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Sensory-Motor Integration in Learning Disabilities:

A Neuropostural Approach to Direct Treatment Strategies – 2nd Edition

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Introduction

The difficulties in motor performance in children with learning disabilities come from a lack of integration of sensory-motor processes, in specific, the efficient proprioceptive matching of visual-vestibular-somatosensory information. Inefficiency in the organization of these systems interferes with the child's ability to learn and their ability to express what they know.

To effect a change in disorganized movement and posture, one must control, modify and grade sensory input and shape, refine and repeat functional motor output. This text suggests that the most effective and comprehensive way to achieve positive change in sensory-motor integration is through direct physical handling which incorporates the principles of:

- Facilitation and inhibition
- Musculoskeletal alignment
- Postural stability-mobility
- Organization of movement components

Treatment strategies presented in this text are based on the necessity of establishing a normal neuropostural base in relation to gravity, reorganization of somatic-vestibular proprioception, facilitation of graded movement components for functional motor patterns, and the establishment of efficient motor learning through improved feed-forward and feedback processes.

A Neuropostural Perspective

The neuropostural approach utilizes principles of facilitation and inhibition and is a therapist-directed physical handling approach to foster the organization of an efficient neuropostural base for functional movement and posture.

Facilitation requires an active response from the client. The therapist uses various techniques to activate musculature, establish alignment, and prepare postural tone, but the actual organized response is always initiated by the client. Facilitation techniques by the therapist allow the child to be more successful in initiating an adaptive response to controlling the center of mass over the base of support and efficiently grading movement components necessary for efficient function.

Inhibition is a component of facilitation in that it prevents through the use of positioning or specific input, inefficient compensatory responses so that the child can initiate a more organized response.

An efficient neuropostural base includes:

- Normal postural alignment
- Equal distribution of weight
- Ability to weight shift in all directions with graded control
- Efficient righting and equilibrium reactions as an underlying foundation for volitional movement
- Efficient organization of flexion-extension-rotational components of movement
- Dynamic interaction of stability and mobility requirements for movement
- Anticipatory initiation for efficient functional movement
- Volitional movement with efficient underlying postural control and support

For movement and posture to be organized, the child must be able to make a sensory-motor adaptation to the demands of gravity, sensory stimulation and environmental influences. To make a normal adaptive response, the child must have a firm base of support; a neuropostural base, from which to activate his adaptations to sensory demands. As such, a neuropostural base is considered a critical and necessary prerequisite to sensory integrative activities that stress sensory input but do not directly prepare the postural basis for adaptation to occur.

- **Normal Postural Alignment**

Normal postural alignment is the most critical prerequisite for establishing efficient functional movement capabilities. The ability to maintain dynamic alignment provides the basis for an organized initiation of movement with graded control of movement components during the process of performing a functional task or movement sequence. Alignment refers to the relationship of each body part to each other and to the relationship of the body to the base of support (BOS). Body alignment is dependent on the kinesiological alignment of muscle groups which in turn depends on joint alignment.

Normal postural (musculoskeletal) alignment establishes:

1. Kinesiological alignment of joint and muscles to activate dynamically and in the best possible efficient functional manner.
2. Alignment of the sensory systems (visual-vestibular-cervical triad) in the best possible vertical orientation for maximizing efficient integration and matching between systems.

Normal postural tone refers to the resting tension of the musculature and the modulation of muscle tensions during movement demands. The tension of the musculature must be sufficient to maintain the body against gravity while allowing tonal changes to produce movement. The background tone must be sufficient to maintain stability and there must also be a corresponding increase or decrease in tone surrounding the demands of movement and the mobility of the joints

required to accomplish that movement. Postural tone therefore modulates in a normal range from a resting state to higher or lower levels of tone within and around structural factors of the body's musculature. Without normal postural tone there is inefficiency of equilibrium and righting reactions and the organization of synergies of movement components.

