Neuroscience and Behavioral Physiology, Vol. 35, No. 9, 2005

Transcranial Micropolarization in the Combined Therapy of Speech and General Psychomotor Retardation in Children of Late Preschool Age

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Translated from Zhurnal Nevrologii i Psikhiatrii imeni S. S. Korsakova, Vol. 104, No. 11, pp. 34–41, November, 2004. Original article submitted April 7, 2003.

The efficacy of a method of combined treatment, developed by ourselves, using transcranial micropolarization in patients with delayed development of speech and general mental development, was studied in 30 children aged 4–6 years. High therapeutic effects were seen with this method in 60–80% of children, with accelerated development of communicative behavior and formation of speech-motor functions, along with increases in the stability of attention and improvements in the processes of perception and the productivity of cognitive activity.

KEY WORDS: children, speech and psychomotor development, developmental delay, transcranial micropolarization.

The phenomenon of delayed nervous and mental development is a type of dysontogenesis. This is one of the most pressing problems in pediatric neurology and associated medical and pedagogical sciences. According to current concepts, delays in neuropsychological development are based on a variety of factors complicating early ontogenesis. These include the hypoxic factor (intrauterine fetal hypoxia, birth complications, etc.), the toxic factor (pregnancy toxemia and other types of intoxication), infections during the embryonic period, and the mechanical factor (birth-assisting instruments, etc.) [29, 32, 33]. These factors lead to partial underdevelopment of brain systems, impairing adaptive behavior and higher mental functions, including speech [2, 22, 24, 26]. It is also known that lesions at the early stages of ontogenesis (during intrauterine development) produce more marked abnormalities of CNS development, especially of the subcortical formations, while later (peri- and postnatal) damage has greater effects on the cerebral cortex [1, 22, 34].

Children with pre- and perinatal CNS lesions in the first years of life (up to age three years) are kept under constant medical observation. If children have no major mental or motor defects in the later periods of development, then the problem with delayed psychomotor and speech development arise in relation to preparation for school. This situation applies to children of late preschool age. Clinical neurological, psychological, and speech assessment usually reveal cerebrasthenic manifestations with hemodynamic, autonomic, and emotional-voluntary disturbances at the neurotic level, with deficient motor functions (including the motor functions of language), decreased motivation for cognitive activity, curiosity, and purposive actions. They also have levels of self-control and abilities to predict actions which are below age norms. In addition, these cases can show impairments of phonematic hearing, impairments of speech memory, and decreases in cognitive abilities, with limitations in their knowledge of their surroundings. There is late development of phrasal speech, along with underdevelopment of logical-grammatical constructions, a restricted vocabulary, difficulties in re-telling read and visualized material, abnormalities of the syllable structure of words, and distorted sound production [2, 8, 25, 37].

The results of neurophysiological studies of children with the sequelae of pre- and perinatal CNS lesions have revealed signs of organic insufficiency and anomalies in

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0097-0549/05/3509-0969

studies of the bioelectric activity in the cerebral cortex: inadequate formation of the slow rhythms, along with spatial abnormalities of this type of activity. A majority of cases (60%) show a brainstem localization for the corresponding changes, which consist of bilateral paroxysms of slow-wave activity or profound dysrhythmia with increases in the overall amplitude and appearance of polymorphous slow waves. Changes in bioelectrical activity are more obvious after hyperventilation, demonstrating functional weakness of non-specific brain systems, evidently due to their immaturity or residual damage [2, 21, 22, 26, 35].

The difficulties and inadequate efficacy of rehabilitation treatment in children with delayed neuropsychological development are well known. Long-term (up to several years) administration of pharmacological agents and physiotherapy are generally used, combined with psychotherapy and speech therapy. Dehydrating and resolving substances are used in the rehabilitative treatment of this contingent of children, along with neurometabolic cerebroprotectors, angioprotectors, hepatoprotectors, vitamins and their analogs, and substances regulating emotional-behavioral reactions; when necessary, anticonvulsants are also used [2–4, 39]. The methods and approaches of speech therapy (visual, practical, and verbal), used in combination with medications, are particularly diverse. Nonetheless, a group of children showing insignificant improvements in the development of mental functions and speech is always identified. A significant proportion of children stop at any of the training stages of speech therapy. These children are characterized by rapid tiring, lack of motivation to learn, and inability to form new concepts and thoughts, along with inadequate maintenance of attention, decreased verbal memory, unproductive memory, and inadequate speech activity. Low activity in relation to the reproduction of learned material (recall from memory) is combined in these patients with limitations in the cognitive sphere.

