Basic Eye Development and Associated Problems

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An essay on brain and eye development

Pupil Response

The pupil response is an automatic brain/eye response to light that every newborn should have.

When light enters the eye by way of the pupil, the brain regulates the amount of light that enters the eye by constricting or dilating the pupil of the eye. When the pupil gets smaller, like in bright light situations, it allows less light into the eye to both protect the sensitive eye nerves and also to improve the vision. In darker situations the brain dilates (makes larger) the pupils. This allows more light to enter the eye, thus allowing better vision in lower light settings.

Even before birth, the pupil response to light develops in the brain. In the womb, as the baby is developing, the eyes have little opportunity to develop as there is limited light available to stimulate them. Once outside the womb the newborn's eyes now receive adequate light and opportunity to develop sight.

The Pupil of the Eye

The brain receives signals from the nerves in the eye that tell the brain how much light is entering the eye. The brain then produces the pupil response when it sends response signals to the pupil's ciliary muscles in the eye. The ciliary muscles are the ones that constrict and dilate the pupil opening. These ciliary muscles are some of the most sensitive muscles in the human body.

A difference in the size of the pupils from one eye to the other can indicate one or more of several things that can be wrong. Things like inappropriate development of lower levels of lateral brain/eye development, brain injury, chemical insult, potassium deficiency, and even parasites. If either of the pupils is not perfectly round but have jagged edges, this is a good indicator of a toxic liver burden.

How to Check Pupil Response

In a normally lit room, use a flashlight to shine into the eye for just an instant. Use a small flashlight and sweep quickly on and back off of the center of the eye at about four inches away from the eye. Only flash the eye for about a half a second to avoid over-stimulating the eye's light sensitive

nerves. Wait for two seconds and flash the eye again. This flashing of the eye should instantly produce a noticeable constriction of the pupil. It should not take more than two seconds before the pupil returns to its original size. Both eyes should have the same fluid pupil response.

In some cases of hypersensitivity to light, you may not be able to perform this test as it may produce a pain response or extreme discomfort.

Problems Associated with Pupil Response

The most noticeable problem associated with inappropriate pupil response development is hypersensitivity to light. This usually causes a pain or discomfort response and excessive squinting or blinking during light changes or bright light situations.

In the pain-hyposensitive child, there is a danger for permanent eye damage when the pupils allow too much light to enter the eye for extended periods of time. This child may not experience pain or discomfort in excessively bright light. With no outward reactions, the problem may go unnoticed until there are vision, academic, or other problems that arise.

Outline Perception

The next level of visual development is outline perception. Outline perception is the ability to perceive the outline of any object. It is like seeing a silhouette of, for instance, an animal but without any specific details of color or depth. Along with outline perception development enters a basic eye-brain tracking ability that doesn't complete its development until later.

Outline Perception is the stage in visual development where the baby begins to recognize and locate familiar sights and outlines. The best distance for this process to develop is within 12-18 inches of the baby's face and usually begins with the silhouette of the mother's face as the baby is nursing.

The eyes are developing laterally at this stage and will not work together until a later stage of development. An important step in eye development happens while breastfeeding. While the baby is nursing on one breast, one eye is occluded from seeing while the other eye is obtaining input from looking at the mother's face. When the baby is nursed on the other breast this will alternate the occluded eye with the formerly occluded eye. This will allow an appropriate development of outline perception details for both eyes.

An unfortunate thing happens to most bottle-fed babies. The baby is generally held on the same arm every time, which gives one eye more

opportunity to develop than the other. This can cause mixed eye and ear dominance, which will result in neurological disorganization along with a host of different related problems.

Problems Associated with Outline Perception Development

Because outline detail perception is a major key to all visual perception, any problems in this area will be cataclysmic and cause all other consequent areas of eye development to not develop appropriately. This child will have trouble responding to shapes and sights and will not recognize even the mother until she speaks or the child smells or touches her.

Eye Convergence

This is the stage of development where the eyes begin to work together at a higher level of brain function as the brain is learning how to coordinate the eyes.

Eye convergence brings depth perception. In lower levels of brain/eye development, the eyes develop separate function. At this next higher level of development, the eyes, while being at two different locations in the head, will work together to focus on one object giving the brain visual depth perception. The brain can visually triangulate the location of an object this way to determine distance.

Even though the brain will have a dominant, or preferred, eye, it learns to take in and process information from both eyes simultaneously and to coordinate the eyes to track together.

Problems Associated with Eye Convergence

The main problem associated with eye convergence is called a strabismus. One form of strabismus is a divergent strabismus or “wall-eyed” where one eye turns out. Another is a convergent strabismus or “cross-eyed” where one eye turns in.

A strabismus occurs when the brain fails to recognize and coordinate the input from both eyes at the same time. The brain will have to ignore the input from one eye, which allows that eye to wander off track. The eye that stays on track will generally be the dominant eye and the other eye is called the “lazy eye”. The brain can switch eyes at any time but generally prefers to use the dominant eye. Some times this is caused or exacerbated by problems in the lateral development of outline perception development of the one or both eyes at an earlier stage of eye development.

