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Neurophysiological Aspects of NeuroTactile Therapy of Masgutova Neurosensory Motor Reflex Integration MNRI® Method

Neurofizjologiczne aspekty Terapii NeuroTaktylnej programu Neurosensomotorycznej Integracji Odruchów MNRI według dr S. Masgutowej

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Keys words
sense of touch, MNRI, tactile, sensory motor integration, rehabilitation

Abstract
In early childhood, touch is the first means of communication with the surrounding world. How the parents touch and hold a baby and how frequently they touch it affects the emotional and physical development and health of the child. Studies demonstrate that deprivation of human contact for children usually causes them future anxiety and nervousness. The main assumptions of the MNRI® NeuroTactile therapy modality is to increase and create kinesthetic awareness in the body of a patient; to regulate functions of skin receptors by activation of the sense of touch and proprioception targeted at their neurological aspects – receptors, dermatomes, reflex circuits and their functions. Techniques of the NeuroTactile Therapy created by Dr. Masgutova rely on providing a controlled amount of sensory stimuli and sensory-proprioceptive information for tactile and also proprioreceptive systems, particularly, to create and facilitate spontaneous physiological adaptive responses. The result is to improve the functions of the neurosensory motor system and overall neuro-development. The aim of this type of tactile training is to activate natural mechanisms for development, regulation and normalization of tactile perception, muscle tension, and also to promote sensory and sensory-motor integration mechanisms, develop kinesthetic awareness while reducing or eliminating stress and increasing neuroplasticity.

Słowa klucze
zmysł dotyku, MNRI, taktylność, integracja sensomotoryczna, rehabilitacja

Streszczenie
W okresie wczesnodziecięcym dotyk jest pierwszym środkiem komunikacji z otaczającym światem, a sposób, w jaki rodzice dotykają i trzymają dziecko oraz jak często to czynią, wpływa na rozwój, samopoczucie i zdrowie małego człowieka. Na podstawie przeprowadzonych badań wykazano, że dzieci pozbawione fizycznego kontaktu zazwyczaj są bardziej niespokojne i nerwowe. Głównymi założeniami terapii NeuroTaktylnej jest wzmocnienie, jak również wytworzenie świadomości kinestetycznej ciała pacjenta oraz stymulacja receptorów skóry, poprzez aktywizację zmysłu dotyku i propriocepcji, ukierunkowanej na neurologiczne jej aspekty – receptory, dermatomy, związki z kołami odruchowymi i ich funkcjami. Techniki terapii NeuroTaktylnej według dr Masgutowej polegają na dostarczaniu kontrolowanej liczby bodźców sensorycznych oraz sensoryczno-proprioceptywnych, w szczególności dotykowych i proprioceptywnych, w celu tworzenia i torowania spontanicznych, fizjologicznych reakcji adaptacyjnych poprawiających funkcjonowanie układu neurosensomotorycznego i neurorozwoju. Celem treningu jest uruchomienie naturalnych mechanizmów rozwoju, regulacja i normalizacja percepcji dotykowej, napięcia mięśniowego, wspieranie procesu integracji sensorycznej, aktywizowanie mechanizmów integracji sensoryczno-motorycznej, kształtowanie świadomości kinestetycznej, zmniejszenie lub niwelowanie stresu, zwiększenie neuroplastyczności.

The individual division on this paper was as follows: a – research work project; B – data collection; C – statistical analysis; D – data interpretation; E – manuscript compilation; F – publication search

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The more positive touch a person experiences in childhood, the calmer s/he will be in adulthood. Research shows that immediately after birth and during the first period of life a child needs direct physical contact, primarily with its mother. The touch of a mother calms a child and provides a sense of security. The sense of touch is a primary tool for communication between a newborn and the outside world. It was one of the dominant senses in the process of evolution. It is one of the most active senses in fetal life[1]. It plays a very important role during the birth process. It is well developed in newborns compared to other senses (e.g. vision or hearing). During the first weeks of life outside the womb, it is the primary way of learning about the outside world and communicating with other people. It gives much better access to the new reality than the other senses[1,2].

Touch is an essential source of information regarding awareness of one's own body, motor

planning, discrimination and visual decoding, language and its motorics, and also school learning, emotional security and social skills[2].

The skin is the most sensitive sensory channel, and touch is undoubtedly one of the most important human sense organs[2,3].

The sense of touch develops very early - between the 6th and 7th week of the gestational period[3]. For the first time, the nerves and muscles begin to work together and it becomes possible to test reactions to touch. In the 30th week of gestation, the fetus feels pain. Due to the sense of touch babies receive 80% of stimuli from the environment. A pioneer in research on sense organs - British neurologist Henry Head distinguished two types of touch sensations[3]. The first is protopathic touch, also known as primary or defensive, which provides information that we have been touched and also informs us about threats (defensive function). The second kind of sense – epicritic touch - is also known as discriminatory or differentiating. It is responsible for providing information regarding where we have exactly been touched, and also gives us details about what we are touching[4-5].

A specialized network of dermatomes creates a kind of map showing which segment of the spine sensorineurally innervates a specific area of the body. Early tactile stimulation motivates the work of the peripheral nervous system, at the same time causing activation of the central nervous system[3-5].

Alike dermatomes and miotomies, in the first weeks of gestation they produced the first primitive reflexes, for example the Babkin palmomental reflex (9th week), the Robinson hand grasp reflex (11th week)[5]. These are automatic stereotyped impulsive reactions that occur in fetal life and are generated from the brain stem. Their integration is linked with a shift of control to the higher parts of the brain. According to Vygotski, primitive reflexes are necessary for a child to survive during the first few weeks of life[4]. However, if the reflexes are active above 12 months of age, they are treated as diagnostic signs of immaturity in the functioning of the central nervous system (CNS), which negatively affects functioning at the cortical level. Prolonged activity of primitive reflexes may also interfere with the development of postural reflexes that allow a child to effectively interact with the environment. And postural reflexes are needed for development of automatic (subconscious) postural control, balance and coordination[3-4].

