, the student is able to simulate a smaller pinpoint opening through his or her pupil. This pinpoint opening gives the student a much longer depth of focus, so they can see clearer, at a greater distance. Try it: poke a small hole in a piece of paper with a stickpin or with a sharp pencil point. Look through the hole in the paper across to the other objects in the room. Are you able to see the numbers on the clock more clearly than without the hole in the paper?

BACK

If we think of focusing the LENS as a muscular exertion, imagine holding a ten-pount weight out in front of you, with your forearm parallel to the ground. This is analagous to what the farsighted person is doing just to see clearly far away. Remember, the farsighted person must focus the LENS of the eye to bring the point of light ray focus from "behind" the eye directly to the fovea on the RETINA.

Now, imagine if someone instantly added 30 more pounds to your initial ten-pound weight and demanded you hold the weight without missing a beat. The farsighted student undergoes this type of burden when he or she shifts focus from distance vision (e.g. the chalkboard) to near vision (e.g. desk work). Can you imagine withstanding this burden as your eyes change focus an immeasurable number of times per day?!

BACK

If we think of the CORNEA/LENS relationship in terms of a tennis ball, the following depiction results. Imagine cutting a tennis ball in half, right down the middle. Discard one of the halves. The remaining half is the shape of a sphere, if looked upon from the front. This shows the CORNEA/LENS relationship in an eye without Astigmatism: the tennis ball has a uniform curve along its entire surface. Due to this uniform curve, light is focused at only one point behind this spherical surface.

Now imagine if you held the half-tennis ball, sphere side out, with your fingers on top of the sphere and your thumb on the bottom of the sphere. Press your fingers and thumb together, so that the front surface of the ball looks elliptical. This ellipse shape demonstrates the CORNEA/LENS relationship in an eye with Astigmatism: the vertical meridian of the ball (between thumb and fingers) has a sharper curve to it than does the horizontal meridian of the ball. The difference in curve sharpness is what causes light to focus at two points instead of one. The vertical, sharper-curved, meridian focuses light more strongly, more toward the front of the eye. The horizontal, flatter-curved, meridian focuses light relatively weakly, more toward the back of the eye (nearer RETINA). The interval of distance between these two points of focus determines the amount of astigmatism. A larger interval indicates more astigmatism; a smaller interval of space represents less astigmatism (see diagrams below).

BACK

To demonstrate **Anisometropia**, wear your glasses or contacts (distance correction) and proceed:

1. Now place a low-power magnifying glass in front of one eye. Notice you can still see objects pretty well out in the environment.

2. Close or cover the eye without the magnifying glass, and look far away. Quite a difference from what you just saw in step #1! This view should be much blurrier.

3. Uncover your "good" eye again, and notice with which eye your brain chooses to look!

4. Test your depth perception in this state by tossing a coin up into the air, trying to catch it on its return down.

5. Remove the magnifying glass; let your eyes readjust for about 10 seconds. Repeat the coin toss now, using two "good" eyes.

Did you notice a difference in the ease of the catch between steps #4 and #5? Step number 5 gives you the "two-eyed" advantage, or what we call depth perception. Humans experience true depth perception only if their eyes are focused at about the same place in space. Depth perception is thus a two-eyed phenomenon. For example, you may be able to appreciate why it might be easier to hit a baseball with two eyes working together, rather than with one eye alone.

BACK

For this experiment, have a helper on hand. The helper is to hold up an object (pen, pencil, etc.) between you and himself. The helper moves the target various directions, while you follow with your eyes. This is a pursuit eye movement. (This experiment is not as effective if you yourself hold the target, because your eyes are receiving input for where the target is in space, via proprioceptive (joint placement) feedback.)

You would also use this type of eye movement watching a car drive past, or watching a baseball being thrown. Reading is essentially the only activitiy where the target stays in place, and the eyes do the traveling on their own across the page. In drawing and writing, the eyes are simultaneously watching and leading the hand movements.

BACK

With assistance from a helper, have the helper stand behind you. The helper should slowly bring a target (pencil, pen, etc.) from behind your head forward. Pick a point of fixation across the room. As you keep your fixation point, do you notice the urge to look at the target being introduced at your side? Your eyes are wired reflexively to look at a new target when it is presented. At its basic level, this is the function of the saccade. (This experiment is not as effective if you hold the target and present it to yourself; your eyes are indirectly receiving information via proprioceptive (joint placement) feedback.)

