MASGUTOVA METHOD OF REFLEX INTEGRATION FOR CHILDREN WITH CEREBRAL PALSY

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"All acts of conscious and unconscious life are reflexes by their origin." *I.M. Setchenov.*

Cerebral Palsy and Primary Motor System Development

Childhood Cerebral Palsy – the group of diseases concerned with motor disorders as the result of brain damage or dysfunction of certain brain centers – is usually acquired during the first years of life, at the time when the system of primary movement patterns is developing. Primary movements are genetically programmed for protection and survival, and also for the development of the conscious movement system. Developmentally their role is to support:

- maturation of the nervous system (synaptogenesis, myelination, and brain plasticity)
- brain function (cognitive development, emotional maturation)
- sensory-motor integration.

Dysfunctions of motor development and sensory-motor integration in the child with CP are a reflection of the type of neurological insult and the developmental stage of the infant/child when the neurological insult occurred. The developmental stages can be divided into prenatal (in utero); natal (during the birth process); or postnatal (after birth but during the first years of life). Each developmental stage is vulnerable to specific neurological insults.

Prenatal palsy can be caused by infection, toxicity in the fetus, or compromised health in the pregnant mother. Some primary motor patterns and reflexes, such as Trunk Extension, Automatic Gait, Grasp, Swallowing and Sucking develop in utero. Prenatal brain damage will cause poor expression of these reflexes and adversely impact the next stage of development.

Natal palsy is generally caused by neurological insult during birth: a consequence of premature birth, sudden deliveries, narrow pelvis of the mother, use of forceps during birth, etc. Natal trauma can negatively affect the activation of primary motor patterns and reflexes characteristic of a normal successful birth. In such cases the expression of these genetic programs will be abnormal. The primary movements and reflexes of childbirth, such as Head Righting, Perez, Tonic Labyrinthine (TLR) in extension, Bauer Crawling, Sequential Side Rotation, Spinning, and Sucking may be dysfunctional.

Postnatal palsy is often caused by an infection with encephalitic symptoms. Other causes include childhood cranial injury, central nervous system injury, and poor systemic health. Infant motor patterns and reflexes will be stressed by postnatal CP, and may develop dysfunctionally or pathologically. *Dynamic reflexes* (e.g., Grasp, Hands Pulling, Automatic Gait, Sequential Side Rotation, Spinning); *positional reflexes* (e.g., Asymmetrical Tonic Neck Reflex [ATNR] Symmetrical Tonic Neck Reflex [STNR], Babkin Palmomental, Tonic Labyrinthine Reflex

[TLR] in flexion and extension); and *postural reflexes* (e.g., Trunk Extension, Spinal Galant and Perez) are most commonly affected.

Central nervous system damage causes dysfunction or pathology in these reflex based motor programs and leads to poor motor function, poor physical development, sensory processing disorder, and learning disabilities.

Motor development is a primary expression of coordinated neurological function in infant and early child development. It influences future development in all other spheres – physical, emotional, cognitive – and the formation of personality. In a child with CP, impaired motor function contributes to disorders in development of perception, memory, speech and self-organization.

Impaired motor function may be due to:

- *poor sensory perception of stimuli* (tactile, visual, auditory, olfactory, vestibular)
- *inadequate brain processing of the sensory input* (dysfunctional or pathological processing of adequate stimuli, e.g. invalid decoding, poor recognition of stimuli)
- *inadequate motor response* due to abnormal muscle tone that prohibits an appropriate response, or to a musculoskeletal problem such as an orthopedic injury or abnormality.

Motor development of the child with CP is impaired on two levels:

- at the level of the genetically encoded *primary motor patterns*
- and at the level of consciously learned and controlled movements

In our work we focus on techniques that support primary motor patterns. We define primary motor patterns as genetically programmed reactions ranging in complexity from simple reflex responses occurring at the spinal cord level, to more complex "survival based" response patterns involving brain stem activity, to sensory-motor coordination systems (eye/hand coordination, visual/auditory integration, etc.), and finally, to application of these fixed patterns in more complex activities (visual tracking of a moving object, articulation for pronouncing sounds, etc). Primary motor patterns serve as the basis for future development, as they are natural resources which support the development of synaptogenesis, myelination, and optimal brain function. Each step of development is based on kinesthetic memory – genetic and experiential. Studies show that kinesthetic memory, which allows us to internalize all types of movements, is damaged in 40-60% of children with CP (N.N. Danilova, A.L. Krilova, 1997). Thus even the simplest motor skills are very difficult for them to explore and anchor into memory and, as a result, their motor and cognitive development are limited.

Our concept of neuro-sensory-motor reflex integration is based on awakening latent brainstem genetic motor memory, so that it may serve as a resource for neuro-development.

Human development, whether normal or abnormal, is continuous. Stages of maturation and the emergence of reflex patterns should not be thought of as static points in development, but as glimpses of particular moments in a dynamic process. Because of the fact that motor function can be measured and quantified, we find diagnostic and therapeutic utility in defining specific reflexes and specific stages of development. In our work we identify traditional, well-known reflexes, such as the Moro and the Babinsky. We also choose to identify and name additional reflex patterns, which may be less familiar. We encourage the reader to explore the possible merits of these unfamiliar reflex patterns with an open mind, and to think of them in terms of potential applications in the clinical setting.

Characteristics of the Early Motor Development of a Healthy Child

To understand the uniqueness of the early motor development of a child with CP, it is necessary to compare it to that of a healthy child, with respect to reflex pattern formation. This comparative analysis offers a profound understanding of the dysfunctional features of motor development in the child with CP, and allows us to design a correction using developmental techniques that influence sensory-motor links within various reflex circuits.

During the first year of life a healthy child sequentially develops reflexes and primary movements that include the Antigravity Reaction and supporting motor patterns (Gravity, Grounding and Stability Reflexes), Automatic Gait Reflex, Crawling, Spinal Galant and Perez Reflexes, Grasp, oral automatisms, etc.

Developing already in the first 1.5 - 2 months of life are the tonic reflexes – TLR, STNR and ATNR, Head Righting and Trunk Extension, and pelvic-trunk movement patterns. The individual reflexes are difficult to detect as they normally mature into other reflex patterns, and are naturally integrated into the movement system by three months of life. The righting reflexes, which mature next, influence the dynamics of body righting and lengthening. These complex reflexes result from spontaneous activity in the brainstem, vestibular-cerebellar centers, motor cortex centers, nuclei of the vision centers and the corpus stratium. Coordination of these areas determines the control of muscle tonus, and the control of muscle activity.

A primary reflex, the Labyrinthine Head Righting Reflex, develops as an antigravity function, allowing the supine infant to raise his head by the age of two months. It triggers him to lift his head when pulled by the hands, or when lying prone. The Labyrinthine Head Righting Reflex is mainly controlled by the labyrinthine nuclei and medulla oblongata (brain stem area). In children with CP this reflex is not expressed until the fifth month, or later.

