Dr. Frank Belgau

In the early 1960's, Frank Belgau, started his research working with children to improve academic performance. He would have the children read passages before and after 10 to 15 minutes of specific exercises and note the differences in fluency, clarity, speed and rhythm.

He moved to the University of Houston where he directed the Perceptual Motor and Visual Perception Laboratory. Here he continued and refined his observations. At the University he directed a parent training program in which parents and children spent 1 1/2 hours twice a week for a month working to overcome their reading and learning difficulties. Many of the parents in those programs were scientists associated with the NASA space program. Their insights helped to direct his attention to the effect of balance and the vestibular system on learning processes and, to the development of the Belgau Balance Board.

Dr. Belgau believes that most learning disabilities are caused by sensory integration disorders, Because of this he developed The Learning Breakthrough Program. The Learning Breakthrough Program is the result of the observations and interactions over many years. Its foundation is the Belgau Balance Board and it includes those materials and activities that he has found to be the most effective and most powerful in showing a consistent improvement in reading, academic achievement and in developing intelligence. It is for this reason that A Total App roach contacted him to train our staff in his method, as we are continuously searching for methods that would improve the learning of the children we serve.

The Theory

NASA has supported and funded research since the 1960's that would study the operation and influence of the vestibular system (the balance system) on visual processing, reading, learning efficiency and academic performance.

When a person views an object through a prism the object appears to shift its position in space. This is because the rays of light that bring the object into the visual field are bent as they pass through the prism. The result is that the object appears to be in a different spot from where it actually is. The object doesn't really move, it only appears to move. This experiment demonstrates one of the fundamentals of visual processing. What we see is sensed by the eye, processed by the brain, and projected into space. The accuracy of our visual perception, the extent to which it matches reality, is dependent not only upon the acuity of our vision, but also on the efficiency of the brain processes that created the images we see. It is important to understand that vision is a brain process of which the eyes are only one component.

The objects and images we see in the space around us are created in the brain using a complex system of neural networks. Neural networks are the mechanism the brain uses to process information. They are made up of many neurons within the brain that transmit information by emitting small electrical impulses. As we look at an object, the brain uses the information gathered by our eyes to begin the visual process. The objects that we see with our eyes are only a part of the information our brains use to duplicate the images in our brain and give them meaning. Data stored in the motion processing and memory systems of our brains provides a large part of the information our brain uses to create the images we see.

The system that the brain uses to project the images we see as well as determine the motion of the object in the space around us is based upon an inertial gravitational process. That is to say that the brain goes through a complex series of events as it processes the information we see and uses the force of gravity to make those determinations.

As different acts are executed, the vestibular system (sense of balance), the visual, auditory, and motor systems, as well as many other systems in the brain which are not directly linked to the main special sense organs (eyes, ears, etc.), begin the process of evaluating the result of the action compared to the plan. The brain then goes through a process of recalibrating itself. It stores the information gained from the event for future planning. There are four distinct phases in this sequence of events: planning, executing, evaluating, and recalibrating for future use.

In order for the brain to overcome the inertial and gravitational problems that it encounters in a variety of different activities, it relies on the vestibular system (balance sense) located in the inner ear. The vestibular system is the primary inertial and gravitational sense. It is able to sense linear and angular accelerations or movements of the head. It accomplishes this by using information received from two separate motion sensors in the inner ear, the semicircular canals and the otoliths, as well as other sensory systems. The semicircular canals can sense angular or rotational movement in three dimensions while the otolith organs sense transient linear movement in any direction as well as changes in tilt (orientation relative to gravity).

The first sensory system to develop and provide the brain with meaningful information is the vestibular system or balance sense. Soon after conception, the human brain begins developing an intelligent response to its environment by utilizing its ability to sense three-dimensional movement and reference it to the force of gravity. The ability for an individual to perform motor actions, control various parts of the body in space, and project objects into visual and auditory space is possible because of the ability of the vestibular system to overcome the inertial and gravitational problems encountered in these types of activities.