Recent studies in clinical neurology have seen use of a non-pharmacological method for the directed correction of impairments in the regulatory functions of the CNS, with reorganization of intracentral relationships in brain systems supporting adaptive behavior in organic cerebral inadequacy; this is transcranial micropolarization (TCMP) [5, 7, 38]. Positive results have been obtained with this approach even in the treatment of children with cerebral palsy [5, 30, 31]. It is also used as a means of correcting profound delays in mental development and mental retardation in children of young and intermediate preschool age with congenital organic cerebral pathology, in the correction of dysgraphia in children with childhood cerebral palsy [30] and for correcting speech defects in logoneurosis [9]. TCMP has also been shown to be effective in the treatment of attention deficit hyperactivity disorder in children and adults [23]. TCMP has been used at the Institute of the Human Brain, Russian Academy of Sciences, to develop and patent "A method for treating retardation in the neuropsychological development of children" [18].

The aim of the present work was to perform clinical-psychological assessments of the therapeutic effects of transcranial micropolarization (TCMP) in children of late preschool age with delayed speech and general mental development.

MATERIALS AND METHODS

A total of 30 children (17 boys, 13 girls) aged 4–6 years with delayed neuropsychological development on a residual organic background were studied. Diagnoses were established on the basis of ICD-9 and ICD-10 criteria and the methodological recommendations of the Ministry of Health of the Russian Federation [2].

Neurological studies of the children were performed using a standard scheme. Levels of development of mental functions, the sound and sense components of speech, and motor functions were determined by psychological and speech assessments using contemporary standardized methods and a series of assessment scales [2, 6, 36]. Existing age-based criteria for differentiating high, above average, average, below average, and low levels of development were used.

Psychophysiological studies of the children were also performed, including: 1) assessment of the oxygen-dependent energy potential in terms of the response to transient hypoxia, measured from the duration of voluntary threshold apnea (VTA) in the Shtanga test [11, 15, 20]; 2) determination of the level of consciousness in terms of ultraslow biopotentials – measurement of the omega potential [12, 13, 16]; 3) evaluation of the autonomic and hemodynamic support of the level of consciousness (in terms of integral measures of autonomic tone, the minute volume of circulation, and the Hildebrandt coefficient).

Ultraslow biopotentials were recorded in vertex-thenar leads using a direct current amplifier (from Krasnodar ZIP, Minpribor, Russian Federation) with impedance 100 MΩ and standard ÉVL-1-MZ liquid AgCl electrodes [14].

The essence of the treatment method proposed for children with delayed neuropsychological development is to optimize the combined rehabilitation treatment by incorporating transcranial micropolarization (TCMP) of the projection zones of the cortex, with currents of 0.03–0.08 mA and session durations of 15–20 min. The projection zones of the cortex for TCMP and the current parameters were selected on the basis of results obtained from psychophysiological and neurophysiological studies [17–19]. Since delayed developments in speech and higher mental function in the children observed here were the leading factors, treatment with TCMP was applied to the projection zones of the secondary and tertiary associative areas of the frontal and parietal areas of the cortex of the left hemisphere, which are responsible for analytical-synthetic and associative-mnestic functions, for performing the motor and thought components of speech, and for voluntary movements. The main targets

for TCMP in the contingent of children studied here were: Broca's area (fields 44, 45), the projection zones (PZ) of the motor cortex (fields 4 and 6) corresponding to the lower half of the face and the upper limbs, and the tertiary associative complex of the parietal cortex (PL zone, field 40).

Rapid diagnosis of the level of consciousness (LC) and its autonomic and hemodynamic support (measured in terms of integral measures of ultraslow biopotentials, autonomic tone, and central hemodynamics) allowed the timing of the beginning of courses and intervals between sessions of TCMP to be determined. Courses of TCMP started and every subsequent session started only when sharp increases in LC were seen, when the stable potential in the millivolt range (the omega potential) in the vertex-thenar lead was greater than –40.0 mV or when there was a rapid decrease in LC, when the omega potential was less than –20.0 mV; according to previously published data, these situations corresponded to tension or, conversely, suppression of the mechanisms controlling the level of consciousness [10, 12, 13, 15, 16, 27, 28].

