CHILD BRAIN DEVELOPMENT AND FUNCTION

by Dr. Scott Theirl

Purpose

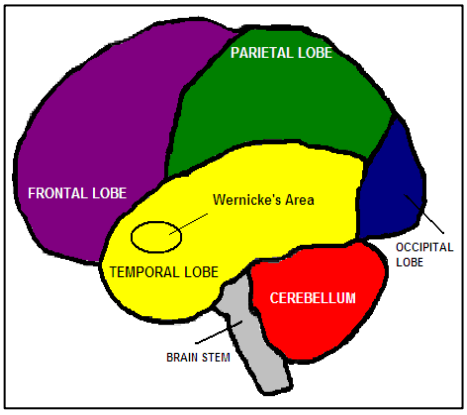
The purpose of the Super Fit Brain Kit is to bring the science of how the brain learns directly to parents and into the home to help insure the classroom success of future generations. This program utilizes simple brain-based exercises that parents perform with their children (ages three and up) in their own home several times throughout the week. These exercises stimulate the regions of the brain that have been shown to be crucial to all higher learning. In essence, these exercises prime the brain for the classroom environment.

Background

There are basic, yet critical, brain functions that need to exist prior to the introduction of any formal teaching methods. These functions include the ability to identify short sounds from long sounds, rhythm, timing, balance, visual coordination for both fast and slow eye movements at distance and close proximity, and kinesthetic/proprioceptive sense (body sense). Though some children develop these abilities naturally, many children benefit from exercises that train the brain. These brain functions, if not present, can sabotage a child's ability to learn. With these brain-based learning dysfunctions, the child's inability to learn is not necessarily due to poor teaching methods, but is due to the brain's lack of preparedness to accept and integrate the information from the teacher. Once one understands the neurology of the learning process, it is easy to understand the necessity of developing these functions during early childhood. Specific exercises are one way to support and encourage that development in young children.

The Super Fit Brain Kit is a brain "primer" that insures the brain has the basic coordination skills to allow it to assimilate information received in a formal classroom setting regardless of the teaching style. For many education professionals, this program will represent a paradigm shift. The old paradigm focuses all attention on what books, curriculums and teaching methods will aid the students the best. This new paradigm first asks, "Does the child have the basic brain skills to learn in the classroom?" In other words, it is important not to put the cart before the horse. Before any type of teaching methods and books can be well utilized, basic brain and body skills must be in place. These necessary brain functions are the basic building blocks of the visual, auditory, vestibular/balance, and sensory/motor systems. These systems are necessary for higher level (frontal lobe) learning. In order to understand how these systems "prime" the brain for higher learning, it is necessary to review the way in which the brain matures and what stimulation most excites its different areas.

Many areas of the brain must work together in order to process our surroundings and allow us to learn from activities. There are general aspects of function that can be associated with the different lobes of the brain and the right or left hemispheres. For example, the region in the left temporal lobe that deciphers spoken language is called Wernicke's area. In children, the cerebellum is a crucial piece for early childhood learning. Much has been discovered about the role of the cerebellum and its relation to learning muscle movement patterns. However, the cerebellum is also involved in cognition, language, planning and attention. These are newer discoveries, and some of the most important findings of recent science in regards to childhood learning. Please refer to the books referenced to gain a deeper understanding. In order to understand just how important the cerebellum is to higher/cognitive learning we will have to go into some depth with neurological connections and functions.



Basic brain anatomy as viewed from the left side.

If indeed specific movement skills are critical to enable a child's brain to learn classroom "book" knowledge, then as a society we are greatly hindering a child's potential by limitation, and more frequently elimination, of physical education classes and recesses that allow for and teach movement as a necessary part of school life. As many school

budgets cannot address this need for physical education, it becomes all the more critical to integrate a home exercise program for the brain and the body. It is also interesting to note that educators continue to demand earlier reading and writing skills from children, even though we are not encouraging one of the major precursors to these skills: movement. Though the concept of cutting physical education class time to allow for more time to study reading, writing and arithmetic may make sense for scheduling and standardized tests, it does not support the neurology of early childhood learning. The exercises contained in this program are not designed to replace physical education at school. In fact, they are designed to compliment gross motor physical activities and cardiovascular benefits that are acquired in a structured P.E. class. If there is no P.E. class at your child's school, this program is still appropriate and it could be argued that it becomes even more important. Although children will not be acquiring cardiovascular benefits, this program will provide neurological benefits of specific brain-priming movements.