In order to induce a child's primitive reflex, touch that triggers the reflex arc chain is necessary[5-6.] Tactile stimulation motivates receptors in the skin. The receptor receives a stimulus that triggers a nerve impulse, the sensory neuron conducts an impulse from the receptor to the appropriate nerve center in the brain or spinal cord. In the nervous system, an impulse is properly processed and modified, and then transmitted by motor neurons to the effector, which is usually a muscle or gland in which a nerve impulse causes stimulation and response or action appropriate to the particular reflex, for example, tactile stimulation of the outer edge of the foot causes the Babinski reflex, touching the base of the palm and the first line of the phalanges causes the Robinson hand grasp motor reflex in infants[5-6].

Tactile stimulation affects the activation and integration of reflexes in infants. This allows the child to reach harmonious development of the central and peripheral nervous systems. The correct response of the arc reflex stimulates the proper functioning of the myofascial bone-muscle system. It is the foundation for the development of postural reflexes, and as the child grows, it ensures holistic development of an organism[5-6].

Lack of tactile stimulation or its incorrect practice affects the formation of deficits in the development of the nervous system, sensorimotor system function disorders, as well as disorders of the reflex arc. As a consequence, improper neuromotor response is shaped, thus an abnormal pattern of the primary reflex, and at the next stage of development, a pathological conditional reflex scheme is formulated[5-6].

There are 11 types of sensory receptors in the skin and muscles that fulfill specific functions. These receptors are used to receive tactile stimuli, pressure, tension, pain, heat and cold[5-7]:

- The feeling of touch is perceived mainly by Meissner corpuscles, Merkel meniscus and free nerve endings. Meissner corpuscles are in the dermal papilla of the skin. They are the most numerous in the skin of the hands and feet, the nipples and lips and the tongue-tip mucosa. Merkel meniscus are located in the nipples, fingertips, palms of the hands, soles of the feet, on the lips and in the mouth. Free nerve endings form a reticular system surrounding the nap capillary base.
- Pressure receptors are Vater-Pacini lamellar bodies. The feeling of pressure is a tactile sensation of the skin caused by stimulation of Vater-Pacini cells, located in the periosteum, tendons, joint capsules. Deep-skin sensory receptors cells are also Goldo-Mazzoni cor-

puscules occurring in the sub-papillary layer of the skin.
- Receptors of heat and cold sensation are Ruffini corpuscules and the bulbs of Krause. Ruffini corpuscles are not only in the dermis and subcutaneous tissue, but also in the periosteum and perimysium. Krause's bulbs are primarily located in the lamina propria of the mucous membranes and the sub-papillary skin layer.
- Pain receptors are mostly bare ends of the coreless fiber. They are located in the superficial layers of the skin, the corneal, the sub-papillary layer and deeper layers of the skin.

Receptors in the skin are sensory organs of: touch, nociception and temperature. These senses are closely related to the sense of proprioception. Proprioception means receiving stimuli associated with the control of body segments, with its movement and location. It is otherwise called a sense of position or musculotendinous. It is responsible for sense and awareness of the body; thanks to this, all deliberate and automatic movements as well as impulsive reactions are possible. This system, like an inner eye, informs the brain where the body is, how its parts are located in regard to each other, how much and how quickly muscles extend and with what force the muscles work. It has significant impact on the proper tonicity and takes a large part in the formation of the body schema. Its receptors, called prioprioceptors, are found in the muscles, skin, tendons, joints, ligaments and connective tissue. An important feature of this system is help in the modulation of the level of arousal. When too low, proprioception raises it, and when too high – they lower it. The same proprioceptive sensations that are associated with stretching the muscle attachments, rotation of joints, deep pressure, have a stimulating effect on a person who is weary and not very active. For hyperactive patients, who are in some sense overstimulated, this therapy has a calming and an **appeasing** effect. The proprioceptive system brings balance and harmony to the internal organization of senses[5-7].

Tactile and proprioceptive systems play an essential role in brain learning to interpret what the eyes see. Neonates and infants naturally use the mouth to explore the world. One of the tests has shown that one-month infants can visually recognize an object, which had previously been explored by his/her mouth. In this study, children were allowed to suck on (not look at) one of two different balls - with a smooth surface or a rough one. Later, they were shown the enlarged version of both items. Each of the children preferred to look at the ball that s/he had just sucked[5-7]. Due to experiencing the object by touch of the mouth, a child creates a visual image of it, which allows the connection of visual and tactile sensations.

When touching objects, a child remembers their attributes and relationships. Young children frequently touch what they are looking at and vice versa - they look at what they touch. Research shows that in the brainstem and thalamus, the integration of visual information with tactile stimuli and proprioceptive occurs[6-8]. This integration means that brain can visualize the shape and the structure of an object[4]. The sensations of touch and proprioception, synchronized with visual information, are required to adopt correct posture while performing various daily activities. Neuroimaging of brain functions has shown very strong activation of the centers of visual stimulation through touch, taking place especially during movement. If the child's nervous system cannot cope with tactile stimuli and cannot process them in a proper way, the integration of visual and tactile stimuli becomes impossible. A child cannot read the sensory stimuli[6-8].

Infants communicate with the outside world and other people mainly by touch. Being touched or touching, they hear relevant comments of guardians about what they are doing and touching. And that is why words begin to be associated with actions, body parts, objects, places, people and emotions[4,6-8]. Speech enables verbal contact, learning and integration of a child with society[4]. This early communication depends on proper reception and processing of tactile sensations by a child and giving them proper meaning[4]. It is worth noting that the correct tonicity throughout the whole body enables the development of stability of the torso, shoulders and neck, which also affects the stabilization of the jaw and enables effortless movements of the jaw and tongue. The proprioceptive system plays an important role here. If the tactile experience of the child is limited or misinterpreted by the brain, the development of speech will not proceed in a proper manner[6-8].