Thanks to the development of this reflex pattern, a healthy six-month-old infant placed on his stomach can support his upper body on his forearms, use appropriate muscle contraction to lengthen his trunk in an arc, and flex his legs above ground. Later the child is able to turn over, get on all fours, crawl, and sit without support. The Head Righting Reflex is the basis for all these movements. It is controlled by the vestibular-cerebellum structures in the medula spinal and medulla oblongata, and also in the reticular formation of the brainstem.

In the second year of life the TLR, STNR and ATNR together help the child learn to control body position at rest, and to move through space.

Characteristics of Early Motor Development in a Child with CP

All reflex patterns described above for the healthy infant are dysfunctional or pathological in the child with CP, and the expression of the pattern is delayed – up to eight years or more. In CP with severe brain damage there is minimal development of the righting reflexes (Child Neurology, 2000); K. Bobath, 1972; L.O. Badalian, 1984; R. Michalowicz, 1993; C.H. Delacato, 1974; G. Doman, 1984; V. Vojta, 1989; K.B. Nelson, J.H. Elleberg, 1979; K.A. Semionova, 1999; D. E. Haines, 2002; L. Sadowska, 1998; S. Masgutova, N. Akhmatova, 2004; S. Masgutova, 2007).

Our observation and understanding of reflex patterns in children with CP has allowed us to identify dysfunction or pathology in a number of reflex patterns such as the TLR in flexion and extension, Grasp, Babkin Palmomental, Leg Cross Flexion-Extension, Asymmetrical Tonic Neck, Thomas Automatic Gate, Bauer Crawling, Moro, Hands Supporting, Segmental Rolling Reflexes, Symmetrical Tonic Neck, Spinal Galant and Perez, Spinning, and Pavlov Orientation "What is this?"

The pathological expression of many reflexes and movement patterns in children with CP is the result of lack of development and poor maturation and integration of tonic reflexes at the appropriate time. Tonic reflex patterns, for which the stimulus is head movements or changes of body position, strengthen the functional links between the vestibular system and the musculoskeletal system, thus supporting appropriate muscle tone, proprioception, posture, and motor control. The vestibular end organs are reflexively linked to extra-ocular and spinal muscles. These neurological links are modulated and matured via tonic reflexes.

Several important reflexes, and their abnormal expression in children with CP, are noted below:

1. Tonic Labyrinthine Reflex (TLR). A prone child with CP, regardless of age, demonstrates abnormally high tension in the upper and lower limb flexors and abdominal muscles. The child can't raise his head, straighten his core, or extend his legs and arms – movement that is typical for a 3 - 6 month old healthy child. In severe cases the muscles demonstrate spasticity. When the child with CP is supine, tone in the limb extensors increases.

A pathological TLR adversely affects the way the child sits, turns over, and stands up. It also can affect the tongue muscle – blocking articulation and preventing stimulation and development of the functions of the Broca speech center, and subcortical links in the brain. A pathological TLR also causes poor head position and abnormal function of the oculo-motor abductors. As a result, the child has a limited view of the objects around him/her, leading to poor development of vision. When sitting or standing, each joint is overly flexed and the child has difficulty extending his limbs.

2. Symmetrical Tonic Neck Reflex (STNR). When the child with CP is put into position to test the STNR and his head is flexed toward his chest, the response is increased tonus of the flexors of the arms and extensors of the legs. When the head is tilted backwards, tonus in the limbs reverses, increasing in the leg flexors and arm extensors. This abnormal reaction interferes with the development of postural control essential for:

- binocular vision
- near-far focus recovery

- integration of central and peripheral vision,
- development of superior and inferior eye muscles.

3. Asymmetrical Tonic Neck Reflex (ATNR). If we turn the head of a healthy newborn lying supine to the side, then the arm and leg on the same side will extend in all joints, and the opposite arm and leg flex. In an abnormal response, the limbs flex on the same side to which the head turns, or there is a global hyperactive response. The abnormal reaction is a protective response that does not support sensory awareness or orientation to the environment.

4. Segmental Rolling Reflexes are of crucial importance for infant development. If such reflexes are not developed and integrated, the child cannot rotate his shoulders independently of his pelvis. This is witnessed in the child with CP who cannot separate movements of different body parts. Abnormalities in the development of the Segmental Rolling Reflexes prevent free balancing of the trunk while walking: the individual will have poor balance and limited ability to subtly shift his center of gravity. Clinical observations include unstable and inappropriate leaning to the side, and poor control of posture and movement.

5. Another reflex linked to tone and tonic function is the *Grasp*. It should mature near the end of the first week, integrate with Hands Pulling by the second month, and develop to allow for easy expression of manual skills by the end of the first year. However, the Grasp Reflex can become fixed and reactive in the child with CP so that after he grasps an object, he cannot relax the palm and open the fingers to release it. Children with CP who have low muscle tone will not explore the Grasp Reflex as a possibility for flexing the fingers and palm into a fist for holding, or for the development of manual skills. Manual skills, represented in the area of the sensory-motor cortex, are strongly correlated with speech centers – Wernicke’s area (auditory center for recognition of human speech) and Broca’s area (phonemes and sounds articulation) and subcortical areas that integrate speech function (W. Penfield, T. Rasmussen, 1950). So poor development of the Grasp Reflex may negatively influence receptive and expressive language in the child with CP.

In normal infants the tonic reflexes discussed above begin to integrate in the second month of life. In children with CP the adequate reflex responses never occur. The abnormal patterns that occur instead involve muscular hyper-contraction and pathological muscle synergies, which limit joint mobility and morphological development, as well as movement.

In summary, the complex process of natural reflex development in children with CP is impaired. Depending on the location of brain damage, different pathological movement schemes are formed in the cortex, and in the subcortical areas. The expression of these pathological patterns can be vividly seen in the first year of life.

In the second year of life, hyperkinesis (unintentional movement) may be diagnosed. Hyperkinesis will involve the tongue, causing the lower lip to protrude. Abnormally high tension of the trunk and limb muscles and poor coordination in the hands may also be noted. Expressed as irregularities in tone, posture and movement, these abnormal muscle synergies underlying the pathological motor stereotype of children with CP, are linked to abnormal tonic reflex patterns.

Table 1. Results of Reflex Integration Assessment in children with CP (580 individuals; Age 0,5 – 18 years)

MCS	DEEPLY DYSFUNCTIONAL and PATHOLOGICAL REFLEX PATTERNS IN CHILDREN WITH CP	NUMBER OF CHILDREN (450)		Statistic Significance *
		No	%	
MEDIAL-LATERAL MCS	Robinson Grasp	250	55.6	2
	Hands Pulling	142	31.6	7
	Babkin Palmomental	248	55.1	3
	Babinsky	240	53.3	3
	Leg Cross Flexion-Extension	249	55.3	2
	Asymmetrical Tonic Neck	252	56.0	2
	Abdominal	195	43.3	5
	Bonding	147	32.7	7
SUPERIOR-INFERIOR MCS	Thomas Automatic Gait	252	56.0	2
	Bauer Crawling	241	53.6	3
	Moro	257	57.1	2
	Fear Paralysis	271	60.2	1
	Hands Supporting	227	50.4	4
	Sequential Side Rotation	235	52.2	4
	Landau	242	73.8	3
	Flying and Landing	256	56.9	2
ANTERIOR-POSTERIOR	Trunk Extension	259	57.6	2
	Symmetrical Tonic Neck	242	73.8	3
	Spinal Galant	243	54.0	4
	Perez	240	53.3	3
	Tonic Labyrinthine	260	57.8	1
	Foot Tendon Guard	237	52.7	4
	Spinning	256	56.9	2
	Pavlov Orientation "What is this?"	160	35.6	6

* Statistical significance – the frequency of deeply dysfunctional or pathological reflex patterns represented in children with CP.

