

# Reflex Integration of Children with Down Syndrome:

## MNRI® Assessment and Therapy Results

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**T**his article presents the study of the assessment and therapy results of 38 children with Down syndrome using MNRI® (based on the presentation by L. Sadowska, S. Masgutova, J. Kowalewska (2009), *Reflex Integration of Children with Down Syndrome; Diagnosis and Therapy Results Using Masgutova Neurosensorimotor Reflex Integration Program – MNRI®. International Scientific-Practical Conference - XXXII National Day of Child Rehabilitation: Down Syndrome. Treatment, Rehabilitation and Education. 17-18.10.2008*). Editing assistance was provided by David Miller (USA).

### Objective of Article

The objective of this article is to offer an appropriate support tool for new solutions based on the 'reason and cause' of the problems concerning the deficits and challenges of motor development in individuals with Down syndrome. Also, to document statistical research to verify that the functions of children with Down syndrome are improved and better facilitated by the use of the Masgutova Method® program, MNRI® processes. This article presents the results of MNRI® with 38 individuals with Down syndrome.

**Key words:** Children with Down syndrome, reflex integration, Masgutova Method®, MNRI® - Masgutova Neurosensorimotor Reflex Integration program, A. Krefft algorithm.

### Introduction

Down syndrome is a genetically originated developmental pathology involving multi-organ and multi-level human development dysfunction, occurring in 1 for 700 born neonates with increasing frequency in the last decades, due to advancement in medical sciences. Genetic disorders determine the set of symptoms of moderate or deep mental retardation, which affect development of different spheres of the child: psychosomatic,



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intellectual, emotional, social behavior, communication, and personality development. Down syndrome is a multiform disorder and any therapy program used should provide multidirectional support, according to the child's general genetic pathological mechanisms and their individual development. The current study demonstrates significant improvement of functioning of reflex patterns in children with Down syndrome as verified by mathematical statistical analysis. Presenting the model of the evaluation of reflex pattern development according to the mathematical statistical analysis by synthesized Z function by A. Krefft allows for an objective approach and scientific analysis of the effectiveness of the MNRI® program designed for 8 days at Therapeutic Rehabilitation Camps in Poland, Canada, and the US.

### ***Specifics of the Development of Children with Down Syndrome***

Down syndrome is a genetically determined, permanent, and incurable development disorder. However, the primary motor coordination disorders and acquired patterns can be improved or corrected (Sadowska, Masgutova, Kowalewska, 2009). Repatterning offers one such possibility. A priority in the purpose of MNRI® therapy is improvement of functioning of reflex patterns and their integration in a general child's static-motor system, facilitation of brain functioning plasticity, plasticity of neurodevelopment, and activation of the emotional, social, and cognitive processes.

Infant reflex patterns of a child with Down syndrome are usually developed poorly and it takes more effort and time to trigger and activate their functioning. The development of reflexes of these children is delayed. The reasons for this are some specific physical and somatic features as well as specific functioning of their central nervous system. Most children after birth have poor muscle tone control (hypo-tonicity), general flaccidity, lower muscle strength, and excessive/hyper motor rotation range in their joints. Characteristic physical features for Down syndrome can cause developmental dysfunctions and deficits in reflex patterns integration as well as a child's motor and cognitive functioning.

### ***About the MNRI® Program***

The MNRI® processes are designed for individuals with neuro-developmental disorders and aimed at improvement of their physical and cognitive functioning. The Masgutova Method® concept of neurosensorimotor reflex integration is based on the idea of awakening the latent brainstem genetic motor memory, so that it may serve as a resource for overall neuro-development.

The purpose of MNRI® processes is to support the reflex pattern's integration within the work of sensory and motor systems and brain functioning to facilitate a greater physiological foundation for appropriate human 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 a glimpse of one moment in a dynamic process. The Masgutova Method® defines specific reflexes and stages of development through the Assessment procedure and therapeutic intervention.

Nature gave every human motor reflexes as the response to sensory and proprioceptive/vestibular stimuli. These responses serve as a basis for neural and defensive mechanisms. Reflexes appear in the prenatal period and after birth. Thereafter, each reflex develops and matures through phases of integration supporting controlled motor coordination and higher sensory-psychical functions.

The concept of reflex pattern integration proposes the means for improvement through the use of primary motor patterns. These patterns present natural, genetically programmed, inner human resources. Integration of these reflex patterns takes place within three parts of the reflex circuit:

- sensory stimulation and identification/decoding of the stimulus by the nervous system and sense organs and transferring the stimulation through the afferent pathway to the brain
- brain information processing and recognition of the stimulus; filtering the information for brain strategy organization for protection and survival or for processing on the cognitive level
- motor reaction to a sensory stimulus, as a brain response coming through the efferent pathway.

### ***The Role of the MNRI® Program for Neurodevelopment***

Reflex as an automatic response presents inherent, genetically programmed motor activity to a sensory or proprioceptive stimulus. Every human, regardless of their health condition, has a system of primary movements and reflexes. In a definition of a reflex, MNRI® uses the physiological concept of conditional and unconditional activity of the nervous system.

Knowledge of reflexes, their structure, and developmental dynamic is very important. Functioning of reflexes is related to fight or flight and also freezing reactions. Those reactions are the basis of the body's protective and defensive mechanisms. In the case where these reflexes are poorly developed at their proper time or are immature, persistent, and inadequately active, they may cause deficits and pathologies in the motor system (genetically given or learned) at certain stages, and in the formation of cognitive abilities – processes of perception, focusing/attention, and thinking. Knowledge of this allows an understanding of the links between gross and fine motor and thinking processes, particularly to:

- choose a method of intervention for integration of the spheres to support development of voluntary control
- facilitate motor skills and their coordination with intellectual processes
- support formation of defensive reflexes for survival in stress or in a state of neurodeficit.

