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Reflex Profile of Children with Down Syndrome Improvement of Neurosensorimotor Development Using the MNRI® Reflex Integration Program

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Abstract

A reflex profile of children with Down Syndrome (n=48) has been created based on an Assessment of their reflex patterns. This profile and its analysis demonstrate that dysfunctional patterns intrude upon the neurodevelopment of children in this group significantly, and cause more delays in their neurosensorimotor integration, motor coordination, and other areas.

The MNRI® (Masgutova Neurosensorimotor Reflex Integration) therapy modality which comprises of techniques and exercises of repatterning, was used for children participating in this research. It has proved its optimizing effect on sensory (tactile, visual-auditory) perception, motor programming and control, and proprioceptive awareness.

The MNRI® concept of reflex integration differs from other traditional theories of reflex inhibition/extinction of retained reflexes. The MNRI® approach with immature or dysfunctional reflex circuits is based on activating the sensory-motor patterns encoded in a human nervous system on the genetic level. Non-invasive exercises and techniques in the MNRI® Program are aimed at the development of proper connectivity between sensory and motor neurons in neurophysiological circuits, and at strengthening and coordinating the links between different reflex patterns. The MNRI® process proposes exercises that remind the body-brain system of reflex patterns in a delicate and safe way, sometimes through the use of games and play. These techniques can be easily used by parents, caregivers, and specialists working with Down syndrome children.

Statistic analysis of five paramers of a reflex pattern: sensory-motor coordination, direction of a response, intensity (muscle tone regulation), latency/dynamics, and symmetry before and after the MNRI® therapy process (based on synthesized Z function; A. Krefft algorythm) allowed for an objective scientific approach of the effectiveness of the MNRI® processes. The therapy program and evaluations were conducted during 11 day therapy-rehabilitation camps with 48 children from different countries (Poland, USA, Canada, and Russia). The feedback reports by parents and specialists on the motor and cognitive function changes in children with Down syndrome after the MNRI® program show certain improvements.

Keywords: Children with Down syndrome; Reflex integration; MNRI® - Masgutova neurosensorimotor reflex integration program; A. Krefft algorithm

Objective of article

The objective of this article is to: 1) Offer a support tool as a new solution based on the 'reason and cause' of problems resulting in sensory-motor and neurodevelopment deficits and challenges in Down syndrome children and 2) To document statistical research which verifies that functions in children with Down syndrome can be improved by the use of the MNRI® program.

Introduction

Down syndrome is a genetically originated a multi-organ and multi-level human developmental pathology occuring in 1 per 700 births with an increasing frequency [1-3].

Genetic disorders determine a set of symptoms resulting in moderate to deep mental retardation which affect the children by delays in psychosomatic, intellectual, emotional, social behavior, communication and personality development [4-10].

The current educational and psychological intervention methods available for children with Down syndrome are directed toward optimizing their developmental, psychomotor, and cognitive resources [2,11-13]. Methods of early childhood intervention, applied from birth, have a huge influence on brain plasticity and development in children with Down syndrome [12,14,15].

In this article the MNRI® (Masgutova Neurosensorimotor Reflex Integration) program of early intervention is presented (http://www.MasgutovaMethod.com). The purpose of the program is to improve dysfunctional reflex patterns that delay the development of higher level motor skills and coordination systems of the children, and later, adults. Work with dysfunctional reflex patterns is directed to the following levels of integration:

- Sensorimotor – to provide correct neurological functioning of a certain reflex circuit

- Reflex patterns with controlled motor skills and abilities

- Locomotor and cognitive processes.

Children with Down Syndrome-specifics of Their Development

Down syndrome is a genetically determined, permanent, and incurable development disorder. However, the primary sensory-motor coordination disorders and acquired patterns can be greatly improved or corrected. Repatterning is one such possibility for correction. Down syndrome as a multiform disorder should be improved in a multidirectional way, according to general genetic pathological mechanisms and the individual development of the child [1]. Many methods and techniques should be taken into consideration within general neurodevelopmental processes and neurophysiological rules [4]. The implementation of MNRI® intervention procedures offers a system to improve the functioning of reflex patterns and their neurological circuit development [16], and the corresponding regulation of behavioural, emotional, social, and cognitive processes.

The reflex patterns of an infant with Down syndrome are usually poorly developed [3,17] and these patterns take more effort and time to trigger and activate. The development of reflexes in these children is delayed and caused by some specific physical and somatic features as well as specific functioning of their central nervous systems. Most infants after birth have poor muscle tone control (hypo-tonicity), general flaccidity, lower muscle strength, and excessive/hyper motor rotation range in joints [3,14,15].

Characteristic morphology features for Down syndrome children can cause developmental dysfunctions and deficits in reflex pattern integration and in their motor and cognitive sphere.

Physical and psychosomatic features or so called dysmorphic disorders and abnormalities are typical for all children with Down syndrome. It depends on the level of severity of pathology, and can negatively influence the proper reflex pattern development and integration [3,4,14,18-22].