Postural tone therefore is a dynamic and constantly changing process which must be interactive and competitive in order for there to be sufficient tone to allow mobility while at the same time sufficient tone to maintain stability. Postural tone is never too low to jeopardize stability against gravity nor too high to restrict movement. Different parts of the body's musculature achieve different levels of postural tone simultaneously and interactively so that this dynamic process is possible.

The dynamic nature of postural tone allows for reciprocal innervation. Agonist and antagonist, within muscle groups and motor patterns, provide a balance of postural tone to allow stability and mobility by constantly modulating increases and decreases of the tonal relationships needed to accomplish a movement pattern. Reciprocal innervation allows for the combination and competition of flexion, extension and rotational components of movement and their organization to perform a functional motor behavior.

Normal postural tone and reciprocal innervation, provides the skeletal system with the possibility of establishing and maintaining normal bony alignment, articulation of joint function, stability around the bony structures and an adequate range for function.

- **Equal Distribution of Weight**

Normal postural alignment allows for the body to distribute weight over the base of support in all planes of movement. In a standing or sitting alignment, weight should be able to be evenly distributed on both body sides. Although we are rarely in a perfect vertical standing or sitting alignment, it is important that this be easily achieved.

Without this ability, weight shifting and crossing the midline for lateral or rotational movements becomes much less efficient and indicates asymmetry of graded control. Observing weight distribution in standing and sitting allows for the determination of a possible postural midline shift and proprioceptive preference in sustaining weight unevenly. This can be a lateral distribution on one side of the body over the other, or an anterior, posterior distribution of weight, or a combination. The distribution of weight over the base of support will determine the efficiency or inefficiency of the initiation of movement, the transitions of that movement and the alignment of the end posture. We move from posture to posture through graded transitions of movement components. The distribution of weight of the starting position and the ability to anticipate the adjustments required to initiate movement and grade the transitions required are critical to efficient sensorimotor function.

For example, if we are sitting and leaning to one side resting on the arm of a chair our weight is not equally distributed. However if we decide to get out of the chair, our first initiation is to reorganize midline and distribute our weight more evenly. We don't stand up with all our weight on one side of our body. We anticipate the action required and make the initial adjustment to midline and more equal weight distribution before shifting our weight forward over our base of support to stand up.

The ability to control and grade weight shift and weight distribution over the base of support establishes a bilateral relationship between body sides around an organized and stable central midline core. Without such an ability and relationship, efficient coordinated movement and functional performance with adaptability is compromised. Movement and functional performance become compensatory to the underlying postural inefficiencies and splinter skill learning results. Normal alignment allows weight to be distributed appropriately to the task and allows the task to be performed in a coordinated and efficient way.

- **Ability to Weight Shift in all Directions with Graded Control**

Graded control of transitional movements requires the ability to dynamically shift weight and modify the amount of weight shifted in all planes of movement throughout a motor sequence or performance of a task. All movement requires a synergy of flexion, extension and rotational components. Graded control of weight shift allows these movement components to interact efficiently and provide movement of the body over the base (flexion), movement away from gravity (extension) and transitional movements (rotation). Various combinations of these movement components are required for any particular task as well as throughout the task. For such a dynamic synergy to be efficient there must be normal postural tone (stability-mobility synergies) normal postural alignment over the base of support (equal distribution of weight) and the ability to shift and sustain weight over various aspects of the body (proprioceptive tolerance for sustained weight.)

- **Equilibrium and Righting Reactions**

Equilibrium and righting reactions can only occur efficiently when there is musculoskeletal alignment in relation to the base of support and sufficient postural tone to provide the activation of postural responses to visual-vestibular-somatosensory information related to the changes in the center of mass over the base of support. The primary function of the righting reactions is to maintain verticality of the head and neck to the midline of the body. Equilibrium reactions, both fixing reactions and tilting reactions relate to a shift in the center of mass outside the base of support which compromises the integrity of the body's balance. Righting and equilibrium reactions occur in concert with one another to provide reactive motor responses as background maintenance for proactive volitional motor control during movement through space and in relation to the surface upon which the movement takes place.

The normal functioning of the postural system is essential for a normal neuropostural base against gravity. Without the integrity of a normal neuropostural base, organized motor behaviors for learning and the performance of functional activities become inefficient and less adaptable.