Tactile sensations arrive from all over the skin, many stimulating levels and areas of the brain, including the thalamus through the limbic system (responsible for emotions) to a part of the sensory cortex of the brain (parietal lobe). An indirect effect of tactile stimulation (touch) is its influence on the endocrine system, and as a result, regulation of the maturation process of various body structures and functions[6,7].

The sense of touch stimulates the ejection of oxytocin. Oxytocin is a neurotransmitter effecting the limbic system, which is the emotional center of the brain. It gives a sense of satisfaction, reduces perceived stress and anxiety and it even makes mammals (including humans) monogamous. This hormone is released during delivery, it affects the formation of the relationships between people, the total devotion to another person. People who hug each other more often have higher levels of oxytocin and lower blood pressure. During hugging, the release of oxytocin occurs from the pituitary gland, leading to a decrease in heart rate and cortisol, which is a stress hormone. Tactility affects the stimulation of the adrenal cortex to eject dopamine, called the happiness hormone. It plays a significant role in the regulation of emotion, mood, coping with stress, anxiety levels and the possibility to sleep. Dopamine levels can also improve decision making capacity and control desires. Similarly to a positive experience, high levels of dopamine can have positive impact on the development of social skills. Sense of touch

influences the stimulation of the hypothalamus to produce the neurotransmitter of serotonin. Deep tactile touch releases endorphins and serotonin, causing a feeling of pleasure, relieving pain, sadness, reducing the likelihood of heart problems, helping to maintain weight and prolong life. In addition, stimulation of the sense of touch strengthens the immune system, helps the body fight infections and stress, making it a natural immune booster[7,8].

Physical exercises, enhanced by tactile sensations, stimulate the formation of the polypeptide nerve growth factor (NGF) and neurotrophin (BDN F)[8]. The brain-derived neurotrophic factor (BDN F) regulates the growth and differentiation of neurons at every stage of life, it is a "brain fertilizer" and its synthesis increases under the influence of physical exercise. The indicated objective factors (NGF and BDN F), generated as a result of tactile stimulation and motor tasks, are crucial for the changes taking place in process of brain neuroplasticity. This process is a response to stimulation directed from the locomotive and sensory apparatus, influenced by specific stimuli or a combination thereof (externalreceptors, mechanoreceptors, thermoreceptors, telereceptors). According to Kossuth, the effect of brain plasticity is learning, in other words, the plasticity of memory. The integration of senses and their impact on brain development is a phenomenon of developmental plasticity. After brain injury, the recovery effect is compensatory plasticity[9]. The process of brain neuroplasticity takes place throughout one's whole life, and it can be triggered by targeted stimulation through systematic training, music and dance, massage, acupressure and acupuncture, as well as through the creation of interpersonal relationships as a result of touch contact, emotional stability. The process of neurogenesis can be stimulated by nutrition, supplementation, neurofeedback meditation, as well as educational kinesiology (brain gymnastics)[8,9].

Research has shown that touch is not just a sensation of pleasure, but also an irreplaceable factor of life as well as physical and mental well-being. The touch of a loved one satisfies the fundamental needs from the moment of birth, throughout life - the need for love and security[9,10]. Although it is still neglected, it plays an invaluable role in medicine because it relieves depression and anxiety, and it also works very positively when pain is to be relieved[10,11]. In early childhood, touch is the first means of communication with the surrounding world, and the way parents touch and hold a baby, and how frequently they do it, affects the development, well-being and health of a little one. On the basis of this study, it has been indicated that children deprived of physical contact are usually more anxious and nervous[12]. Touch is a unique and invaluable gift to humanity, because it creates the possibility of giving and receiving. Thus, the sense of touch fulfills many functions in human life. The most important ones include: a protective function supporting visual perception, or verification of information, information about the arrangement and shaping of body schema, regulating praxis, developing manual skills, but also strongly affecting the emotional sphere (sense of security, social maturity). Tactile stimulation is a deliberate therapeutic action using the sense of touch, aimed at enhancing the effects of compensating deficiencies in the development of human[12]. Neurotactile stimulation - according to Masgutova, is providing tactile stimuli through the skin, muscle stimulation and activation of movement (extension, flexion and rotation as well as stretching and compressing muscles, etc.) in order to integrate with the earlier patterns of reflexes - their tactility and facilitating their ways[13,14].

Touch plays a huge role in the proper development of a child, both in the field of neurophysiology and physical development (it stimulates physical development) as well as in mental development (it supports the development of kinesthetic awareness and limits of one's own body, emotional, cognitive, social)[12-14].

SENSORY HYPOSENSITIVITY AND HYPERSENSITIVITY

Carl H. Delacato was one of the first scientists who described disorders in the perception and processing of sensory stimuli. He detailed two types of disorders that tend to hinder a child's development. These include sensory hyposensitivity and hypersensitivity[12,13].

Insufficient sensitivity to tactile stimuli (low reactivity) occurs when the nervous system does not record or improperly recognizes sensorimotor information that reaches it. As a result, it may appear that children have an increased need for sensorimotor stimulation, which they signal by the irresistible compulsion of movement or by a continuous search for other intensive sensorimotor experiences. Without sufficient sensitivity, the child uses autostimulation in a stereotypical way (it provides sensorimotor stimuli for himself/herself), e.g. by irritating its mouth area, swinging, tapping fingers/hands, etc.[12,13].