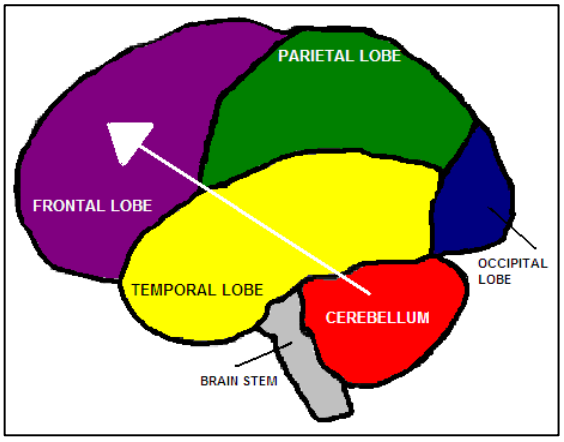
Child brain development, maturation and the role of the cerebellum is a very interesting progression. At birth the human brain weighs approximately 0.9 pounds. As an adult, the brain weighs approximately 3.1 pounds. This is considerable growth much of which happens in the first years of life. The brain doubles in weight during the first year alone. As an infant, we possess the ability to use all of our senses, but not all of our senses well. The visual field is limited to approximately eight inches for the first three months, but by age five we should be able to hold focus on objects twenty feet away. The infant can respond to sound, but it takes many months of learning to distinguish between happy and threatening noises and many years to learn proper language. Taste develops in the later months with new food and drink experiences and preferences quickly become apparent. The sense of touch is present immediately with infants typically wanting to be held and hugged closely. The vestibular system (inner ear canals that tell the brain if the head is moving through space) works immediately at birth as demonstrated by the relaxation that happens with gentle rocking motions. The proprioceptive system (feedback from joint and muscle receptors) works immediately at birth giving the brain information on where the body is moving, but it takes many years for this system to become well coordinated for specific movements such as those required in dance and sports. The balance ability of a child takes years to develop and starts slowly with sitting postures, then crawling, walking while holding on, walking alone, and running.

The picture is quite clear: brain maturation takes time and skills build upon themselves to allow for a more complex understanding of, and interaction with, our surroundings. The most complex early childhood brain integration is that involved with balance and movement because it uses three systems: visual, vestibular and proprioceptive all at the same time. These systems all feed into and are integrated in the cerebellum to help the child coordinate their balance, body and eye movements. The reality of these multiple input systems into the cerebellum allows us many opportunities to stimulate and exercise the cerebellum. Brain excitation from proprioceptors is possibly the most influential stimulation to the brain. Proprioceptors respond to the Earth's gravitational field and gravity is the only constant stimulus in our environment. For example, since the cerebellum receives input from proprioceptors (receptors that tell the brain where the body is in space) we may want to have the child sit on an object, such as an inflatable cushion, that allows their body to move a little instead of always sitting on a hard floor or chair. The result: the brain receives more stimulation from the proprioceptors. This information is processed through the cerebellum, up to the frontal, temporal and parietal lobes typically resulting in improved focus and concentration. Additionally, the children have to utilize more of their postural stabilizing muscles to sit on a soft object resulting in improved spinal strength and posture. As a side note, it is interesting to realize how many adults stand, walk around, pace and fidget with objects when they are concentrating on problem solving. Movement helps the brain "think".

It is time to visit the anatomy that explains why the Super Fit Brain Kit is the premier program for bringing the science of brain development into the home and school. Under optimal circumstances, the brain matures in a certain hierarchal order. However, critical developmental steps are frequently being missed as children physically move less and replace exercise and playing with sitting and staring at video/digital sources for long periods of time. This recent change of less movement quality and quantity can be especially detrimental to child brain

development in the first five years as these are the years when many of the basic physical movement patterns are learned and practiced. The basic order of brain development is from the bottom upward and from the back forward.