The ®Program Background

The MNRI® Program-goals, strategies, experience

The MNRI® (Masgutova Neurosensorimotor Reflex Integration) processes are designed for individuals with neuro-developmental disorders and aimed at the improvement of their sensory-motor integration, motor coordination, and cognitive development. Its concept is based on the idea of awakening the latent brain stem genetic sensory-motor memory, so that it may serve as a resource for neurodevelopment further on.

The purpose of MNRI® is to support the reflex pattern's integration within the process of sensory and motor systems and brain functioning to facilitate the most physiological base for appropriate overall 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 (18-22). This program defines specific reflexes and specific stages of their development.

The MNRI® program consists of two basic elements:

A) Assessment of reflex patterns

B) A corrective program for facilitation of the reflex patterns improving sensory-motor connectivity and neurodevelopment [23-25].

Nature gave every human 'ready-made' sensory-motor patterns – reflexes – as the response to sensory/proprioceptive /vestibular stimuli to complete a two-folded task – as a defensive mechanism and as the support for neurodevelopment [26]. The reflex appears in the prenatal period and after birth continues to develop, mature, integrate, and become a subordinated structure facilitating the sensory-motor programming, planning, and control for higher psychical and cognitive functions [18,19,27,28].

Integration of the reflex patterns takes place within the three transitions of the reflex circuit: a) the sensory aspect transfers the input through the afferent pathway to the central nervous system/brain; b) processing of the input by the central nervous system/brain for decoding or recognition of the stimulus; 'filtering' the information for protection and survival in case of 'danger', or for analytical processing at a higher cognitive level; c) motor response following via the efferent pathway [19,21,29-31] (Chart 1).

The MNRI® Method is based on research led by Dr. Svetlana Masgutova and her MNRI® Team. During the last 20 years they have conducted International Rehabilitation Camps in Poland, USA, and Canada. Individuals with developmental challenges from age 1–18 years old are the focus of the camps. Over 3,650 children have participated in this research through medical and psychological examzination, educational tests, and by receiving the MNRI® Assessment and therapy program [24,25].

Neurophysiological bases of the MNRI® therapy program

Reflex is an automatic response of the nervous system to a sensory stimulus from the external environment (sound, light, touch, smell) or internal environment (changes of blood chemistry, irritation of internal organs, etc.) designed for facilitation of protection and survival in specific conditions [19,29,30]. As an automatic response it presents inherent, genetically programmed motor activity in form of a muscle contraction (causing an action or gland secretion (saliva or gastric juice, etc). Every human, regardless of their health condition, has a system of primary movements and reflexes [19,29,30].

Reflex as a 'program' for survival, it is affected by neurodeficits to a certain degree as the deficit holds back the chronological development of sensory-motor processes and other functions. Thus reflexes in children with Down Syndrome, according to our resupposition, can be affected by overall delays and dysfunctions on a biological level causing more challenges on a higher level of development – behaviour regulation, emotional maturity, and control of physical and cognitive functions.

The role of MNRI® - sensorimotor reflex integration program for neurodevelopment

The knowledge of reflexes, their structure, and developmental dynamic is very important. The functioning of reflexes is related to fight and flight and freezing reactions [19,29,30]. Those reactions are the basis of the body's protective defensive mechanisms.

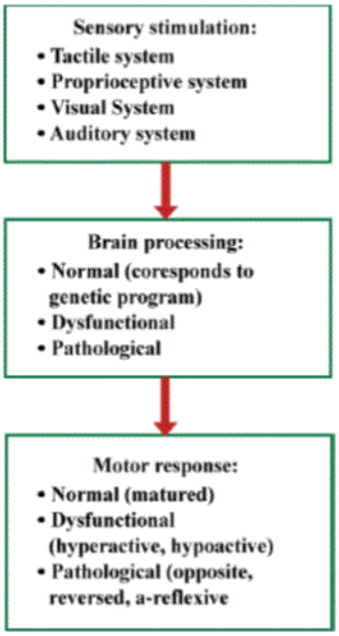


Chart 1: Aspects of sensory motor integration within a reflex circuit.

In the cases where these reflexes are poorly developed at the correct time and are immature, persistent and inadequately active, they may cause deficits and pathologies in the motor system (genetically given or learned) at certain stages, and formation of cognitive abilities – processes of perception, focusing attention, and thinking. Knowledge about this allows understanding of the colligation of gross and fine motor coordination and thinking processes to obtain:

- Stimulation of integration in consensual and volatile type responses.

- Formation of motor skills and their influence on intellectual processes.

- Formation of defensive reflexes, which can help an individual to survive in stress.

Matured and properly functioning defensive reactions determine proper neurodevelopment. In children with Down Syndrome reflexes fulfilling the protective role are delayed which restricts their behavior, thinking, and negatively influences the coordination of the sensory-motor and brain processing system at various developmental stages [13,24,25]. In events of stress the individual system regresses back to a reactive state typical for an infant and young child when the sympathetic nerve system is dominant (reactive, dependent on external stimuli, impulsive, and lack of regulation and inner control). Poorly developed reflexes naturally influence the cognitive sphere through gross and fine motor coordination involving higher level of brain functioning.

