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Intensive Rehabilitation in Children with Cerebral Palsy: Our View on the Neuronal Group Selection Theory

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A B S T R A C T

Cerebral palsy (CP) is one of the major forms of developmental disorders. There are different approaches and controversies in rehabilitation treatment. The Neuronal Group Selection theory could provide theoretical explanation for Stojčević Polovina rehabilitation method. The aim of the study was to evaluate long-term impact of intensive and continuously performed rehabilitation on the motor autonomy level children with CP. Motor autonomy levels, defined according to the Gross Motor Function Classification System (GMFCS) and Gross Motor Function Measure (GMFM), were analyzed in 24 children with CP at the beginning of the study and at the last visit. During rehabilitation, GMFM scores increased above the expected value of initial GMFCS level in the majority of patients. Intensive rehabilitation had significant influence on motor improvement in children with CP.

Key words: *cerebral palsy, rehabilitation, Neuronal Group Selection theory, Gross Motor Function Classification System, Gross Motor Function Measure*

Introduction

»A major function of animal and human nervous systems is the coordinated control of limb and body movements. Coordinated motor activity enables an animal to explore its environment and to sample and attend to sensory stimuli, and it is essential for its survival within its econiche. Initially, however the motor capabilities of newborn higher vertebrates are generally inadequate to accomplish any of these vital tasks, and these capabilities undergo profound changes over an extended period of postnatal development. This period is of particular interest in human infants, many of whose motor abilities at birth appear to be among the least developed when compared to those of other vertebrate species. A child's continued progress in achieving precise control of motor functions is an obvious prerequisite for its further behavioural, cognitive, and social development...«[1–3].

Theoretical frameworks for the development of motor control are found in three main theories: the Neural Maturationist Theories, the Dynamic System Theory and the Neuronal Group Selection Theory (NGST).

Neural-Maturationists Gesell and Amatruda claimed that »maturation is the net sum of the gene effects operating in a self-limited time cycle«, a concept which virtually left no place for interaction with the environment[4,5]. The idea that behavioural patterns emerge in an orderly genetic sequence, resulted in the recognition of general developmental rules such as the cephalocaudal and central-to-distal sequences of development. These notions prompted the pioneering work on »developmental diagnosis«, consisting of neat series of tests for the assessment of developmental milestones[5]. Motor development was considered to be the result of an increasing cortical control over lower reflexes.

The ideas of Kugler et al., known as the Dynamic Systems Theory, is based on the principles of non-equilib-

rium thermodynamics; systems which maintain energy by interaction with the environment thus creating globally stable structures over extended periods of time[6].

Thelen et al. considered development as a dynamic system where continuously occurring changes of the environment can induce discontinuous changes (transitions) in behaviour[7–9].

The Dynamic Systems Theory and the Neural-Maturationist Theories differ especially in their view on the role of the nervous system in motor development. The Neural-Maturationist Theories consider the maturational state of nervous system as the main constraint of developmental progress, whereas in the Dynamic Systems Theory the neural substrate plays a subordinate role[10].

According to NGST, successful developmental coordination between neuronal activity and biomechanics of the musculoskeletal system is based on variation and is the result of somatic selective processes within brain circuits. Selection acts to match possible motor commands to constraints posed by neural structure and kinematics. This selection occurs for particular neuronal groups when their activation in a given context matches given environmental and internal constraints as compared to competing groups. The mechanism of selection in the nervous system is synaptic change (by a variety of detailed mechanisms) leading to selective amplification or diminution of neuronal group responses. The selection of neuronal groups ultimately allows for discrimination and categorization of sensory inputs and the integration of sensory and motor processes to yield adaptive behaviour[3].