With this order we observe that the cerebellum is the primary brain area to be stimulated and utilized early in life. The cerebellum is stimulated primarily by two sources: 1) the vestibular system and 2) the proprioceptive system. The vestibular system is part of the inner ear and is composed of the semi-circular canals, utricle and saccule. These anatomical components tell the brain if the head is moving in space and give specifics to what direction and how fast the movement is occurring. The proprioceptive system is composed of receptors in the body's joints and muscles. These receptors tell the brain where a body part is in space and if it is moving. To demonstrate the proprioceptive system in action: close your eyes, put your arm up in front of you, guess whether your palm is facing up or down, open your eyes and see if you were correct. If you were, then your proprioceptive system was working! The highest concentration of proprioceptors in the body is in the spine, specifically the cervical spine/neck. This makes good sense as it is crucial that our brain know how our neck is moving in order to protect itself.

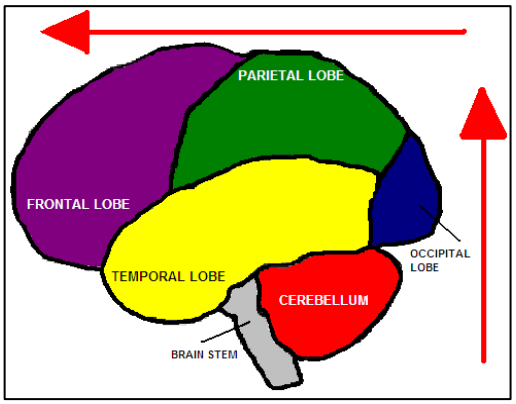


The cerebellum uses this proprioceptive feedback from the neck muscles and joints, and information from the vestibular system, to help coordinate reflexive eye movements as well as neck movements. The pathway that connects eye movements with spinal muscles and vice-versa is called the medial longitudinal fasciculus (MLF). Proper function of the MLF and cerebellum are crucial for optimal learning potential as children are continually using their eyes and moving their necks to and from objects on desks and around the classroom. If the MLF and cerebellum are poorly coordinated, the child will have great difficulty when eye movements and/or neck movements are required. These brain-based coordination difficulties between the MLF and cerebellum can contribute to a child seeming inattentive, disinterested or frustrated. Consequently, the Super Fit Brain Kit places great emphasis on exercising the MLF and cerebellum connections to insure student success in the classroom.

It is important to know that the cerebellum has different areas that correspond to the different parts of the body. The pathways that coordinate eye movements and spinal muscles lie in the middle/medial part of the cerebellum. The pathways that coordinate arm/hand and leg/foot movements lie in the outer/lateral part of the cerebellum. In general, the further out to the sides of the cerebellum, the further out to the sides of the body it is coordinating. These different areas of the cerebellum that coordinate specific body movements have also been shown to work together with other areas of the brain.

The middle/medial cerebellum, known as the vermis, is also known as the limbic cerebellum, because difficulties in this area can present as limbic system problems. The limbic system is deep inside of the brain and consists of multiple nuclei (groupings of cells) that are responsible for emotional processing, responses or outbursts. Children that have anger, tantrums, rage, emotional fragility, etc. are showing their limbic system in action. It is the job of the frontal lobes to keep the limbic system in check by inhibiting it.

The outer/lateral cerebellum, known as the neocerebellum, is involved in cognitive processing. It is also involved in hand/foot coordination through the dentate nucleus. Cognitive processing is done primarily in the frontal lobes of the brain, specifically in

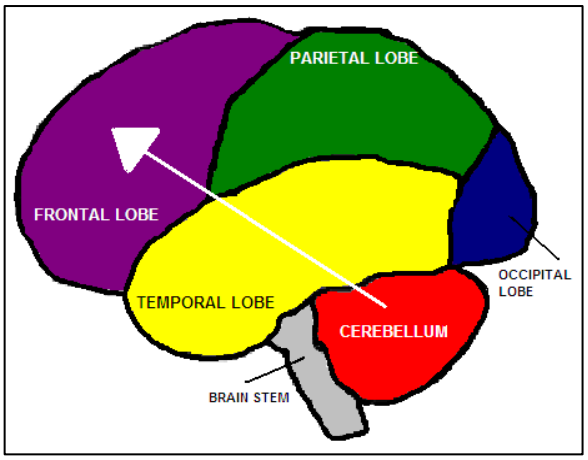


Basic order of brain development; bottom upward and back forward.