Material and Methods

Study design and study groups

This study shows data on Reflex Profiles in 48 children (6 months to 18 years old) with Down syndrome; 19 females (8 children of 0-5 years, 7 children of 6-12 years, and 4 children of 13-18 year old age) and 29 males (11 children of 0-4 years, 10 - of 6-12 years, and 8 of them of the age of 13-18). 44 children were diagnosed by genetic analysis as trisomy disorder and 4 as mosaic disorder (mixed).

The research group of children (Study Group) attended at least one MNRI® training conference held during the 2011 and 2012 calendar years versus the control group of 46 individuals with Down Syndrome (the same age of 6 months to 18 years old; females and males) (Control Group 1) and also individuals with neurotypical development (Control Group 2) that did not attends conference training. Conferences were held in Warsaw, Poland; San Francisco, CA, New Jersey, NJ, and Orlando, FL, USA; and Vancouver, Canada. Group sizes at these multiple day conferences were 12-24 participants. Inclusion criteria included: completion of a Reflex Parameters Assessment before (pre-test) and after (post-test) the training conference (11 days: 6 days of intense training, one day rest, followed by another 5 days of training), and completion of six 50-minute training sessions during a training conference (total 66 therapy hours). Training session sub-programs included: Neurostructural Reflex Integration; Tactile Integration; Dynamic and Postural Reflex Re-patterning; Visual and Auditory Reflex Integration and Oral-Facial Reflex Integration; Proprioceptive and Vestibular Skills Development, Lifelong Reflex Integration; and Archetype Movement Integration [23-25]. Receipt of informed consent was received from all participant parents or legal guardians. Assessments were conducted and therapy administered by Core Specialists or Core Specialists in Training who have successfully completed a specific set of courses and clinical hours in MNRI®.

The research also presents study data on a control group of 46 individuals with Down syndrome (Control Group 2, the same age of 6 months to 18 years), who did not go through MNRI® training. Among them there were 19 females (8 children of 0-5 years, 6 children of 6-12 years, and 5 children of 13-18 year old age) and 27 males (10 children of 0-4 years, 9 children of 6-12 years, and 8 children of 13-18 years). Forty-one children were diagnosed as trisomy disorder and five as mosaic disorder (mixed).

The third group that participated in research were children with neurotypical development (780 individuals from 6 to 19 years; 421 females and 359 males [some of this data was reported at international conferences and was published previously]); 356 children of 0-5 years, 265 children of 6-12 years, and 159 children of 13-18 years). They did not go through the MNRI® training. The pre- and post-test of reflex patterns were carried out within the same time frame of 9 days.

MNRI® reflex assessment and therapy modality

MNRI® assessment principles

The MNRI® Reflex Assessment helps to explain specific disorders in the functioning of a reflex circuit. It is based on evaluation of sensory-motor patterns that depend on:

- The age of child/adult

- The neurological state of the individual and their possible symptoms

- The structure and dynamics of reflex pattern development (evolution) as an inborn, genetic motor program.

The MNRI® Reflex Assessment is based on evaluation of the following parameters: 1) reflex pattern components: sensory perception, processing of the sensory stimulus in the central nervous system, and motor response (the individual reactions for specific stimuli); 2) latency (time response after the stimulus influence, time of duration of the response; other dynamic features); 3) direction of a response in a reflex pattern; 4) strength/intensity of response; 5) locomotor or positional symmetry [17,23].

In order to determine the level of a reflex pattern development the MNRI® assessment uses the criteria in points from 0–4 for each of five parameters (Table 1), which, if the reflex is in full integration, results in a maximum score of 20 points. 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) partially correct to completely developed and integrated from 10–20.

MNRI® therapy modality principles

The MNRI® processes based of assessment results propose individualised corrective procedures of intervention for neuro-optimization of different sensory-motor patterns to support the following:

- Correct defense responses (Tendon Guard, Moro, Fear Paralysis, Hands Supporting reflex patterns)

- Physical development and gross motor coordination (Spinal Galant and Perez, Crawling, Automatic Gait, Leg Cross Flexion-Extension reflex patterns)

- Body posture and locomotion control (Trunk Extension, Head Righting reflex patterns), also related to binocular vision and binaural hearing (Head Righting, Ocular-Vestibular, Optokinetic and Stapedial auditory reflex patterns)

- Cognitive processes – decoding, listening and memorizing (Asymmetrical Tonic Neck, Pavlov Orientation, auditory and visual reflex patterns), also manual skills, drawing, writing, and reading (Robinson Hands Grasp, Hands Pulling, and Hands Supporting reflex patterns)

- Proprioceptive system (Tonic Labyrinthine, Symmetrical Tonic Neck, Trunk Extension reflex patterns).