The NGST proposes three mechanisms to account for the production of adaptive behaviour by rich nervous systems: developmental selection, experiential selection and reentrant signalling. Each mechanism acts within and among collectives consisting of hundreds to thousands of strongly interconnected neurons, called a neuronal group. According to the theory, primary repertoires of neuronal groups are established during development. While anatomical structures in a given area of the brain are modally alike in different individuals of a species and are constrained by genetic programs, enormous epigenetic variation occurs during development at the level of fine axonal and dendritic ramifications and connections. This developmental process leads to the formation of degenerate networks of neuronal groups whose dendritic trees and axonal arbors spread over relatively wide areas with a great degree of overlap[11]. Degeneracy as a term means the ability of elements that are structurally different to perform the same function or yield the same output[12]. After most of the anatomical connections of the primary repertoires have been established, the activities of particular functioning neuronal groups continue to be dynamically selected by ongoing mechanisms of synaptic change driven by behaviour and experience. The neuronal group is considered to be the basic functional unit or unit of selection. Experiential selection leads to the formation of secondary repertoires of neuronal groups in response to particular patterns of signals. Because of the changes that occur in synaptic efficacies, upon later encounters with signals of similar types, the previously selected circuits and neuronal groups in such secondary repertoires are more likely to be favoured over others. Specific neuronal groups are selected over others in a competitive fashion. Unlike natural selection in evolution, which results from differential reproduction, experiential selection results from differential amplification of synaptic populations. The theory proposes that coordination and reinforcement of patterns of neuronal group selection must occur among various locally mapped regions of the brain. Different maps must also be coordinated. The NGST proposes that mapped regions exchange and coordinate signals by a higher order selection process called reentry. Reentry can be defined as ongoing parallel signalling between separate neuronal groups occurring along large numbers of ordered anatomical connections in a bidirectional and recursive fashion. Reentrant signalling can take place *via* reciprocal connections between and within maps (as seen in corticocortical, corticothalamic and thalamocortical radiations) as well as *via* more complex arrangements seen in the connections among cortex, basal ganglia and the cerebellum. Reentry is a dynamic process that is inherently parallel and distributed[11,13].

Hadders-Algra suggests that extension of the NGST to the domain of developmental motor disorders, such as cerebral palsy (CP) and developmental coordination disorder (DCD), could offer new insights into the mechanisms directing this type of dysfunction. Studies indicate that children with severe types of CP have deficits in primary variability with no appropriate functional activity in primary neuronal networks. Children with mild and moderate forms of CP, as well as children with a complex form of minor neurological dysfunction (MND) have reduced repertoires of primary neuronal networks. All children with CP and children with complex MND have deficits in selection and inappropriate processing of afferent information. These children as well as children with simple MND have deficits in secondary variability and inappropriate coordination of parallel networks of secondary neuronal repertoires. The resulting concepts might inspire the development of innovative and effective therapies for these disorders[10].

The rehabilitation method developed by Stojčević Polovina is a self-developed method whose basic elements can be explained by NGST. The most important characteristics of the rehabilitation method, that makes it unique, are the intensity of physiotherapy and the process of following normal development regardless of chronological age, while respecting individual variations[14]. The hypothesis of the Stojčević Polovina method is that specific and very intensive therapy can influence experiential selection and consequently reentry.

The natural course of disease can be described using the Gross Motor Function Classification System (GMFCS), which is considered to be stable. There is a strong correlation between GMFCS levels and Gross Motor Function Measure (GMFM) scores[15]. Therefore, the impact of re-

habilitation can be observed in relation to these two measures.

The aim of the study is to evaluate the possibility of changing the natural course of cerebral palsy by the specific therapeutic method created by Stojčević Polovina and to propose a theoretical background for this method using the NGST.

Patients and Methods

Study design and patients

Twenty-four children with CP were included in the study. All children were diagnosed with CP based on published diagnostic criteria[16]. Before the beginning of the study, all children had already received rehabilitation in other institutions, usually the Neurodevelopmental treatment (NDT) approach[17].

Motor development was analysed at the beginning of the study (when children started a new rehabilitation protocol) and at the last visit, using GMFCS and GMFM in combination[15,18,19].

All children underwent rehabilitation according to the Stojčević Polovina method[14].