Properly matured and functioning defensive reactions determine proper neurodevelopment. The delay of reflex development restricts our behavior and thinking, and negatively influences the coordination of the sensory-motor-brain processing system at various developmental stages. In times of stress, events may cause the individual system to return to primary reactions: postural and motor patterns – reflexes.

The reflex naturally influences the formation of cognitive processes to a certain extent. It also forms the basics for individual motor development on a higher level of human functioning. Intervention therapy aimed at the correction of the reflex circuit components can bring improved results for the release of dysfunctions and improve various spheres of human functioning: motor development; functioning level for skills and abilities; and, emotional and intellectual abilities.

The information in this article offers an option for appropriate support tools to give new solutions based on the reason and cause of problems concerning deficits and challenges in motor development for individuals with Down syndrome.

Reflex integration Assessments help to explain specific disorders in the functioning of a reflex circuit. A detailed Assessment of a reflex pattern and its level of development and integration evaluates the following parameters: reflex pattern components: sensory perception, brain processing of the sensory stimulus, and motor response (the individual reactions for specific stimuli), latency (time after the stimuli influence, time of duration of the response; and other dynamic features), movement direction in the reflex pattern, strength of reaction, and locomotor or positional symmetry.

In order to determine the level of reflex pattern development, the MNRI® Assessment uses the criteria in points from 0–4 for each of five parameters (see the chapter, *MNRI® Assessment for Determining the Level of Reflex Development* in this book). If a reflex is in full integration – a maximum score of 20 points is possible. If the reflex is not fully developed and integrated, the score can fall in the following ranges: a) pathological and dysfunctional development from 0–10, and b) partly appropriate or completely developed and integrated state of patterns from 10–20.

The MNRI® processes demonstrate the basics of assessment and corrective procedures for the intervention of different motor patterns to support the following:

- developmental mechanisms presenting the proper defense reactions (Tendon Guard, Tonic, Antigravity, Grounding, and Hands Supporting Reflex patterns)
  - physical development (Spinal Galant and Spinal Perez Reflex patterns)
  - body posture, locomotion control, and coordination (postural reflex patterns)
  - cognition processes (Asymmetrical Tonic Neck, Pavlov Orientation, Auditory and Visual Reflex patterns)
  - listening and memory (Asymmetrical Tonic Neck, Pavlov Orientation, Auditory and Visual Reflex patterns)
  - proprioceptive system development (Tonic Labyrinthine, Symmetrical Tonic Neck, Trunk Extension Reflex patterns)
- body posture control related to binocular seeing and binaural hearing (Auditory and Visual Reflex patterns)
- perception for reading and writing (Robinson Hands Grasp, Hands Pulling, and Hands Supporting Reflex patterns)
- the motor aspects of writing and drawing skills.

Assessment procedures of the integration/non-integration of a reflex pattern are based on:

- features of defensive reflexes, as an automatic, unconditioned reaction for a certain stimulus. These reflexes stay in relationship with an individual's age, sensorimotor reflex integration maturity, dynamics of development, and reflex integration.
- occurrence of characteristic reflex components in a range of sensorimotor pattern properties, including: proper duration time, reaction strength, proper direction, and response symmetry. The matter of reflex integration is a key program idea.

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. Defined sensual or proprioceptive stimulation will produce a proper glandular response or motor reaction. This type of specific link, throughout the nervous system and between the sensory apparatus in a reflex circuit, is genetically conditioned.

If the sensory stimulus is not properly recognized by the sensory apparatus, it will result in an incorrect interpretation by the brain. Also, if the efferent nervous system conducts the command in an incorrect way, the development of the reflex pattern will be pathological, which means the development of the reflex and its integration with controlled movements will be delayed and inadequate. This fact is especially true in stressful situations or situations where the person is learning something new.

Every reflex appears at a certain time and develops its own basic pattern in three phases. The fourth phase of development is a period of change that prepares for the development of 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 task of reflex pattern development in successive phases is the basis of the creation of reflex pattern integration with new skills and movement capabilities. This serves as a foundation for new skills, including accomplishments at school like reading, drawing, writing, and math. 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 evident in the next level of development; the reflex will not develop an appropriately matured, neural network. Thus there will be dysfunctions or compensations rather than ideal patterns. The 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 the inhibition of a reflex. As it was mentioned before, attitudes differ considerably from traditional repression (inhibition) of a remaining, partial reflex.

### *Evidence and Methods of Research*

In this article, the results of the MNRI® Assessment and intervention for 38 children ranging from 6 months to 10 years of age, diagnosed with Down syndrome, are demonstrated. The children were participants of the MNRI® program aimed at the improvement of dysfunctional and pathological reflex patterns according to the following MNRI® programs: Neuro-Structural Reflex Integration, Tactile Integration, Dynamic and Postural Reflex Pattern Integration, Lifelong Reflex Integration, Proprioceptive and Cognitive Integration, Visual and Auditory Reflexes Integration, Oral-Facial Reflex Integration, Dance Therapy, Art Creation and Reflex Integration, and Archetype Movement Integration. These programs were facilitated by a group of professionals trained in the MNRI® program during organized therapeutic camps, and individual therapy with children with developmental deficits. Statistical analysis was carried out before and after 8 days of MNRI® programming, at the neurosensorimotor rehabilitation camps/clinics organized by the International Dr. Svetlana Masgutova Institute (Warsaw – Poland; San Francisco, New Jersey, and Florida – USA, and Vancouver – Canada).

An evaluation was conducted of 24 reflex patterns in three groups referring to the following body movement planes: sagittal, horizontal, and dorsal. Every reflex pattern was evaluated on a scale of 0–20 with regard to five parameters: reflex pattern, direction of movement, strength of reaction, timing of reaction, and symmetry. The testing within these parameters was done for each reflex pattern individually. The rating 10 on the scale determines the transition state in development of the pattern between its pathological/dysfunctional and normal state, whereas numbers from 15–20 represent normal functioning.