It is very important to understand that the eye muscles rarely if ever cause a strabismus! It is a brain development issue. The eye surgery that shortens the eye muscles to give the eyes the appearance of tracking, and the prism glasses only treat the symptoms and not the cause. Soon after the surgery the lazy eye will often drift right back off course causing another invasive cosmetic surgery. Or, as soon as you remove the prism glasses, the lazy eye will turn off course. The only true cure for a strabismus is to treat the brain issue and alleviate the cause thereby remediating the symptoms (see therapies and exercises for eye convergence).

How to Test Eye Convergence

Although in some children the strabismus is fairly obvious (especially when the child is tired), quite often a strabismus will go unnoticed or ignored and is a cause of brain disorganization in how the brain takes in, stores, retrieves and utilizes visual input.

To test eye convergence, use a small but high interest object or dim flashlight and move it around in front of their face at about 8-10 inches away. Move the object from side to side and up and down in large arcs in front of the face for about 15 seconds while the child attempts to follow the object with their eyes. Stop the object at about 8-10 inches away from the face and in the exact center of the face. Slowly bring the object in towards the bridge of the nose and stop at about 1-1/2 inches away. Notice the eyes as you perform this exercise to see if they track the object together all the way to 1-1/2 inches from the bridge of the nose. If one eye turns either inward or outwards before you reach the 1-1/2” stopping point, this indicates a strabismus. (Inside of about an inch and a half from the nose, the eyes will normally lose convergence and this will not indicate a strabismus but may indicate the dominant eye as the one that continues to track inside of 1-1/2”.)

Now cover one of the child’s eyes with one of your hands and continue this exercise by making about ten more passes both up and down and side to side about 8-10 inches in front of the child’s face. Now, with the one eye still covered, stop the movements with the object at mid-face. Move the object quickly in towards the nose and stop about 1-1/2 inches away from the bridge of the nose. Slowly reverse directions taking about 2 seconds to return to the 8-10 inch starting point at the center of the face and stop the object and hold it still. At this point you will quickly uncover the occluded eye while still holding the object in its place. Notice the position of the occluded eye. Was it on track with the other eye or did it drift in or outward during the exercise to snap back into place when you uncovered it? If the occluded eye moves to regain tracking with the uncovered eye after you uncover it then this is indicating a strabismus.

Test the opposite eye in the same manner by covering it up with your hand and repeating the above steps. If an eye drifts inward during this test, it is a convergent strabismus. If it drifts outward it is a divergent strabismus.

To be completed on this level of brain development called convergence, each eye should track together completely and without wandering off course during this test. In other words, the brain should cause the occluded eye to track with the non-occluded eye at all times.

Bilateral Tracking

Basic tracking begins with outline detail perception but does not complete its development until after the eyes develop convergence or the ability of the brain to utilize the information from both eyes simultaneously.

Bilateral tracking is the ability of the eyes to follow an object in motion with both eyes while maintaining depth perception at all times. It has a big impact on whether or not the child can track and catch a ball.

Problem associated with bilateral tracking

The most obvious problem associated with inappropriately developed bilateral tracking is the inability to catch a ball that is thrown to the child. The child with development problems in this area will often close their eyes and hold out their hands in a vain attempt to catch the ball or prevent it from striking them. After they miss catching the ball, they may stand still and wait until the ball stops moving on the floor before they pick it up to throw it back. Other problem will often be uncoordinated body movements, falling down and tripping, motion sickness, startling at things that are moving towards them, and over-exaggerated body movements.

Testing the bilateral tracking

Using a small but high interest object or dim flashlight, move the object from side to side, ear to ear, and up and down, from just above the forehead to just below the chin, and in front of the child’s face. Move the object in an arc about 8-10 inches in front of the face with smooth movements taking about two seconds to make each back and forth pass. Do this about 15 times alternating at random both horizontal and vertical sweeps. They eyes should track together, and smoothly with a fluid motion.

If the child cannot hold their head still to track but insists upon moving their head while attempting to track this is because of either undeveloped tracking skills or because of cortical spillage. (See article on cortical spillage.)

Nystagmus

If the eyes should have a quiver, jerk, or a glitch in the tracking that causes the eyes to jump at a certain spot while tracking, this is called a nystagmus. A nystagmus is caused by either a brain injury or insult, or inner ear problems and can cause considerable tracking and catching problems.

Central Detail Perception

Central detail perception comes from the part of the eye called the macula. You can experience the challenge a child has with problems in this area will have if you make fists with both of your hands and then hold them three inches in front of each eye, you will block out the macular vision leaving only peripheral (around the edges) vision.

The central detail perception starts by developing laterally in the brain at the lower level of outline detail perception. At this stage of development called central detail perception is where the finer details of vision develop.

The macula of the eye is also known as the central detail vision area. It is a critical function in vision to later be able to read and recognize fine detail. If you have ever experienced the blue dot you get in your vision when you have your picture taken with a flash camera, then you have experienced an over stimulation of the macula of the eye. Also, the “red-eye” you see in developed pictures is merely the reflection of the light of the flash off of the macula of the eye and back into the lens of the camera to show up on the film. The intention of a double flash camera, where the camera does a flash, pauses, then flashes again for the picture, is to over-stimulate the macula. The first flash causes the macula to shut down so as to eliminate the “red-eye” in the second flash that takes the picture.