Equilibrium reactions consist of fixing reactions, tilting reactions and protective extension reactions.

Fixing reactions are activated when there is an outside force to the body, such as being bumped or pushed. **Tilting reactions** are activated when there is a change to the base of support such as uneven terrain or being on a tilt board. **Protective extension reactions** are activated to protect against a fall when balance cannot be maintained.

Fixing reactions are important because they activate elongation of the weight bearing side and lateral flexion of the opposite side. This is important in physical handling because as we shift the child's weight laterally it should activate fixing reactions. These are centered around the midline and are important for grading weight shift and managing control of the center of gravity. If the child has low resting tone and cannot react spontaneous to the shift in the center of gravity, then the reaction is less efficient and gets exaggerated with less graded control.

Fixing reactions active the ankle- foot strategy. Balance reactions in the foot and ankle are the first initiated from an outside force. This is important to realize since many children with movement and posture disorganization have instability in the ankles and medial arch collapse of the foot. The foot is not prepared for the reaction and thus the response is slow and the balance reactions is more exaggerated. Once the center of gravity is more challenged without firm fixing reactions, balance shifts to a hip strategy with more trunk participation. Again, this is significant because children with movement and posture disorganization often have slow pelvic adaptation and a lack of quick active trunk control.

Tilting reactions are initiated from changes in the base of support. Fixing reactions are also initiated .As the tilt gets more extreme or happens more quickly, it causes more activation of elongation stability and greater lateral flexion, with abduction of the opposite side seen both in upper and lower extremity reactions, depending on whether in sitting or standing and the degree and speed of the tilt. Without graded midline control and efficient fixing reactions, tilting reactions will be less controlled and more extreme and inefficient.

Young babies with low tone that use a wide base of support, such as w-sitting or sitting with a wide base with legs spread apart inhibit any experience in developing efficient fixing and tilting reactions. This contributes to the disorganized movement and posture that is seen later.

Righting reactions include the optical and labyrinthine reactions and the neck, head and body reactions. Optical and labyrinthine reactions are dependent on the neck. They don't appear until around two months when the neck musculature is sufficient to support the head. This is important to consider since many children with movement and posture disorganization have less

Treatment Techniques for Changing Tone

It is necessary to establish a normal distribution of postural tone. Imbalances of postural tone can be observed in areas of the body which are overused, presenting as areas of tightness or fixing and in areas of the body which are underused, presenting as low tone or passive inactive musculature. Areas of tightness need to be inhibited or reduced and passive or lower tone areas need to be facilitated and activated.

As previously described, the child with movement and posture disorganization often has tightness in one or both shoulders, due to misalignment of the scapula and posturing in elevation, abduction and slight protraction. The thorax may also have some tightness due to this chronic posturing. The mid-trunk is often inactive or passive and therefore, lower in tone. The low back may be tight due to anterior pelvic tilt in standing postures and the pelvis may be tight on one side or the other due to lateral alignment imbalances. The hamstrings may be over lengthened in the presence of back kneeing. The feet are usually low tone, as well as the hands, and the wrist may posture in flexion that inhibits good availability of active wrist extension in support of distal finger control. All of these areas need to be fully addressed to determine specific needs for inhibition or facilitation in relationship to normalizing the distribution of active postural tone.

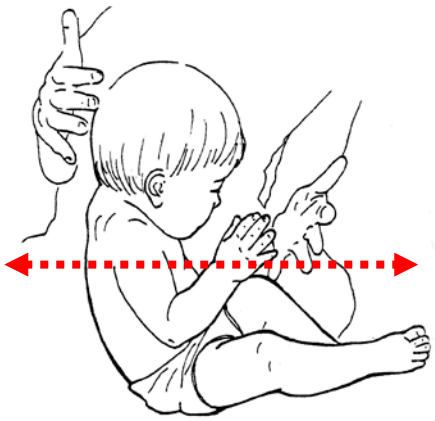
Normalizing postural tone is important as a preparation for initiating activities to increase the organization of flexion-extension-rotational components of movement. Weight bearing over a body surface tends to inhibit tightness while intermittent support and quick tapping lend itself to increasing tone. Compression into a joint, for instance the shoulder helps to reduce tightness while approximation into the shoulder tends to increase tone and therefore stability.

