# The Neurophysiology of Hanna Somatic Education

Gloria Hester, ERYT
Certified Equine Hanna Somatic Educator

If one did not know the basis of how we function neuro-physiologically, then the experience of a Hanna Somatic session might seem like magic.

Hanna Somatic Education addresses and corrects postural misalignments, limited mobility and painful chronically contracted muscles at the root of their cause. Most often that root cause is something known as "**sensory-motor amnesia**" (SMA). SMA is a common, everyday occurance in the human soma. (The same is true for any vertebrate animal). Soma is a Greek word that means"living body". It is not only a "living body" but it is a body that is capable of sensing and self-regulating from within (Hanna, 1988, p.20). To be able to assist one in re-awakening this innate ability is the art of a Hanna Somatics practitioner.

Thomas Hanna, the father of Somatics, coined the term as well as the phrase "sensory-motor amnesia" as a way of expressing his findings on what actually causes the postural misalignments commonly associated with aging. SMA is a "habituated state of forgetfulness." "It is a memory loss of how certain muscle groups feel and how to control them" (Hanna, 1988, p.xiii). This state results in less than optimal functional movement. It can occur not only from habituated response to stress but also from injury, accident or trauma. Hanna discovered that, "during the course of our lives, our sensory-motor systems continually respond to daily stresses and traumas with specific muscular reflexes" (Hanna, 1988, p.xii). Because these patterns are reflexive in nature, (subcortical – brain-stem and spinal cord) they are not on the voluntary or conscious level and are therefore out of our conscious voluntary control. They have become deeply habituated by the cerebellum.

This phenomenon, however, has nothing to do with age itself. A child of eight years of age may be just as affected neuro-muscularly by the experience of fright or trauma as is an eighty year old man. Both may habituate to the pattern. "Children who grow up in disturbed family situations or in other fearful environments such as war, show symptoms of sensory-motor amnesia: sunken chests, permanently raised shoulders, hyper-curved necks" (Hanna, 1988, p. xiii).

The good news is that the effects are reversible for both the eighty year old as well as the eight year old. The following will explain how this is possible using commonly understood and accepted principles from the field of neurophysiology. For example, in Hanna Somatic terms, not being able to "properly control the muscles of the trunk and pelvis is a motor deficiency". Not being able to sense what these muscles are doing is a "sensory deficiency" (Hanna, 1988, p.5). Both of these situations are not uncommon, even in children, and are directly related to the central nervous system.

Hanna Somatics is by definition a sensory motor re-learning program. It is actually re-educating the brain as to how it relates to and moves the muscles. This is where the need for the understanding of neurophysiology comes in. The brain and spinal cord are what control voluntary movement, after all. Practicing Hanna Somatic movement results in more organized, functional movement for the entire soma. If one's pain is due to SMA, once the sensory motor system is able to recognize it, then one's movement is more organized, functional and the chronic pain vanishes. Chronically contracted muscles are painful due to lack of blood supply and oxygen. If those chronically contracted muscles have been impinging nerves, this can result in pain. Compensatory patterns of adaptation can create other problems as well. The purpose of Hanna Somatic Education is to have the client sense movement "in the first person" using the frontal lobe, because that is the only place lasting change can originate. In the course of a Hanna Somatic session, the client becomes a true "learner."

By having the client consciously contract and consciously slowly de-contract the muscle that is holding the dysfunctional pattern, the resting rate of the muscle activity will be reset. This change is permanent because the change is created in the brain and nervous system, the control center of the body. The nervous system receives and acts as an interpreter as it responds to an internal and external stimulus or stimuli, information and conditions. As a result of the new sensory information the brain can change it's motor output signals. It can sense the difference between contracted and not contracted.

**Structures and Functions of the Nervous System as they relate to Hanna Somatics:**

Neurophysiology is the study of nervous system function. The nervous system is a system that contains a network of specialized cells called **neurons**. Neurons function to receive and send information from sensory receptors or other neurons or effector organs (Crossman & Neary, 2005, p.1). Neurons coordinate actions and transmit signals (electrochemical waves) between different parts of the body. Neurons send their signals along fibers known as axons. This causes chemical transmitters or neurotransmitters such as acetylcholine to be released at junctions known as **synapses**. The neurotransmitter acetylcholine esterase neutralizes and stops motor units from firing repeatedly. At the end of the axon, "**terminal boutons"** occur, where information is transferred to the dendrites of other neurons. **Dendrites** receive information and share it with other neurons by way of the axons. When a cell receives a signal, it may be excited or inhibited. A **nerve** is a bundle of axons surrounded by myelin. The neurons exit the spinal cord and are grouped together as nerves.