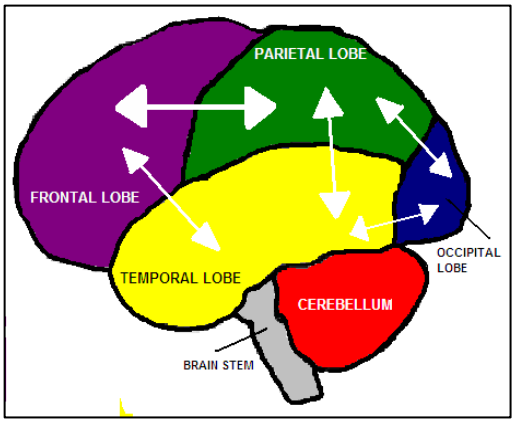
the prefrontal cortical areas, and allows for attention, organization, planning, etc. The cerebellum is in constant communication with the frontal lobes. These connections are known as corticopontocerebellar pathways and are some of the largest pathways in the brain.

The Super Fit Brain Kit is based on these neurologic pathways. For example, when children use and strengthen their cerebellum, the cerebellum stimulates their frontal lobes which can then help keep emotional outbursts in check by inhibiting the limbic system. This is but one benefit of well functioning frontal lobes. The frontal lobes are also responsible for cognitive processing and executive functions including problem solving, planning, organization, motivation, attention, and socially appropriate interactions. Expressive speech, the ability to talk, is also part of frontal lobe function, specifically the left frontal lobe. It is the frontal lobes that make human beings human and allow for such great intellectual potential.

There are many connections from the cerebellum to the other lobes of the brain. One example is sensory pathways that go from the body, up the spinal cord in spinocerebellar paths, to the brainstem, through the cerebellum and end in the parietal lobes. The parietal lobes tell us where on our body we feel something. The parietal and frontal lobes then plan if and how we should move to accommodate the sensation we just felt. A second example demonstrates connections between the cerebellum and an area in the temporal lobe known as the superior temporal gyrus (a.k.a. STG). Studies demonstrate that the cerebellum and STG, among others, are involved with timed movement activities such as finger tapping. More importantly, the STG is involved in auditory function (hearing) and implicated in perception of speech, speech production, and integration of auditory and visual function. This demonstrates how it is possible to use specific cerebellar movement exercises to stimulate known brain pathways that can result in improved hearing, language and speech. Stimulation and strengthening of specific brain areas is the scientific basis behind the Super Fit Brain Kit.



Association areas are key to understanding how the brain ties together all different types of information. Association areas are regions of the brain that lie between the specific lobes and connect them. The job of these association areas is to help any one area of the brain realize all of the different functions that another area of the brain may be performing at the same time. After receiving information on what the surrounding areas of the brain are doing, the association areas coordinate all of this information and send it to the frontal lobes so that we can make an "executive decision" on how to respond to the current situation.



Association Areas gather together and share information from the separate lobes of the brain.

One example is the parietotemporoccipital association cortex. This particular area ties together what we feel (parietal lobe) with what we hear (temporal lobe) with what we see (occipital lobe). It is easy to see the importance of these association areas otherwise how would we know whether the roar of a lion is from an educational film or an actual lion. Though this example is dramatic, we must use our vision, hearing, smell, touch, taste and proprioception senses to "paint the big picture" of our surroundings. Association areas provide insight to why multi-sensory exercises and multi-sensory teaching methods are so important. The Super Fit Brain Kit frequently uses multi-sensory exercises to encourage strengthening of brain association areas.