Some children due to anatomical and dynamical contractures, underwent orthopaedic procedures and/or botulinum toxin applications as adjuvant intervention/s during the rehabilitation. Orthopaedic procedures and/or botulinum toxin applications were not in and of themselves a form of treatment, but rather were a necessary precondition for the treatment of patients with anatomical or dynamic contractures. Because of the possibility that different orthopaedic procedures and/or botulinum toxin applications could influence GMFCS levels and GMFM scores, two groups were formed in order to show that the rehabilitation itself regardless of additional procedures has an impact on the natural course of disease[15]. One group consisted of patients treated only with physiotherapy ($N_1=12$) while the other group consisted of patients treated with physiotherapy combined with orthopaedic surgery and/or botulinum toxin treatment ($N_2=12$). During the initial assessment there were no significant differences between the groups with respect to the severity of impairment assessed by GMFCS.

The study was approved by the Ethics Committee of the Polyclinic. Informed consent was obtained from the parents.

Treatment

The treatment by itself is a combination of intensive, variable sensorimotor stimuli through the facilitation of automatic reactions (some facilitation of automatic reactions is used in a way similar to NDT, the majority of facilitations are self developed), Vojta therapy (not in all patients), complex combinations of passive movements in chosen postures, normal active movement when possible, audio-visual stimulation and occupational therapy[17,20].

The therapy lasts a minimum of three hours *per* day (often even more), without strict time restrictions. Due to the high intensity of physiotherapy, parents are the key figures in the rehabilitation process. They are educated and trained to perform therapy, continuously, several times *per* day. Therapies are performed by following the process of normal development whenever possible, regardless of chronological age, but respecting individual differences. The initial therapeutic focus is on particular developmental sequences in which the children's overall performance is closest to normal. Parents and caregivers are instructed to inhibit all unwanted patterns of movement, to promote normal motor patterns and to encourage spontaneous activity within the developmental milestone which is the current focus of therapy throughout the day (i.e. not only during active physiotherapy). For example, if a child's focus of therapy is learning to crawl properly, the child is discouraged from standing or attempting to walk during spontaneous activity.

The main tasks for the rehabilitation team are to determine the developmental sequence/s within which the focus of therapy is to be carried out and to define the intensity of the treatment. This is unique for each child and because of that the rehabilitation program is always personalised.

The use of any assistive mobility devices (walkers, crutches, canes) were strongly discouraged except for wheelchairs when absolutely necessary, and orthopaedic shoes in some children. Selective use of different orthopaedic procedures and/or botulinum toxin application, mainly because of anatomical and/or dynamical contractures, in some children (regardless of the degree of disability) was also part of the treatment.

Measurements

The severity of cerebral palsy was based on GMFCS, which is a reliable and valid system that classifies children with CP by their age-specific gross motor activity[15,19,21,22]. The GMFCS describes the major functional characteristics of children with CP in each level within the following age windows: prior to the second birthday; between age 2 and 4; between 4 and 6; and between 6 and 12. The description for each level is broad and is not intended to describe all aspects of gross motor function. The distinction between GMFCS levels is usually based on functional limitation, the need for assistive mobility devices (walkers, crutches, canes) or wheeled mobility, and to a lesser extent, quality of movement[21]. At the beginning of the study all children who already used assistive mobility devices were assessed with them, while during the study and on the last visit the assessment was performed without assistive mobility devices (with the exception of wheel chairs in Level V patients).

Motor function was assessed with the GMFM[18]. The GMFM is a widely used criterion-referenced, clinical observation tool with a scale from 0–100 that was developed and validated for children with CP or Down syndrome[23]. It has excellent reliability and demonstrated ability to evaluate meaningful change in gross motor function in children with CP. The GMFM consists of 88 items grouped into 5 dimensions: lying and rolling (17

items), sitting (20 items), crawling and kneeling (14 items), standing (13 items) and walking, running and jumping (24 items). The GMFM were scored by observation of a child's performance on each item. Scores for each dimension are expressed as a percentage of the maximum score for that dimension. A total score was obtained by adding the scores for all dimensions and dividing then by the total number of dimensions. Each dimensions contributes equally to the total score[18,21].

Statistical analysis

All statistical analyses were performed using SAS (version 9.1.3). Data are presented as median, minimum and maximum, and proportions. Differences between groups of independent numerical variables were analyzed using the Mann-Whitney U test, while the Wilcoxon matched pair test was used to determine differences between initial and final values. Differences in the prevalence of categorical data were measured using the χ^2-test and Fisher's exact test. Statistical significance was defined as a p-value of 0.05 ($p<0.05$) in all analyses.