As a rule, courses of treatment with TCMP consisted of from 1–2 to 3–6 sessions with intervals between sessions of at least one week. The number of sessions of TCMP per course depended on the results of dynamic assessments of neurophysiological measures and the efficacy of speech therapy. Given that neurological review and psychophysiological testing yielded diagnoses of cerebrasthenic syndrome in all the children, additional medication directed to increasing the energy potential was started 2–3 weeks before the start of TCMP and was continued throughout TCMP treatment. Addition of antihypoxic and antioxidant agents, trace elements, amino acids, and enzymes into pharmacological treatment facilitated decreases in the extent of cerebrasthenic syndrome and general cerebral symptomatology, decreasing the risk of exhaustion during TCMP (medication protocols were selected by neurologist Dr. V. M. Shaitor). Further medication, given throughout the course of treatment, maintained and enhanced the positive effect of TCMP by optimizing cellular metabolism.

Speech therapy was performed as three 35-min sessions per week in the mornings throughout the course of treatment. Speech therapy provided on the background of TCMP in combination with maintenance medication allowed objective assessment of the accelerated formation of speech-motor, higher mental functions, and the adaptive behavior of the children seen in these conditions.

Psychological-speech therapy testing was performed before treatment, after the first course of treatment with TCMP, and before and after each subsequent course, as well as six months, one year, and subsequently after the end of treatment.

The efficacy of the treatment was assessed in terms of the ratio of the initial level of development of the study functions to the level of development of the same functions after treatment. Calculation of these ratios yielded the coefficient of efficacy (K_{eff}). K_{eff} values of 2.0–3.0 identified the maximum effects of treatment when age norms were reached from initially low and intermediate levels of development of the study functions; values of 1.5–1.7 evidenced marked increases in the level of development of the study function, going from sharply reduced to average or from average to higher average levels of development; values of around 1.3 identified weak therapeutic effects in cases going from sharply reduced to low levels of development or from lower average to average levels of development of the study functions. K_{eff} values of 1.0 and below indicated the absence of any therapeutic effect.

RESULTS AND DISCUSSION

The results of neurological and psychological assessment of the severity of the defect identified three groups of children: group I consisted of 10 patients with profound delays in the development of speech (level I) and general mental development; group II consisted of nine patients with general underdevelopment of speech (level II) with a delay in general mental development; group III consisted of 11 patients predominantly with a delay in speech development as compared with their peers (level III) and no delay in general mental development.

Children of group I showed profound impairments in the development of speech with low levels of development of mental functions (Table 1). The main difference of children of group II was the absence of profound impairments of sound production (78%). More than half of the children of this group showed average and above average levels of development of general speech sound production, articulatory motor function, and motor behavior. Otherwise, the level of development of adaptive behavior, higher mental functions, and the thought components of speech in children of group II were comparable with the level of development of group I children (see Table 1). Unlike children of groups I and II, those of group III showed a predominantly non-uniform development of the mental functions studied here and speech with a dominance of average and above average levels of development (see Table 1).

The prognostically favorable signs for effective combined treatment in children of groups I and II were the appearance of interest in corrective tasks, general psychoemotional "feeling," and the spontaneous appearance of new sounds 1–3 days after the first sessions of TCMP, with subsequent stepwise shifts in the efficacy of speech therapy sessions (rapid filling of the active vocabulary and appearance of new phrases and new vowel and consonant sounds; children started to form patterns consisting of several parts, counting operations appeared, previously absent movement functions such as holding a pencil and drawing straight lines appeared, etc.) after repeated sessions of TCMP.

As an example, we will consider the therapeutic efficacy of combined treatment using TCMP in one of the children of group I.