The MNRI® program for these children was directed to the improvement of dysfunctional and pathological reflex patterns with the use of the following programs: Neuro-Structural Reflex Integration, NeuroTactile Integration, Dynamic and Postural Reflex Pattern Integration, Lifelong Reflex Integration, Proprioceptive and Cognitive Integration, Visual and Auditory Reflexes Integration, Oral-Facial Reflex Integration, and Archetype Movement Integration [24,25].

These MNRI® programs and Reflex Assessment were realized by a group of professionals, who have specialized and trained in MNRI® during lectures and therapeutic camps/clinics and individual work with children with developmental deficits (http://www.MasgutovaMethod.com).

Statistical Methods

Statistical analysis of the results of Reflex Assessment was carried out to create Reflex Profiles for children with Down Syndrome to identify strategies for neurodevelopment corrective work for them. This analysis was also accomplished after 11 days of MNRI® corrective processes at the neurosensorimotor rehabilitation camps/clinics organized by International Dr. Svetlana Masgutova Institute (Warsaw, Poland; San Francisco, CA, XX, NJ, and Orlando, FL, USA; and Vancouver, Canada).

The evaluation was conducted for 24 reflex patterns in three groups referring to corresponding body movement planes: saggital, horizontal, and dorsal. Every reflex pattern was evaluated individually in a scale from 0–20 with regard to such parameters as: reflex pattern, direction of movement, strength of reaction, time of reaction, and symmetry.

Normal Function		Dysfunction/Pathology	
Points	Level of reflex integration	Points	Level of reflex dysfunction
20	Full / Complete integration	10-11.75	Marginal pathology and dysfunction
18 – 19.75	Mature and integrated	8 – 9.75	Light dysfunction
16 – 17.75	Functional – normal	6 – 7.75	Average dysfunction
14 – 15.75	Functional, but low level of development	4 – 5.75	Severe dysfunction
12-13.75	Functional, but very low level of development	2 – 3.75	Pathology
10-11.75	Marginal pathology and dysfunction	0 – 1.75	Severe pathology

Table 1: Clinical assessments of reflex pattern assessment scores.

A score of 10 is the transition point between a pathological/dysfunctional and normal state, whereas numbers from 16–20 are considered norm. Table 1 shows the points scale determining the criteria of evaluation of pathology/dysfunction, norm, and integrated level of reflexes.

Results of the assessment procedure of integration/dysfunction of the reflex patterns in children with Down syndrome were analyzed based on the function z = f (x) by the Krefft Method [31]. Diagnostic Function of the Non-Observable Phenomena. Oficyna Wydawnicza Politechniki Wroclawskiej. Wroclaw, Poland). This function allows for the estimated level of changes in expression (z) of reflex patterns as the result of the synthesis of information of the chosen diagnosis qualities (x) within three groups of body movement planes: saggital, horizontal, and dorsal. This method of mathematical analysis according to the Anna Krefft algorithm was used in order to evaluate in a synthesized way the level of reflex patterns integration, called synthesized diagnostic function Z.

A static model for statistical validation of the synthesized function Z=f(x) is used in this article within a linear model, which can be written as follows:

$Y = \beta 1X1 + \beta 2X2 + \ldots + \beta KXK + \beta 0$ (1)

Where:

Y - is an explained variable that describes the considered synthesis variable (degree of pathology development in a child with Down syndrome)

$X_1, X_2, \ldots, X_K$ - are explanatory variables in model (1) (diagnostic variables)

$\beta_1, \beta_2, \ldots, \beta_K$ – are model parameters (1), that are constants that characterize this model

Evaluation of the individual values of a model (1) parameters within a given set of diagnostic features $X_l, X_2, \ldots, X_K$ allows finding out the value of synthesized variable Y. To set a synthesized function Z, the following material was used.

Statistical material in the form of a matrix X dimensioned [n x k], n > k, where n is a number of simultaneous researches (tests) of diagnostic features (researches related to the same correction procedures), where the researcher describes the states of synthesized variable Y, that is the variables within the model (1), the number k expresses the quantity of these variables. Generally the matrix X can be presented as follows:

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1k} \\ X_{21} & X_{22} & \cdots & X_{2k} \\ \vdots & \vdots & \cdots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nk} \end{bmatrix}$$

Information about so called ‘influence directions’ of the corresponding individual diagnostic variables in relation to explained variable Y. For the individual variables this information is expressed with “+” (plus) or “–” (minus). If the given variable Xj numbered “j”, j=1,2,...,k is a stimulant for a variable Y, therefore the increase of variable X_j level also causes the increase of variable Y. In that case the information about ‘influence direction’ in relation to the variable Y is expressed with ‘+’. In case where variable X_j is dissimulate for a variable Y, therefore its increase causes the decrease of variable Y level - the ‘influence direction’ is expressed with “–”. Therefore the information about the ‘influence direction’ of the individual explanatory variables in model (1) is given in a form of a sequence with k elements. Each element is expressed with ‘+’ or ‘-’. Each one of these symbols express ‘influence direction’ of variable X_j with an adequate number.

$$\boldsymbol{K} = [\, + + - \ldots + \,] \qquad \underbrace{\qquad\qquad}_{k - \text{elements}}$$

Therefore the experimental material [X, K], using Krefft’s Method, allows a model (1) to be determined.