The three-dimensional referencing system provided by the vestibular system allows our brain to develop structures to create language, to think and create linguistically, and to read and write. The coordination of all of the brain's timing processes is probably dependent upon and referenced to inertial gravitational information provided by the vestibular system. In order for the brain to successfully integrate its many senses and systems it must depend on a stable, highly evolved coordinating mechanism. The brain's ability, or inability, to achieve the necessary resolution required in this process determines the resolution and efficiency of all other brain processes. The resolution of this calibration is also relative to the resolution of an individual's balance.

The brain is not a static system. It changes over time and is subject to manipulation depending on the inputs it receives. As we already know, every act of the human brain involves a recalibration component. In order to recalibrate an instrument, one must have a reliable standard of reference. The acceleration of gravity is the standard of reference for the brain as it uses information provided by the visual, auditory, motor, and secondary systems to perform the complex operations required in reading, writing, playing music, athletics, etc. In short, a person's ability to learn is dependent upon their ability to process information effectively. Many people who struggle with learning differences also struggle with poor brain processing ability. The brain's difficulty with regards to processing information from the various senses efficiently is commonly called sensory processing disorder.

Sensory processing activities that require individuals to balance precisely, make spatial judgments and provide a means of allowing feedback are the most powerful and effective activities available for maintaining and improving brain-processing efficiency and allowing an individual to become an efficient learner and improve academic success.

When a person engages in balance therapy that includes motor activities involving many different sensory systems, the brain utilizes neural networks to organize and execute the activities effectively. As the difficulty of a task increases, the number of neurons the network requires to perform the task increases.

We understand that the complexity of the task dictates the level of neural involvement required. Balance activities that incorporate increasing levels of difficulty on the Belgau Balance Board have the effect of constantly building and creating more extensive neural networks. Because the neural networks that are created in this process are the same ones that are responsible for the resolution and efficiency of the brain's visual, auditory, motor, and sensory processes, balance activities improve the efficiency of the brain.

We have the ability to learn because of the existence of these many brain systems. It follows that the ability to learn is relative to the resolution and efficiency of these systems.

Balance and Multi-Sensory Integration

The vestibular system gets its raw information from the vestibular organs, which consist of three semicircular canals and the otolith organ. The three semicircular canals are oriented along the x, y, and z axes, and define motion on each of the three dimensions of space. When the head moves, hair cells detect the motion of the fluids inside each canal. The brain uses this information to calculate changes in inertia, in much the same way that the inertial navigation system on an airliner senses changes in position and velocity. The otolith organ uses a pendulum-like appendage, the utricle, to orient the sense to the vertical force of gravity.

The vestibular system combines the inertial information from the three semi-circular canals with the gravitational orientation provided by the otolith organ, and so it is the basis of our **inertial gravitational model of the world- that** is, our model of the world as three-dimensional space with a clear sense of up and down. Because the vestibular system plays such a key role in the foundations of perception, balance problems can cause many, seemingly unrelated problems in brain function.

In order to form a complete and accurate picture of the world around us, we need to integrate the information from all of our senses, so that we can match the sound of a jet engine with the small silver streak overhead, or small round object we feel with our hands with the white baseball we see with our eyes. The three-dimensional model of the world provides the framework into which all other sensory data must be integrated. Because the vestibular system is the basis of this three-dimensional model of the world, the effectiveness of the various senses in communicating information accurately to the brain is limited by the precision of the vestibular system.

Spatial Awareness

Spatial awareness is, very simply, an organized awareness of the objects in the space around us, and also an awareness of our body's position in space. Without this awareness, we would not be able to pick food up from our plates and put it in our mouths. We would have trouble reading, because we could not see the letters in their correct relation to each other and to the page. Athletes would not have the precise awareness of the position of other players on the field and the movement of the ball, which is necessary to play effectively. Spatial awareness requires that we have a model of the three-dimensional space around us, and it requires that we can integrate information from all of our senses.