### Statistical Methods

**Measures.** The primary outcome of interest was change in the reflex patterns of the 38 children diagnosed with Down syndrome. Each of 38 study participants received a pretest at the beginning of an 8-day conference and a post-test at the end. Initial evaluations of motor and cognitive patterns considered the child's age, neurologic abnormalities, and status of inborn reflex patterns. This entailed assessing 24 reflex patterns (coded  $X_1$ - $X_{24}$ ) using five criteria: reflex pattern (or sensory-motor circuit), direction of a response (or movement), strength of reaction, time of reaction, and symmetry. Rating for each parameter was assigned on a scale of 0-4, with 4 indicating full display of a parameter, and 0 indicating the parameter's absence. This results in a maximum score of 20 for each pattern. Summary scores of 11-20 represent varying degrees of partially or fully integrated reflex patterns, scores 0-9 reflect varying degrees of abnormal development, and scores of 10 to 11.75 are intermediate. Scores 16-17.75 represent the norm. Reflex patterns were further categorized according to body movement planes. There were eight reflex patterns each corresponding to a plane of body movement: sagittal (medial-lateral), horizontal (superior-inferior), and dorsal (anterior-posterior) (Masgutova, 2011).

**Statistical analysis.** Results of the reflex pattern assessment completed on 38 children diagnosed with Down syndrome were analyzed based on the multivariable function  $z = f(x)$  of directly non observable phenomena. (Krefft, 2007). Briefly, this function estimates the level of the reflex pattern integration  $Z$  as a function of the entailed grading reflex patterns  $X_1, X_2, \dots, X_{24}$ , with the assumption that this is a linear function. So, variable  $Z_s$  (sagittal body plane) collects the information from the first 8 reflex patterns  $X_1, X_2, \dots, X_8$ , variable  $Z_h$  (horizontal body plane) describes the information from the second set of 8 reflex patterns  $X_9, X_{10}, \dots, X_{16}$  and variable  $Z_d$  (dorsal body plane) integrates the last 8 reflex patterns  $X_{17}, X_{18}, \dots, X_{24}$ . The level of the reflex pattern integration  $Z_c$  is estimated by all measured reflex patterns  $X_1, X_2, \dots, X_{24}$ . Mean values of  $Z_c, Z_s, Z_h$ , and  $Z_d$  were compared before and after 8 days of a MNRI® program using an ANOVA test (IBM SPSS Statistics Grad Pack 22.0). Results were considered statistically significant where  $p < 0.05$ .

### A Brief Description of the Reflex Patterns of 38 Children Diagnosed with Down Syndrome

The main feature of dysfunctional/pathological reflexes in children diagnosed with Down syndrome is the delay of their Tonic Reflex patterns. They inhibit formation of many other static postural dynamic reflexes, such as:

**Tonic Labyrinthine Reflex (TLR).** In a normally functioning infant/child, the prone position (lying down on their stomach) triggers the tone of flexors of the neck, abdominal muscles, and legs. When supine (on back) TLR also triggers the tone of extensors of the upper and lower limbs and also the trunk. TLR is active during the first 3-6 months of life and later must integrate with head and trunk righting and flexion and rotational movements. The development of this reflex in a child with Down syndrome is very poor, and typically extremely hypoactive. All of this blocks the muscle tone and postural control development resulting in a delay of the ability to roll over from their back to stomach and to support the trunk on their elbows in a prone and sitting-up position. This reflex also affects the tongue muscle tone regulation. With children with Down syndrome, the tongue is usually placed too much in the frontal part of the oral cavity, disturbing articulation formation. The delay of control of head righting affects the tone of extra-ocular muscles and causes dysfunctions in eye leveling (horizontal and vertical) limiting perception of surrounding objects. In the vertical position, they have hyper-rotation in their joints, and difficulties with muscular-proprioceptive control and spatial orientation.

**Asymmetrical Tonic Neck Reflex (ATNR)** is triggered by spontaneous turning of the head to the side. ATNR appears when the limbs extend on the side of the body on which the head is turned, and the limbs of the opposite side flex. This reflex is active up to 4-6 months of age and integrates with the intentional turning of the head around 6-7 months. Thanks to ATNR, the motor abilities of the left and the right body sides are developed. ATNR most actively helps with the exploration of the body midline (sagittal plane) functions. It stimulates development of the monaural and then, binaural hearing. During the next stage, this reflex helps the development of the STNR also. During 'the asymmetric period' of development, babies spend 80% of their time in the ATNR position. For a child with Down syndrome, poor muscle tone regulation and hypo-tonicity leads to limitation of ATNR pattern use – thus leading to a lack of head-core-trunk motor control, hand-eye coordination, and spatial orientation. This reflex especially creates the basis for left hemisphere functions and speech development – for the Wernicke Center to start decoding human speech (emotional and cognitive aspects), and for the Broca Center to code and express the child's first sounds and syllables at 6-9 months of the



life). As the child with Down syndrome demonstrates a considerable delay in development of this reflex, their phonemic auditory discrimination, speech formation, and comprehension processes are delayed.

*The Symmetrical Tonic Neck Reflex (STNR)* is stimulated by straightening the head of an infant lying on their abdomen which triggers the arms to straighten and the legs to flex automatically. It also occurs while flexing the head down to the chest, triggering the arms to flex and the legs to extend. This reflex develops actively around 6 months of age and integrates up to 10 months preparing the baby for the first creeping movements, and then to be able to stand and walk. A child with Down syndrome demonstrates significant delay in development of this reflex, as well as of muscular hypo-tonicity and postural control resulting in an inability to sit down and crawl on all fours. All this affects the formation of visual perception mechanisms (horizontal and vertical eye tracking, close-far vision, and visual adjustment to gravity changes in the body). The STNR of a child with Down syndrome is poorly developed. This leads to hyper-tonicity of the neck flexors (a tendency for a low or upraised head position). It negatively affects horizontal eye leveling and two-dimensional perception (e.g. for drawing, reading, and writing).