Results

The study included 24 children, 11 boys and 13 girls. The median age at the first assessment was 19.5 months (min=12, max=55) and the median duration of rehabilitation was 50.5 months (min=17, max=93). Six children were diagnosed as spastic diparesis, 3 hemiparesis and 15 spastic tetraparesis.

There were no statistical differences between group 1 and group 2 according to gender, gestational age, age at first assessment and duration of physiotherapy ($p>0.05$). Data of baseline characteristics are presented in Table 1.

At first assessment, the number of children (N_1+N_2) *per* GMFCS level was as follows: Level II-one, Level III-five, Level IV-eight, Level V-ten, while at the last visit: Level I-two, Level II-two, Level III-nine, Level IV-seven, Level V-four.

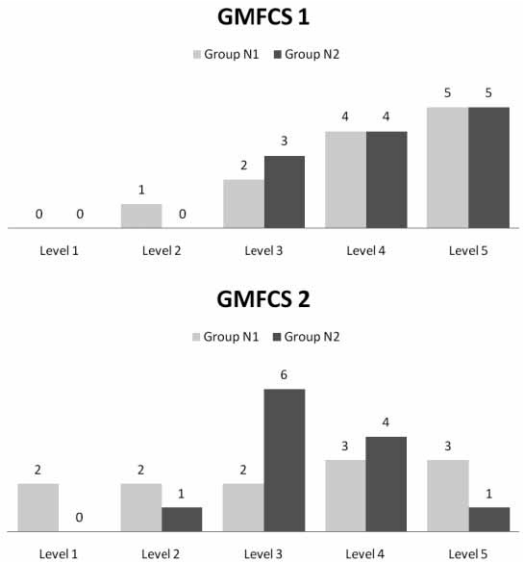

Fig. 1. GMFCS levels before (GMFCS1) and after treatment (GMFCS2).

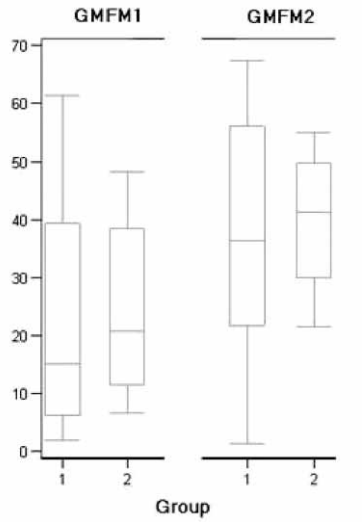

Fig. 2. GMFM score before (GMFM1) and after treatment (GMFM2).

The GMFCS levels (N_1+N_2) were statistically significantly higher before rehabilitation in comparison to the levels after treatment. Study group 1 (N_1) did not differ significantly to study group 2 (N_2) according to GMFCS levels at the initial assessment (0.065), however, differences were recorded at the last visit (0.004). In both groups, significantly higher GMFCS levels were observed at the beginning of the study in comparison to GMFCS levels observed at the last visit ($p_1=0.013$, $p_2=0.013$). The GMFCS levels according to groups are presented in Figure 1.

The median GMFM1 (before the treatment) in group 1 was 15.20 (minimum, maximum; 1.90, 61.40) while the median GMFM2 (after the treatment) was 51.95(minimum, maximum; 1.90, 96.40). The median GMFM1 in group 2 was 20.80 (minimum, maximum; 6.70, 48.20) and median GMFM2 was 58.85 (minimum, maximum; 30.80, 78.60). The difference in GMFM1 and GMFM2 between groups (N1 *vs* N2) was not statistically significant (GMFM1, $p=0.755$; GMFM2, $p=1.000$) neither at the initial nor at the final assessment; while in each group a significantly higher GMFM scores were observed at the end of the study, i.e. GMFM2 was higher than GMFM1 (group 1, $p=0.003$; group 2, $p=0.002$) (Figure 2).