TABLE 1. Numbers of Children with Different Levels of General Psychomotor and Speech Development in Groups I–III Before the Start of Treatment

Functions	Measures	Level of development												
		Group I (n = 10)			Group II (n = 9)					Group III (n = 11)				
		L	LA	A	L	LA	A	HA	H	L	LA	A	HA	H
Mental functions	Development of speech communication functions	7	3	–	4	4	–	–	–	–	1	5	5	–
	Cognitive interest, relationship to sessions	7	3	–	5	2	2	–	–	–	2	5	4	–
	Mental capacity	10	–	–	9	–	–	–	–	3	1	6	1	–
	Stability of attention	8	2	–	4	5	–	–	–	–	4	5	2	–
	Perception of color, shape, size	8	2	–	5	3	1	–	–	2	1	4	3	1
	Constructive praxis and gnosis	8	–	2	7	1	1	–	–	1	3	3	3	1
	Level of conceptualization of surroundings	9	1	–	7	2	–	–	–	–	2	5	4	–
	Elements of mathematical concepts	9	1	–	7	2	–	–	–	–	2	5	4	–
Sound components of speech	Sound production	7	2	1	2	–	3	3	1	–	–	5	4	2
	Overall sounding of speech	7	2	1	2	2	4	1	–	–	1	5	5	–
Thought components of speech	Understanding of speech	6	4	–	3	5	1	–	–	–	2	2	5	–
	Vocabulary	8	2	–	5	3	1	–	–	–	2	3	5	–
	Syllabic structure of speech	9	1	–	5	2	2	–	–	1	–	4	5	1
	Phonematic hearing	10	–	–	6	3	–	–	–	1	3	2	5	–
	Grammatical structure of speech	9	1	–	6	3	–	–	–	–	3	5	2	–
	Connective speech	10	–	–	7	2	–	–	–	–	2	3	6	–
Motor functions	Articulatory motor function	6	2	2	2	2	2	3	–	–	2	3	6	–
	Fine motor function	9	1	–	5	3	1	–	–	1	4	5	1	–
	Overall motor function	10	–	–	3	4	1	1	–	1	1	6	3	1
	Motor behavior	4	3	3	1	3	5	–	–	–	–	8	3	–
Additional details	School attendance	–	–	–	7	1	1	–	–	–	4	4	2	1

Notes. L = Low level of development; LA = low average; A = average; HA = high average; H = high.

Child A., male, age 5 years, was admitted for treatment with a diagnosis of minimal brain dysfunction on a residual organic background and the sequelae of perinatal CNS damage. There was a general underdevelopment of speech. Motor alalia was present.

History: pregnancy progressed with toxicosis in the second half. Delivery was urgent and the anhydrous period was long. Birth weight was 3550 g. Neurological assessment at birth yielded diagnoses of perinatal encephalopathy, motor impairment syndrome, and congenital cleft of the hard and soft palate. The patient was kept under neurological observation to age one year. Motor landmarks: sat at seven months, walked at two years. Surgery for congenital pathology of the mandibulofacial area was performed under general anesthesia in 1997.

Clinical examination at admission: the head was hydrocephalic in shape; Greif syndrome (+), Hvostek syndrome (+). There was residual disseminated focal symptomatology. Muscle tone was uniformly decreased, and dystonia was present. Tendon reflexes were stable and strong, relatively greater in the legs; stable clonus was seen on testing the Achilles tendon reflex. Fine motor function was unsatisfactory. Coordination tests were performed unevenly.

There was low body weight and tissue turgor, sleep disturbance with delayed onset of sleep, prolonged, restless sleep, sometimes with sleeptalking, and decreased appetite. Cardiac auscultation showed a labile heart tone, respiratory arrhythmia, and a functional systolic sound. The skin was pale, with pink dermographia. Blood pressure was 90/65 mmHg ($D = S$), heart rate was 108 per min, and respiratory rate was 18 per min. There was asymmetrical vibration of the soft palate on sound production, and the amplitude of soft palate vibration was reduced.

There was profound delay of speech development (absence of word formation and sound imitation). The patient understood speech presented to him. There was a decrease in communicative functions (poor contact with the doctor). The patient was asthenic.

Speech assessment. The child did not make contact. There was general motor clumsiness, awkwardness, and

TABLE 2. Mental-Speech Therapy Measures of the Efficacy of the First Course of TCMP in Patients with Initially Different Severities of Delayed Psychomotor and Speech Development in Children of Groups I–III, %