The central detail vision of the eye is what gives the brain the visual perception of details like hair definition in a picture of a person.

Problems Associated with Central Detail Perception

Problems with central detail perception will cause problems in reading and mathematics. Important details will be missed in the course of performing mathematics, reading, and other academic processes, causing the child to add instead of multiply in mathematics, misread numbers, invent words as they read, and skip whole lines of text. The child may seem inattentive, fail to complete tasks, have difficulty catching a ball thrown straight at them, may be unable to recognize familiar people in photographs, have varying degrees of color blindness, fail to make direct eye contact, and will be easily distracted by movements to the side of them.

Problems with the detail perception can also cause difficulties in language development as a child needs clear visual images of others making sounds to be able to model the sound. The child needs to see the sound produced by watching the lips, tongue, jaw, and cheek positions as you speak to them.

“Stimming” or playing with peripheral vision is an action the child with inappropriate macular vision will do such as spinning an object near but often to the side of the face, flapping or waving the hands to the side of the face, spinning on a bar stool for hours on end, watching a ceiling fan, sitting just inches from a television, and a host of other feel-good stimulations that produce endorphins in the brain but leave the brain temporarily less able to process in an organized manner than before the “Stimming” activities. Much like the rush of riding a roller coaster.

Testing the Central Detail Perception

The best test for underdeveloped macular vision is observation. Does this child examine things from the side of their face? Do they have trouble looking you in the eye? Do they like to line toys up on the floor and then lay on the floor to look at them sidelong or play with them? Do they spin objects near their face or wave their hands to the side of their face? When given a task like cleaning up their room, do they start one area, go to another, and then another, and circle the room never quite finishing any portion of the task? If you give them a paper towel roll to use as a telescope, will they look straight through it or turn their face and look sidelong through it indicating a central detail perception problem? Can they look straight into a kaleidoscope, or again, turn their head to look sidelong? Do they prefer to watch television from very close up, even inches away? Can they see what is right in front of their face or often miss the obvious? Do they prefer noisy toy to visual toys?

Recognition of Symbols

Recognition of symbols is a very important part of brain/eye development. This happens at higher levels of brain development where the child begins to associate first environmental symbols and then alphanumeric symbols with specific meanings. For instance, one of the child’s first environmental symbols they might recognize could be the “golden arches” of MacDonald’s ™ restaurant. Any time they see these “arches”, they will associate them with food and the playground inside and become excited and maybe hungry. They will be able to recognize their numerals, ABC’s, and groups of letters with meaning such as “cat” or “dog” and even bigger combinations of letters (even though they cannot spell).

Problems Associated with Recognition of Symbols

The recognition of symbols is the basis for reading and understanding language as well as performing visual math. The child with developmental problems in this area will not be able to associate symbols with meaning. The child may develop language and communication skills using auditory function, but will have difficulties recognizing letters and numbers while having reasonably good vision.

How to Test Recognition of Symbols

The simplest way to test the recognition of symbols is to have the child identify random letters of the alphabet and random numerals. The child should be able to recognize letters and numerals instantly every time they are asked to identify one. Do not present them in a particular order, but mix the letters and numerals together. (Please note that this test is for ages of development relative to at least four or five years old of appropriate brain development. However, two year old children should begin to recognize basic environmental symbols i.e. the “arches” and even letters and numbers)

Reading Skills

Skilled reading ability is the level of brain/eye development where the brain/eye development is considered complete as long as all subsequent levels of eye development are also complete.

Skilled reading ability is the ability to read and comprehend at the level of second grade reading abilities or higher. This development occurs at higher, cortical areas in the brain than other levels of eye development.

Accelerated ability in the level of skilled reading abilities will include skillful oration of complicated scripts and also the ability to read and comprehend a second language.

Problems Associated with Reading Skills

Skilled reading abilities are a combination of brain processes, which will include sequential processing abilities (see article on sequential processing), eye dominance (see article on laterality), lower level eye development, and cortical brain function.

The problems associated with skilled reading abilities are difficulties reading and difficulties in comprehending what is being read. Skilled reading abilities are often affected by other developmental issues including eye development, eye dominance and other issues at lower levels of eye

development that will have to be addressed to bring about completion at this level.

Low sequential processing abilities (6 digits or below [see article on sequential processing]) and mixed eye dominance (see article on laterality) are two areas that will in particular affect reading comprehension.

Problems in the central detail perception area of the brain will cause difficulty in word recognition as well as cause problems skipping lines of text and difficulties in simple mathematic processes. Problems in visual tracking will also cause undo difficulties in the areas of both reading and mathematics.

How to Test Reading Skills

To test the skilled reading abilities observe the age level of books that the child prefers. You can check out several books from the local library that are second grade level or slightly above. To be complete at the level of reading skills, the child needs to be able to read and comprehend easily what is written without inventing words or skipping lines of text. All words in the second grade level should be understood with the only exception being words the child may not have encountered before.

To determine actual level of reading skills abilities above second grade will require a standardized reading test.