The abnormal synergies and movement patterns discussed above are well known and typical of the child with CP. The clinical question is: ***can effective interventions maximize the motor development of children with CP, help them to acquire motor skills, and support higher levels of function?*** In short, can we improve the lives of children with CP?

As an answer to this question we propose our program entitled: "Masgutova Neuro-sensory-motor Reflex Integration" (MNRI™), created for children with challenges by Svetlana Masgutova, Ph.D., and her colleagues.

Children with CP are the largest patient group in our work. Our assessment of their primary movement patterns has helped us identify specific dysfunctional reflexes and design programs that raise the level of reflex integration and restore function in the central nervous system.

The Masgutova Method of Neurosensorimotor Reflex Integration – MNRI™

Many authors have recognized the importance of motor development for general and cognitive development. Their works focus on a variety of aspects of human function: bio-mechanics and physiology of movement (N. Bernstein, 1947, 1997); motivation (F. Lesfaft, 1998); psycho-structural and cognitive-motivational aspects of development (N. Leontiev, 1971, 1977); sensory-motor integration of tactile, vestibular, and proprioceptive systems (J. Ayres, 1975); neuro-developmental assessment of spontaneous movements, treatment of righting mechanisms, postural reactivity, and neonatal reflexes (V. Vojta, 1989); locomotor function restoration, Dynamic Neuromuscular Stabilization (Lewit, 2001; (P Kolar, 2007), motor units correction within NDT rehabilitation (B. Bobath, 1963, 1984); motor rehabilitation treatment within early static-motor development (L. Sadowska, 2001); neurophysiological treatment of motor development based on reflexes (M. Barnes, C. Crutchfield, C. Heriza, 1977); movement centered education, self awareness through movement (M. Feldenkries, 1981); (F. Alexander, 1932, 1996), movement based learning for skills of concentration and self-organization (P. Dennison, G. Dennison, 1989); and numerous others. Some of the works noted above are treatment oriented approaches, others are education oriented. In most of them, an early motor development approach is the medium for change.

Similarly, the Masgutova Method of Neurosensorimotor Reflex Integration (MNRI™) addresses primary motor system function and its influence on developmental and learning processes (S. Masgutova, 2004, 2005). It is directed toward the restoration of healthy neuro-sensory-motor development and the integration of reflex patterns, motor coordination systems, and skills for optimal motor and cognitive functioning. Our approach involves the activation of reflex patterns to awaken the body's natural resources, to strengthen the genetic motor memory, and support the coherent functioning of sensory and motor systems.

The program emphasizes the importance of primary movements for the child's motor and cognitive development, utilizing developmental models of L. Vigotsky (1986), J. Piaget (1976), S. Rubinstein (1946), L. Bodzowitch (1972, 1997) and I. Dubrowina, N. Tolstykh (1991). These, along with the authors cited earlier, provide the conceptual foundation for our program. Our therapeutic interventions are the result of long-term research and practical work with children and adults with challenges conducted by Dr. Svetlana Masgutova and her colleagues.

Simply stated, the MNRI™ program proposes intervention within the sensory-motor reflex circuit. We use procedures and techniques applied at the level of known neurological patterns to facilitate genetic programs for reflex development.

MNRI™ includes diagnostic as well as therapeutic procedures (S. Masgutova, N. Akhmatova, 2004, 2005). MNRI™ assessment is based on the evaluation of reflex patterns relative to currently established norms of neuro-motor development. For this we draw on brain integration concepts developed by A. Luria (1969), A. Anokhin (1968) and N. Amosov (1978), and by the concepts of neurological reflex function as a response of the "brain-body" system to external and internal stimuli by I. Pavlov (1960), I. Setchenov (1995), V. Simonov (1987).

Diagnosis

We believe that healthy CNS function is dependant on motor development and because motor development can be measured and quantified, tests of motor development are reliable indicators of CNS function. The primary diagnostic goal is to assess the level of maturity and integration in the motor patterns of dynamic and postural reflexes. Diagnosis includes testing 24 reflex patterns, including the ATNR and STNR, Hands Pulling, Leg Cross Flexion-Extension, Spinal Galant and Pereze, Moro, and Grasp. Test clusters include from 15 to 25 checks for each reflex. Assessment parameters involve several criteria, assessed with scores from "0" to "20."

Diagnosis procedures focus on the individual reflex patterns:

- Does the development of the reflex correspond appropriately to the patient's age?
- Is the reflex integrated on the sensory-motor level?
- Are both the basic reflex pattern and its variants appropriately matured and functional?
- Is the reflex integrated with motor skills and abilities that are used for conscious learning and movement?

The diagnosis shows functional strengths and weaknesses in dynamic and postural reflex patterns, identifies specific reflex patterns that contribute to a child's developmental delay and provides the practitioner with information necessary to design an individualized reflex-based treatment plan.

Each reflex has its own developmental dynamics and role. Delayed maturation and integration of a reflex often disrupts the next level of motor development and cognitive function. For example, poor formation of the Grasp Reflex can negatively affect the development of manual skills and handwriting (S. Masgutova, 2005, 2007). A delayed ATNR may affect spatial orientation, hearing, and auditory processing. This may lead to receptive and expressive language disorders (S. Masgutova, 2005, 2007). Our clinical experience also suggests that delays in maturation and integration of reflex patterns are a primary factor in dysfunctions such as impulsivity and behavior disorders; inadequate formation of more highly organized and consciously controlled movements and skills; and regression in self-management, communication, and learning.

For further refinement of our diagnostic profiles, we have divided the reflex patterns into three systems, highlighting the interrelationship of motor coordination, brain anatomy, and brain function (Table 2).