Hyposensitivity, that is the deficit of touch differentiation manifests through[12,13]:

- excessive motor activity, which is the cause of neurosensorimotor sensations feeding the brain,
- weak recognition of objects by touch, without the use of sight (stereognosis)
- difficulty in recognizing area on the body, where a single tactile stimulus worked, even more so if the two stimuli are applied at the same time,
- limited capacity to visualize tactile information (if we draw a simple shape on a blindfolded child's hand with our finger, it cannot either imagine it or replicate it),
- inability to differentiate sharp stimuli from dull stimulus,
- poor body awareness (the child does not notice a cut or a hit),
- too powerful touching of other people (which can be interpreted as aggressive behavior),
- preference for intense, long-lasting effort, e.g. games like swinging, twirling, often without symptoms of discomfort.

Hypersensitivity to tactile stimuli creates an image of a disproportionate reaction to the strength of the stimulus. Children do not like undressing and dressing, they are irritated by e.g. the proximity of other people, cotton, woolen clothing, fur, they hate dirt on their hands, performing manual work such as modeling, painting. They often show physical and emotional hyperactivity, as well as problems with concentration[12,13].

Among the signs of excessive response to touch (hypersensitivity), the following should be listed[12,13]:

- physical or verbal expression of discomfort when the child is touched, sometimes resulting in withdrawal or aggression in response to touch,
- feeling huge discomfort in crowded places,
- avoiding some textures, which may refer to materials from which clothing is made (e.g. wool, rough linen) or food structures,
- frequent poor tolerance of any treatment involving the face and oral area,
- excessive stimulation and activity.

It is worth noting that tactile hypersensitivity has negative impact on the development of the fine motor skills because it leads to avoidance of multiple object manipulation, which is later reflected in the reduced ability of these children to learn. Children with hypersensitivity to touch do not like to be cuddled, they may avoid close contact with other people (this even applies to parents), which is a risk factor for interference in the mother - child relationship, or more broadly - with regard to social functioning[13].

MNRI® NEUROTACTILE THERAPY

NeuroTactile therapy plays a vital role in stimulating the development of children with various neurological and neurodevelopmental challenges[13,14].

The main goal of NeuroTactile therapy is to strengthen as well as create awareness of the patient's body and the stimulation of the skin and muscle receptors through neurosensorimotor stimulation of the sense of touch and proprioception. Dr. Masgutova's NeuroTactile therapy techniques involve providing a controlled number of sensory stimuli, in particular tactile and proprioreceptive, to create and facilitate the spontaneous, physiological adaptive responses improving the functioning and integration of the reaction caused by stimuli[13].

The tasks of this training are: activating natural mechanisms of development and self-regulation of the organism as well as regulation and standardization of touch perception, balancing tonicity, supporting the process of sensory integration, activating the mechanisms of sensory-motor integration, stimulation of sensory zones and integration of reflex circles, arousal and stimulation of bone-myofascial biomechanical chains to activity of the fine and gross motor skills, development of kinesthetic awareness, activation of the bonding reflex and stimulation of higher cognitive activities[13,14].

NeuroTactile therapy proposes techniques of stimulating the skin, muscles and joints, including all body surfaces and bone-myofascial biomechanical chains. This activation affects the proper development and integration of dynamic and postural reflexes by stimulating the correct functioning of the bone-myofascial, endocrine system and others. This activity is essential for the stimulation of the central and peripheral nervous system[13,14] (Figure 1).

The sagittal axis divides the human body into the right and left side, and in the sagittal plane, the flexion and extension movement of the torso occurs. The control center is the neocortex which coordinates the work of the opposite hemisphere and is responsible for the sensory sensations of coding, programming the movement and numerous cognitive functions[17-18]. The cerebral cortex is divided into four lobes: frontal, parietal, occipital and temporal (each is even). It is in charge of typical human abilities such as memory, language, thinking and planning[19-20].

The frontal lobe represents what distinguishes man from other species the most, that is the ability for conscious thought and sense of identity (awareness of their own integrity and separateness from the environment, the knowledge of who you are, the knowledge about yourself). The frontal lobes are responsible for executive functions, meaning the abilities that enable controlling and coordinating thoughts and behaviors, which include: programming and planning, initiating and monitoring activities, goal setting and achieving, decision making, predicting the consequences of actions and the ability to modify them, assessment of the situation and control of emotions arising in the limbic system, planning and coordinating movement, ability of social interaction, decision making. The frontal lobe affects the prediction of the consequences of actions and the ability to modify them, and also includes Broca's area, which helps to find words needed while speaking[17-20].

The parietal lobe is responsible for spatial orientation, understanding math, geometrics, abstract concepts as well as symbolic language. The front part of the parietal lobe is in charge of sensations (such as touch, temperature, pain), bordering with the sensory-motor areas of the rear part of the frontal lobes, which control movement. Another important function of the parietal lobe is the integration of movement and sight as well as feeling and sight[18-20].

Occipital lobes are associated with the sense of sight. They analyze: line, shape, motion, color, planes, volume and depth of an object. They are also responsible for visual associations[17-20].

The temporal lobe is the primary area of the brain responsible for hearing. In the upper part of the left temporal lobe we can find Wernicke's area, which is in charge of decoding sound stimuli and understanding words. This part helps to interpret what has been said[17-20].

The temporal lobe also takes an active part in: the analysis of sound sensations, categorization of objects, recognition of objects and faces as well as the analysis of smells[17-20].