Many complex brain functions are interrelated to cerebellar functions. The cerebellum provides much stimulation to the lobes of the brain to allow for sharp thinking and healthy executive functions such as attention, social interaction, planning and organization. It is easy to understand why the cerebellum is a logical place to focus on for early childhood exercises.

The cerebellum performs many functions including:

- Coordinates smooth (vs. shaky) muscle movements
- Controls body muscle tone (poor cerebellum function = hypotonia or low muscle tone)
- Coordinates rapidly alternating body movements (ie: flipping your hands up and down)
- Coordinates balance
- Coordinates gait (walking)
- Initiates body movements/responses
- Stops eye movements
- Involved with the ability to keep rhythm
- Involved with the ability to decipher short from long sounds
- Coordinates muscles of speech

It is important to note that as a child grows, the cerebellum and brain continue to mature. Consequently, if a child demonstrates difficulties with some of the above listed functions, they may simply need more time to mature. Many children will develop these basic neurologic abilities without any additional intervention or practice, but that does not mean that they will have all of these abilities in place as they begin school. Some will need to learn these skills for the first time. Because these brain functions are learned, and not necessarily automatic, it would benefit all children to engage in a brain-based exercise program to develop and/or strengthen these basic body and brain functions necessary for success in a formal classroom environment. At any age, the brain and cerebellum learn and grow stronger with stimulation and repetition. The Super Fit Brain Kit stresses the importance of repetition of exercises that stimulate these areas of the cerebellum and brain which can result in improved body, balance, speech, reading and cognitive function. Children that have already accomplished the ability to perform the body/brain exercises that are included in the Super Fit Brain Kit will strengthen their already existing abilities. Children that have difficulty with the body/brain exercises work to establish the neurologic connections, known as plasticity, that are necessary building blocks for greater body and brain function. Improved plasticity allows for easier learning and teaching as well as athletic ability. The Super Fit Brain Kit helps all children be strong and ready for excellence right from the start of their academic career.

A discussion of early childhood development is not complete without an overview of the video information age. Children of all ages are now consuming many hours of television, computers and video games each day. These sources of stimulation to the brain, through the eyes, have consequences that are not fully realized yet, but clearly have the potential to stimulate and change the young, malleable brain. TV, computers and video games should be limited so as to minimize possible changes in the brain that may affect optimal functioning in the school setting. Many professionals, myself included, are beginning to theorize that prolonged hours in front of the TV and computer are literally rewiring children's brains to be primarily passive, visual-only learners at very young ages. Consequently, these "newly rewired" brains do not learn to seek out active multi-sensory learning experiences that integrate vision, hearing, touch, smell, taste, movement and balance. In some cases, the child might actually reject such experiences for lack of an ability to process the incoming stimulation.

The argument is often raised, "I watched television as a child and do not have any of these learning/attention difficulties." But today's TV programming and advertising is quite different than that of past decades. Often, the colors are brighter, the images move quicker and change more frequently and the sounds are louder and faster. Advertisers have spent much time and energy researching and designing the perfect commercial that will grab and hold your attention. And if you do not think that TV is addictive for the brain, just observe an infant working to turn their head towards the TV the moment it is turned on. The child can't comprehend what they are watching and yet their brain is instantly stimulated by it.

What does all of this have to do with the classroom? Children's brains have been "wired" to take in very fast images and ever changing sounds. As a consequence, children are not as adept at focusing on slower images that often accompany one sound--that of a teacher. It is unreasonable to think that a child can sit in a classroom for hours every day, with the same visual vantage point, listening to one person if their brain is used to working in quite the opposite manner. With the implementation of the Super Fit Brain Kit, the child's brain and body will be exercised in ways that are designed to balance the slow, coordinated physical movements that are needed in the classroom with the multi-sensory stimulation that they are often surrounded by.

I imagine that this summary of neurologic development and integration has provided understanding and insight as to the importance of mastering the seemingly simple exercises that make up the Super Fit Brain Kit. It is my experience that these exercises can be truly life changing for children, regardless of age, gender, level of development or previously diagnosed challenges.