The intensive development of tonic reflexes of healthy children begins in the second month of life. For children with Down syndrome, tonic reflexes stay dysfunctional or pathological for a much longer time period. Their muscular hypo-tonicity creates excessive mobility of their joints, inhibiting the development of motor coordination and motor control.

### ***Antigravity and Rotational Reflexes***

*The Sequential Rolling Reflex* is triggered by the turning of the body, starting from the top (head ==> shoulder ==> pelvis ==> knee) when an infant is rolling over from back to front. This happens, thanks to the ability to rotate isolated horizontal parts of the body in the range of the neck, shoulders, and pelvis. This reflex develops actively from the fourth month and integrates at up to 10-11 months of age preparing the child for rolling over both ways, from back to front and vice versa. The development of this reflex for a child with Down syndrome is also delayed. They are not capable of rotating in a standing position or while walking, which challenges their equilibrium. The lack of proper development of this reflex causes a homolateral manner of walking for the child instead of cross-lateral walking.

*Hands Supporting Reflex* is an automatic response of the arms and hands to extend forward in the direction of the ground at the moment an individual loses the stable position of their body in space. This reflex integrates up to 6 months of life. It influences the development of the control of the upper part of the body, grounding, and stability. It also supports formation of 'hand-eye' coordination, close-far vision, self-defense abilities, and orientation in their own personal and interpersonal space. This reflex is delayed for a child with Down syndrome limiting the exploration of their personal space, demonstrating immaturity, infantile features, lack of ability to build communication, and causes dependency on another people. This reflex pattern is used in MNRI® as a corrective exercise for improving one's ability to protect their own personal boundaries.

The Hands Supporting Reflex of a child with Down syndrome typically stays dysfunctional or pathological. This results in muscular hypotonicity with excessive mobility of joints inhibiting the extension mechanisms, gravity, grounding, and stability, as well as, motor coordination and postural control.

*The Bauer Crawling Reflex* is activated by touch on the plantar surface of the feet of an infant lying down on their stomach with their head and trunk in the midline. This triggers the head to move up and initiates automatic cross-lateral crawling movements by pushing off by their feet. This reflex integrates at up to 4 months of life. For a child with Down syndrome, this creeping reflex develops later causing a delay in crawling on all fours, standing and walking, as well as, rolling over on their stomach and back. The Bauer Reflex influences development of reciprocal motor coordination. Creeping and crawling on all fours for the child with Down syndrome is usually homologous (appears to 'jump like a frog'). This can negatively affect motor coordination as well as their pace for perception, thinking, multitasking, and learning.

### ***Spinal Reflexes***

*Galant Reflex:* the linear stimulation along one side of the spine when a child is lying on their side causes the lateral flexion of the trunk on the same side. Sometimes the arm and leg abduction/extension occurs additionally. This reflex is active from the third and to ninth month. For a child with Down syndrome, this reflex is often hyper-sensitive and hyperactive. Together with muscular hypotonicity, this causes overall hypersensitivity to

touch for the body, as well as poor antigravity mechanisms, and thus lack of control of spine movements.

*The Perez Reflex* is a reaction to stroking the fingers along the spinal column in the direction from the sacrum to the neck causing the trunk and head to straighten in a posterior and inferior direction, resulting in the upper limbs abducting with flexion. This reflex is active from birth to 2-3 months of age. For a child with Down syndrome, this reflex is often oversensitive and hyperactive. In combination with hypotonic muscles, it leads to overall hyper- or hypo-sensitivity to touch and physical weakness, as well as, poor control of spine (lordosis-kypnosis) movements, and reactivity in movements and behavior.

The poor development of spinal reflexes negatively affects focusing, short and long term memory, and thinking processes (resulting in a lack of cause-and-effect thinking). Children with Down syndrome show a lack of persistence in focusing, motor reactivity, limited visual span, poor internal control, poor gross-motor coordination and walking patterns, as well as, emotional instability, and fear and phobias. Hyperactive Galant and Perez Reflexes can also cause hypersensitivity to tight clothes or belts.

### Manual Reflexes

*Hands Grasp Reflex* is a response to touch of the palm (at the base of the fingers) by closing the palm and fingers and holding them tightly while the stimulus is present. This reflex normally is reactive during the first week of life, then follows through seven developmental phases (phase 2 is a basically completely closed palm and phase 4 is the use of a 'hanging grasp' pattern), and integrates with manual abilities and skills at the end of the first year of life. For a child with Down syndrome, this reflex is hypoactive and, usually, strongly delayed. It influences the development of hand-eye and hand-mouth coordination, manual skills (for holding objects, manipulating them, taking and giving, and catching), and fine motor control of fingers and palms (for drawing, writing, playing with toys and objects). Delay of this reflex causes an inability or refusal to do activities requiring precision and fine motor control. It also affects the development of speech and communication.

### Visual and Auditory Reflexes

Visual and Auditory Reflexes affect horizontal eye tracking, convergence/divergence, ocular-vestibular, vestibular-ocular, ocular-kinetic; stapedius-acoustic, and sound localization (directional) skills.

*Eye Tracking Reflexes* in a child with Down syndrome are usually hypoactive and immature. Chaotic eye movements, poor eye mobility, and problems with sight make visual focusing impossible or cause the ignoring of visual objects. Immature eye tracking leads to the use of too much head righting, which means the lack of freedom of all horizontal planes of the body, and rigidity of the body within the sagittal body plane.