In order to obtain the scale of value for a synthetic variable that is easy to use, variable Y is transformed into variable Z (Y + Z):

$Z = e^Y (1 + e^Y) -1$,

Where: e – is a base of natural logarithms, Z€ (0; 1).

The closer the value of synthetic variable Z is to number 1, the higher its level.

On the base of a determined model (1) the values of three synthetic variables Z_S, Z_H, Z_D, and also Z_{Sum} (summary of three) have been obtained for the individual research of children in terms of the chosen diagnostic qualities. This means that every simultaneous test of diagnostic features allowed us to obtain corresponding values of synthesized variables and average values of individual functions Z_S, Z_H, Z_D, and also Z_{Sum} in a group of children with Down syndrome before and after 11 days of participating in the MNRI® therapy processes. Mean values of Z_S, Z_H, Z_D, and also Z_{Sum} were compared before and after 11 days of participating in the MNRI® program using an ANOVA test developed for this type of analysis (IBM SPSS Statistics Grad Pack 22.0). Results were considered statistically significant where $p < 0.01$ and not significant at $p > 0.05$.

Part of statistical evaluations was performed also with the Mann-Whitney U-test, using Statistica (version 6.0; Stat Soft Inc, Tulsa, OK, USA). P values (M ± SD) less than 0.001 were considered significant and not significant at $p > 0.05$.

The assessment of the level of reflex pattern dysfunction/integration has been conducted using function $Z = f(X_1, X_2 \ldots X_{24})$ which had been obtained by the Krefft Method and is shown in the form of graphs and tables. Information concerning neurosensorimotor diagnostics of every child has been grouped within 24 collective diagnostic qualities and marked from X_1–X_{24}. They form the database for computer calculation of synthesized function Z€. This determines the level of development/integration of all examined child reflex patterns.

The description of individual diagnostic qualities has been compared in Table 2.

Individual reflex patterns, called diagnostic qualities, with the evaluation of pathology/dysfunction, norm and reflex integration level, shown in a point scale for both before and after the MNRI® therapeutic program. In this table the reflex profile of neurotypical children is also presented as a criteria of normal development of reflex patterns.