Studies have suggested a link between a well-developed sense of spatial awareness and artistic creativity, as well as success in math. It can also be important in the development of abstract thought. The ability to organize and classify abstract mental concepts is related to the ability to organize and classify objects in space.

Visual thinkers, in particular, will tend to use their visual imagination to organize abstract thought. Because spatial awareness is so important in all activities of human life, from the most basic to the most advanced, deficiencies in spatial awareness can hold people back from achieving their true potential.
However, because spatial awareness requires integrating the information from the different senses into the three-dimensional model of the world provided by the vestibular system, activities which refine the vestibular system and develop sensory

integration can refine all aspects of brain processing.

Integrating the two brain hemispheres

The human brain is composed of two hemispheres, which function like two networked computers. The left hemisphere receives motor and sensory input from the right side of the body, and the right hemisphere receives input from the left side of the body. When we bring the two systems together and begin the task of developing harmony and synchrony, the first step is to achieve an efficient balance between the two sides of the brain. Because most mental processes involve both sides of the brain, integration problems between the two hemispheres can result in inefficiencies in brain processes. Thus, some children with reading problems, central auditory processing disorder, language delay, and other learning problems may be suffering from a lack of integration between the two sides of their brain.

Lack of integration between the two sides of the brain can become a vicious circle. A child who experiences a learning difference may be suppressing one eye. This can be a symptom of lack of integration between the two hemispheres. But because suppressing one eye means that the child reads with one eye only, the brain networks to support the other eye will become further disorganized through lack of use, exacerbating the lack of integration. Since the left hemisphere re of the brain controls movements on the right side of the body, and the right hemisphere of the brain controls movements on the left side of the body, a person can refine the integration between the two sides of the brain through activities involving both sides of his body. These movement s bring the two systems into balance.

One of the most significant points on a child's perceptual and motor skill development continuum is the establishment of a synchronized cross pattern creep (crawling). This is the point where both sides of the body and both hemispheres of the brain are operating within the framework and under the control of a consistent timing system, a system in which the standards for measure for both sides of the body are matched perfectly. For the left leg to move forward synchronously with the right arm and for the same pattern to occur when the right leg and left arm move, requires that the time and space increments for both sides of the brain be in phase. As the child begins to learn to walk, the sensory integration and balance requirements become much greater. 1n order to achieve synchrony the child must achieve a higher level of integration between his two sides. The most efficient possible walking pattern for a human is the one in which the two arms are swinging as pendulums counterbalancing the movement of the legs and setting the rhythmic pace for the total movement pattern.

Successful integration between the two sides of the brain is necessary for improving all brain processes, including those for reading, writing, academic achievement, motor skill development, and many others.

Brain Timing / Reaction Time

Brain timing is very closely related to integration between the two hemispheres of the brain. Successful integration of the two hemispheres of the brain cannot be accomplished apart from efficient brain timing. The most basic element of a computer chip is its clock. The clock speed of the chip is the most significant measure of its ability to process information. For the brain to process information more efficiently, the processing speed must be faster. Because slower brain processing speed is manifested in motor skill deficiencies, a simple concept will provide a framework for analysis of movement: the greater the balance requirements, the faster the brain must process information provided by the various senses and the faster the brain must process the interaction of the two hemispheres of the brain.

When we observe movement, we can indirectly observe the efficiency of brain processing. Smooth, coordinated movements are the result of precise timing and good integration between the two sides of the brain. Suppressions, rigidity, and uncoordinated movements are the result of poor timing and faulty integration and are indicative of poor brain processing ability that can manifest itself in learning problems, and learning disabilities, poor academic performance, and many other struggles in life. Studies have also shown that slow brain timing is a factor in learning disorders like ADD/ADHD and may also be a factor in Central Auditory Processing Disorder. These inefficiencies resulting from poor brain timing or slow reaction time can be remediated by activities that improve the timing processes in the brain. Activities that require the individual to move both sides of his bod y synchronously are dependent upon the timing resolution in the brain.