Table 2. Motor Coordination Systems, Brain Levels and Infant Reflexes

 **Medial-Lateral Motor Coordination** ***Anatomical symmetry*** Movements of left and right sides of the body.	 **Superior-Inferior Motor Coordination** ***Dynamic Symmetry*** Movements of upper and lower sections of the body	 **Anterior-Posterior Motor Coordination** ***Postural Symmetry*** Movements of front and back of the body
Cerebral cortex (cerebrum-Consciousness): Left and right hemispheres	***Diencephalon (Consciousness and subconscious:*** Thalamus, hypothalamus. Epithalamus, subthalamus, basal ganglia (caudate nucleus, globus pallidus, putamen, Claustrum, amygdala) Connects cerebral cortex and brain stem	***Brain stem system (Unconsciousness):*** Medula spinalis, Medulla oblongata, pons, midbrain (connection with cerebellum)
Functions:	**Functions:**	**Functions:**
Rational thinking, cause and effect, sequence, whole perception, experience based intuition	Emotions, affects, and feelings, experience? Emotional processing, self-regulation, organization	Unconditioned reflexes, automatic – routine actions, habitual behavior, instincts
Reflexes: • Robinson Grasp • Hands Pulling • Babkin Palmomental • Babinsky • Leg Cross Flexion-Extension • Asymmetrical Tonic Neck • Abdominal • Sequential Side Turning • Spinning • Bonding	**Reflexes:** • Thomas Automatic Gait • Bauer Crawling • Moro Embracing • Hands Supporting • Leg Cross Flexion-Extension • Landau • Masgutova Flying and Landing • Foot grasp • Sequential Side Turning • Amphibian • Pavlov Orientation "What is this?"	**Reflexes:** • Trunk Extension • Symmetrical Tonic Neck • Perez • Spinal Galant • Tonic Labyrinthine • Foot Tendon Guard • Landau • Sequential Side Turning • Spinning • Pavlov Orientation "What is this?"

The first subset of reflex patterns, which we termed the *"Medial-Lateral" Motor Coordination System* (MCS), supports the development of Right/Left symmetry, and Right/Left side movements, postures, and skills. For example, MCS patterns in this subset include homolateral (one sided motion – catching a ball with one hand), and cross lateral movements (limbs of opposite sides acting reciprocally – as in dance, running, and most sports).

The second subset of reflex patterns, termed the *"Superior-Inferior" MCS,* supports the interrelationship between gross and precise motor coordination (as in crawling on all fours while looking at a specific object, maintaining posture while writing; running on the football field while focusing visually on the ball in motion).

The third subset, the *"Anterior-Posterior" MCS,* provides a basis for postural development. This includes static postures and movements that balance core flexion and extension, providing postural control in response to gravity.

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Looking at reflex patterns in the context of these three Motor Coordination Systems allows for a deeper understanding of more global developmental patterns. Assessment of individual reflexes allows us to determine which Motor Coordination System is most compromised.

Sensorimotor Integration in a Reflex Circuit

Neurophysiology dictates that each reflex must integrate on the sensory-motor level. A specific sensory stimulation will trigger a corresponding motor/gland response. The neural link between the sensory and motor aspects of a reflex is genetically based, having evolved over thousands of years.

Sensory stimulation:
- **Tactile end organ**
- **Visual end organ**
- **Auditory end organ**
- **Vestibular end organ**

↓

Brain processing:
(of genetic program)
- **Normal**
- **Dysfunctional**
- **Pathological**

↓

Motor response:
- **Normal (matured)**
- **Dysfunctional (hyperactive, hypoactive)**
- **Pathological (opposite, reversed, a-reflexive)**

Table 3. Three aspects of sensory-motor integration of a reflex circuit.

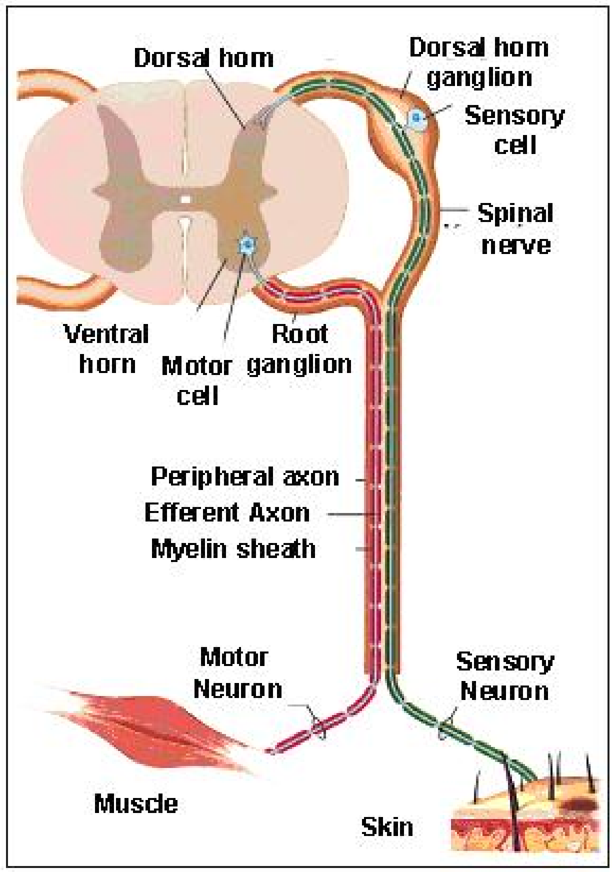


Figure 1. Sensory information is received by the brain, which determines the character of the motor/gland response.

If a stimulus is not recognized by the peripheral sensory apparatus, it will be unnoticed or misinterpreted by the brain. If the central nervous system's response is abnormal, the expression and development of the reflex motor pattern will also be abnormal. The integration of the reflex with controlled movements and skills will be delayed and unreliable. The dysfunction will be most obvious in situations of new learning or stress.

The Dynamic of Reflex Integration

Each reflex emerges at a specific time. It develops its own basic pattern, expressed in three phases. It then goes through a transition time (the fourth phase) before developing variants during the fifth, sixth, and seventh phases.

Each phase has its own role. For example, a **basic pattern** is responsible for coding the sensory-motor circuit. It creates the nerve network for specific stimuli, in order to establish appropriate physiological functioning and protection. The **transition phase** is important for the maturation of the basic pattern. The reflex **variants,** developed during the last phases, are characterized by a highly developed neural network. The reflex pattern now evolves from the level of reflexive protection to the higher level of intentional response.