*Vestibular-Ocular Reflexes* (horizontal and vertical) support stability of visual images created due to the movement of their eyes in the opposite direction of head movement. For a child with Down syndrome, we observe rigidity, the lack of equilibrium, hyper- or hypo-active physiological nystagmus, and poor vestibular-visual coordination leading to visual and proprioceptive disorientation.

*Convergence/Divergence Reflex* responses for bringing the eyeballs close together (to see close objects) and apart (for distant objects) often are delayed in children in this group. Bringing their eyeballs together is especially challenging because of the genetic physical features of their face (more flat), and location of their eyes (more distant and lateral) which affects their visual cognition (focusing, decoding, and analysis). Divergence can cause too much separation of the eyes and an inability for proper peripheral vision. Convergence/divergence affect the visual perception and cognition of the world. In children with Down syndrome these reflexes are delayed in development, leading to poor eye mobility, and poor visual analysis and comprehension, to a certain extent.

*The Stapedius Acoustic Reflex* also affects sound localization/direction. The Stapedius Acoustic Reflex (triggered by the contraction of the stapedius muscle in the middle ear) is an involuntary response to auditory stimuli of high frequency. At the time of exposure to the high frequency sounds, this reflex reduces the vibration of the cochlea and is used for sound perception and processing by the brain. The Stapedius Reflex is usually stimulated only by intense sounds; its activation at low sound frequency can lead to auditory dysfunctions – lack or loss of hearing, poor auditory decoding, or discrimination. Children with Down syndrome often have a hypo- or hypersensitive Stapedius Reflex leading to their 'ignoring' an auditory stimulus, possible self-stimulation (closing their ears, talking to themselves, or constant vocalizing), overall poor muscle-tendoneous tone, and excessive loosening of the jaw.

*Pavlov Cognitive Orientation Reflex* is caused by a new bright or interesting stimulus or its qualities. It is seen in a variety of reactions such as, head and eye movement toward the stimulus/source of information, change in breathing rhythm, increase in muscle tone, and cognitive reactivity (cortex activation, dominance of beta and alpha high frequency brain waves). The sensory component of this reflex leads to an increase of visual-auditory focusing, decoding and analysis, and a decrease in the sensory threshold ('protection'). The novelty, which triggers sensory-cognitive activity within the Pavlov Reflex in a child with Down syndrome is poorly developed in infancy and thus causes a delay in whole cognitive development at its later stages. The demands to learn at home and at school often causes stress and the child may refuse to participate in learning activities, have low learning motivation, and defensive reactions toward learning.

### **Oral-Facial Reflexes**

*The Sucking Reflex* is triggered by tactile stimulation in the oral cavity, especially the tongue and upper hard palate closer to the soft palate. The response is a sequential and rhythmical retraction of the tongue and cheek muscles and muscles around the soft palate and deep mouth cavity followed by swallowing and breathing (inhale-exhale) regulation. This reflex was originally connected with a survival function (the nutritional need). It gives the feeling of comfort and relaxation. The Sucking Reflex of a child with Down syndrome is often poor as they have lack of muscle tone and poor coordination for swallowing and breathing. This leads to difficulty for the child in eating and drinking well, as well as, regulation of satiation. This reflex can also affect the feeling of being content and bonding, which, in turn, influences communication.

*The Babkin Palmomental Reflex* is triggered by pressing the middle of the palms resulting in the mouth opening and the head flexing and moving down and forward. This reflex develops actively during the first months of life and integrates with 'hand-mouth' coordination around the fourth month. A child with Down syndrome usually has a very poorly developed and pathological Babkin Reflex. Dysfunctional oral-facial morphology results in pathologies of this reflex (open mouth, poor tongue posture and coordination, and increased salivation). This reflex influences the development of other reflex patterns concerned with eating, articulation, and speech formation. Dysfunction in this reflex and the developmental pathology of a child with Down syndrome is significant.

Our reflex Assessments of children with Down syndrome show a multi-dysfunctional nature of development in combination of poor reflex pattern and genetic disorders, which, at the same time, differs from child to child. This is why the knowledge of an overall reflex profile and individual differences in them can help to create an individualized MNRI® program for a child with Down syndrome. MNRI® techniques are directed toward correction of disorders, improvement of sensory-motor dissonance, neuro-facilitation of reflex circuits, integration of tactile, visual, auditory, vestibular, and proprioceptive senses.

Down syndrome is a permanent and incurable disorder, but their primitive and voluntary motor activity can be improved significantly. The work of 'remodeling' reflex patterns is one of such possibilities. As Down syndrome is a polymorphic disorder, the therapy program should be of multi-directional character and provided in accordance with genetic pathological mechanisms including individual developmental specifics for each child. A priority goal of MNRI® therapy for a child with Down syndrome is to improve their overall neuro-development, emotional, social, and cognitive functioning through reflex integration.

### **Results and Discussion**

The results of Assessments of the level of development/integration of each of the 24 reflex patterns (in points from 0–20), presented as the qualities  $X_1$ – $X_{24}$  of children with Down syndrome at the beginning and after the MNRI® program are shown in Table 1.

Table 1 shows the results of changes in the level of reflex pattern integration of 38 children diagnosed with Down syndrome after completing treatment at a 8 day MNRI® camp. The information in this table demonstrates a positive change for all reflexes. This data, as given in the examples, suggests the results of statistically important validation of the synthesized function  $z = f(x)$  and a high degree of effectiveness for the MNRI® process applied to children with Down syndrome during this time of intervention. Each parameter (x) shows the level of development of the specific pre and post Assessment of the given child.

Analysis of the level of development/integration of all 24 reflex patterns was carried out, and it has been described using function  $Z_c$  and three functions for systems in planes A, B, and C. (A – Sagittal, B – Horizontal,



C - Dorsal). Results are shown on graphs and statistical verification in tables, based on both before and after the MNRI® program.

