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## *Visual Tracking, Eye Convergence, Reading and Writing*

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I didn't learn about the importance of visual tracking and eye convergence during medical school, pediatric residency or my fellowship in behavioral and developmental pediatrics. During that time, I did what I thought was a thorough eye exam. Yet, my studies in Extra Lesson at Rudolf Steiner College, my visits with a developmental optometrist, and my own clinical practice have provided a great deal of insight into the examination of children's eyes.

When children come to my office, one of the first things I check is whether they can clearly see pictures and/or letters with each eye separately at a distance of 20 feet. This is the test for visual acuity and it also will show if children are having any difficulties tracking with their eyes. Usually if older children have difficulty tracking with their eyes, they will have difficulty accurately identifying letters on an eye chart as compared to identifying pictures on the picture chart. As the letters become smaller on the eye chart, the letter F will often appear as an R since any instability in children's eye movements (ie. "jiggling" of their eyes during tracking) will alter the letters they see. This does not happen when they look at the picture chart since any movement or jerking of their eyes moves the entire picture so the picture is not distorted. In addition, if children have difficulty tracking with one or both of their eyes, they often turn their head sideways when looking at the eye chart, using their peripheral vision instead of their central vision.

Another way to find out if both eyes are seeing equally is to shine a bright light from about 12 inches away into both eyes and notice the location of the light reflection within the central, dark circle of the eyes (the pupils). The reflected spots of light should be symmetrically located within the center of both pupils. If the spot of reflected light is only in the center of one pupil but off to the side in the other pupil, then the vision of that later eye will be weaker.

A newborn infant has very poor distant vision. The infant's vision will gradually strengthen throughout the toddler years and into early childhood. From my experience children usually have a visual acuity of 20/20, 20/25 or 20/30, equally in both eyes, by the time they are 7 years of age. If there is a difference in vision between the two eyes or if the vision in both eyes is weak (ie greater than or

equal to 20/40 at this age), then biodynamic cranial osteopathic treatments are often needed to relieve any cranial compressions, in addition to a referral to an ophthalmologist or developmental optometrist. When there is a cranial compression, children of 4 years of age and older often can not wink in one or both eyes. The winking is restored after biodynamic cranial osteopathic treatments.

Eye muscles also can become restricted in their movements because of a cranial compression which occurs when excessive force has been applied to the cranium during a difficult birth (ie. prolonged labor, fast delivery, pitocin use to induce delivery after the water has broken, vacuum forceps delivery and sometimes during a C-section delivery). If eye muscles are not properly functioning, then children can show a turning-in (esotropia) or turning-out (exotropia) of the involved eye and over time this eye will develop a decrease in vision. The same thing happens if the eye muscles in one eye can not move (track or converge) as effectively as the muscles in the other eye.

Vision develops best in the eye that can easily track and converge and stops developing and even worsens in an eye that can't track or converge well. In other words, the mind will stop paying attention to visual information coming from an eye that does not see as well or does not track and converge as well. This is because eyes that are tracking or converging asymmetrically will create images that are distorted and/or doubled. Both eyes, seeing with equal acuity, are also needed for the development of depth perception. In order to see this phenomena just cover one eye when you look across the room at an object, then uncover the eye and notice the improved sense you have for the distance between that object and other surrounding objects in the room.

Children who are 6 years or older are said to track well with their eyes if they can easily follow an object, like the tip of your finger, for 60 to 90 seconds without needing to turn their head. The eye movements should be sustained, smooth and symmetrical. I usually draw a figure "8" with my fingertip in the air about 12 inches in front of the child's eyes. I draw this figure "8" horizontally (ie. laying on its side) with the intersection of the figure "8" occurring in front of the child's nose so that the child's eyes move from one side to the other. I then carefully observe the child's eye movements as the child's eyes follow my moving finger. If the child's head has to move side to side while following my finger or if the child's eyes show jerking movements, excessive blinking, or have to refocus every few seconds, then I know that child has problems with visual tracking.

When I test children for convergence, they need to be able to smoothly and symmetrically move their eyes towards their nose. I have children follow the tip of my finger from a point in the air, 12 inches from their nose, to a point in the air that is close to the tip of their nose. Convergence, this moving of the eyes medially (toward their nose) as children shift their gaze from a far away place to a closer place, is essential for children to be able to easily copy numbers or letters from a blackboard on to a piece of paper. If the eyes don't move or converge symmetrically, then the letters or numbers the children are copying will thicken or split into two, a type of double vision. This phenomena is what makes copying letters and numbers from a blackboard very frustrating for some children.

Children need to be able to track and converge well with both of their eyes, since tracking and converging serve as major pre-reading skills. Children that can't track or converge properly will often lose their place while reading, skip words, and tire easily. It will require a tremendous effort from these children to follow a line of letters (ie. words) on a page or to copy letters and numbers from the blackboard. Sometimes these children will need to move their head side to side while reading because their eyes have difficulty tracking. This also will cause children to become dizzy and tire easily when trying to read or do written work.