There are sensory neurons as well as motor neurons. **Sensory neurons** send signals that communicate to the CNS about external stimuli as well as information about the body. **Motor neurons** cell bodies' are located in the central nervous system and connect the nervous system to the muscles.

The **ventral horn** contains two types of motor neurons that innervate skeletal muscle: (also known as lower motor neurons). They are: **Alpha motor neurons**. These innervate extrafusal muscle fibers. **Gamma motor neurons** innervate intrafusal muscle fibers (Crossman & Neary, 2005, p.73).

**Upper motor neuron's** cell bodies are in the motor cortex. They go down the spinal cord and synapse on another neuron. The **lower motor neuron** goes to the muscle fibers. The upper motor neuron comes down the spinal cord and synapses on the lower motor neuron. The lower motor neuron's cell body rests in the spinal cord.

A **motor unit** is made up of an alpha motor neuron and the muscle fibers it innervates. The neurons from the cortex inhibit the alpha motor neuron's firing by way of interneurons. This is what brings relaxation to the muscle. The belly of the muscle is where the neurons are synapsing (E. Criswell-Hanna, personal communication, Hanna Somatic Education training module lecture, Novato, CA, June 17, 2009).

**Two Parts of the nervous system: Central and Peripheral:**

The nervous system is divided into two parts: central and peripheral. The **central nervous system** is made up of the brain and spinal cord. The peripheral nervous system consists of cranial and spinal nerves and their ramifications (Crossman & Neary, 2005, p.3). The **peripheral nervous system** consists of sensory receptors, sensory neurons, motor neurons and clusters of cell bodies of neurons known as ganglia, and neurons that connect them to each other as well as to the central nervous system. They respond to internal and external stimulus. Within the PNS there are thirty-one pairs of spinal nerves and twelve pairs of cranial nerves. The spinal nerves have a dorsal root and a ventral root. Sensory (dorsal root) of the spinal nerves in the spinal column contain afferent (incoming) fibers that send information from the spinal cord to the brain. The motor (ventral root) contains efferent (outgoing) fibers. These carry messages from the spinal cord to the muscles. The peripheral nervous system functions to relay information to and from the central nervous system.

Propagation of an **Action Potential:**

An action potential in muscle cells is the first step leading to a muscular contraction. An action potential in a neuron is known as a "nerve impulse". An action potential is a shift in electrochemical potential difference created by input into the neuron in which a sodium and potassium shift takes place. When excited there is a reversal of the polarity (this creates the action potential). It has a domino effect. In Hanna Somatics, the practitioner keeps asking the client to produce an output. The sodium potassium pump takes things back to where they were in the resting potential. Some neurons are purely electrical. Most are electro/chemical. Muscles become contracted by numerous motor units firing, recycling, and firing again.

**Three Techniques of Hanna Somatics:**

There are three techniques used in Hanna Somatic Education that enable the client to sense movement from within and to thereby self-correct habituations. Each is based on ways to reset the resting levels of the muscles with predictable, consistent results. These techniques result in more relaxed muscles and also stimulate the parasympathetic nervous system. Relaxed muscles are less prone to injury. The client will also have greater control of the muscle, resulting in a greater sense of wellbeing and self-confidence over all. Since Hanna Somatics is a sensory-motor re-learning program, it is set apart from some other bodywork modalities. The Hanna Somatic Practitioner is not working "on" the client. Rather, the practitioner is working "with" the client in a partnership to enable the client to regain freedom of mobility utilizing the following methods and techniques.

**Means Whereby: which encourages Proprioception/Self Sensing:**

The first technique, known as "**means whereby**," was inspired by the Alexander Technique, developed by the late F. Matthias Alexander. "Means whereby" involves having the client move through space, either actively or passively aided by the practitioner. This enables the client to get sensory information via the sensory feedback loop and improves functional movement.

Sensing, breaking down the movement, and focusing one's awareness during the movement will help to let go of any subconscious reflexes that may have become habituated. Awareness is the key here. Means whereby is not goal oriented. Alexander Technique "was the beginning of Somatic education in the twentieth century" (Hanna, 1990, p.5).