The level of changes in development of all the examined reflex patterns is illustrated in Figure 1. There we see the results of synthesized information of all the diagnostic qualities ( $X_1$ – $X_{24}$ ). In Figure 1, the 24 reflex patterns of children with Down syndrome within different planes of body symmetry and movements are presented as follows:

A) Sagittal: 1) Robinson Hands Grasp, 2) Hands Pulling, 3) Babkin Palmomental, 4) Babinski, 5) Leg Cross Flexion-Extension, 6) Asymmetrical Tonic Neck, 7) Abdominal, 8) Bonding

B) Horizontal: 9) Thomas Automatic Gait, 10) Bauer Crawling, 11) Moro, 12) Fear Paralysis, 13) Hands Supporting, 14) Segmental Rolling, 15) Landau, 16) Flying and Landing

C) Dorsal: 17) Trunk Extension, 18) Symmetrical Tonic Neck, 19) Spinal Galant, 20) Spinal Perez, 21) Tonic Labyrinthine, 22) Foot Tendon Guard, 23) Spinning, 24) Pavlov Orientation

Figure 1 illustrates the pathology and dysfunction of the 24 reflex patterns and shows the synthesized function Z. It illustrates the level of pattern development before and after the MNRI® program. After the program we still observe dysfunction and pathology in 15 reflex patterns. However, we also see significant positive changes and improvement in motor development overall. The comparison of the results before and after MNRI® intervention shows a significant difference at the level of  $p < 0.001$ .

See Table 2 for the  $Z_c$  synthesized function of the level of development/integration of reflex patterns in all body movement planes described as qualities from  $X_1$ – $X_{24}$ . Children with Down syndrome demonstrate poor maturation or immaturity. They also have dysfunction and pathology of a wide variety of reflex patterns. Particularly, they show developmental deficits for such reflex patterns as: Babkin Palmomental, Robinson

Diagnostic Quality/ Feature	Body Movement Plane	Reflex Pattern	Assessment Before Program	Assessment After Program
X1	A	Robinson Hands Grasp	6.4	8.2
X2	A	Hands Pulling	8.4	9.2
X3	A	Babkin Palmomental	4.5	5.4
X4	A	Babinski	6.7	7.3
X5	A	Leg Cross Flexion-Extension	5.5	6.9
X6	A	Asymmetrical Tonic Neck	6.7	7.4
X7	A	Abdominal	8.2	10.4
X8	A	Bonding	12	13.2
X9	B	Thomas Automatic Gait	8.8	9.3
X10	B	Bauer Crawling	6.5	9.4
X11	B	Moro Embrace	11	13.2
X12	B	Fear Paralysis	12	13.4
X13	B	Hands Supporting	8.3	8.9
X14	B	Segmental Rolling	7.2	8.1
X15	B	Landau	6.4	7.2
X16	B	Flying and Landing	5.2	5.8
X17	C	Trunk Extension	8.2	8.8
X18	C	Symmetrical Tonic Neck	6.3	8.4
X19	C	Spinal Galant	8.3	11.2
X20	C	Spinal Perez	11	12.3
X21	C	Tonic Labyrinthine	9.2	11.2
X22	C	Foot Tendon Guard	8.1	10
X23	C	Spinning	8.3	12.4
X24	C	Pavlov Orientation	6.6	6.8

Table 1. Changes in the level of average reflex pattern integration for 38 children with Down syndrome before and after completing treatment at MNRI® camps.

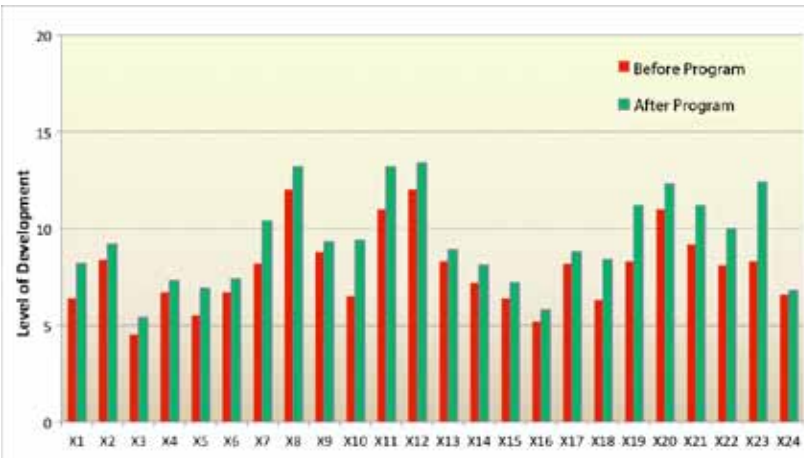


Figure 1. Graph of diagnostic results of the level of development/integration of each of the 24 reflex patterns (in points from 0–20) of 38 children with Down syndrome at the beginning and after the MNRI® program.

Hands Grasp, Sequential Fingers Opening and Closing, Hands Pulling, Leg Cross Flexion-Extension, Symmetrical Tonic Neck, Bauer Crawling, Moro, Thomas Automatic Gait, Segmental Rolling and Spinning, Asymmetrical Tonic Neck, Spinal Galant, Spinal Perez, Fear Paralysis, and Pavlov Orientation. The reflexes of a child

with Down syndrome emerge and develop with delay. They are disharmonious in their development. The sensory system of some reflex patterns is hypersensitive and others are hyposensitive. This is seen in reflex responses, accordingly, as hyperactivity and hypoactivity. Poor and inadequate development of reflexes in these children is the result of genetic deficits inhibiting and blocking their motor and cognitive development.

The comparative analysis of the level of development/integration of reflex patterns in this group of 38 children with Down syndrome occurring before and after the MNRI® program is presented in the following three figures. A reflex Assessment was done for each of the 38 children. The detailed analysis of the level of development/integration of the reflex patterns in the three body movement planes is presented in Figures 2–4 with statistical results given in Tables 3–5.