The consequence of tactile stimulation is active effector response. It

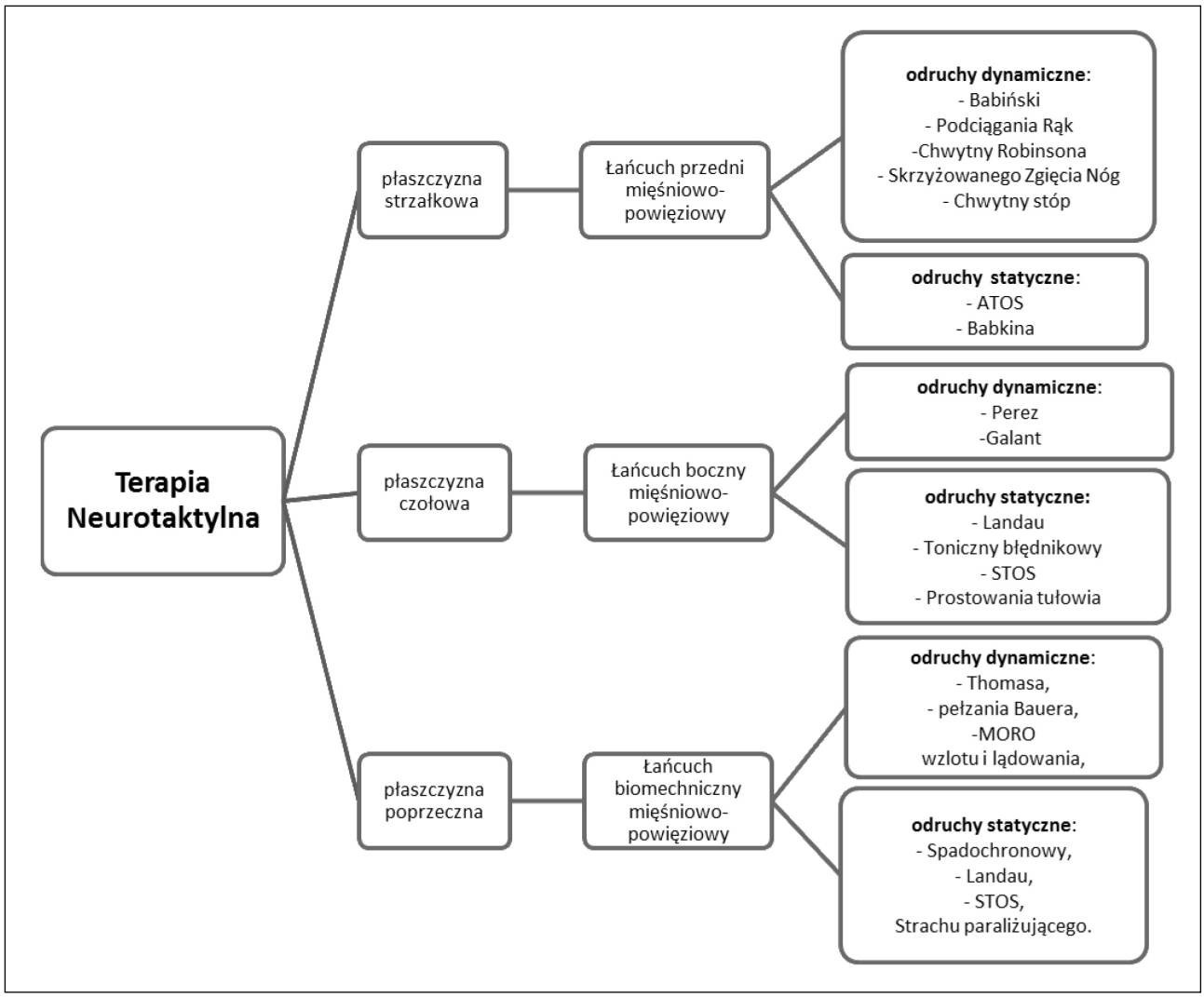

Figure 1

NeuroTactile therapy and therapeutic planes of the body

is the executive organ of a living organism, performing or changing its activity under the influence of nerve impulses (the final part of the reflex arc). Effectors are, for example, skeletal muscles, smooth muscles and glands. The effector makes the reaction, providing an effect after the activation of stimulus. In biomechanical terms, man uses bone-myofascial chains for active responses to stimulus[17-20].

In conclusion, activation of sensation and movement of the body within the sagittal plane in the new cortex stimulates and integrates the function of the right and left brain hemispheres. Man develops coordination (e.g. hand-hand, leg-leg, arm-leg, eye-hand, eye-tongue), balance, speech, synchronizes binocular vision, binaural hearing. This condition affects the interaction of perception and ability to communicate with others[17-20].

The foundation of coordinated and proper motions are integrated dynamic or postural reflexes. Reflexes accompany man from the first weeks of fetal life. The correct picture of a reflex is a sign of a well-working central and peripheral nervous system[17-20].

The frontal plane, vertical axis divides the body into front and back, directing the postural control of the body in space. It is closely connected with the functions of biomechanical reflexes like extension of the torso, positioning of the head, STOS, and others. In terms of development, thanks to tactile-motor coordination within the plane, there are stimulated vestibular-proprioceptive mechanisms, managing the mechanisms of survival and defense as well as receiving sensory stimuli and an adequate reaction to the ongoing events and phenomena[16-18]. On the basis of these processes, the habits between concentration (the convergence of the eyes) and "extension" of the field of attention (divergence of the eyes) can be developed. These habits affect the development of logical and visual perception, memory and thinking[17-20]. At the brain level, it is the brainstem (medulla oblongata, the bridge and the cerebellum) that is responsible for the work. Evolutionarily, it is the oldest system. The medulla contains a nucleus that controls the reflex functions, such as breathing, blood pressure, sucking, chewing, swallowing, sneezing, coughing, retching control, yawning, sweating. It is worth men-