Diagnostic Quality/ Feature	Body Movement Plane	Reflex	Results of Assessment					
			Study Group (48 individuals with Down Syndrome)		Control Group 1 (46 individuals with Down Syndrome)		Control Group 2 (780 individuals with neurotypical development	
			Pre-test: Before Program	Post-test: After Program	Pre-test	Post-Test (in 9 days)	Pre-test	Post-Test
X_1	S	Robinson Hands Grasp (RGR)	6.2 ± 0.3	8.1 ± 0.6*	6.2 ± 0.4	6.3 ± 0.3	17 ± 0.7	17 ± 0.7
X_2	S	Hands Pulling (HPR)	8.5 ± 0.6	9.2 ± 0.4*	8.1 ± 0.3	8.2 ± 0.5	16 ± 0.5	16.1 ± 0.8
X_3	S	Babkin Palmomental (BPR)	4.4 ± 0.2	5.4 ± 0.2*	4.5 ± 0.4	4.4 ± 0.6	16 ± 0.8	15.8 ± 0.9
X_4	S	Babinski (BR)	6.5 ± 0.3	7.3 ± 0.4*	6.7 ± 0.4	6.6 ± 0.3	16.5 ± 0.8	16.5 ± 1.2
X_5	S	Leg Cross Flexion-Extension (LCFER)	5.6 ± 0.6	6.9 ± 0.5*	5.3 ± 0.2	5.3 ± 0.3	17 ± 0.9	17.1 ± 0.7
X_6	S	Asymmetrical Tonic Neck (ATNR)	6.4 ± 0.5	7.4 ± 0.3*	6.4 ± 0.3	6.3 ± 0.2	15 ± 0.7	15 ± 0.9
X_7	S	Abdominal (AR)	8.2 ± 0.6	10.4 ± 0.7*	8.4 ± 0.6	8.3 ± 0.5	16 ± 1.0	16.1 ± 0.9
X_8	S	Bonding (BR)	11.7 ± 0.4	13.2 ± 0.7*	11.6 ± 0.5	8.9 ± 0.7	15.5 ± 0.7	15.5 ± 0.8
X_9	H	Thomas Automatic Gait (TAGR)	8.9 ± 0.2	9.3 ± 0.3	8.5 ± 0/4	8.6 ± 0.3	17.5 ± 0.9	17.4 ± 1.3
X_{10}	H	Bauer Crawling (BCR)	6.6 ± 0.5	9.4 ± 0.7*	6.6 ± 0.3	6.5 ± 0.5	15.5 ± 0.6	15.5 ± 0.8
X_{11}	H	Moro Embrace (MR)	11.4 ± 0.6	13.2 ± 0.6*	11.2 ± 0.7	10.9 ± 0.5	15.5 ± 0.6	15.5 ± 0.8
X_{12}	H	Fear Paralysis (FPR)	11.7 ± 0.5	13.4 ± 0.6*	11.8 ± 0.5	11.9 ± 0.6	14.5 ± 0.5	14.6 ± 0.7
X_{13}	H	Hands Supporting (HSR)	8.4 ± 0.5	8.9 ± 0.4	8.1 ± 0.3	8.2 ± 0.2	15.5 ± 0.7	15.5 ± 0.9
X_{14}	H	Segmental Rolling (SRR)	7.1 ± 0.4	8.1 ± 0.4*	7.4 ± 0.4	7.2 ± 0.5	15 ± 0.8	15.4 ± 1.2
X_{15}	H	Landau (LR)	6.3 ± 0.4	7.2 ± 0.4*	6.1 ± 0.3	6.1 ± o.4	15 ± 0.8	15.1 ± 1.1
X_{16}	H	Flying and Landing (FLR)	5.3 ± 0.4	5.8 ± 0.5	4.8 ± 0.4	4.9 ± 0.5	14.5 ± 0.7	14.5 ± 0.9
X_{17}	D	Trunk Extension (TER)	8.1 ± 0.3	8.8 ± 0.2*	7.8 ± 0.4	7.9 ± 0.6	16 ± 0.7	16.2 ± 0.8
X_{18}	D	Symmetrical Tonic Neck (STNR)	6.2 ± 0.7	8.4 ± 0.6*	6.4 ± 0.5	6.5 ± 0.6	16 ± 0.6	15.8 ± 0.9
X_{19}	D	Spinal Galant (SGR)	8.4 ± 0.7	11.2 ± 0.7*	8.5 ± 0.5	8.4 ± 0.6	15 ± 0.9	15 ± 1.2
X_{20}	D	Spinal Perez (SPR)	11.2 ± 0.3	12.3 ± 0.7*	10.4 ± 0.9	10.2 ± 0.8	16 ± 0.7	16.1 ± 1.2
X_{21}	D	Tonic Labyrinthine (LTR)	9.2 ± 0.8	11.2 ± 0.6*	9 ± 0.7	8.9 ± 0.5	16 ± 0.9	16.1 ± 1.1
X_{22}	D	Foot Tendon Guard (FTGR)	8.1 ± 0.6	10 ± 0.8*	8 ± 0.4	7.9 ± 0.5	15.5 ± 0.8	15.3 ± 1.2
X_{23}	D	Spinning (SR)	8.3 ± 0.8	12.4 ± 0.7*	8 ± 0.6	8.2 ± 0.5	15 ± 0.9	15.1 ± 1.7
X_{24}	D	Pavlov Orientation (POR)	6.5 ± 0.2	6.8 ± 0.3	6.7 ± 0.3	6.6 ± 0.5	18.5 ± 0.7	18.5 ± 0.9

Table 2: Diagnostic Quality Feature (X_1-X_{24}), body movement planes (S = sagittal; H = horizontal; D = dorsal), reflexes, and assessments before and after participation in neurosensorimotor reflex integration (MNRI®) conferences. *$P < 0.05$

The analyses of the change in the level of reflex pattern integration of Down syndrome children after completing treatment at MNRI® camps (Table 2) demonstrate a positive change in the reported reflexes. This information as given in the examples suggests the results of statistically important validation of the synthesized function $z = f(x)$ and the significant degree of effectiveness of the MNRI® process applied to the Down syndrome children during this time of intervention. Each parameter (x) shows the level of development of the specific pre- and post-Assessment of the given child.

The level of changes in development of all the examined reflex patterns is illustrated in Figure 1 and Table 2. There we see the result of synthesized information of all diagnostic qualities (X_1–X_{24}).

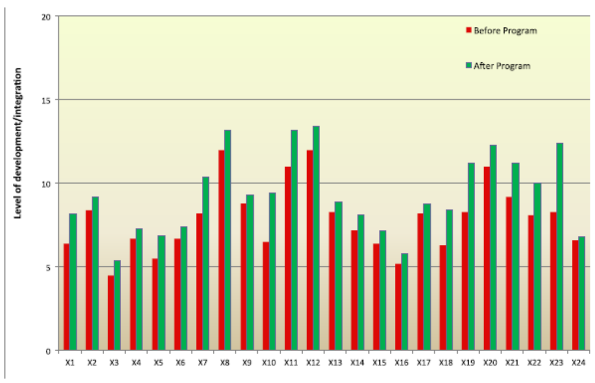


Figure 1: Levels of reflex (Diagnostic Quality Features X_1–X_{24}) development/integration for children with Down syndrome before and after the neurosensorimotor reflex integration program.