Discussion

Children with CP receive a variety of long-term physical and occupational therapy interventions to facilitate development and to enhance functional independence in movement, self care, play, school activities and leisure. A considerable degree of uncertainty remains about the appropriate therapeutic approaches to manage the habilitation of children with CP[24]. The review of the literature indicates that convincing evidence for beneficial effects

TABLE 1
BASELINE CHARACTERISTICS OF STUDY GROUPS (ACCORDING TO CURRENT THERAPY)

	Group 1 (physiotherapy) n=12	Group 2 (physiotherapy+botulinum toxin/orthopedic therapy) n=12	p-value
Gender (n)			
Male	5	6	0.682
Female	7	6	
Gestational age (weeks)	31.5 (28.42)	33.5 (28.41)	0.630
Age at first assessment (months)	17 (12.55)	23 (13.46)	0.977
Diagnosis (n)			
Spastic Diparesis	2	4	
Hemiparesis	3	–	
Spastic Tetraparesis	7	8	
Duration of physiotherapy (months)	50.5 (17.79)	56 (24.93)	0.378

*data are presented as median (minimum, maximum) unless noted otherwise

of intervention programmes is lacking[25,26]. Furthermore, it is generally believed that intervention does not, on average, change the natural course of the disease, which is confirmed with the stability of the GMFCS level[15].

GMFCS has become an important tool to describe motor function in children with CP. Palisano et al. conducted a study to assess the stability of the GMFCS by examining whether children with CP remain at the same level over time. Their data showed that seventy-three *per* cent of children remained at the same level for all ratings. Furthermore, there was a tendency for children younger than 6 years to be reclassified at a lower level of ability. Children initially classified in levels I and V were the least likely to be reclassified[27]. Several studies confirm the prognostic stability of GMFCS in children with CP[21,22,28].

The results of our study show significant changes in GMFCS levels. All study children except one (regardless of additional orthopaedic surgery and/or botulinum toxin application), had better GMFM scores, and in half of them motor improvement was good enough to be reclassified toward a higher level of ability (lower GMFCS level) at the end of the study. It is important to stress that ten children were initially classified in Level V. This could implicate that the rehabilitation method that was conducted in the study had an important influence on the natural course of disease.

There is no doubt that GMFCS classification is a reliable and valid system for children with CP in average conditions (natural course of CP, common therapeutical approach), but the main differences between our study and many others are the intensity and type of treatment. Arpino et al. showed that intensive treatment was tended to have a greater effect than non-intensive one; however results were not statistically robust. A treatment was defined to be intensive if it was undertaken for more than three times *per* week[29]. It was reported that children who were treated four times a month improved more than children treated once a month[30]. Conversely, no significant differences were found in the gross motor function scores of children who were treated five times a week over a six-month period instead of twice a week[31]. Trahan et al. define intensive physical therapy as four-times weekly over a four-week period followed by an eight--week rest period without any treatment[32]. The recommended therapy »dose« in our study was 3 hours *per* day (often even more). The average duration of continuously performed therapy was 50.5 months in group 1 and 56 months in group 2.

Is it possible to change the natural course of CP? We believe it is.

Neuronal plasticity allows the central nervous system to recover from brain injuries by reorganizing neuronal networks in response to environmental stimulation. The basic mechanisms that are involved in plasticity include neurogenesis, programmed cell death, and activity-dependent synaptic plasticity. Repetitive stimulation of synapses can cause long-term potentiation or long term depression of neurotransmission. These changes are associated with physical changes in dendritic spines and neuronal circuits[33,34].

The Neuronal Group Selection Theory could provide a theoretical explanation for the rehabilitation method developed by Stojčević Polovina.

Children with CP usually follow the natural course of disease; it means some motor improvement is possible due to normal growth and development but within their GMFCS level despite common rehabilitation therapy. Clinical findings suggest that children with CP have a reduced primary repertoire, impaired secondary selection and sensory input[10,35]. Reduced primary repertoire will probably lead to limited selection and hindered reentry. The final result could be one of the various types of CP. According to the theory, motor development depends on developmental diversity and variation, experiential selection and reentry. Developmental diversity and consequently primary repertoires are clearly diminished in children with CP but competition between groups still exists during experiential selection. In children with CP

competition between normal and abnormal motor patterns results in the selection of abnormal patterns because these patterns are more common and become fixed in given neuronal groups.

