



## ONTOGENETIC CONDITIONAL TECHNOLOGIES OF EARLY HABILITATION OF CHILDREN WITH PERINATAL BRAIN PATHOLOGY

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### ABSTRACT

The high level of disability in children with perinatal pathology of the central nervous system implies the need for timely abilitation measures. In an early age child, rehabilitation planning is carried out taking into account the timing of the formation of the main functional systems. Knowledge of the neurophysiological mechanisms of the integrative activity of the brain, patterns of development of motor and sensory systems in ontogenesis is the methodological basis for constructing the habilitation programs. The authors presented in detail the anatomical and neurophysiological levels of motor, cognitive, speech ontogenesis and habilitation technologies used to correct developmental disorders. In the article, the authors proposed a neurophysiological justification for the application of various modern and traditional technologies of early habilitation in children with perinatal central nervous system lesions in accordance with the concept of movement construction developed by N. A. Bernstein and the structural and functional model of the brain proposed by A. R. Luria. Implementation of this approach will reduce the number of adverse outcomes.

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### INTRODUCTION

Habilitation as medical, social, psychological and pedagogical measure, directed towards prevention or reduction of evidence degree of defects of developing functional systems of a child in early age becomes more much-needed and actual. This is because of the high percent of children at the age from 0 to 3 years in the structure of primary disablement (41%) and because of the predominance of nervous breakdown in perinatal period in this age category (32.9%) and also birth defect (35.9%) which materially affect on child development (Utkuzova *et al.*, 2015). The methods which do not always have scientific evidence and accordance with age-related and ontogenetic needs of a child are widely advertised at the market of rehabilitation services.

During rehabilitation programming it is necessary take into account not only available neurologic impairment of a child, but in the first instance age-related, neurophysiological particularities of formation and development of functional systems at this age (Batysheva *et al.*, 2014). It is possible to consider child development from the perspective of neurophysiology to be variation of responses (of behavior) while acquisition and accumulation of personal experience and sensory perception from external and internal environment (Isanova, 2011; Skvortsov, 2014). According to Badalyan L.O. a child who does not get visual-oral information and does not have appropriate contact with adult – he will be unavoidable psychomotor retarded (Badalyan, 2010). Perceptual date is a motivation and a stimulation pulse to movement from easy reflex forms to movements-activities within a framework of complicated hierarchy motor system. Sensory influence and motor activity forced by it waken analytico-synthetic activity of cerebral cortex, which begins to control flow of sensory information at specific stage, regulating deliberate response or

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neglect. Methodological and neurophysiological feasibility of rehabilitation development conception can be found in structural and functional model of integrative activity of brain by A.R. Luria (2007) and in the system of multilevel construction of movements by Bernshtein N.A. (Bernstein, 1966). The structure of psychic activity by A.R. Luria contains several consistent stages implemented with the involvement of three brain units:

- Energy unit of brain activity regulation;
- Unit of reception, processing and storage of exteroceptive information;
- Unit of programming, regulation and control of functional systems activity in accordance with verbal formulated intentions, purposes and motivational goals of a man. Inefficiency of any of the three units (or disease of any units) leads to damage of a correspondent stage of its realization and affects the psychic activity as a whole. The 1st unit consists of reticular formation of brainstem, structure of midbrain, diencephalic region, limbic system, mediobasal units of fronto-temporal lobes. The structures of the first unit is notable for early maturation in the process of ontogeny which is explained by importance and vital necessity of controlled by its' functions.

#### Problems resolvable at this point are:

- energy provision of consciousness and attention – indiscriminate and selective
- perception and processing of information about state of internal environment of a body and regulation by way of neurohumoral mechanism
- provision of the process of memorizing, storage and processing of information
- integration of neocortex and brainstem functions
- brain substrate of motivational goals, emotional processes and conditions (base emotions – fear, pleasure etc.)