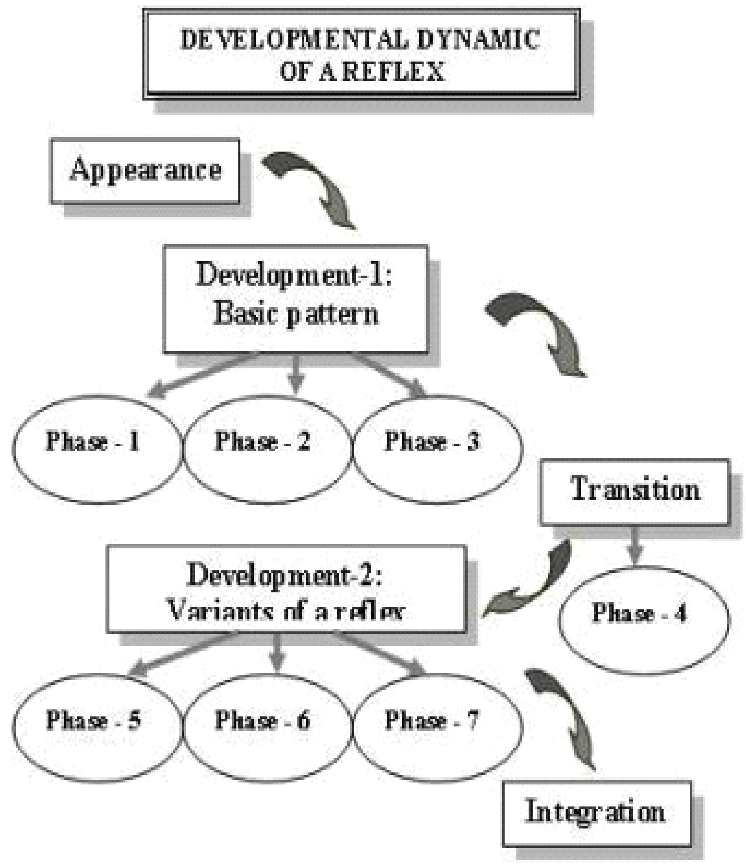


Table 4. Reflex development dynamic

Maturation of the nervous system involves the inter-connection of reflex circuits. The role of these latter phases is to expand the development of a reflex in order to create the groundwork for reflex integration with motor skills and abilities. This supports the development of academic skills such as elementary reading, drawing, writing, and calculating. Delayed reflex development, or the omission of any phase, adversely affects the formation of future skills. The result is always evident in the next level of development. Lacking an appropriately matured neural network the reflex will find expression in dysfunctions or compensations rather than ideal patterns. These altered patterns are less reliable in situations of stress or unexpected transition. It is critical for a reflex to evolve through ***each*** phase for full development, maturation, and integration. This concept is unique, and should be distinguished from the traditional understanding based on “inhibition” of a reflex.

Reflex Characteristics

The five main characteristics we evaluate are: pattern construction, timing and dynamics, motor direction, strength of the reaction, and symmetry. These characteristics are evaluated solely through the observation of the motor response. Direct measurement of brain processing and the level of sensory sensitivity are not possible at this time.

Figure 3. Correct Grasp Reflex: basic pattern and variant (phase-4).

Figure 4. Incorrect Grasp Reflex: basic pattern and variant (phase-4).

Pattern construction of a reflex. Pattern is the co-ordination of a set of reactions and movements organizing the response to the stimulus (Fig. 3 and 4).

Direction of motion in a reflex response. Each reflex represents a certain sequence of reactive movements that either end in a specific posture or continue as movement in a specific direction. Our neuro-musculo-skeletal system serves to organize these postures and movements (Fig. 5).

Response time. The reflex circuit involves sensory input, brain processing, and the motor response. The motor response (latent time) should take approximately 10^{7} bit/seconds from the moment the sensory stimulation starts. The reaction must happen within a very short time; it must be quick because the primary function of a reflex is for protection. A temporal delay will delay the protective response needed at any moment, and may result in injury. The temporal delay in a reflex will persist in later patterns and conscious movements developed on the foundation of that reflex.

Figure 5. Direction of motion in Hands Supporting Reflex pattern: a) correct and b) asymmetrical/inappropriate

Strength of the reaction. This characteristic of a reflex reaction includes the physical strength supplied by the tone and status of the musculoskeletal system. The strength of the muscles serving the functioning of a reflex pattern must reflect the intensity of the stimuli. Hyperactive or hypoactive reactions, or no reaction, are inadequate responses.

Symmetry. Motor reaction in a reflex circuit can be evaluated in relation to the bilateral organization of the body. Symmetry should be seen in the body structure, timing, strength and direction of the motion of the reflex response (Fiure. 6).

Reflex Pattern Assessment and Interpretation

Assessment of each reflex is based on the five parameters described above, each scored from 0 to 4, allowing for a total score of 20 for each reflex. This simplified procedure allows us to measure the level of reflex development/integration or dysfunction. A final score of "20" represents complete reflex pattern integration and "0" represents an overt pathological response. Table 3 shows an example of an evaluation form for a reflex.

Figure 6. Asymmetry in Babinsky: the reaction is correct in the left foot, incorrect in the right.

Main Parameters of the Basic Reflex Pattern Evaluation

Key description:

4 = Correct response
3 = Correct in all basic features
2 = Elements of correct pattern, but incorrect response to stimuli in some features
1 = Dysfunctional response
0 = Pathological response

Table 5 demonstrates the characteristic description of the reflex pattern evaluation.

Table 5. Example of a Reflex Pattern Evaluation

Score for a reflex pattern	Pattern constuction	Direction of motion	Strength	Timing	Symmetry	Notes (compensa-tions, distortions)
4 Completely right/ appropriate	Completely right	Completely right direction	Completely appropriate/ adequate and stable	Completely appropriate timing	Completely symmetrical	
3 Right and appropriate in whole	Right in whole	Right direction in whole	Appropriate in whole and almost stable	Appropriate timing in whole	Approximately symmetrical	
2 Several components are incorrect	Several components are incorrect	Several components are incorrect	Inappropriate, and unstable	Too late, too slow, or too fast	Symmetrical in some elements and asymmetrical in others	
1 Dysfunc-tional	Dysfunc-tional (wrong)	Wrong direction	Too strong or too weak	Too late, too slow, or too fast hyperactive	Completely asymmetrical	
0 Pathological	Pathological	Wrong direction, opposite direction	Pathological (hyperactive or hypoactive or no response)	Excessive delay or no response	Pathologically asymmetrical (functions against reflex pattern damaging its development)	

Reflex patterns are evaluated before and after the integration procedures (Reflex Pattern activation/Re-patterning Exercises).

Table 4 is an example of a Grasp Reflex pattern evaluation for a child with delays in motor development and sensory processing.

Table 7. Example of a Grasp Reflex – Basic Pattern Evaluation Before and After Re-patterning Procedure

Grasp Reflex Basic pattern	Pattern construction		Direction of movement		Strength		Response time		Symmetry	
	Before	After	Before	After	Before	After	Before	After	Before	After
	1	3	1	2	1	2	3	3	1	3
	Dysfunctional (wrong)	Basically Correct	Wrong direction	Small positive change in direction	In-adequate (too weak)	Small positive change in strength	Appropriate timing in whole	Appro-priate timing in whole	Asym-metrical/ wrong pattern	Approximately symmetrical

The score before the re-patterning procedure is: 6 (Incorrect pattern. Moderate dysfunction).
The score after the re-patterning procedure is: 13 (Pattern is functional, but still at a low level of development).
The interpretation of the score is presented in Table 8.

Table 8. Criteria for Evaluation of Reflex Pattern Integration/Dysfunction

NORMAL FUNCTION		DYSFUNCTION/PATHOLOGY	
POINTS	LEVEL OF DEVELOPMENT / INTEGRATION	POINTS	LEVEL OF DYSFUNCTION
19-20	High level of integration	10	The pattern is on boundary of normal function and dysfunction. Elements of right pattern.
17-18	Matured level, integration is above average	8-9	Incorrect pattern. Mild dysfunction
15-16	Development and integration is average level = NORM	6-7	Incorrect pattern. Moderate dysfunction
13-14	Pattern is functional, but below average	4-5	Incorrect pattern. Deep dysfunction
11-12	Pattern is functional, but at a very low level of development	2-3	Incorrect pattern. Pathology
10	The pattern is on the boundary of normal function and dysfunction. Elements of right pattern.	0-1	Incorrect pattern. Severe pathology

The evaluation process for Reflex Pattern Integration requires thorough knowledge in the area of Neuro-Sensory-Motor Reflex Development, special professional education, and extensive clinical experience. We teach practitioners of our Method at special courses, workshops and clinics.