It is hard to predict at what level reduced repertoires will produce CP because the whole process is very dynamic and depends on many segments. An essential part of the theory known as »degeneracy« plays an important role in the rehabilitation process. Degeneracy means that, given a particular threshold condition, there must in general be more than one way of recognizing a given input signal in a satisfactory way. This implies the presence of multiple neuronal groups with different structures, each capable of carrying out the same function more or less well: degeneracy entails that some non-isomorphic groups must be isofunctional[13]. The Stojčević Polovina method assumes that even in a case of reduced repertoire some »lost functions« can be »hidden« in other neuronal groups.

What is the role of therapy here? We believe that specific and very intensive therapy can affect experiential selection and consequently reentry.

During the rehabilitation process, maximal efforts were taken to change the natural course of the disease creating conditions to favour competition between normal and abnormal movement patterns, by as much intensive rehabilitation as possible. During rehabilitation all team members tried on the basis of »normal« sensorimotor experience to anticipate which activities could promote the selection of those neuronal groups that would be closest or equivalent to normal development. Spontaneous activities were strictly controlled by blocking abnormal motor patterns and promoting normal motor patterns whenever they occurred. In such a way specific sensory input was produced that could allow selection from those parts of the repertoire which normally could not be selected because of strong competition with abnormal patterns. It means rehabilitation has to produce, like selection pressure in natural evolution, »therapeutical selection pressure« in which desired specific neuronal groups will be selected over others in a competitive fashion.

It is very clear that most of the sensorimotor information coming to the child with CP depends very much on its achieved developmental level and quality of motor activity, rather then the child's chronological age, because these motor activities predominate and will in the end be modelling forthcoming selections. Constant repetition of abnormal patterns will lead to its selection. Any continuously performed abnormal patterns at a lower developmental level will influence milestones that follow (i.e. if the child crawls in a diparetic pattern it will probably walk in a diparetic pattern). Because of that, the foundation of the Stojčević Polovina method is to follow normal motor development and insist on each developmental sequence(s) until the child begins to use it in the best possible way, whenever is possible. The starting point of the therapy is the developmental milestone(s) in which child's overall performance was closest to normal. During therapy, maximal efforts were invested to try to achieve increased variability of movements on each developmental level to encourage an increased variability of movements and better selection at the developmental milestones that followed. In terms of the NGST, it could mean that favourable network group combinations are selected in a competitive fashion as a result of the treatment.

In almost all patients, Vojta therapy was performed during the selected period of rehabilitation. According to the Vojta theory two global motor complexes are induced during therapy: reflex rolling and reflex crawling. Neither of them is fully present in normal motor development but their components are found in normal motor chains. Regularly performing Vojta therapy can enhance their selections. The Stojčević Polovina method and Vojta therapy have some additional similarities: both are performed by parents trained in the treatment method, both focus on the intensity and continuity of treatment. Despite the similarities, clear philosophical and practical differences between the two methods exist. After Vojta therapy children try on their own elements which they practiced during therapy. In such a way competition between wanted and unwanted motor patterns is still ongoing. In the Stojčević Polovina method there is a tendency to perform the therapy almost all day long, combined with the other techniques mentioned, trying in that way to actively and constantly promote specific selections.

Intensive facilitation of normal postural reactions (mainly self-developed, some similar to NDT) may also lead to the selection of the most favourable neuronal groups.

Passive movements in chosen postures, depending on the developmental milestones, are an important part of the therapy for several reasons: a) they can easily be learned by the parents who will then provide sufficient intensity of treatment; b) diverse passive movements will provide different sensory input signals which otherwise would not be possible due to the reduced repertoire or dynamic contractures; c) they will prevent fixed anatomical contractures. Many controversies about using passive movements exist, especially in the standard NDT treatments where passive movements are generally avoided. Despite this, Guzzetta et al. showed that no difference was detected when contrasting active *versus* passive tasks using functional magnetic resonance imaging[36]. Weiller et al. were also exploring the representation of passive movements in humans and showed that passive movement was able to produce activation of most of the cortical areas involved in motor control[37]. Furthermore, Martin Staudt showed that passive motion results in cortical activation, while Konczak asked a question how much passive motion one should apply to actually see some functional improvement[38,39].