Attention which is measured as good when talking about a child of the first months of life, long-lasting visual contact («eye to eye») – is the first and the most important milestone in child's development, it is the primary target which all our efforts should be sent towards regardless of the age of the child. Emotional (parent or micro social) reinforcement of cognitive activity and psychic activity in whole, is critical even in early childhood because it is reflected on rate of formation any behavior reflex. Positive reinforcement of child's activity – is a key element of any rehabilitation technique. The origin of positive emotions for an infant is an emotional meaningful significant person, the most frequently it is his parents. For this very reason parents must be actively involved in the process of rehabilitation within a framework of family-centered methods of correction, and provided methods must be fitted in activities of daily living of a child and his family members. Parent lessons for the children must be of evolutive care and game nature on the back of positive parent-child interaction. Exercises for infants by Tsukunft-Hoover B. may serve as an example (Zukunft, 2000).

#### The second unit consists of

- **Primary zone of cortex (cortical area)** - reflection of stimulus of one modality takes place there; herewith topical principle of organization is held whereby each part of receptor surface is associated with specific part

of primary zone according to rule “point to point” (by Penfield). The volume of zone of cortical representation depends on functional significance of receptor part and requested function.

- **Secondary areas** generate transformation of somatic impulses (afferent impulses transmission through associative thalamus nucleus) into perception
- **Tertiary (associative) areas (overlapping zone)** – integrate processes of excitation, which come from the secondary areas of the whole complex of analyzers

#### Functions of the II<sup>nd</sup> unit

- Provision of modal-specific processes
- Integrative processing of exteroceptive information

Sensory integration is formed under appropriate and sufficient supply of a variety of sensory stimulus in accordance with the ontogeny of development of basic analyzers (kinesthetic, visual and acoustic). The most prepared and mature analyzer by the time of birth of a child is a kinesthetic analyzer. All the basic information a child "reads" from the receptors of the skin, mucous membranes, muscles, tendons and joint capsules. It is the kinesthetic analyzer that is the basis, support for the development of all other sensory systems at all times during the pre-school age. The massage, gymnastics, swimming, laying and reflex stimulation of locomotor systems by V.Vote contribute the development of the kinesthetic analyzer (Vojta, 2007). The ethnic methods, such as traditional Indian maternity massage (massage Chantal) (Leboyer, 2006) and the method of Castillo-Morales (8), based on the traditions of the indigenous people of South America, special attention is given to the face area of a child which is most representative in the cerebral cortex, according to Penfield scheme, while at the same time it has a powerful impact on the brain stem structures relating to the Its structural and functional unit. It is known that ergotherapy and Montessori method adapted for children with special need contribute to better differentiation of perception, to development of skills, and to production of operating procedures. Leading part in this process play structures related to the III structural and functional unit. Anatomical structures included in it: it is the prefrontal areas of the brain, having connections with the underlying parts, with the reticular formation, with the temporal, parietal, occipital cortex and the limbic system.

The primary objectives of this level are:

- Generation of plan and program (algorithm) of activity, taking into account the methods of implementation and the "image of the desired result"
- Collation of the result with the expected image

Prefrontal area – it is a filo- and ontogenetically late maturing part of the brain. The first manifestations of the activity of this level can only be observed close to 12 months, and the final terms of the frontal functions data formation are dated from 12-15 years of age. Optimal functioning of the III block is achieved with sufficient ontogenetic maturity of I and II blocks. From the perspective of the development of rehabilitation and ontogenesis of motor function of structural and functional model of integrative activity of the brain according to A.R. Lyria accords with the concept of multilevel movements forming-up by N.A. Bernshtein. N.A. Bernshtein is an author of an activity physiology concept, divided the whole complicated process of development of movements and systems that control the movements in several levels:

- A – the level of tonus and posture
- B – the level of synergism
- C – the level of space
- D – the level of activity and speech

Regulation and perfection of movements in ontogenesis are carried out by different CNS (central nervous system) structures, which are strictly subordinated and reflect consistent variation of motor functions in the process of evolution. It is important to assess the level of development of the motor system and contributing to solving current level tasks, developing and improving existing skills, consistently strive to achieve the next stage during making up a program of rehabilitation. The better background (baseline) levels of motion are developed, the richer and more various the movements of higher levels are. Level A – structures that operate at this level, have the character of segmental structure. These structures are the structure of a spinal medulla and brain stem. Phylogenetically it is the level of fish movement organization, which is characterized by holding the position of equilibration with the environment, out of tangible action of gravity. At this level activities is carried out unconsciously under the regulating influence of red nucleus, vestibular apparatus and kinesthetic analyzer. Isolated activity of the man at this level is possible in gravity-free state or in a state of free fall.