Figure 2 shows the dynamic of the changes in the development of reflex patterns grouped within the Sagittal Plane. The resulting statistic analyses are presented in Table 3.  $Z_s$  represents the synthesized function of the level of reflex integration within plane A – Sagittal described as diagnostic qualities from  $X_1$ – $X_8$ .

Figure 3 shows the dynamic of the changes in the development of reflex patterns grouped within the Horizontal Plane. The resulting statistic analyses are presented in Table 4.  $Z_H$  represents the synthesized function of the level of reflex integration within plane B – Horizontal described as diagnostic qualities from  $X_9$ – $X_{16}$ .

Reflex patterns found in the Dorsal body movement plane are noted with a high degree of integration and indicates an improvement of psychomotor skills verified as statistically important. This result is illustrated in Figure 4 and Table 5.  $Z_D$  represent the synthesized function of the level of development and integration of the reflex patterns in plane C – Dorsal described as diagnostic qualities from  $X_{17}$ – $X_{24}$ .

The statistical analysis shows a high validity of the results that the MNRI® intervention demonstrates improved reflex pattern expression in children with Down syndrome after 8 days of therapy. The results indicated in the previous graphs and charts demonstrate the improvement in development of reflex patterns in the control research. The average value of the synthesized function  $Z_c$  for the whole group of children with Down syndrome shows the change in the coefficient from 0.3924 before program, to 0.6038 after 8 days of MNRI® techniques. Lineal function with possible deviation of the Method is 2.82%. This result indicates a high level of accuracy and validity of the MNRI® processes diagnosis and therapy.

Quality Group	$Z_c$			ANOVA Test
	Average	N	Stand. Error/deviation	
Before	0.3924		0.1884	$p < 0.001$
After	0.6038		0.1790	
Total	0.4981		0.2113	

Table 2. Statistic verification of the value of average functions and synthesized  $Z_c$  described as qualities from  $X_1$ – $X_{24}$  in research of 38 children diagnosed with Down syndrome before and after 8 days of MNRI® intervention.

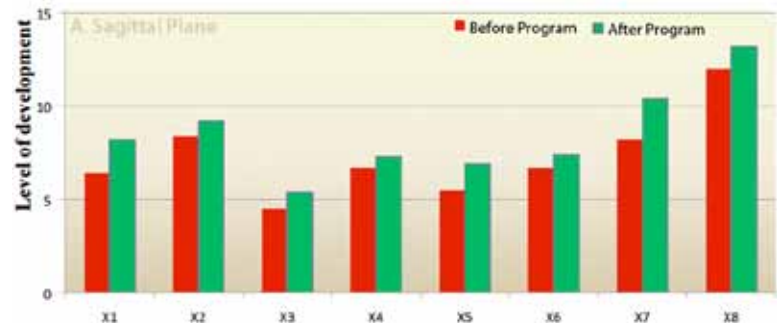


Figure 2. The dynamic of change in the development of the eight reflex patterns of these 38 children with Down syndrome in body movement plane A – Sagittal: 1) Robinson Hands Grasp, 2) Hands Pulling, 3) Babkin Palmomental, 4) Babinski, 5) Leg Cross Flexion-Extension, 6) Asymmetrical Tonic Neck, 7) Abdominal, 8) Bonding.

Quality Group	$Z_s$			ANOVA Test
	Average	N	Stand. Error/deviation	
Before	0.4083	38	0.1890	$p < 0.001$
After	0.5912	38	0.1940	
Total	0.4998	76	0.2113	

Table 3. Statistical verification of the value of average functions and synthesized  $Z_s$  described as qualities and features from  $X_1$ – $X_8$  in research of the 38 children diagnosed with Down syndrome before and after MNRI® intervention.

The Masgutova Method® program supports optimal function of the motor, tactile, visual, and auditory systems. This program differs from others in that it 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. MNRI® integrating techniques and exercises are aimed at facilitation and maturation of “neurological pathways” corresponding to specific reflex patterns (Pavlov, 1960; Setchenov, 1960). The program proposes non-invasive gentle movements and playful exercises which can be learned by parents of challenged children, adults, and professionals who work with challenged individuals. These techniques require few external resources and can be used in conjunction with other therapies. The results as highlighted in the above tables and charts demonstrate the significant power of the MNRI® processes which assist in the sensorimotor integration of dysfunctional reflex patterns and facilitate the maturation of these reflex patterns for natural development of the body-mind system for self-regulation of motor patterns. The neuro-facilitation of the genetic developmental motor system supports improvements in the balanced and higher developmental functioning of the motor functioning of children with Down syndrome, independently of their chronological age. The positive results in the integration of the reflexes of the motor sphere directly influence the development of the intellectual sphere (organization of attention span, memorizing, and thinking).

### Summary and Conclusion

The Masgutova Method® is designed to facilitate the growth and potential of children or adults with challenges. This article provides the results of MNRI® Assessments and corrective therapy with children with Down syndrome. The children were participants of a 8 day MNRI® Intensive intervention aimed at the improvement of dysfunctional and pathological reflex patterns.

The interpretation of these results, based on scientific analysis giv-

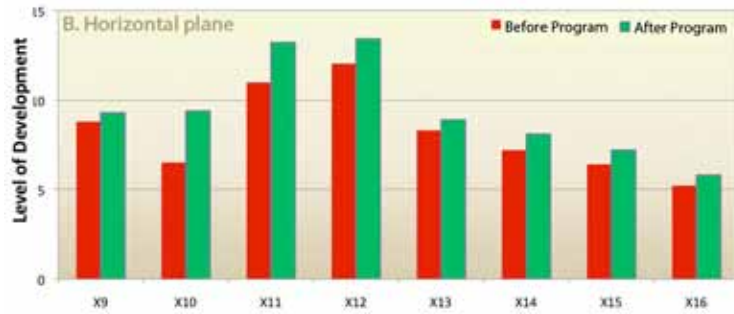


Figure 3. The dynamic of change in the development of eight reflex patterns of 38 children with Down syndrome in plane B - Horizontal: 1) Thomas Automatic Gait, 2) Bauer Crawling, 3) Moro, 4) Fear Paralysis, 5) Hands Supporting, 6) Segmental Rolling, 7) Landau, 8) Flying and Landing.