All the mentioned parts of the therapy should create specific motor experiences and activity individually adapted for each patient. Surprisingly, little is known of the importance of motor experience and activity-dependent processes in shaping development of the motor system and the behaviours they control[40]. In the developing vi-

sual system, Wiesel and Hubel (1965) first described in kittens the progressive loss of responsiveness by the primary visual cortex to an eye deprived of vision, thereby providing the premier physiological model of activity-dependent plasticity[41]. Presumably, a similar mechanism operates in the developing corticospinal system. Activity- and experience-dependent mechanisms assure that neural events at the time of motor circuit formation play a critical role in the long-term function of the system[40–47].

Continual audio visual stimulations and other tactile stimulations are performed during the treatment. In that way therapy is much easier to perform and very often becomes a game with some specific tasks. How can that be connected with NGST? Edelman says that perceptual categorization does not occur solely in a particular sensory area which then executes a program to activate motor output. Instead, the consequences of continual motor activity are an essential part of the perceptual process itself. Perception depends upon action. This implies that the neural structures that carry out various categorizations must contain multiple sensory and motor maps, forming what Edelman has called global mappings. Neuronal group selection within such mappings occurs in a set of dynamic re-entrant loops that continually match gestural and postural movements to several kinds of sensory signals[11].

After a brief description of the treatment principle and its NGST theoretical background one major difference must be stressed between the Stojčević Polovina method and some other methods which also explain themselves through NGST.

As stated earlier, somatic selection in the nervous system results from the competitive strengthening of neural connections involved in the generation of »successful« movements (e.g. those involved in touching an object or bringing it to the centre of the visual field). As a result of selective synaptic change, movements that help to accomplish the task become more probable on average than others[3]. Studies on normal motor development indicated that frequent experience with trial and error enhances the process of selection[48–50]. Some authors propose programs in children with CP which require considerably more repetition of the trial and error experience and believe they might benefit from ample opportunities to try to actively develop motor skills[35,50]. The basic problem in these programs is the fact that children with CP and consequently reduced repertoire cannot find »successful« movements on their own. Their spontaneous activities will follow the natural course of disease. According to Edelman, there is little direct evidence that the nervous system precomputes desired trajectories, computes comparisons between actual movements and desired ones, or uses explicit error signals to adjust individual components of the motor control system and minimize future error[13].

Conclusions

1. There is a chance for changing the course of the disease in some children with CP.
2. The intensity and type of physical therapy together with highly motivated parents can provide conditions for motor and overall improvement in children with CP.
3. The aim of intensive rehabilitation is to produce therapeutical selection pressure which will favour the selection of those neuronal groups whose combination will lead to normal development or the closest equivalent thereof.

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INTENZIVNA REHABILITACIJA U DJECE S CEREBRALNOM PARALIZOM: NAŠ POGLED NA TEORIJU NEURONALNE GRUPNE SELEKCIJE

S A Ž E T A K

Cerebralna paraliza (CP) je jedan od glavnih oblika razvojnih poremećaja. Postoje različiti pristupi i proturječja u rehabilitacijskom tretmanu. Teorija neuronalne grupne selekcije mogla bi dati teorijsko objašnjenje rehabilitacijske metode po Stojčević Polovina. Cilj studije bio je ispitati dugoročni učinak intenzivne i kontinuirano provođene rehabilitacije na razinu motorne autonomije u djece s CP. Razina motorne autonomije definirana prema klasifikacijskom sustavu Gross Motor Function Classification System (GMFCS) i Gross Motor Function Measure (GMFM) analizirana je u 24 djece s CP na početku studije i prilikom zadnjeg posjeta. Tijekom rehabilitacije rezultat GMFM se u većine djece povećao iznad očekivanog s obzirom na početnu razinu GMFCS. Intenzivna rehabilitacija je imala značajan učinak na motoričko poboljšanje u djece s CP.