Watching television and videos as well as playing hand-held games and computer games are some of the most damaging activities we can do with our eyes. When children look at flat, two-dimensional screens, their eye muscles hold their eyes in a fixed or frozen position. The three pairs of eye muscles that are responsible for moving their eyes, side to side, forward and backward, and up or down are rarely used when children are watching television or playing computer and video games. Because television and computer screens are relatively small, their eyes remain in this fixed position while staring at the screen even though the objects that appear on the screen are moving. There has been a concern that preschool-aged children can actually show a distortion in the growth of the globe of their eye from watching too much television or spending too much time in front of the computer screen. This is because the eyeball is still growing in the young child and instead of the eyeball growing symmetrically in all directions it grows asymmetrically because of the lack of movement of the eyes. There is also a concern that older children and teenagers are losing their distant vision because they are spending so much uninterrupted time staring at flat, two-dimensional computer screens, and therefore not exercising their eye muscles by moving their eyes in three-dimensional space.

Most children who have difficulties tracking with their eyes will show challenges in the development of their vestibular system (sense of balance). These children need biodynamic cranial osteopathic treatments, which are nonmanipulative, to release any compressed areas in their cranium, particularly over the part of the brain known as the cerebellum, located in the back of the head near the upper part of the neck. These cranial compressions result either from excessive force being applied to their cranium, usually during labor or at delivery, or from head and/or neck injuries resulting from accidents or falls. When cranial compressions are not fully resolved, the back neck muscles and sometimes the muscles along the spine of infants and toddlers will tighten, restricting passive movements of their head and interfering with their ability to creep flat on their belly and enjoy "tummy time". Being born with a stiff neck or torticollis is a definite sign for having a cranial compression, as is showing asymmetry in the position of the child's shoulder blades, hip bones and foot arches when comparing the right to the left sides of the body.

For young children, strengthening their sense of balance through Therapeutic Eurythmy movement therapy, Extra Lesson work, and/or specific sensory integration/processing exercises with a specialized occupational therapist will often improve visual tracking and convergence by strengthening children's vestibular-balance pathways. There are also some developmental optometrists that no longer just recommend eye exercises. Instead, these optometrists evaluate

which of the six eye muscles are weak in a particular child, and then have that child work with sensory integration occupational therapists to strengthen the corresponding spatial planes (forward/backward, up/down, or left/right) which correspond to the movements of those weak eye muscles. Therapeutic Eurythmy movement therapy also has specific exercises for strengthening eye tracking and convergence.

Vision activities to do at home to strengthen eye tracking, eye convergence, and eye-hand coordination include playing catch with small soft balls or bean bags. The smaller the ball the more the eyes need to track and converge to keep the ball in focus. For younger children I recommend having a parent toss a balloon in the air, and then everyone keeps tapping the balloon up in the air to keep it from touching the ground. Playing blow soccer, an exercise from the HANDLE Institute, where children try to blow a soft one-inch wide ball off the end of a wooden table also strengthens both tracking and converging skills. Even sucking thick liquids through a straw strengthens the muscles that converge the eyes.

For older children there are additional noncompetitive games like ping-pong, badminton, or tennis. Also, learning how to juggle is a great eye-hand activity that can be done on a balance board or a unicycle. It is important that children stay relaxed and have fun while doing these visual movement activities. This is to avoid activating the stress portion of their autonomic nervous system. If the child is stressed, then their brain can not function or develop well.

All eye-hand activities such as drawing, painting, and coloring as well as doing pencil paper games, especially mazes, will strengthen visual tracking. Doing handwork such as beading, sewing, or knitting also strengthen eye tracking and convergence. Once again, these eye-hand movement activities need to be done in three-dimensional space and not on a flat, two-dimensional computer screen! Finally with respect to reading and writing, smooth and sustained visual

Finally with respect to reading and writing, smooth and sustained visual tracking as well as symmetrical eye convergence are needed for the correct imprinting of the orientation and shape of every letter and number. Children also need a fully developed proprioceptive system, a sense of their body in threedimensional space, so they have an intact bodily sense of the different directions of movement: left/right, up/down, and forward/backward. When children first look at a number or letter, they carefully track the lines and curves they see with their eyes. If these tracking movements are correctly imprinted in their mind (once again requiring a functioning proprioceptive and vestibular-balance system), then children will develop an accurate visual memory for this number or letter. They will now be able to correctly visualize the form in their mind and accurately write it without confusion.

Dyslexia, the reversing of numbers and letters, results when children are asked to learn to read or write letters and numbers too early, before these pathways of eye tracking and proprioception, along with the vestibular-balance system, have fully developed. If children can not accurately and easily track the shape of a letter or number with their eyes, and if they do not have an inner proprioceptive and vestibular sense for the relationship of horizontal, vertical, curved or diagonal

lines, there will be confusion when they read and reversals when they write. This is why certain children reverse numbers like 2, 3, 5, 6, or 7, and get confused when trying to write and identify the letters b versus d.

If children's foundational neurological pathways are not yet fully developed for reading and spelling words and for writing letters and numbers, and we push them to read or write too early, nonverbal learning challenges and attention and behavioral problems will result. Children will spend too much time struggling to think when trying to identify the numbers or letters they are seeing. They will be overwhelmed when trying to make sense of letters while reading and writing and frustrated when trying to write numbers during math. Children will experience so much stress that they will dislike school, dislike their teacher and dislike learning. Yet, we want children to love learning for their whole life. We want children to love and respect their teachers and to be enthusiastic about going to school. For when there is joy in learning instead of fear, children remain in the present moment, their autonomic nervous system is deeply relaxed, and their minds are fully open and receptive to experience the wonders of this world.

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