Our evaluation provides us with a deep understanding of the etiology of poor motor-cognitive development. It is not intended as a basis for assigning labels of any kind. Information from reflex pattern evaluations enables us to create individualized programs to help children and adults to reach their highest potential. The evaluation serves primarily to guide our support, through genetic motor programs, for further development of motor-cognitive function. For example, pre and post testing at MNRI™ workshops has revealed correlations of the following reflex patterns to health and development:

- "Red and Green Light" Tendon Guard and TLR– for the healthy self-regulation.
- ATNR – for hearing, memorization, and development of the proprioceptive system;
- STNR, Truck Extension – for body posture control, binocular vision and binaural hearing.
- Spinal Galant and Perez – for cross motor coordination;
- Visual Reflexes: Horizontal and vertical tracking, staring – for visual function, reading, and writing;
- Grasp and Hands Pulling - for supporting writing skills and drawing;
- Sequential Fingers Opening - for calculation and other mathematic skills.

Our goal in each individualized program is to change the dysfunctional or pathological expression of a reflex pattern so that it becomes a resource for healthy maturation and development.

Therapeutic Approach

Our MNRI™ therapeutic approach is a neuro-sensory-motor correction of dysfunctional reflex patterns. The approach is based on "re-patterning" movement exercises and techniques (re-education, re-coding schemes). It focuses on repetition of dynamic and postural reflex patterns to revive traces of genetic motor memory, and to activate defensive mechanisms in the body-brain system. The exercises stimulate the expression of genetically encoded resources, such as programs of self-regulation and stress release. "Re-patterning" is based on stimulation of "defense" functions in lower brain areas (I.M. Setchenov, 1895, A.A. Ukhtomsky, 1950-1952), stimulating synaptic growth and myelination (L. Lundy-Ekman, 2002). The approach uses specific protocols developed by Dr. S. Masgutova, including "Neuro-Structural Reflex Integration" (2003), "Tactile Therapy" (2005), "Reflex Re-patterning" (2004), and "Visual and Auditory Reflex Integration" (2007). MNRI™ programs have been used for the past seven to nine years by practitioners of sensory-motor integration, somatic oriented psychology, occupational therapy and physiotherapy in over 40 countries including the USA, Canada, Australia, Germany, France, and Belgium. The Method shows statistically significant favorable results.

The goal of the following study was to determine the important clinical parameters in the assessment of children with developmental delays and to assess the effectiveness of the Neuro-sensory-motor Reflex Integration (MNRI™) Program. Children and adults involved in our study participated in a therapeutic clinic for 14 days at the International Dr. S. Masgutova Institute of Movement Development and Reflex Integration in Warsaw (Poland) and/or for 10 days at the Svetlana Masgutova Educational Institute for Neuro-Sensory-Motor and Reflex Integration (USA). Each clinic consisted of 6 - 7 hours per day of treatment that included active structural motor therapy and directed relaxation procedures.

Application of MNRI™ to Children with CP
Results and Discussion

The MNRI™ program supports optimal function of the motor, tactile, visual, and auditory systems. An important difference from other models is that MNRI™ proposes neuro-sensory-motor integration of reflex patterns instead of inhibition. The program demonstrates the possibility of integration of reflexes (natural genetic motor programs) with consciously learned and controlled movements, skills, and abilities. Our techniques integrate motor programs by promoting the exercise and maturation of "neurological pathways" (I.P. Pavlov, 1960; I.M. Setchenov, 1960) corresponding to specific reflex patterns. The program involves non–invasive gentle movements and playful exercises, which can be learned by parents, adults, and professionals who work with challenged individuals. These techniques require few external resources, and are compatible with other therapies.

Results of the assessment of integration/dysfunction of the reflex patterns in children with CP were analyzed based on the function z = f(x) by Prof. Anna Krefft Method ("Diagnostic Function of the Non-observable Phenomena." (Oficyna Wydawnicza Politechniki Wrocławskiej. 2007. Wrocław. Poland). This function allows us to estimate the level of the change in expression (z) of the reflex patterns as the result of the synthesis of data on the chosen diagnosis qualities (x) within 3 groups of Motor Coordination Systems (MCS): *"Medial-Lateral," "Superior-Inferior," and "Anterior-Posterior."*

In Table 9 we present examples of results of statistically important validation of the synthesized function z = f(x). Each parameter (x) shows the level of development of the specific reflex pattern; this function allows us to measure each parameter (x) for each individual child.

The data was taken before and after the use of the MNRI™ program for children with CP who attended a 10 or 14 day clinic at the Rehabilitation Camps for Children with Challenges, part of the Dr. S. Masgutova Institute. Results demonstrate the effectiveness of the MNRI™ Program with children having severe CP. The study group consisted of 42 children ranging in age from 2 to 8 years. They attended either a 14 day clinic (in Poland; 31 children) or a 10 day clinic (in the USA; 11 children).

Table 9. Example Fragment of the Analysis of Reflex Pattern Change within the Group Anterior-Posterior MSC

Function z = f(x) is the synthesized function of changes in reflex patterns development (z) and presents synthesized information of chosen diagnosis parameters (x).

Nr of Child	NR of Assessment	X1	X2	X3	X4	X5	X6	X7	X8	Z (Coefficient of the change)
Child 1	1 (Before)	5	5	7	5	4	5	4	8	**0,351**
	2 (After)	8	8	9	7	7	7	5	9	**0,472**
Child 2	1 (Before)	14	11	5	3	6	3	6	5	**0,382**
	2 (After)	15	13	8	4	15	5	9	13	**0,611**

Reflex patterns: X1 – Trunk Extension; X2 – STNR; X3 – Spinal Galant; X4 – Perez; X5 – TLR in flexion and extension; X6 – Foot Tendon Guard; X7 – Spinning; and X8 – Pavlov Orientation. The parameters (x) were estimated according to the criteria of reflex pattern assessment noted in Table 8.

Figure 7. Dynamic of the changes in development of reflex patterns in children with CP within the Anterior-Posterior Motor Coordination System.