#### Problems of A level

- Development of statokinetic functions of the body and neck.
- Regulation of muscle tone, initial for the opportunity of realization of movements - the background tension.

The ability to keep symmetrically stable position as on the back and on the stomach is critically important for infant. It is this movement skill that makes possible the realization of target-oriented movements together with equal background muscle tension, and hereafter – first locomotion. Level B – it is the level of musculo-articular sheafs and synergism. Phylogenetically it is the level of amphibian and birds. As well as the level A it is the background level of movements organization, id est control of movements is carried out without the involvement of consciousness. A pale nucleus is a motor centre at this stage (globus pallidus). Sensor correction of movements is carried out by thalamus (thalamus). Ontogenetically this level is the lead one of a young infant.

#### Problems of B level

- The guideline of big set of muscles, synergism, rhythm of movements
- Optimal body positioning and position of individual sets of muscles for motion performance
- Coordination of movements
- Equality of cyclical movements
- Formation of motor skills and automatisms
- Facial gesture, plastics and pantomime of body movement

The limitation of the level B is a lack of incoming information from telereceptors – vision, hearing that does not allow to adapt complex movement to the external conditions and the actual situation at this level. This problem is successfully solved at the next level – the level of space C. The perception

of the outside world is projected onto the cortical analyzers through telereceptors (vision, hearing) and sensory information of conductors of superficial and deep sensibility coming from the thalamus. Realization of movements in space is carried out both the extra pyramidal motor system and conductors of voluntary activity - pyramidal motor system.

#### The C level movements

- locomotions (swimming, crawl, walking, running, etc.);
- locomotions with using therapeutic appliance
- movements of the body moving in space (dance, ballet, acrobatics, gymnastics, etc.);
- exact target-oriented hand movements in space,
- overcoming resistance
- power movements (lifting of severity, etc.);
- ballistic and impact movements (strength and precision);
- imitation and emulation movements

This level is predominant and leading at preschool age. It is a correspondence of locomotive skills to Level C of children is explained their need of movements, action games with sophisticated storyline, their motivation to high mobility. These ontogenetic processes must be considered, giving priority to those methods of rehabilitation, where the realization of opportunities at this level will be able to find the maximum expression. N Bernshtein called the level D «a human» action level. Movements at this level are consistent and informative. Control and regulation is carried out by cerebral cortex, basically, - by the prefrontal area which is responsible for behavior modeling. The executive body is mostly hand. This is the level of substantive actions, semantic chains. The action constitutes not an isolated motor movement, but chains («links») of consecutive motions that are needed for solving assigned motor task.

#### Specific characteristic of level D

- chain structure, adaptive variability in composition and structure of the chains;
- more complex actions with objects (than level C);
- strategy formulation based on adequate and socially acceptable principle of achievement of results and getting the desirable.

The highest manifestation of this level is speech, as a chain of consecutive motions of the lips, tongue, vocal cords. Level of action begins to sound at the end of the 1 year, when the asymmetry of the work of hemispheres begins to appear (dextrality or left-handedness becomes obvious or ambidexterity is observed) and praxis and speech are formed. The child is able to plan action based on general ideas and concepts (memory, sensorimotor experience), to carry out the correction of movements by comparing the result of the movement with its' idea and with the expected result (relating it with getting possible benefits or avoiding a punishment). Multisensory techniques of cognitive rehabilitation, such as the Montessori therapy and occupational therapy are better suited for stimulate the development of the D-level. Thus, an individual program of habilitation of the child with defect of sensomotor functions should be formed based on the neurophysiological bases of integrative activity of the brain, multi-level principle of the motor function and the stages of

ontogenesis in norm, in accordance with pathological syndromes and functional patient's age.

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