Ethical Approval

Institutional Review Board (IRB) approval was granted by the New England IRB (85 Wells Avenue, Suite 107, Newton, MA 02459) (IRB ll-173). The New England Institutional Review Board is a central institutional review board for sponsors, CROs and individual researchers across North America (http://www.neirb.com). The IRB ensures the safety of human subjects in clinical trials by committing a thorough and ethical IRB review process. The New England IRB is registered with both the FDA and the Office for Human Research Protections (OHRP) under IORG Number IORG0000444, and has Full Accreditation status from the Association for Accreditation of Human Research Protection Programs (AAHRPP). Adverse effects (new or worsening medical conditions of any kind) were promptly investigated and reported to the IRB. All participants were assigned codes to protect anonymity.

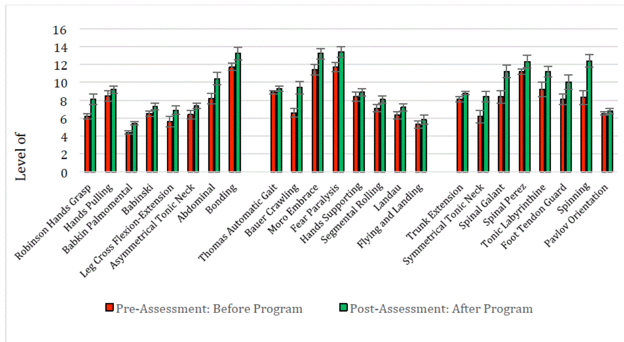
Also, Ethical approval was received from Health Sciences, Department of Developmental Rehabilitation of Medical Academy by Piastow Slaskich (Wroclaw, Poland).

Results and Discussion

The Reflex Profile of children with Down Syndrome (n=48) based on the analysis of their individual reflex patterns are found in Table 2 (pre-Assessment; Study Group) and Graph 1 (red columns). There the results of the Assessment of each of the 24 reflex patterns (in scores from 0–20) are presented as the qualities X_1–X_{24} before and after the MNRI® program. The table also shows the summary of reflex evaluation in three groups, particularly, activating the motor/postural response within the sagittal plane: X1) Robinsons Hand Grasp, X2) Hands Pulling, X3) Babkin Palmomental, X4) Babinski, X5) Leg Cross Flexion-Extension, X6) Asymmetrical Tonic Neck, X7) Abdominal, X8) Bonding; next within horizontal plane: X9) Thomas Automatic Gait, X10) Bauer Crawling, X11) Moro, X12) Fear Paralysis, X13) Hands Supporting, X14) Segmental Rolling, X15) Landau, X16) Flying and Landing; and also dorsal: X17) Trunk Extension, X18) Symmetrical Tonic Neck, X19) Spinal Galant, X20) Spinal Perez, X21) Tonic Labyrinthine, X22) Foot Tendon Guard, X23) Spinning, X24) Pavlov Orientation [23].

Analysis of the data shows that there are no reflexes that are in the normal range in children with Down syndrome in the Study and Control Group-1 – 100% of their reflex patterns are immature and dysfunctional. The level of development of reflexes is the following: 12.5% (3) reflex patterns are severely dysfunctional (4-5.99 points), 33.33% (8) – average dysfunctional (6-7.99), 37.5% (9) light dysfunction (8-9.99), 16.67% (4) – of very low development (12-13.99).

In summarizing, 83.33% of reflex patterns (20 out of 24) of children in Study Group were dysfunctional, and 16.67% (4 out of 24) were functional, but of a very low level of development. This information correlates with the statistic analysis based on NewKreft's algorithm [31], that 35% of dysfunctional reflexes cause reflex integration disorder (RID) [17]. This fact allows interpreting the RID as one of the underlining factors in developmental delays of children with Down Syndrome [16], meaning that their neurodevelopmental deficits could also be reasons in delayed/dysfunctional reflexes, and that these deficits could be lessened/ and development can be improved by treatment to their reflexes within a certain degree to extend the boundaries of genetic limits.



Graph 1: Reflex profile of Children with Down syndrome (n=48) before (red columns) and after the MNRI® program (green columns). Changes in profile after the MNRI® Neurosensorimotor Reflex Integration program (green columns).

After the MNRI® intervention many reflex patterns are still at the level of dysfunction or pathology, however, significant positive changes in reflex patterns and improvement in their sensory-motor development overall are noted.

The level of development of reflex patterns after the MNRI® therapy has changed in the following way (Table 2): 8.33% (2) reflex patterns are severely dysfunctional (4-5.99 points), 20.83% (5) – average dysfunctional (6-7.99), 33.33% (8) light dysfunction (8-9.75), 16.67% (4) – marginal pathology and dysfunction (10-11.99), 20.83% (5) of very low development.

In summarizing, 62.5% of reflex patterns (15 out of 24) of children in the Study Group are dysfunctional vs. 83.33% in pre-Assessment. 16.67% of their reflex patterns improved to a level of marginal pathology and dysfunction (4 out of 24), and 20.83 % (5 out of 24) became functional moving to a very low level of development vs. 16.67% in pre-Assessment. In other words, 45.83% (11 out of 24) reflex patterns moved to next level of development and comparative analysis also shows that overall 83.33% (20 out of 24) reflex patterns changed significantly (see * in Table 2).