tioning that the nucelus in the medulla calculates auditory information, especially the differences in the arrival time of sound to the left and right ear, which allows the spatial location of auditory stimuli. The bridge provides medulla oblongata with information about the signals controlling the muscles. The cerebellum transmits additional signals modifying the work of muscle contractions. The locus coeruleus, located in the dorsal bridge, is the nucleus producing noradrenaline (norepinephrine), a neurotransmitter that regulates the level of stimulation of the brain, and some autonomic functions (e.g. thermoregulation). Increased sensitivity to noradrenaline in the base-lateral part of the amygdala is responsible for anxiety resulting from stress, including acute post-traumatic stress disorders (PTSD)[14-18]. Strong stress interferes with the nucleus coeruleus. PTSD can develop slowly, from weeks to months, causing delayed stress reactions, feeling of numbness and dulling of emotions, inability to experience pleasure, insomnia, anxiety and depression, recurrence of traumatic situations, and even mental collapse and unresponsiveness to the environment. Operational disturbances in the nucleus are also observed in Parkinson's disease, Alzheimer's disease and Down's syndrome. Locus coeruleus is also associated with the regulation of REM sleep stages. The brainstem is therefore the key structure to understanding holistic human activity, in particular, consciousness. The midbrain (cover with quadruplet mounds) mediates in auditory (lower mounds) and visual (upper mounds) reflexes; it is also responsible for the orientation mechanism. The cap contains the largest nucleus, that is the black matter producing dopamine. It also contains the gray middle matter, red nucleus and part of the paracentral reticular formation[-20].

Tactile activation affects the stimulation of receptors and triggering dynamic and postural reflexes through stimulation of myofascial chains. In the transverse plane, a special role is played by the postural function of maintaining balance between the front and back of the body and the work of synchronization and coordination of the left and right part of the body[18-20].

The transverse axis, transverse plane separates the upper body from the lower. At the same time, it is responsible for the interaction of the upper and lower part of the body. It runs from the right to left side of the body, setting the direction of the medial and lateral direction. The map of brain projection by Penfield helps to understand that the sensory-motor patterns of the upper part of the body are more controlled by and synchronized with fine motor skills, that affect the processes of decoding/encoding and rational thinking[21]. Sensory-motor patterns of the lower part of the body are less controlled and associated with gross motor skills affecting the mechanisms of integrating the kinesthetic-motor sphere[22]. Thanks to tactility and coordination of movements of the upper and lower body, a human develops relationships between programming, planning and motor-postural control, as well as balance while walking and during other motor activities. Coordination of movements and tactility within this plane affect people in the organization of activities and behaviours[22,23]. Tactile-motor coordination, within the transverse plane, is biomechanically linked with reflexes such as Moro, Landau, crawling or automatic walking. They prepare a child to work at higher positions, such as, for example crawling on all fours, sitting, walking. Diencephalon is the structure responsible for emotional and cognitive processes. The main function of this level of the brain, including the limbic system, is the analysis of stimulus flowing from the external and internal environment within the processes of excitation and inhibition (Thalamus) and in terms of their emotional significance and managing impulsive-emotional behaviour (intake of food and water, reactions of aggression, territorial behavior, self-preserving, power, etc.)[19-22]. In addition, it is responsible for the formation of emotional states, coordinating activities of the somatic and autonomic as well as sensorimotor system. It affects cognitive processes, learning and memory. It is worth noting that the hypothalamus controls the sympathetic-parasympathetic nerves which coordinate the work of internal organs, i.e. heart, liver, lungs, gastrointestinal tract and blood vessels throughout the body. It takes part in decoding stress and the activation of alarming/fear, and is of particular importance in the Moro reflex, paralyzing fear, stability and grounding[14,18-21].

Proper development of sensation after appropriate stimulation of all brain regions is of great importance for the development of the motor, cognitive, emotional spheres of a patient. It particularly affects the development of the correct patterns of dynamic and postural movement and then, the development of skills and habits. Reflexes are the natural patterns and programs that respond to sensory and proprioceptive stimuli.

They are innate programs, characterized by a stereotyped sequence of implementation of the act of movement or behavior. They arise as a result of the emergence of "specific" stimulus, thus ensuring stability of performing the most important vital functions of the organism, regardless of random, transient environmental conditions. A characteristic feature of reflexes is that their performance is determined by both external determinants, as well as by patterns of receiving stimulus. According to Masgutova, tactile sensation and sensorimotor integration of reflexes are a process specified by innate programs[23,24]. Their goal is to provide the body with a protective function in the event of changes in the environment, as well as changes in attitude and movement, e.g. related to the laws of gravity and acceleration (movement forward/backward, turning left/right). This relationship is significant in ATOS reflexes and the tonic labyrinthine. Knowledge of the rules regarding sensorimotor and proprioceptive stimulation of sensation as well as postural and dynamic reflexes determines the correctness and ways of correcting and integrating patterns in case of different developmental abnormalities[21-23].

The method of NeuroTactile therapy by Masgutova plays an important

role in stimulating the development of children with various challenges. Deep neurosensomotory stimulation affects the activation of natural mechanisms to support the functioning of the systems: original touch, proprioceptive, biomechanical chains, reflexes, regulation of stress, and nonverbal-emotional. Tactile therapy is especially recommended for patients with neurological, sensory or cognitive challenges as a result of underdevelopment because of depravity or tactile hypersensitivity or impediment due to stress. It is especially recommended in the case of[23-25]:

- brain paralysis and brain damage,
- autism and spectrum,
- fears, phobias and OCD (obsessive compulsive disorder),
- suppression in psychomotor development,
- hyperactivity disorder (ADHD and ADD),
- posttraumatic stress disorder (PTSD),
- learning difficulties and dyslexia,
- suppresions and speech disorders.

In accordance with the objectives of NeuroTactile treatment during work with various disorders, receptors present in the skin and muscles are stimulated, the functioning of the nervous system is optimized. Stimulating and therapeutic work is focused on the specific properties of psychomotor development, characteristic of individual disorders.