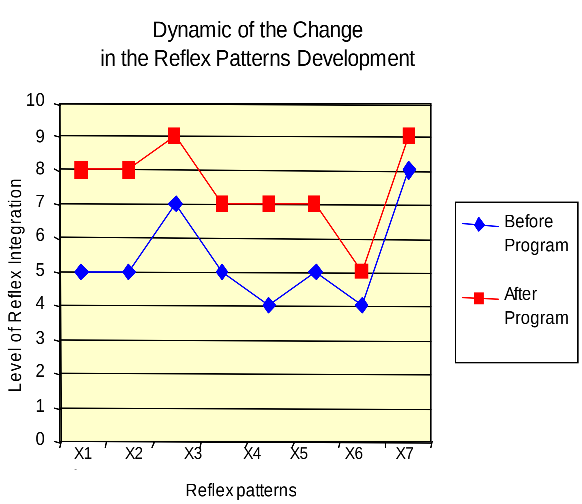
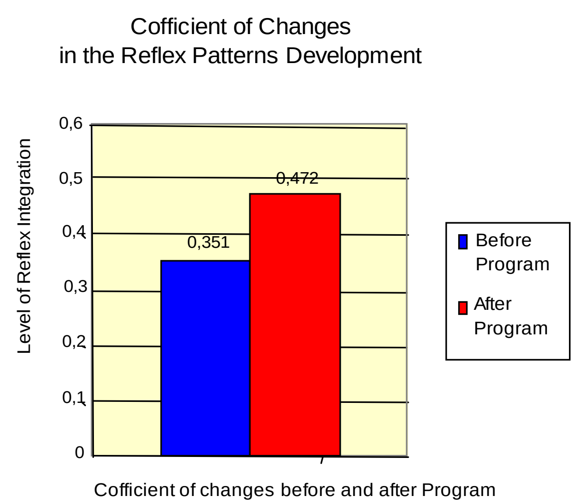


Figure 8. Coefficient of the changes in development of reflex patterns in children with CP within the Anterior-Posterior Motor Coordination System.



In Figure 7 we see a fragmentary example of the dynamic of changes in development of reflex patterns within the *Anterior-Posterior* MCS. Mathematical statistical analysis demonstrates the statistical importance and validity of changes within each reflex pattern and also for the whole group of reflex patterns referring to *Anterior-Posterior* MCS. This type of analysis was used for all diagnostic parameters of reflex patterns for each child, with comparison of results before and after the MNRI™ Program, for all three MCSs: *Medial-Lateral, Superior-Inferior,* and *Anterior-Posterior*. In Figure 8 we see the fragmentary example of the coefficient

(z) by Prof. A. Krefft (2007), which demonstrates the statistical validity of the changes in expression of reflex patterns in children with CP within the *Anterior-Posterior* MCS.

Figures 9, 10, and 11 show examples of dynamic changes in the expression of reflex patterns in children with severe CP after 14 or 10 days of utilizing the MNRI™ Program.

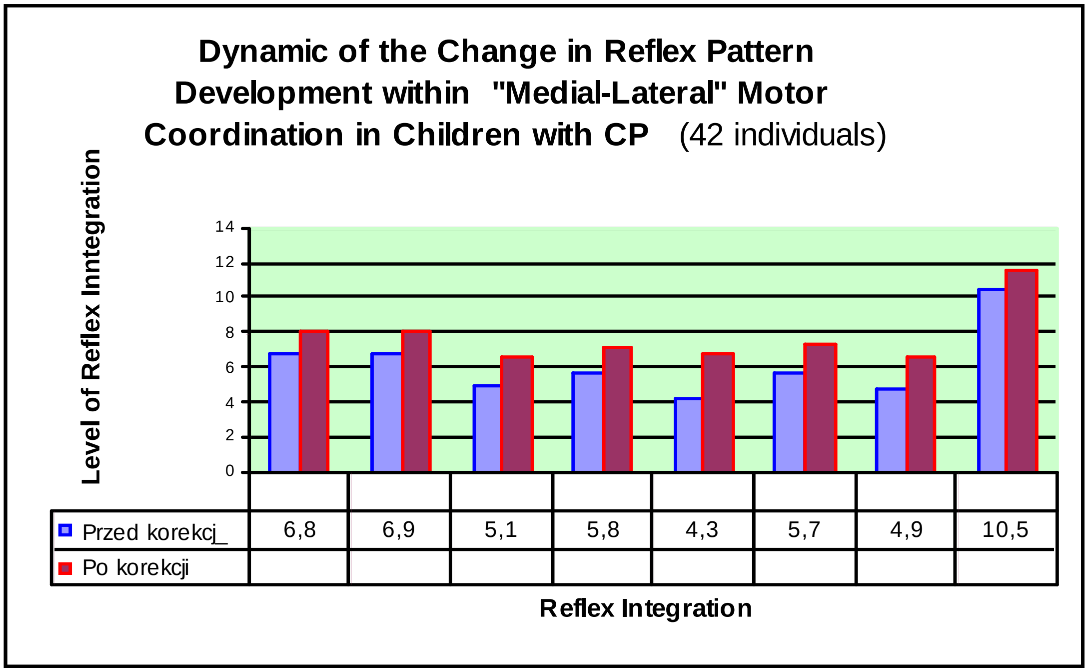


Figure 9. Dynamic of the Change in Reflex Pattern Development within "Medial-Lateral" Motor Coordination in Children with CP (42 individuals).

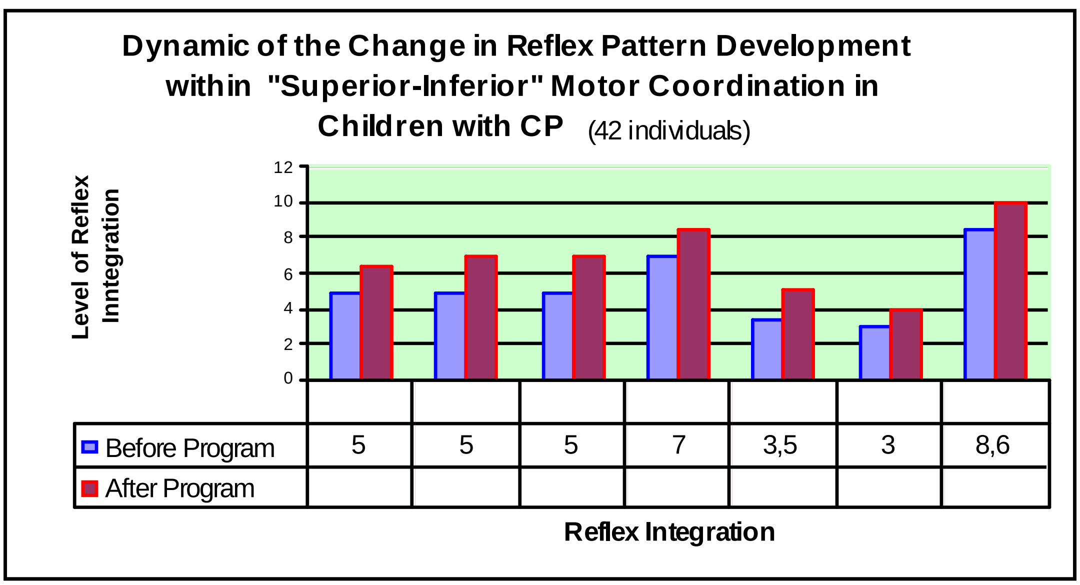


Figure 10. Dynamic of the Change in Reflex Pattern Development within **"Superior-Inferior"** Motor Coordination in Children with CP (42 individuals)