Functions	Measures	Achievement of a high level of development (K_{eff} = 2.0–3.0)			Marked increase in the high level of development (K_{eff} = 1.5–1.7)			Slight increase in the high level of development ($K_{eff} \leq 1.3$)			No improvement in the level of development		
		I	II	III	I	II	III	I	II	III	I	II	III
Mental functions	Development of speech communication functions	10.0	22.0	91.0	30.0	56.0	–	60.0	22.0	9.0	–	–	–
	Cognitive interest, relationship to sessions	30.0	22.0	82.0	60.0	78.0	–	10.0	–	18.0	–	–	–
	Mental capacity	20.0	22.0	73.0	70.0	78.0	27.0	10.0	–	–	–	–	–
	Stability of attention	30.0	44.0	82.0	30.0	45.0	–	40.0	11.0	18.0	–	–	–
	Perception of color, shape, size	40.0	22.0	82.0	20.0	22.0	–	20.0	56.0	18.0	20.0	–	–
	Constructive praxis and gnosis	20.0	11.0	64.0	40.0	22.0	27.0	20.0	67.0	9.0	20.0	–	–
	Level of conceptualization of surroundings	–	–	82.0	30.0	44.0	–	50.0	56.0	18.0	20.0	–	–
	Elements of mathematical concepts	–	–	82.0	30.0	44.0	–	50.0	56.0	18.0	20.0	–	–
Sound components of speech	Sound production	–	45.0	100.0	30.0	33.0	–	60.0	22.0	–	10.0	–	–
	Overall sounding of speech	10.0	56.0	91.0	20.0	22.0	–	60.0	22.0	9.0	10.0	–	–
Thought components of speech	Understanding of speech	10.0	11.0	91.0	40.0	56.0	–	40.0	33.0	9.0	10.0	–	–
	Vocabulary	–	11.0	82.0	30.0	45.0	–	30.0	44.0	18.0	40.0	–	–
	Syllabic structure of speech	–	33.0	91.0	10.0	11.0	–	60.0	56.0	9.0	30.0	–	–
	Phonematic hearing	–	–	64.0	10.0	33.0	9.0	30.0	56.0	27.0	60.0	11.0	–
	Grammatical structure of speech	–	11.0	73.0	10.0	44.0	–	60.0	45.0	27.0	30.0	–	–
	Connective speech	–	–	91.0	10.0	22.0	–	50.0	78.0	9.0	40.0	–	–
Motor functions	Articulatory motor function	10.0	11.0	82.0	40.0	56.0	–	50.0	33.0	18.0	–	–	–
	Fine motor function	–	22.0	64.0	50.0	45.0	–	50.0	33.0	36.0	–	–	–
	Overall motor function	10.0	22.0	64.0	50.0	67.0	27.0	40.0	11.0	9.0	–	–	–
	Motor behavior	20.0	44.0	100.0	50.0	45.0	–	20.0	11.0	–	–	–	–
Additional details	School attendance	–	–	64.0	–	–	27.0	–	–	9.0	–	–	–

Notes. Rows show the proportions of subjects with changes in the levels of development of functions a as percentages of the total numbers of subjects in each group.

movement incoordination. Maximal difficulties were seen in the movements of the fine and articular motor apparatus: the patient could not hold a pencil, could not form a fist, and could not draw a line. The patient did not perceive tongue articulation and could not copy a demonstrated articulatory pose. Phonematic hearing was impaired. The patient understood speech addressed to him, identified known grammatical categories, but did not differentiate singular from plural (doll, dolls), diminutive suffixes (doll, dolly), and did not understand the singular and multiple persons (he drinks, they drink). Vocabulary was limited and consisted of some vowel sounds and sound imitations. He did not know color names; elementary mathematical concepts were impaired; auditory and visual attention and memory were impaired. Gestural language was present. Speech therapy was performed using a traditional scheme – three 35-min sessions per week, in the first half of the day. The patient was passive at the first sessions, made no contact, and remained unacclimated. He had no interest in the sessions, which resulted in difficulty with the training. Over a period of six months (before admission for treatment at the Institute of the Human Brain, Russian Academy of Sciences), speech therapy sessions had produced very slow progress in forming motor coordinations of the speech apparatus. The patient could switch from one articulatory pose to another only with great difficulty and mechanical assistance. Progress in increasing the patient's active and passive vocabulary was slow, and sounds presented to the patient did not undergo automation. There were great difficulties in developing fine motor function. There was insignificant developmental progress at six months.