Preparatory techniques are designed to influence the general state of postural tone and are used to prepare the somatic system for movement. Postural tone is influenced by various factors of sensory input, such as speed, frequency, duration and intensity of specific sensory cues. In general, fast input tends to increase tone while slow input tends to decrease tone. Input can be long in duration and intensity, such as compression into a joint or short and alternating such as approximation of a joint. The actual response to the presentation of sensory input depends on the child's individual nervous system and the degree of sensitivity of the handler to monitor and modify the input.

Tapping is a technique that is used as a means to apply repetitive sensory input or tapping to the surface of a muscle. **Quick tapping** or fast tapping increases tone. This type of tapping is used to increase the muscular activity of low tone children or to balance agonist and antagonist muscle groups in areas of high tone or tightness. **Sweep tapping** is another form of stimulation to facilitate motor patterns of muscle groups. Sweep tapping is a technique that provides a facilitating input in the direction of a desired movement, such as sweeping the triceps and extensors of the arm in the direction of extension to inhibit flexor tightness. Slow sweeping can also be used with deep pressure to tight muscle groups in the direction of the desired response,

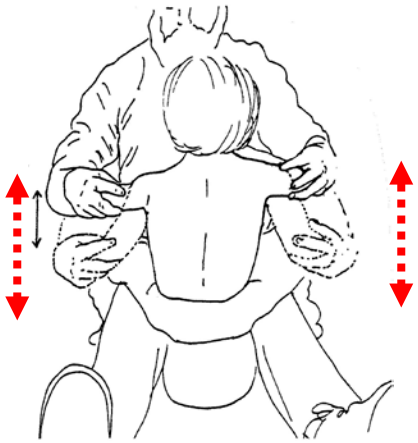
such as slow deep pressure sweeping of the biceps to reduce tone and facilitate an extensor response of the arm. **Alternating tapping** is used to control a small range of movement to increase graded control. It can be used to inhibit low tone collapse into gravity or to maintain active tone for stability.

Alternating Tapping



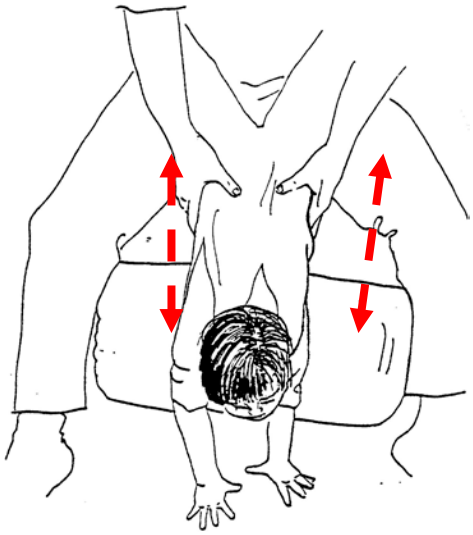
Oscillation is a term that is used to describe a repetitive swinging or swaying of a limb. As with all sensory techniques, the speed of application determines the sensory-motor response. Fast oscillation tends to decrease tightness when applied distally to a limb. However, this fast oscillation may need to be interspersed with times of no oscillation or slow oscillation, to avoid compensatory tightness from returning. Prolonged oscillation, applied bilaterally to the arms, has a tendency to increase trunk tone in a low tone child as it stimulates arm motion for the joint receptors. Slow oscillation, particularly with slight traction of the limb can result in decreasing tightness, while repetitive quick traction has the tendency to increase tone around a joint. Extreme care must be exercised during these techniques to protect the joints from subluxation or dislocation.