Varying the difficulty level ofactivities

As the difficulty level of an activity increases, the brain must utilize more neurons to achieve the precision necessary to complete the activity. For example, throwing a ball

and hitting a small target at 8 meters as
opposed to 4 meters requires the brain to involve) sixty-four (2^6 times as many neurons to achieve the same
degree of accuracy. Therefore, increasing the difficulty level of a task increases the brain integration (neural involvement) needed to complete the task.

If a person has difficulty executing a particular sensory integration activity, this may be because the activity is more complex than their brain is currently capable of organizing to complete. In order to avoid a crippling sense of failure, then, everyone should start out with activities that are simple enough for them to perform, and gradually increase the difficulty level. At each stage, the neural networks in the brain will improve their organization, which enables them to be stretched to reach the next level.

As the difficulty level of an activity increases, it requires increased spatial awareness, enhanced integration between the two sides of the brain, and more precise brain timing.

Sequencing; Binocular Teaming

Studies have validated the premise that attention deficit disorder is a reliable predictor of motor skill deficiencies. Additionally, it has become apparent that approximately half of all children with developmental coordination disorders suffer from varying degrees of ADHD and that children with motor skill disorders experience restricted reading abilities. Further studies have indicated that a variety of motor skill and sequencing abilities are necessary for interactions with others and the environment. Children must be able to construct complex patterns in order to carry out multistep activities both at home and at school. There is significant interaction between the neural networks involved in ADD/ADHD and those involved in the regulation of brain timing and motor skill and planning. An individual' s ability to improve motor skill efficiency and brain timing impacts his or her ability to sequence. It is apparent that these abilities are necessary for academic achievement and that the failure to master these abilities is a significant inhibitor of academic success. Activities that are designed to address the inefficiencies in the neural networks that are involved can be very helpful in changing the physiological conditions in the brain that are contributing to the difficulty.

Binocular teaming is the ability of both eyes to work together to provide accurate information to the brain. Binocularity and stereopsis (the working together of the two eyes in providing different views to the brain which are integrated into one image) are important visual processing skills and are responsible for providing depth perception. These visual perception skills are necessary in order to perform a variety of visual tasks such as tracking, fixating, converging, and visual motor integration. These tasks are important for reading, writing, and functioning in the classroom or workplace. Inability to perform these tasks well has a detrimental effect on an individual's ability to function in society. It also has a tremendous negative effect on children in the classroom.

In order to deal with binocular deficiencies it is important to become involved in some type of vision therapy. There are many types of therapies available which help to address these problems. When choosing vision therapy, it is important to remember that vision is a brain process of which the eyes are only a part. It is also important to remember that vision is not a process unto itself but is integrated with and dependent upon the vestibular system (sense of balance). A variety of vision problems occur when both eyes do not work properly together. For instance, one eye might not be processing as much information as the other, one or both eyes may not focus at a specific point due to over or under-convergence, and there may be vertical or horizontal alignment problems that cause the aim of the eyes to be incorrect.

Proprioception

The brain constantly engages in a process designed to position our bodies based upon the information it receives from our senses. This ability is made possible because of the existence of proprioceptive processes. Proprioception can be explained as the awareness of movement and body position. Sometimes proprioception is defined as the body's joint positioning system. Effective proprioceptive processes are dependent upon the ability of the brain to integrate information from all of the sensory systems including feedback from muscles, joints, vision, the tactile sense (touch/pressure) and the sense of balance or vestibular system.