The comparative analysis of the results before and after the MNRI® program and synthesized function Z shows the significant difference on the level of $p < 0.001$ (Table 3).

Of the reflex patterns (the Automatic Gait, Hands Supporting, Flying and Landing and Pavlov Orientation), 16.7 % did not show a statistical significance though positive changes were noticed, particularly in such patterns as the Automatic Gait pattern became a more balanced movement with greater speed of walking and the Hands Supporting pattern showed improved movement orientation in space and strength of their muscles. The means of all reflexes summarized by body plane symmetry (Z values) increased after completion of the MNRI® program, as did the cumulative ZC value (Table 3).

Variables	Average values and standard deviations for three synthetic variables, ZS (sagittal body plane), ZH (horizontal), and ZD (dorsal)														
	Study Group (48 individuals with Down Syndrome)					Control Group 1 (46 individuals with Down Syndrome)					Control Group 2 (780 individuals with neurotypical development)				
	Before		After		ANOVA	Before		After		ANOVA	Before		After		ANOVA
	Mean	S.D.	Mean	S.D.	P <	Mean	S.D.	Mean	S.D.	P >	Mean	S.D.	Mean	S.D.	P >
ZSum	0.3825	0.1062	0.6136	0.1723	0.001	0.4112	0.1912	0.4213	0.1619	0.05	0.2914	0.1782	0.3424	0.1672	0.05
ZS	0.4173	0.0931	0.6022	0.1612	0.001	0.3876	0.1812	0.3576	0.1872	0.05	0.3063	0.1680	0.2852	0.1662	0.05
ZH	0.3757	0.1652	0.5763	0.1755	0.001	0.4084	0.1712	0.4102	0.1692	0.05	0.2851	0.1572	0.2641	0.1585	0.05
ZD	0.4122	0.2033	0.6747	0.1735	0.001	0.3913	0.1893	0.3818	0.1953	0.05	0.3142	0.1265	0.3341	0.1357	0.05

Table 3: Statistic verification of the value of average functions and synthesized ZC described as qualities from X_1–X_{24} in research of patients with Down syndrome before and after MNRI® process application.

The improvements in reflex patterns affected the motor skills and also improvement of fine motor coordination, speech development, learning motivation, communication skills, and a decrease in behavioral problems.

Analysis of reflex patterns in children in the Control Group 1 (with Down syndrome) that did not go through the MNRI® training shows no positive dynamics (there is no statistical significance – $P > 0.05$) (Table 2 and 3). The same result is noted towards children with neurotypical development – there are no changes in their reflex dynamic when MNRI® intervention is not proposed (Table 3).

Summary and Conclusions

The Reflex Profile of Children with Down syndrome (n=48) studied with the use of the MNRI® Reflex Assessment shows that reflex integration disorder (RID) in these children is one of underlining reasons of lower performance of sensory-motor abilities and skills, whose neurodevelopment and learning is limited by genetic disorder. Their profile nevertheless is changeable – after the MNRI® Reflex Integration therapy it was optimized significantly. Over 45.83% (11 out of 24) reflex patterns moved to next level of development, and comparative analysis (Table 2) also shows that overall 83.33% (20 out of 24) reflex patterns changed mathematically significantly (see * in Table 2) vs. reflex patterns of children that did not go through this therapy procedure in Control Group 1 (children with Down syndrome) and in Control Group 2 (with neurotypical development). However, reflex patterns of children with Down syndrome in Study Group did not grow to a normal level which can be of a two-folded reason: limits caused by genetic disorder and absence of specialized work with their reflexes as reflexes are the basis for further neurodevelopment, particularly at early childhood. Early intervention based on concept of integration vs. inhibition of retained reflex patterns is mostly required procedure. Neurosensorimotor reflex integration services are still very rare in modern therapy modalities.

The average value of the synthesized function ZC for the whole group of 48 children with Down syndrome demonstrates the change level of development of reflex patterns before the MNRI® program (Mean: 0.3825; SD: 0.1062) and after 11 days of the MNRI® process interventions (Mean: 0.6136; SD: 0.1723) is significant and equals $P<0.001$. These results indicate a high level of accuracy and validity of the Assessment and effectiveness of the MNRI® processes with this specific group of syndrome.

The Masgutova Method® concept differs from other concepts in that it proposes neuro-sensory-motor integration of reflex patterns instead of inhibition. MNRI® integrating techniques and exercises are directed toward the facilitation and maturation of 'neurological pathways' [19,30] corresponding to specific reflex patterns. They support optimal function of the motor, tactile, visual, and auditory systems though reflex integration (natural genetic motor programs) with consciously learned and controlled sensory-motor coordination, skills, and abilities.

Intensive work using the MNRI® during 11 days at rehabilitation camps/clinics is highly effective according to the opinion of parents and specialists. They point out the positive influence of integration of sensorimotor reflexes directly on the development of the performance of skills and also intellectual processes – control of attention span, memory, and thinking.

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