Oscillation



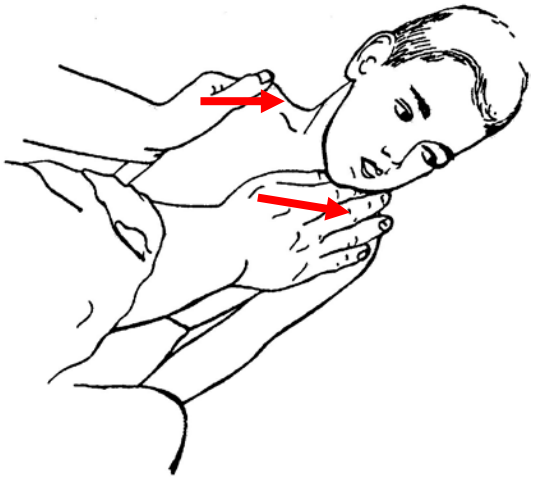
Intermittent support is a term used to describe active stabilization within a range of movement. It is essentially a hold and release technique that supports body weight and releases it with various frequency and duration as needed to enhance active stability and equilibrium. It can be performed with the body weight slightly off center to activate automatic responses or in a stable midline position to enhance stability. It is a good technique for stabilizing fluctuations in midline postures and activating low tone responses to a shift in the center of gravity.

Intermittent Support

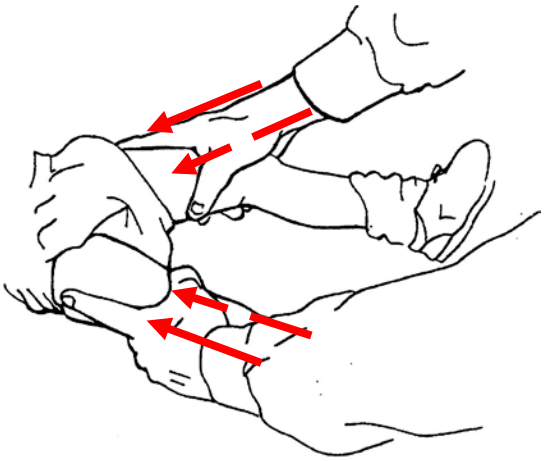


Compression is a sustained pressure into a joint in alignment. Sustained pressure into a joint has the effect of reducing tone or tightness around the joint. Intermittent compression into a joint, or approximation can increase joint stability and tone if repeated rapidly or decrease tone if performed in a slow and rhythmic manner. Deep sustained pressure over a muscle belly has an inhibitory influence and is effective in reducing tightness.