ADD/ADHD

Many children who have been diagnosed with ADD/ADHD are extremely frustrated because of the problems they encounter in school. Providing effective therapies for these individuals is critical in allowing them to lead normal productive lives. Consider the following in individuals with ADD/ADHD:

- A child with attention deficit disorder has a slow reaction time, which can be indicative of slow brain processing. Many physicians diagnose ADD/ADHD on the basis of reaction time tests and prescribe Ritalin or other drugs in order to speed up reaction time. The prospect of medicating the condition long term is a concern for those dealing with sufferers of attention deficits and many of them are looking for a Ritalin alternative. Learning Breakthrough uses balance therapies to improve brain processing speed and efficiency without Ritalin or other medications.
- A fundamental reality is that the higher the level of balance, the faster the brain must react. It has been determined that there is a mathematical relationship between the number of brain neurons in the network and the reaction time of the network. By increasing the balance difficulty of an activity, the brain is forced to constantly recalibrate itself and involve more neurons in order to perform faster. This addresses the slow reaction time symptomatic of ADD/ADHD by actually changing the physiology of the brain.
- Much has been made of the fact that ADD/ADHD is a physiological problem and not a mental/emotional problem. This is very likely true. Studies indicate that over 50% of children with attention deficit hyperactivity disorder suffer from sensory integration dysfunction as well. It is important to understand that because the behavioural problems exhibited by those with ADD/ADHD are not the result of a mental problem but a physiological problem, that the therapy involved must affect the brain on a physiological level.

Dyslexia

Dyslexia makes it very difficult for students to achieve academic success. The tragedy is that the problem masks the fact that these students are probably very intelligent, with aptitude and creativity in a variety of areas. We feel frustrated as we watch bright students struggle with schoolwork, knowing that their ability far exceeds their actual achievement. They are not the victims of low intelligence.

- Dyslexia includes facets of brain-processing difficulties and sensory integration disorder, difficulties which keeps them from reaching their maximum potential.
- A teacher knows how students with dyslexia can be disruptive in the classroom, acting out as a way of dealing with the frustration of academic struggles.
- Teachers already have mechanisms in place to deal with dyslexic students, but do the tools given to teach them to adapt to the dyslexia or can we help them to address the fundamental brain processing problems that are the root cause of the disorder?
- Dyslexics often confuse left and right, write letters or numbers backward, and transpose letters and numbers. These are symptoms of an underlying problem with spatial awareness.
- Problems in sequencing (e.g. difficulty following 2 or 3 step instructions or difficulty putting things in order) are also common symptoms of dyslexia.

Handwriting

We know that the ability to write neatly and quickly is one of the crucial foundations of success in school and in life. Students who need to improve handwriting skill will often have difficulties in other areas of academic achievement, not because they lack the intelligence to achieve, but because their handwriting problems stand in the way of communicating the knowledge they have. We also know the frustration of grading papers with sloppy handwriting. We want to do justice to students' efforts, but it can be difficult to discern *what* they have written, because of *how* they have written it.

- There are several basic brain processes involved in handwriting. Binocular teaming, or the proper focusing of the eyes, requires integration between the two hemispheres of the brain.

- Writing neatly on the paper is a fine motor activity which requires good hand eye coordination and good fine motor skill.
- Most handwriting problems are caused by a sensory integration disorder which inhibits coordination and integration between the many brain structures and systems involved in the writing process.
- The question is simply this: how can we begin to address the brain processing problems that are making it difficult for the students to write neatly and quickly?

Brain Injury / Stroke

Research is beginning to indicate that there are links between synaptic activity in the brain and the brain's ability to learn. Studies show that lab animals experience changes in their brains as the result of learning a new skill. This is important for those involved with brain injury rehab because it indicates that activities that stimulate synaptic, or neural, processes are necessary for learning new skills and allowing other parts of the brain to begin to compensate for the injury.