**Kinetic Mirroring: Bringing the origin and the insertion of the muscle closer together:**

The second, "**kinetic mirroring**," was inspired by the late Moshe Feldenkrais, developer of Feldenkrais work and was named by Thomas Hanna. Kinetic mirroring causes the muscle to relax by bringing the origin of the muscle and the insertion of the muscle closer together. This occurs partly due to sensory receptors known as **golgi tendon organs**. Golgi tendon organs are located at the juncture of a muscle and it's tendon. They serve as protective sensory receptors that keep us from overstretching or tearing muscle fibers. "GTOs produce autogenic inhibition of their host muscle and reciprocal excitation of antagonists. In contrast, spindles produce stretch reflex excitation of their host muscle and reciprocal inhibition of antagonists" (Moore, 2007). An antagonist is the opposing lengthening muscle and the agonist is the contracting muscle. Golgi Tendon organs are activated by muscular contractions that stretch the tendons. The inter neurons inhibit alpha motor neurons causing contracted muscles to relax. Kinetic mirroring is a spinal cord event and does not produce a permanent, lasting change. During kinetic mirroring, gamma motor neuron activity decreases, (gamma motor neurons innervate intrafusal muscle fibers or muscle spindles). This allows the alpha motor neuron activity to lessen the contraction of the extrafusal muscle fibers. "As Feldenkrais describes it, 'If you do the work of a muscle, it ceases to do it's own work', that is, it relaxes" (Hanna, 1990, p.6).

**Pandiculation: Re-setting the Alpha Gamma Co-activation Levels:** The third technique, known as "**pandiculation**," is where the practitioner has the client move

slowly, using the voluntary motor cortex to consciously contract the muscle, bringing the origin and insertion ends of the muscle closer together and then to slowly inhibit (de-contract) the muscle as it is lengthening. This causes the alpha and gamma motor neurons to fire and as a result, the alpha *and* gamma motor activity is decreased. This causes a client to use a lot more of their frontal lobe with the movement. "And what you use, you get more of. If the goal is to lengthen the muscle, the best way to do it is to pandiculate" (E. Criswell-Hanna, personal communication, Hanna Somatic Education training module lecture, Novato, CA, June 12, 2009). When animals pandiculate it is an involuntary reflex. We are doing it voluntarily. Consciously contracting a muscle excites alpha and gamma motor activity. **Gamma motor neurons** innervate intrafusal muscle fibers or muscle spindles. As a result, this increases the tension on intrafusal muscle fibers. Gamma motor neurons are excited prior to stretching. This increases alpha motor neuron contractions. "**Alpha motor neurons** are large lower motor neurons of the brain and spinal cord. They innervate extrafusal muscle fibers of skeletal muscles and are directly responsible for initiating their contraction" (Crossman & Neary, 2005, p.73).

As a Hanna Somatics Practitioner, adding "load" (or steady resistance) is asking the client to recruit more and more motor units. If the client can generate the load, then the client will be able to sense more than their habitual contraction. This will increase gamma motor neuron activity. Gamma and alpha motor neurons set the resting levels of the muscles. Then when the practitioner asks the client to lengthen the muscle, this causes the client to inhibit the motor units that are contracting the muscle.

The corticospinal tract is the only motor tract that can actually relax the muscle. A person has tight muscles because the motor units are firing over and over. Pandiculation is a way of helping the client bring the muscle back under his or her conscious voluntary control by resetting the resting level of the muscle. Whereas previously the muscles were controlled by subcortical reflexes, control is returned to the cortical area of the brain.

Sensory Motor Amnesia cannot be corrected unless it is brought back into one's conscious awareness. Voluntary pandiculation results in this outcome. The end result is a muscle that is more relaxed and lengthened. When a muscle is stretched or over stretched it will contract by reflex action. This is called the **stretch reflex**. Pandiculation works to release the muscle to a new resting length. This is not a stretch. It is voluntary activity to contract and de-contract. On the other hand, kinetic mirroring sends a message to the brain after the shortening of the muscle in a different way, passively. The involuntary centers of the brain are allowed to decrease their motor output to the muscles. The golgi tendon organs play a vital part in this taking place as the spindle cell is shortened. Pandiculation is far superior to stretching, as stretching is a spinal cord event and therefore has no lasting effect. In Hanna Somatics, the client is using their voluntary motor cortex to create lasting change for the resting level of the muscle.

It is necessary for muscles to work in pairs in a harmonious fashion if one is to have freedom of mobility. For example, when the biceps contract, the triceps have to lengthen. This is known as **reciprical inhibition.** In order to move, muscle fibers have to shorten as others lengthen. Reciprical inhibition occurs as the agonist muscle is contracting. As the client contracts a muscle, the brain will have already inhibited the antagonist muscle to allow it to lengthen. This is what provides and allows for joints to move comfortably. If there are unconscious co-contractions occurring simultaneously in the body, then freedom of mobility is not possible. This is what Thomas Hanna referred to as the "**dark vise**". The co-contractions of the dark vise are responsible for the posture of senility. In co-contraction, there is not much reciprocal inhibition going on.