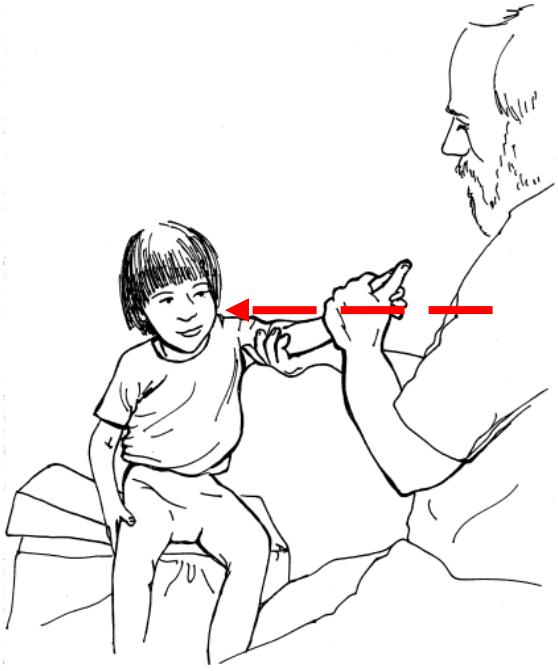
Sustained Pressure/Compression



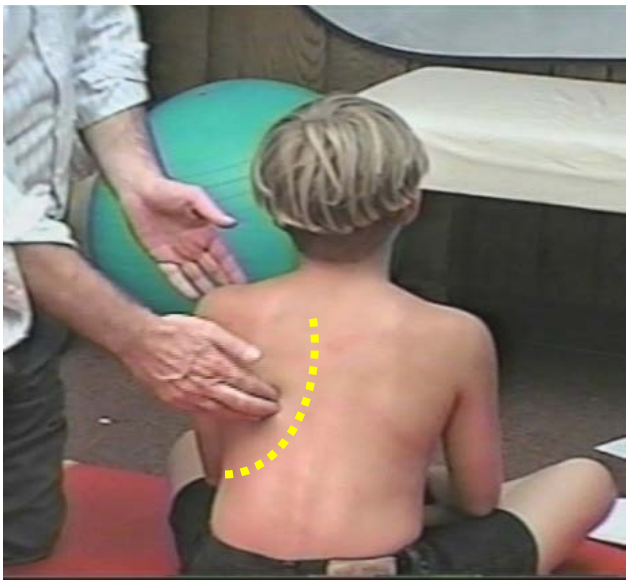
Sustained/Alternating Compression



Approximation into a Joint

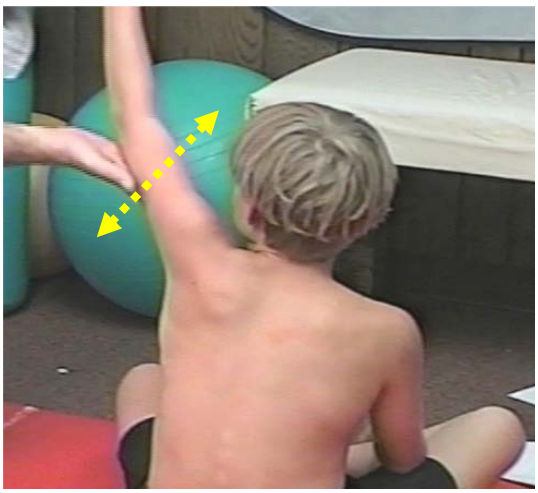


Repetitive approximation into a joint to influence tonal changes, followed by sustained compression into the joint to increase sensory proprioceptive tolerance.



Increasing stability around the scapula

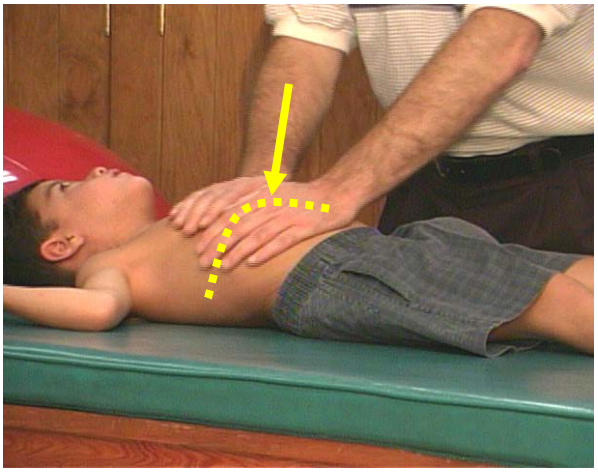
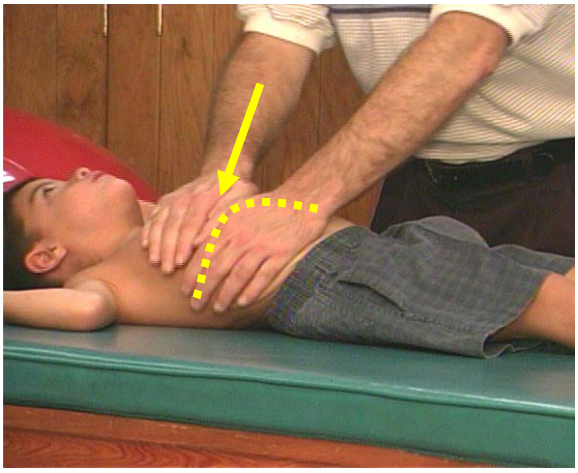
Quick tapping around the scapula helps to increase muscle tone to stabilize the scapula in the more efficient alignment.