- Activities that involve precise balance, precise space-time judgments, and a feedback component are probably the most powerful and effective activities available for improving brain processing efficiency and sensory integration ability.
- When a person engages in balance activities that require motor skill and sensory integration abilities, the brain utilizes neural networks to organize and execute the activities effectively
- As the difficulty of an activity increases the number of neurons the network requires to perform the task increases. As the number of neurons in a network grows, the network becomes more efficient. Consequently, balance activities, which incorporate increasing levels of difficulty on the Belgau Balance Board, have the effect of constantly building and creating more extensive neural networks
- Because the neural networks that are affected by balance activities are the same ones that are responsible for the resolution of the brain's visual, auditory, motor, and sensory processes, balance activities that promote motor skill development improve the efficiency of the brain.

- The existence of these processes give us the ability to lead normal productive lives. It follows that therapies which increase the resolution and efficiency of these systems can have rehabilitative effect among those with traumatic brain injury or stroke.

Balametrics Balance Therapies stimulate the development of neural networks in the brain which...

- Improve motor control and coordination
- Improve ability to sequence
- Improve spatial awareness
- Improve sense of balance
- Improve ability to perform fine motor skills
- Improve visual perception
- Improve sensory integration
- Provide for constant improvement in the resolution of neural processes by allowing for increased difficulty level

Central Auditory Processing Disorder

Clients with Central Auditory Processing Disorder (CAPD) have problems understanding spoken language

- problems at home, and greatly increased problems when the background noise and other distractions of school or work are added. We understand the frustration they experience at home, at school, at work and in social settings. We also know that unless the problem is solved, they will never realize their full potential.

Children with CAPD often have:

- Difficulty understanding instructions
- The need to have directions to be repeated
- Problems understanding in the presence of background noise
- Spelling, reading, and other academic problems
- Behavioral problems
- Difficulty repeating sounds, letters, or numbers in sequence
- Speech or language delays
- A tendency to drop middle consonants or phonemes when learning to speak or write
- Slow reaction time

Since many children with CAPD do not have a peripheral hearing problem, it is safe to say that CAPD is more a brain processing sensory integration problem than a hearing problem. Children affected by CAPD process information more slowly than it is received, therefore, they fail to process much that they hear creating perceptual gaps. They have difficulty understanding directions and frequently need directions repeated. This slow processing of information is the result of slow reaction time and is indicative of slow brain processing and a sensory integration disorder

Children who suffer from CAPD can improve brain processing speed and sensory integration efficiency by engaging in balance therapies that have the effect of increasing neural involvement. Central to the program are the Belgau Balance Board, which allows for balance therapy to be done at constantly increasing levels of difficulty, and the Pendulum Ball, which stimulates the development of brain timing processes.

These therapies are very effective at improving the brain processes and sensory integration disorders that are responsible for the problems associated with CAPD. In order to understand the link between balance and CAPD, it is necessary to understand the role that the vestibular system (balance sense) has in all brain processes. By improving basic brain organization, Balametrics' therapies can help students with CAPD to process auditory information more efficiently and improve academic success. We do not claim to be audiologists or that we could cure CAPD, though understanding the underlying theory explained above, we could, through effective programming, influence sensory processing as it relates to the auditory - vestibular system.

Academic Achievement

Academic achievement is not always a reliable predictor of intelligence. There are many very bright children who are not able to achieve academic success. When the student is trying their best to learn yet cannot seem to make any progress the lack of academic performance is often the symptom of an underlying issue that needs to be resolved. Most learning problems can be linked to inefficient brain processes and sensory integration.

- Studies have shown that many children who do not perform academically also have poor motor skill development. The brain processes that are responsible for allowing a person to have good motor skill are the same processes that must function efficiently in order to learn.
- Motor skill ability and learning are both dependent on efficient sensory integration. If a person is not able to integrate the senses well, then there is a good chance that they will not be able to perform well academically. This lack of sensory integration ability is often the undiagnosed reason that many people struggle academically.
- We understand that frustration inherent in poor academic performance, and we provide solutions to help struggling students to catch up and to forge ahead to new heights of achievement.
- Our programs improve the basic, foundational brain processes necessary to academic success. These activities are fun and easy to use and understand.

Research

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