The aim of NeuroTactile techniques in therapy is[17-19]:

1) Realization of the length, size, body boundaries;
2) Activation of kinesthetic awareness of boundaries, a sense of self;
3) Activation and stimulation of surface and deep sensory sensation;
4) Activation of biomechanical chains in response to tactile stimulus and production of the correct neurosensorimotor response of the organism;
5) Awareness of connections between the middle of the body with limbs and strengthening the orientation of the scheme's of one's own body;
6) Stimulation of receptors responsible for surface, deep sensations and pressure;
7) Activation of reflex patterns: extension of the torso and head, breathing, protective center of the body, upper limbs (flexion and support for arms) and lower (babinski, protection of the feet's tendons, gripping feet, alternating flexion and extension of the leg), gravity, grounding and others;
8) Awakening and support of regulating tonicity mechanisms, the bone-ligament system;
9) Stimulation of endocrine and immune systems;
10) Activation and stimulation of receptors in the skin;
11) Support and activation of defense mechanisms, stress resistance and bonds: calming the hypersensitive paralyzing fear reflex, supporting bonds;
12) Activation of self-regulatory mechanisms and processes in the neocortex, hippocampus, hindbrain;
13) Activation of balancing mechanisms and inner balance;
14) Normalization of sensory deprivation (pressure, which is produced in the tissues during the stimulation of the body resembles the intrafetal pressure produced by amniotic fluid);
15) Activation of the interaction between: skin and muscles, tendons and muscles, tendons and bones; activation of the connection of skin and the biomechanical chains' work;
16) Increasing mobility of the body and stimulation of rotation;
17) The plasticity of kinesthetic memory associated with stress;
18) Mobilization of the diaphragm and the interaction between peres and galanta reflexes;
19) Stimulation and normalization of the digestive system's work, pain relief in the knees, flatulence and constipation;
20) Activation of the spine and peripheral joint mobility;
21) Neurosensorimotor stimulation of frontal, lateral and rear surfaces of the body.

SELECTED NEUROTECTILE TECHNIQUES OF THE MNRI PROGRAMME

The main therapeutic techniques include: stroking, traction of limbs, tactile compressions and rotations in the joints.

Exercises are performed in a supine position on the back. The therapy begins with the stimulation of the front surface of the body. These include[17-19]:

- stimulation touch sensation of the front/rear part of the body (Figure 2),

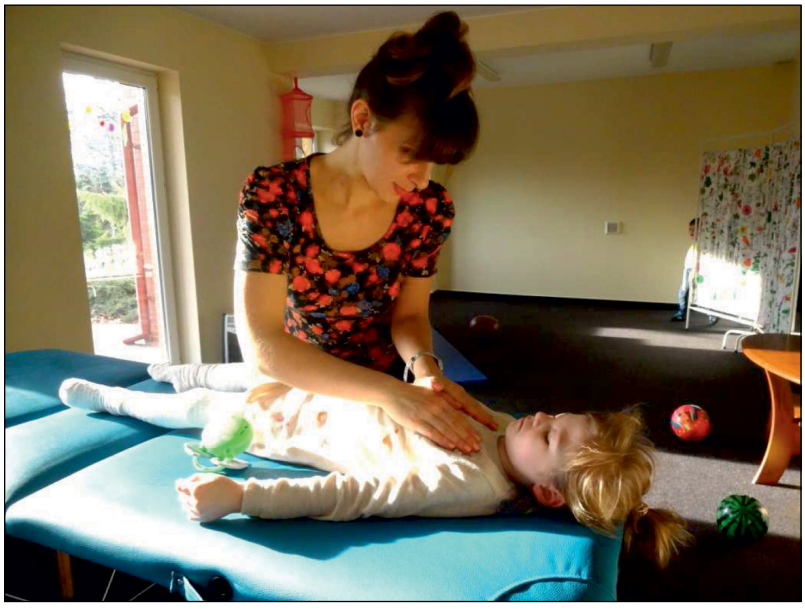

Figure 2

Neurosensory motor stimulation of the frontal surface of the body

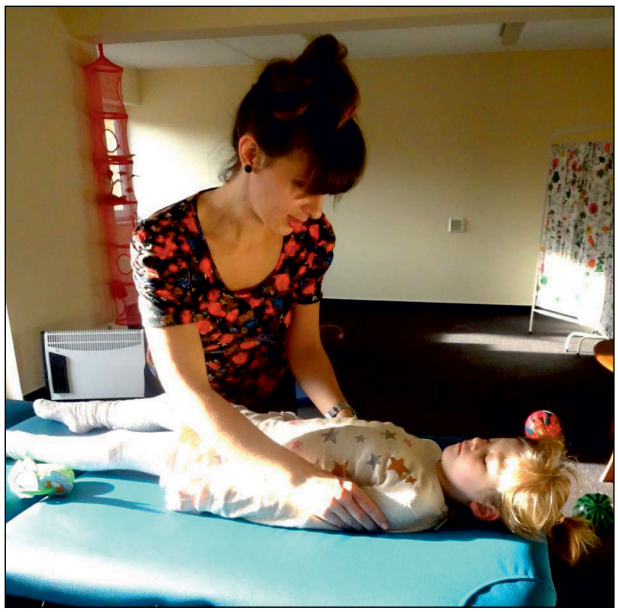

Figure 3

Neurosensory motor stimulation of the upper limbs

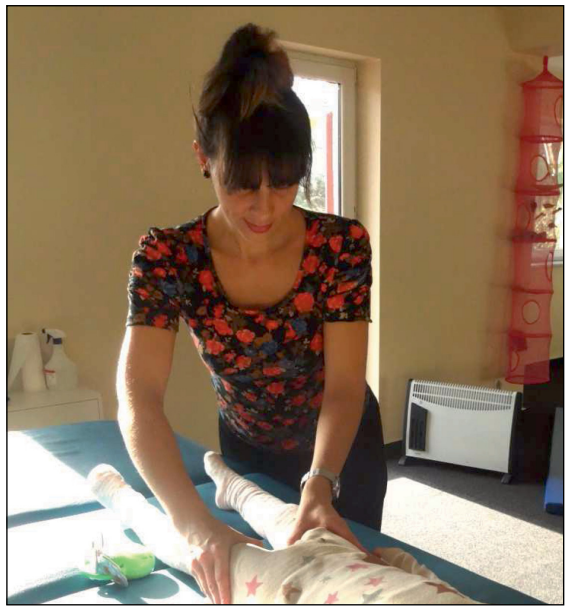

Figure 4

Neurosensory motor stimulation of the lower limbs

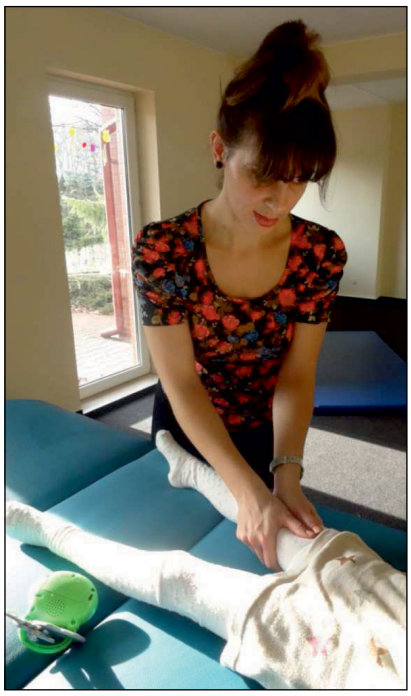

Figure 5

Tactile pressure

- stimulation with stress on the joints (Figure 3),
- sensory stimulation of the lateral surface of the body (Figure 4),
- stimulation of the abdominal wall,
- stimulation in the direction of the growth of limbs with work on segments of the limbs
- tactile pressure of the limbs (Figure 5),
- traction of the upper and lower limbs,
- rotation in the joints,
- stimulation of the diaphragm,
- lazy "eights" on the chest.

Each of the above techniques should be repeated three times. During work, it is important that the touch is warm, that the therapist's hand adheres well to the patient's body, the movement on the patient's body is smooth and deep at the same time.

SUMMARY

Tactile stimulation is a deliberate action using the sense of touch to enhance the effects of compensating for deficiencies in human development. Tactile stimulation (ST) is providing tactile stimuli through the skin. It is realized by the touch system in order to increase the sensitivity to stretching of muscles and the use of sensory stimulation to activate motor response (bone- myofascial chains).

An indirect effect of NeuroTactile stimulation is its influence on the hormonal system, and as a result - regulation of maturation processes of different body structures and functions. The activity of dynamic and postural reflexes after tactile stimulation enhances touch sensations in various parts of the body - its planes and biomechanical chains. Stimulating the relations between the sense of touch with sensory areas belonging to the reflex patterns, normalizes a baby's stretching reflexes, torso extension, breathing, Moro reflex, paralyzing fear, bonds and various others, supporting maturation of reflex circles and extrapyramidal nerve pathways. It also regulates defense reactions such as "freezing" and "fight or flight" normalizing levels of stress hormones.

NeuroTactile stimulation enhances the formation of neuronal growth factors - polypeptide nerve growth factor NGF and neurotrophins BDN F. The generated factors, as the effect of tactile stimulation, significantly affect the processes of brain neuroplasticity. The brain plasticity is the possibility for permanent functional transformations under the influence of certain stimuli or a combination thereof (externalroreceptors, mechanoreceptors, thermoreceptors, telereceptory). It is believed that the effect of the brain's plasticity is learning (plasticity of memory), the integration of senses and their impact on brain development (developmental plasticity) and the effects of recovery after brain injury (compensatory plasticity).

Touch and proprioception provide the nervous system with infor-

mation in the field of fine and gross motor skills necessary for proper management of movements and help stabilize the body during all activities. These systems help to sense and decide how much pressure is required from the muscles to grip, hold and lift objects and with what force these specific activities should be performed. Each physiological movement requires proper tonicity, smooth movements, smooth coordination of the large muscles' work and a good sense of the body. Full control of fine motor skills enables to use the muscles of the fingers and toes, the tongue, mouth and lips in order to perform precise activities. It develops on the basis of gross motor skills. A child with impaired tactile and proprioceptive sense does not develop proper tonicity, does not have contact with its own body, lacks stability, coordination, balance. Therefore, the skills associated with fine and gross motor skills may be delayed or poorly developed.

A child with a properly functioning tactile and proprioceptive system has a properly developing schema and body image. The beginnings of this process take place already in fetal life. Well working receptors stimulated by movement and touch convey correct information to the brain. Thanks to this, they support the proper development of somatosensory maps. Correct body schema is the result of the synthesis of tactile, vestibular, proprioceptive, visual and auditory sensations. With good body awareness, a baby can move smoothly and freely. It has a well-developed sense of all parts of the body, automatically knows and feels how to use them and what for; they feel good in their own body. Appropirate sense of one's body is associated with a good perception of the space outside of it. When an image of the body is disturbed, the child may be unaware of the position of its body and its parts in space. It has difficulties or cannot locate the place of tactile stimulation on its skin and wrongly interprets stimuli. The child does not know how to use the limbs and is clumsy in action. The movement usually means touch, so in a case of hypersensitivity to tactile sensations, a child will avoid any activity which deepens the already existing deficits.

Thanks to NeuroTactile therapy, strengthening is achieved as well as creating the awareness of the patient's body and stimulating receptors in the skin, musculo-ligamentous, endocrine, etc. through neurosensorimotoric stimulation of the sense of touch and priprioreception. Dr Masgutova's NeuroTactile therapy techniques rely on providing a controlled number of sensory stimuli, in particular touch and proprioreception, to create and pave the spontaneous, physiological adaptive responses that improve the functioning and integration of stimuli. Systematic training affects the stimulation of natural mechanisms of development and self-regulation of the body, and stimulates regulation and normalization of tactile perception, balancing tonicity, supporting the process of sensory integration, activating the mechanisms of sensory-motor integration, developing kinesthetic awareness.

Conflict of interest: none

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