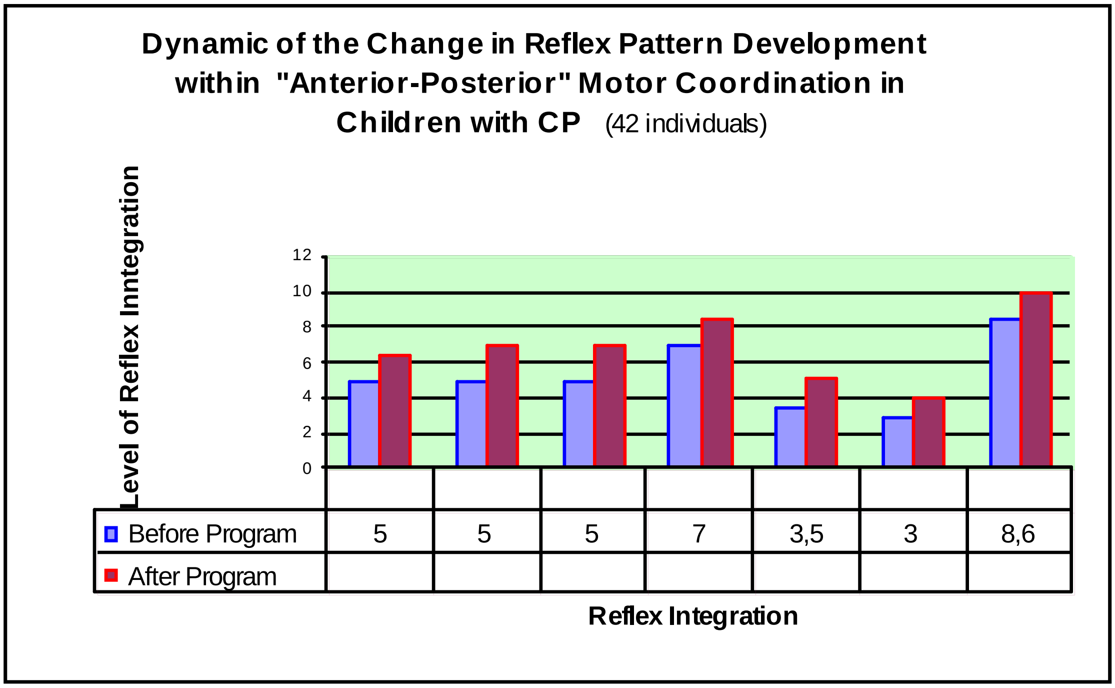
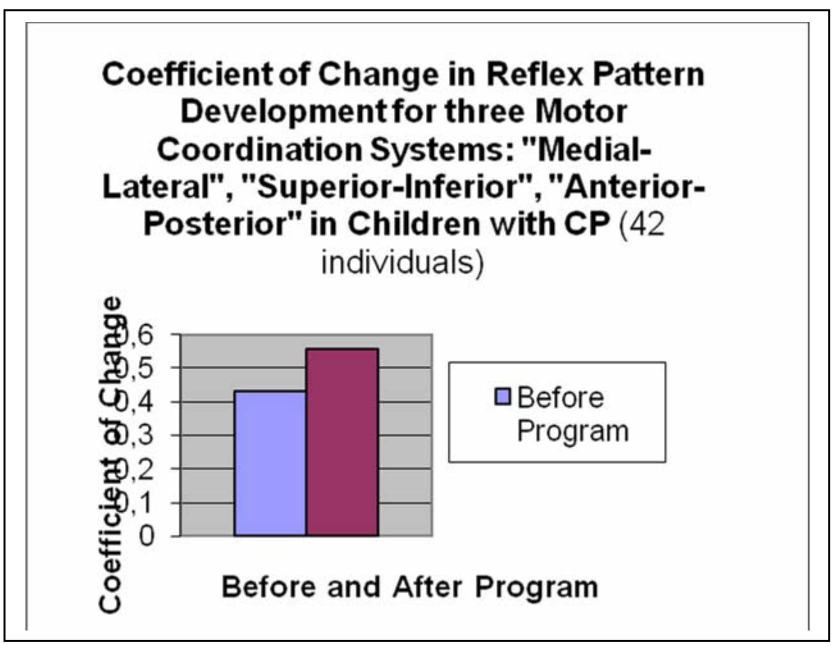


Figure 11. Dynamic of the Change in Reflex Pattern Development within **"Anterior-Posterior"** Motor Coordination in Children with CP (42 individuals)

Mathematical statistical analysis shows the high validity of our results: improved reflex pattern expression in children with CP after attending the MNRI™ program.



These scores reflect the whole group of children with CP. The coefficient of change is 0.43 before the MNRI™ Program and 0.56 after which supports a valid and significant change (Fig. 13).

The lineal error in projection of changes is not more than 1.87 – 2,82 %, again supporting the conclusion that the MNRI™ Program results in statistically significant changes in reflex pattern expression.

Figure 12. Coefficient of Change in Reflex Pattern Development for three Motor Coordination Systems: "Medial-Lateral", "Superior-Inferior", "Anterior-Posterior" in Children with CP (42 individuals).

Summary

Our program is designed to facilitate growth and potential in children and adults with challenges: CP (cerebral palsy), autism spectrum disorders (ADD, ADHD, LD, NLD, OCD, Asperger's, PDD, PDD-NOS, Autism), dyslexia and hyperlexia, genetic conditions, and FAS (Fetal Alcohol Syndrome). Our results demonstrate the importance and effectiveness of working with primary movements and reflexes and validate our understanding that these foundations of sensory-motor development powerfully influence all neuro-development.

MNRI™ interventions are based on the concept of reflex pattern integration as a prerequisite for motor development. Improved coordination among inborn neurological, sensory and motor components provides the foundation upon which reflex movements are integrated with intentional movements, learned motor skills and consciously controlled motor abilities in children with CP, as in all human beings. Our repatterning and relaxation techniques are designed to awaken latent genetic motor memory in the brainstem, so that it may serve as a resource for neural development. They involve natural movements and other non-invasive procedures that can easily be learned by parents, adults and professionals who work with challenged individuals. The techniques require few external resources and are compatible with other therapies.

Statistical analysis supports the effectiveness of the MNRI™ diagnostic protocol and validates the results of the therapeutic part of the program. Our work using the MNRI™ Method with children with CP demonstrates measurable results in reflex pattern expression, with these implications for primary motor system function: improved postural control, stability, and sense of equilibrium. This improvement in sensory motor function provides the neurophysiological support needed for development and learning.

The method is currently practiced by a growing group of professionals certified in MNRI™ by the International Dr. Svetlana Masgutova Institute (Poland) or the Svetlana Masgutova Educational Institute (USA). They obtain training through courses offered in the US, Canada, Poland and other international locations, with clinical experience gained in rehabilitation camps/clinics (www.masgutovamethod.com). Our hope is that MNRI™ will inspire widespread the creation of new programs and recognition of new developmental possibilities for all who desire to realize their full potential.

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