Quality	$Z_H$			ANOVA test
Group	Average	N	Standard error/deviation	
Before	0.3861	38	0.1792	$p < 0.001$
After	0.6088	38	0.1754	
Total	0.4974	76	0.2088	

Table 4. Statistical verification of the value of average functions and synthesized  $Z_H$  described as qualities from  $X_9 - X_{16}$  in research of the 38 children with Down syndrome before and after MNRI® intervention.

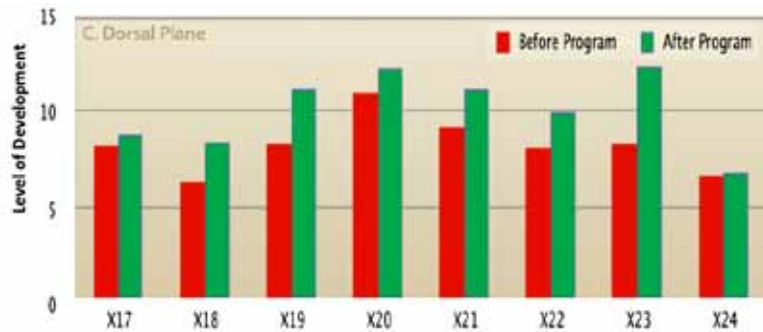


Figure 4. Dynamics of changes in development of eight reflex patterns of 38 children with Down syndrome in plane C - Dorsal: 1) Trunk Extension, 2) Symmetrical Tonic Neck, 3) Spinal Galant, 4) Spinal Perez, 5) Tonic Labyrinthine, 6) Foot Tendon Guard, 7) Spinning, 8) Pavlov Orientation.

Quality	$Z_D$			ANOVA Test
Group	Average	N	Standard error/deviation	
Before	0.4135	38	0.2076	$p < 0.001$
After	0.5849	38	0.1853	
Total	0.4992	76	0.2136	

Table 5. Statistical verification of the value of average functions and synthesized  $Z_D$  described as qualities from  $X_{17} - X_{24}$  in research of 38 children diagnosed with Down syndrome before and after the MNRI® intervention.

en within this article indicates improvement in the development of reflex patterns of the children diagnosed with Down syndrome. The average value of the synthesized function  $Z_c$  for the whole group of 38 children with Down syndrome demonstrates the change in coefficient from 0.3924 (before the therapy) to 0.6038 (after 8 days of MNRI® process interventions). Lineal function with possible error/deviation of MNRI® is 2.82%. These results indicate a high level of accuracy, validity, and effectiveness of the MNRI® processes with this specific group of Down syndrome children. The results of the MNRI® program with these children show the importance of appropriate corrective procedures directed at the level of motor reflexes.

The aim of rehabilitating children with Down syndrome using MNRI® corrective techniques and exercises is to activate the proprioception, tactility, and hearing-vision system for optimal motor function. This concept differs from others in the way that it draws on neurosensory-motor integration of reflex patterns instead of inhibiting them when they are preserved and active. MNRI® also draws on the integration of reflexes and their basic motor patterns (genetic 'programs' with learned and controlled movements, habits, and skills). The exercises and corrective movement activities are formation and maturation oriented, which means facilitation of impulse transmissions along nerve pathways and coordination of reflex patterns. The program includes exercises that facilitate reflex patterns are noninvasive, delicate, and child-friendly, as well as, fun movement activities. They are easy to learn by parents, caregivers, and professionals working with children with Down syndrome.

The level of reflex integration is presented with a synthetic function  $Z$  based on a mathematical model, which allows for an objective evaluation and analysis of the efficacy of this corrective 8 day MNRI® rehabilitation program used with children with Down syndrome. The parents' reports and the therapists' observations were positive, noting functional improvements of the children. Statistical tools and mathematical analysis according to Prof. Anna Krefft allowed for an objective evaluation of the outcome and provided the following:

Children diagnosed with Down syndrome need early intervention based on the MNRI® processes to start as soon as possible for the correction of dysfunctional and pathological reflexes which otherwise serve as the basis for the Down syndrome child's development of postural control, overall postural and motor development, fine motor coordination, speech and thinking processes, and learning skills.

Children having Down syndrome need a total program of intervention at the neurosensorimotor integration level for the correction of primary motor system and reflex patterns that are poorly developed. MNRI® processes are composed for that purpose, and were realized by MNRI® professionals during the 8 days of direct intervention with these children.

The results of mathematical and statistical analyses prove the high level of validity of diagnosis techniques with the Masgutova Method®, as well as, the intervention processes and procedures aimed at the correction of deficits in the Down syndrome children's primary motor system and cognitive functioning.

The use of the Masgutova Method® opens new possibilities for triggering natural, genetically given motor memory resources of children with Down syndrome and supports, through the use of the neurosensorimotor reflex integration procedures, reflex circuit functioning, and consciously learned motor system.

The Masgutova Method® offers a strong support for creation of new developmental possibilities and programs for Down syndrome children that can be applied in conjunction with other therapies. The Masgutova Method® demonstrates the primary importance of addressing reflex patterns to support the development and function of motor and cognitive systems. Statistical analysis has supported the effectiveness of the MNRI® diagnostic protocol and validates the results of the therapeutic part of the program.

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Dear children, thank you for your participation in our research, you were so great! Thank you for your great results! Be healthy and reach even better results in your learning and life! – Authors