BACK

Try this! Observe a target on the wall before you. Now, make a quick head movement to either side. Do you notice your eyes stay relatively fixed on the target you have chosen? Think how off-balance the world would seem if, every time we turned our head, the world spun. It would be happening all of the time. The vestibulo-ocular reflex steadies our visual world despite gross head, neck or body movements.

BACK

Try this! Hold your index finger, pointing upward, at arm's length. Gradually bring your finger in closer to you, and stop your finger about 4 inches from your nose. As you watch your finger coming closer to you, your eyes are converging, being pulled inward from a straight-ahead position. Now, look from your finger to an object on the wall opposite from where you currently are. The movement of your eyes from your finger target to the wall far away is what we call divergence. Your eyes are moving from a relatively inward-pointing position to a straight-ahead position.

BACK

Hold a finger or a pencil close to your face, but look at an object on the far wall. How many fingers do you notice? You should notice two. This observation is a result of the design of our visual system. Any object not being viewed with the fovea on the RETINA will be doubled because the image of a near object (in our example) is projected to opposite sides of the fovea in each eye. Our brain processes this information, and the result is "double vision," or diplopia.

If you do not notice two fingers, one of your eyes may be suppressing, or "turning off" the information from an eye. See Suppression for more information.

BACK

Try this! Hold your index finger 4 inches away from your nose. Look rapidly between your finger and a chosen point of fixation on the far wall behind your finger. Try looking rapidly between the two targets 10 times, making sure the distance target is clear before cycling back to the finger (and vice-versa). How do you feel after doing this exercise? Dizzy? Tired? Do you have a headache? Students with Eye Teaming problems often present to eye doctors with these complaints. It's no wonder why--a lot of effort is expended on maintaining clear, single vision in the learning process

BACK

Try this! The Floating Finger phenomenon. To demonstrate divergence, place your index fingers pointing toward each other. Hold at about a foot away from your eyes. Now, pick a point across the room to focus on. As you do so, try to pay attention to how many "fingers" you see. You should be able to see "three" fingers--one of the fingers will appear to float between the other two. You may need to adjust the distance between the tips of your fingers to see the effect.

Gradually change the distance between your finger tips, toward each other, then away from each other. Notice any change in the floating finger? This trick is possible because your brain perceives each of your true fingers as being double when your eyes are attending to a distance target. The combination, then, of the "doubled" fingers yields the illusion of the floating finger.

BACK

Try this! If you have access to a handheld magnifier, try holding it before a printed page, at a point where it distorts the letters or makes them slightly blurry. Do your best to guess at the consecutive words, as they appear in the field of view of your magnifier. Even if the words are fairly easy to guess at, do you notice any strain? Does it seem that more energy is required to read the print?

Now, do you notice any difference in the ease of "focus" if you hold the magnifier a distance appropriate for its power (this is the point where the letters are most distinct)? Many children go through this focusing battle throughout the school day--a process which can lead to fatigue and avoidance of near tasks.

BACK

Try this! Try writing a note to someone, using only pictures as words--no letter or number characters allowed. Does the person receiving the note understand your message? Does it take them several reading trials to get the idea of your communication? This situation may be analagous to the student who is unable to read or write efficiently--it takes him a moment to appreciate what the symbols for letters and numbers actually represent, to decode their meaning.

Think about what your behavior response would be to the following situations:

- Approaching a red light, while driving a car
- Observing a baseball coming toward your head
- Observing a pothole four feet in front of you, while walking
- walking about an unknown town

In all of the situations listed above, vision is providing the information about what is out there in front of you. The response you choose may have good results (e.g. ducking into a deli in a new town for a treat) or bad results (e.g. not stopping for the red light), but your vision nonetheless provided the context for your behavior.

BACK

Close or blindfold your eyes. Have another person place three fairly unusual objects in front of you. Inspect them by touch, and smell, if you wish. How long does it take you to guess what the three objects are?

Close your eyes again. Your friend should place three new objects out on the table. Now open your eyes. Inspecting the objects with your vision, how long does it take you to guess what the three objects are?

Usually, there is a marked discrepancy in how long it takes on to analyze visually versus with the sense of touch. If we translate this activity to work done in the classroom, imagine the amount of time required to learn the world "by hand." Most learning is done through vision and audition. A touch-oriented child will labor more at learning if eye-hand coordination is difficult. If he doesn't learn to perceive the environment with his vision, he will always need to resort to another sensory modality to process his world.

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