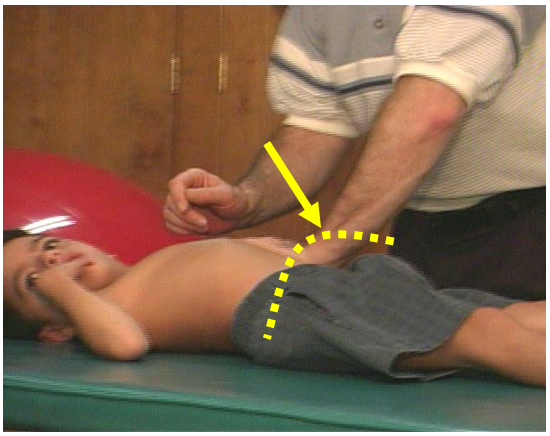
Using sustained pressure and intermittent support

Sustained pressure can also reduce shoulder tightness. Stabilize the scapula with the arm in 45 degrees of extension and provide sustained input into the shoulder. Slowly release the input and repeat. Once the shoulder relaxes, use intermittent support. Support the weight of the arm and then release slightly and quickly and then regain support. This tends to increase shoulder stability in the new and more efficient alignment.

Place your hands over the ribcage and use firm sustained pressure.Move the tissues laterally with oscillation as you move the tissues over the ribcage. Repeat the procedure until you feel more freedom of movement and ease of tissue gliding.

Repeat the procedure in both directions.

Once there is more movement of the ribcage and the chest musculature, stretch in a diagonal to gain more adaptability of the trunk and shoulders. Maintain stable pressure on the shoulder and move the leg and hip across the body. Oscillate as you increase the range of the diagonal stretch.

The photo on the left shows the initial presentation of chest tightness, shoulder protraction, and lack of neck elongation. On the right we can see the changes after a 1 hour session that included specific mobilization of the rib cage and chest musculature. The chest is more elongated, the shoulders are in a better alignment, the trunk has more active extension, and the neck is elongated.

Changes after a 1 hour assessment/treatment session

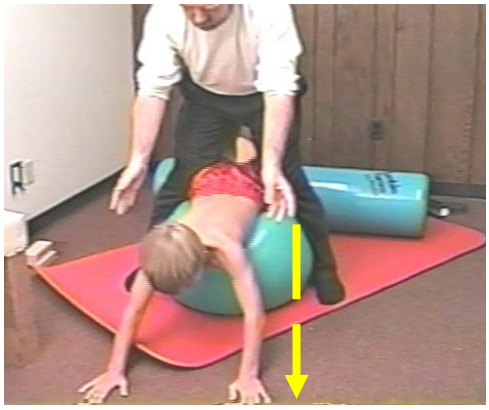
In sitting, the photo on the left shows this child's postural compensations of posterior pelvic tilt, rounding of the back, inactive chest musculature, and poor head/neck alignment. The photo on the right shows the changes in alignment and more efficient postural organization after the treatment session. The chest is elongated. The shoulders, head and neck are aligned with trunk extension and there is slight anteriot tilt of the pelvis which supports and activates trunk extension.

Changes after a 1 hour assessment/treatment session

In cases of low tone in the shoulders, there is joint laxity and the arms tend to hang in a passive traction. The shoulders are not able to provide proximal stability for the arms or the trunk.