**The Three Postural Reflexes**

The three reflexes that Hanna Somatics addresses are the **Startle Reflex (Red Light), the Landau Reflex (Green Light), and the Trauma (or cringe) Reflex**.

Each of these reflexes involves particular and specific prime mover muscles that engage in response to a perceived experience or emotion. The knowledge of the existence of these contraction patterns and how to release them is invaluable and is of great benefit for any vertebrate animal.

The **Startle Reflex** is brought about anytime there is a sudden change in sensory stimulation. The main prime mover muscles during the startle reflex are the rectus abdominus, the internal and external obliques, and the pectoralis major and minor muscles. Other muscles, such as the iliopsoas, (psoas and iliacus), the sternocleidomastoids in the neck, the rectus femoris (a very strong flexor of the hip), the adductor muscles in the inner thighs, the tibialis anterior (which dorsiflexes, supinates and inverts the feet) are involved as well. All of the above are "automatic reactors" in the Startle reflex that bring us into flexion. The **Landau Reflex** happens involuntarily in response to a perceived need to move forward in the world, to go after what one wants, opening up to the world. It is involved in the feeling of responsibility, keeps us upright and brings us into extension. The prime mover muscles are the paravatebral muscles, the rhomboids, the trapezious, and the latissimus dorsi. Additionally, the gluteus medius, (responsible for abduction and external rotation), gluteus maximus, piriformus, hamstrings (medial: semitendinosis and semimembranosis), (lateral: biceps femoris), calf muscles ("triceps surae"): made up of the gastrocnemeous (medial & lateral heads) and the soleus. These are the "automatic reactors" of the Landau reflex. The **Trauma Reflex** is in response to accident or injury. This reflex can involve compensation to guard and protect from a fall or as one is healing from a broken foot, for example. As one habituates these contractions, sensory motor amnesia takes over. Often times in the trauma reflex, the internal and external obliques are pulling the torso into a "side bend". This is sometimes referred to as scoliosis.

**Spinal tracts**

The three postural reflexes are brought to us by the motor tracts in the brainstem.

The green light reflex is brought to us by the **lateral vestibulospinal tract** in the spinal column. It is responsible for extension or standing up. The red light reflex is brought to us by the **rubrospinal tract**. This tract activates the flexors and unlocks extension (E. Criswell-Hanna, personal communication, Hanna Somatic Education training module lecture, Novato, CA, June 12, 2009). "It exerts control over the tone of limb flexor muscles, being excitatory to the motor neurons of these muscles" (Crossman & Neary, 2005, p. 81). The senile posture (the **dark vise**) is a combination of the red light and green light posture and involves the **reticulospinal tract**, which tones the muscle for readiness or excitability. The tectospinal tract involves face and neck orientation (E. Criswell-Hanna, personal communication, Hanna Somatic Education training module lecture, Novato, CA, June 12, 2009).

**The Brain**

The two main hemispheres of the brain are connected by the corpus collosum. The primary motor cortex (located in the frontal lobe in the precentral gyrus in front of the central sulcus) is the highest level in the brain for the control of movement (Crossman & Neary, 2005, p.15). Involuntary contractions happen from the brainstem down. With Hanna Somatic Education, we are taking the control away from here and giving it back to the motor cortex. The cerebellum is located just above and behind the brainstem, beneath the occipital lobes at the base of the skull. It is responsible for quick, ballistic movements. Its function is to control fine movement coordination, balance, equilibrium and muscle tone. The cerebellum is "concerned with the coordination of movement and operates at an entirely unconscious level" (Crossman & Neary, 2005, p. 13).

**The Homunculus:**

There are two hemispheres of the brain. Each hemisphere controls muscles on the opposite side of the body. The motor homunculus represents the organization of the primary motor cortex.

The sensory homunculus represents organization of the sensory cortex (Crossman

& Neary, 2005, p.137).

**Conclusion:**

As one can see, the knowledge of neurophysiology in Hanna Somatics is as invaluable to the client as it is to the practitioner. This is due to the fact that the client is now empowered and educated. Self-care is now possible as one is armed with the knowledge of what is causing the limitation and or pain. The knowledge of the structures and functions of the nervous system allow us to produce amazing results if we practice with precision. We are working with the brain and the body to enable both to begin to have a different kind of conversation or relationship with each other in order to have more freedom; freedom of movement, freedom of thought and freedom of awareness.

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