Functional diagnostic results on admission: EEG data demonstrated immaturity of cortical biorhythms, instability of the functional state of the CNS, dysfunction of the median non-specific structures of the brainstem (mainly at the mes-

encephalic level) with a predominance of synchronizing influences. CNS convulsive readiness was increased, especially in functional loading tests. X-ray encephalography showed a decreased pulse filling amplitude in the vertebrobasilar basin (50% below age norms on both sides). There was a moderate vertebrogenic influence of a compressive type (decreased AOm on head rotation by 25–35% from baseline); mild and moderate angiodystonic disturbance was present, along with increased arterial tone with unstable signs of hindered venous outflow (weak to moderate). Studies of ultraslow biopotentials from the vertex-thenar lead demonstrated sharp reductions in the level of consciousness (the plateau baseline omega potential at rest was –4.3 mV, $D = S$) and psychoemotional instability, manifest as a sharp increase in the positivity of the omega potential from the initially very negative values before reaching a plateau (by 33.0 mV). Studies of autonomic tone showed marked sympathetic tone (coefficient 58.0, $D = S$) with discordance between the autonomic support of the interaction between the cardiovascular and respiratory systems (Hildebrandt coefficient 5.2 compared with a normal 2.8–4.9).

Complex psychophysiological and neurophysiological assessments showed a) marked impairments of the brainstem mechanisms controlling the level of consciousness leading to a sharp decrease; b) tensioning of the suprasegmental mechanisms of autonomic control of functions (marked sympathetic tone); c) involvement of formations of the limbic-reticular complex in the pathological process, resulting in marked psychoemotional lability.

Investigation results were used as the basis for prescribing combined treatment including medication in accord with the scheme developed here, addressing cerebrasthenic manifestations, speech therapy, massage, and transcranial micropolarization.

Transcranial micropolarization was started three weeks after initiation of medication. Each session lasted 15 min and intervals between sessions lasted two weeks. Before the first session of TCMP, the omega potential in the vertex-thenar was –4.5 mV, $D = S$.

In the first TCMP session, the position of the anode at the junction of the lower frontal and anterior parts of the upper temporal gyrus of the left hemisphere and the cathode was placed at the lower parts of the occipital area of the same hemisphere. Treatment was with a direct current of 0.08 mA and session duration was 15 min.

Before the session, the child was tense and showed no interest in his surroundings. The procedure was tolerated well and the patient experienced no unpleasant feelings; there were no negative reactions. Immediately after the sessions, the child behaved freely. Three days after TCMP, the speech therapist reported the first signs of interest in the session (he started to show interest in toys on the table, books, and examined items in the cabinet). Speech showed the first spontaneous appearances of the consonant "m" and the child showed interest in his own articulation and started to repeat articulatory exercises alone. During the week after TCMP, parental observations showed a general psychoemotional revival; the child became more coordinated (he could sit on a chair alone). For the first time he listened to long stories.

The second session of TCMP was performed two weeks later. Before the session, the omega potential at rest was –9.8 mV, $D = S$. The anode and cathode positions were as in the first session. Current was 0.05 mA (due to persistence of cerebrasthenia) and the session lasted 15 min. There were no complaints before the session. The child was neurologically stable. There were no visible changes in status immediately after the session.

Speech therapy observations showed that during the therapy session three days after the second session of TCMP the child quickly completed the active vocabulary, produced a simple phrase, uttered the new consonant sounds "p" and "t'" [Translator's note: this is the Russian soft t sound, as in the t' of t'ulip], drew pictures consisting of 2–3 components (constructive praxis), and counted up to three. He was able to hold a pencil and draw straight lines. There were no significant changes in articulation. Given the continuing decreased level of consciousness and clinical signs of asthenia, the decision was made to maintain the interval between subsequent TCMP sessions at two weeks with continuation of medication directed at increasing energy potential with speech therapy continuing on this background.

Subsequent TCMP sessions (Nos. 3, 4, and 5) continued with the same conditions, anode and cathode locations, and intersession intervals. There were no side effects. During the course of treatment, there were positive changes in neurological status, with loss of symptoms indicating increased convulsive readiness, decreases in the signs of cerebrasthenia (weight gain, improved appetite, normalization of sleep), and decreases in functional load in terms of the cardiovascular system. Dynamic measurements of the omega potential before each sequential session showed a gradual and significant increase from –14.0 mV before the third session to –17.5 mV before the fourth and –18.8 mV before the fifth.

Parental observations during these weeks revealed a significant increase in cognitive activity; the child started to notice the fine details of objects, showed more imitative behavior, and watched cartoons with interest.