Preparatory Trunk Activities

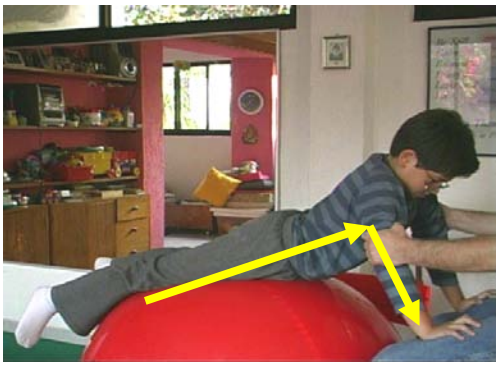
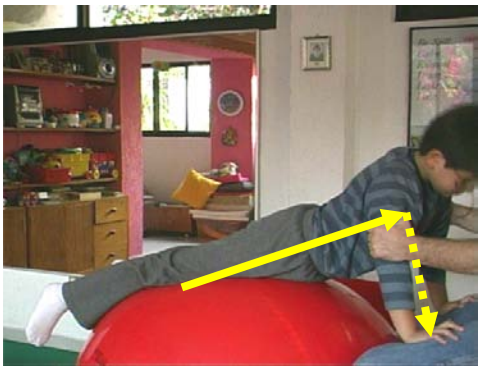
In order for the trunk to grade extension, flexion and rotation, and provide mobile-stability throughout those ranges of functional components of movement, it must first be able to activate and hold extension with a balance of flexion to provide stability for the adaptations of the shoulders and pelvis. There are a number of ways to prepare the trunk for active responses. Both flexion and extension may require preparation before more active trunk activities can be efficiently activated.

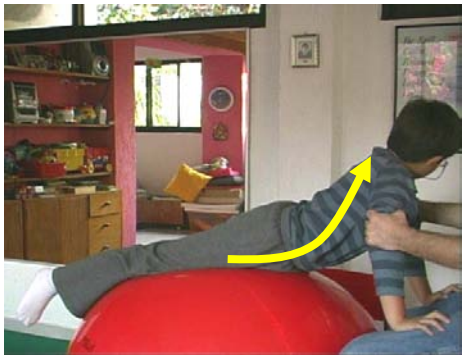
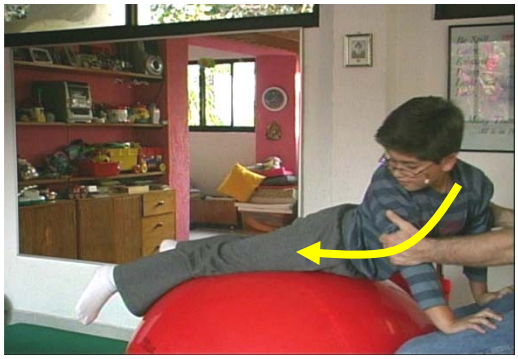
Trunk tone can be increased by lifting the child in prone over a ball, lowering him toward the floor and gently dropping the arms to the surface. This provides firm compression into the shoulders and requires an increase in trunk tone to sustain support of the arms against the surface. This should not be done with children who lock their elbows in hyper extension. The elevation of the hands off the surface before gently dropping should only be a few inches to begin with and gradually higher to about 1 foot high. Extreme caution must be taken in the alignment of the wrist to the hand, and the arms to the shoulders.


Distal control with intermittent compression and intermittent support helps to increase trunk tone and promote holding in extension for improved stability. Hold the hands and provide repeated quick compression input through the arms into the shoulders and trunk to elevate the resting tone

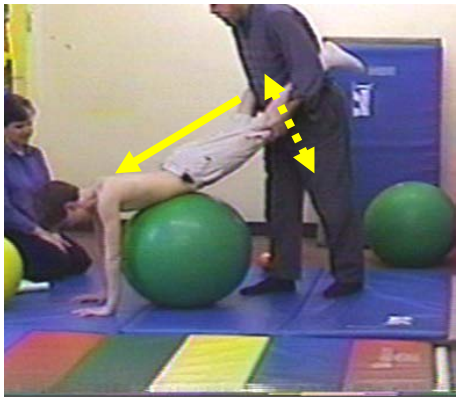
of the trunk. Caution must be taken to be sure safe and proper alignment of the arms to shoulders is maintained. Use intermittent support by diminishing the support of the arms andguickly regaining maximum control. Doing this repeatedly increases the holding tone of the trunk.

Using a large ball supports full body extension. Bringing the weight forward over the hands provides the input to facilitate more active holding of trunk extension. Use intermittent downward input into the hands and intermittent support to keep extension active.

Asking the child to turn his head side to side adds the demand to activate lateral flexion and elongation of the trunk, as a preparation for more active trunk responses in standing and sitting.

Elevating the legs places more weight forward and requires more trunk extension and holding as you bring the body weight over the hands. Intermittent support keeps the extension active.