Speech therapy observations showed that speech became more understandable. Cognitive processes improved. The intonation pattern of words persisted; emotional coloration appeared, age-appropriate generalizing concepts were assimilated, he started to re-tell short texts and cartoons, recognized pictures of heroes from stories (improved associative functions), counted to 10, performed calculations up to five, recognized geometrical shapes, and identified the shapes of objects. There was a significant improvement in higher mental functions, with persistence of dyscoordination of articulatory movements; there was no significant change in motor activity in the distal upper limbs.

With the aim of improving motor activity, the decision was made to provide further TCMP sessions with the anode over the motor cortex of the left hemisphere at the projection of the center corresponding to movements of the facial and upper limb musculature; the cathode was located over the lower parts of the occipital area of the same hemisphere. Before the session, the omega potential was –18.3 mV, $D = S$. A direct current of 0.08 mA was used in a session lasting 15 min. Two such sessions were undertaken with an interval of two weeks. There were no significant changes in neurological and psychoemotional status during these sessions. There were no side effects. The same maintenance medication protocol was continued throughout the whole course of TCMP.

After the last TCMP session, parental observations and speech therapy reports showed that the child became more competent, with improvements in fine movements (he drew circles, outlines, and shading, and completed small, simple puzzles); he jumped on one leg and caught a ball. The course was regarded as complete because of the marked positive effect.

In monitoring observations of the patient one month after completion of the course of treatment using TCMP, neurological, psychological, and speech therapy observations showed continuation of the positive dynamics of the overall neuropsychological development and adaptive behavior of the child. Increases in positive effects were supported by complex psychophysiological studies. Measurement of the omega potential showed maintenance of the optimal level of consciousness (the omega potential was –34.4 ± 3.6 mV) with persistence of psychoemotional lability. EEG results showed disappearance of signs of increased convulsive readiness. X-ray encephalography showed decreases in angiodystonic manifestations. The discordance in autonomic support for the interaction of the cardiovascular and respiratory systems disappeared (the Hildebrandt coefficient normalized). The child entered school in the remedial group. Before treatment, he had been with a group with profoundly delayed neuropsychological development (for mentally retarded children).

Summarizing the results of courses of treatment using TCMP showed that the maximum effect, consisting of disappearance of non-uniformity in the development and achievement of age norms in the development of mental functions and speech, was seen in 64–82% of children in group III (Table 2). Weak effects on the thought component of speech and fine movements were seen in 18–36% of group III children. Children of this contingent received additional courses of combined therapy with TCMP using the same conditions, which allowed significant extension of speech therapy programs and increased efficacy of therapeutic sessions.

As shown by the results obtained here, the first course of combined therapy including TCMP was effective in children of groups I and II primarily in relation to increases in the overall levels of activity and functional capacity and expansion of cognitive capacities. Increases in attention were observed, along with improvements in perception processes and motor behavior, including fine movements. The vast majority of children of group I showed no significant changes in the sound or thought components of speech. In group II, 65–70% of children showed marked increases in the level of development of the sound components and some of the thought characteristics (including the understanding of speech addressed to them, vocabulary, and grammatical structure) of speech after the first course.

Thus, the therapeutic effects of transcranial micropolarization applied to the secondary and tertiary associative zones of the cortex of the left hemisphere in children with delayed neuropsychological development are mediated by directed partial activation of cortical-subcortical intra- and intersystem interactions supporting the level of integration needed to optimize the programs of ontogenetic development of higher mental functions, speech, and the adaptive behavior of the children.

The occurrence of stepwise effects over short periods (1–2 months), with increases in the levels of development of higher mental functions (attention, perception, cognitive interest, constructive praxis, and gnosis) in 60–80% of cases in children of groups I and II, increasing functional capacity in virtually all children, is evidence that low-intensity TCMP, when applied to correctly selected neocortical inputs using appropriate TCMP regimes and protocols, acts as a trigger factor activating previously inhibited mechanisms of the ontogenetic development of integrative processes in the brain. Additional support for the long-term consequences of TCMP was provided by increases in the positive effect seen as increases in the levels of development of adaptive functions and speech behavior in children of groups I and II 0.5–1.5 years after the end of TCMP on the background of continuing corrective speech therapy combined with maintenance pharmacotherapy.

This study was supported by the Russian Humanitarian Scientific Fund, Project No. 03-06-00139a.

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