

Neurodynamic Features of Elderly Teachers as Indicators of Professional Performance

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Abstract – The study of psycho-physiological characteristics of elderly teachers is of great importance. The article aims to study functional indicators of the central nervous system and cognitive performance of elderly teachers. The sample included 21 women at an average age of 56.2). The integral characteristics of the central nervous system activity were diagnosed using Biomysh-Research (LLC Neyrolab, Moscow). Chronoreflexometric tests (simple visual-motor reaction and complex visual-motor reaction) estimated the speed of neuronal sensory information processing, mobility of nervous processes, stability of human sensomotor reactions. The functional state of the central nervous system was diagnosed using the Loskutova's criteria (the functional level of the system, reaction stability, the functionality level). The results were processed in Microsoft Excel and Statistica v.7.0. An optimal functional state of the central nervous system is characteristic of the group of teachers aged 56.2. Processing performance of complex sensorimotor information and duration of differentiating inhibition reflect the reduced cognitive performance in most of the teachers.

Key words – elderly teachers, functional state of the central nervous system, visual-motor reaction, cognitive performance, neurodynamic reactions.

I. INTRODUCTION

All over the world the age structure of population is changing. According to the UN, by 2025, older people and long-livers will make up about 15 % of the global human population. Research on gerontology shows the dependence of the state of an aging organism on the individual lifestyle [6, 12, 17].

According to the survey of pensioners, 96 % of respondents fell changes in their life. About a third of respondents take a rest while doing housework; the same number of survey participants watch TV and read; two-tenths of respondents visit different events, theaters, concerts; 5 % of respondents travel. 60 % of respondents prefer passive rest; 70 % of respondents spend their time with their families; 30 % like loneliness [13, 14].

Life expectancy depends on the level of social development. The high social status, social success of an

individual, and professional self-determination have a positive influence on the life expectancy. The life expectancy of university teachers is about seventy-five years, that of clergymen – 73 years; lonely people live less. When examining the population aged 35–44, it was found that single and divorced men and women and widowers die more often than married ones. Predictors of longevity are mutual love, family well-being, successful professional realization, high spirituality, social, physical and cognitive activity [8].

Longevity is determined by the functional state of the cerebral cortex. In long-livers, the higher nervous activity is strong and balanced. They have good memory, high mental and physical activity. This means that life expectancy depends on individual characteristics of nervous activity which manifest themselves in human behavior.

The leading property of the human central nervous system is its ability to adapt. The human has to predict social and professional changes. This ability is related to the cognitive function. Cognitive functions allow us to adapt to changes.

The modern educational environment is focused on participants with a high level of mental performance. The level of mental performance is determined by the functional mobility of excitation and inhibition. Mobility is extremely important especially when adapting to the natural and social environment.

Mobility of the nervous processes is a property of the central nervous system. The state of the central nervous system is influenced by peculiarities of the human emotional and psychological state and the level of mental stress. There are studies on the dependence of coordination of the functions of the physiological systems and nervous processes which increase the level of mental performance [2, 5].

The literature provides data on the age-related changes in mental performance. Daily physical activity is important for maintaining mental performance at the age of 40–79.

The article aims to study functional indicators of the central nervous system (CNS) and cognitive performance of elderly teachers.

II. METHODS AND MATERIALS

Elderly teachers of Chelyabinsk State Pedagogical University were involved in the study of functional indicators of the central nervous system (CNS) and cognitive performance. The sample included 21 women (mean age was 56.2 years). The integral characteristics of the central nervous system were diagnosed using a computerized express technique of "Biomysh-Research" (LLC Neyrolab, Moscow). Chronoreflexometric tests (simple visual-motor reaction (SVMR) and complex visual-motor reaction (CVMR)) were used to estimate the speed of neuronal processing of sensory information, mobility of nervous processes, and stability of human sensomotor reactions. The functional state of the central nervous system was diagnosed by the Loskutova's criteria (functional level of the system (FLS), reaction stability (RS), the functionality level (FL)). The results were processed in Microsoft Excel and Statistica v.7.0.

The survey was conducted on a voluntary basis.

III. RESULTS

The results are presented in Table 1.

TABLE I. AVERAGE VALUES OF INDICATORS OF NEUROMOTOR REACTIONS

Indicator	M±m	σ	CV	Regulatory Values
Average SVMR time, ms	249.90±4.19	19.19	8 %	203–253
Average deviation from the SVMR, ms	46.79±0.54	2.47	5 %	33–66
SVMR variation coefficient, %	19.05±0.48	2.2	12 %	
FLS, RU	5.36±0.03	0.13	2 %	4.9–5.9
RS, RU	2.87±0.02	0.1	4 %	2.0–2.9
FPL, RU	5.26±0.07	0.33	6 %	3.8–4.9
Reliability, %	90.16±2.05	9.38	10 %	
Efficiency, %	72.18±3.25	14.9	21 %	
Average CVMR time, ms	475.57±13.46	61.67	13 %	332–434
Average deviation from the CVMR, ms	110.81±5.90	27.04	24 %	69–113
CVMR variation coefficient, %	24.28±1.99	9.1	37 %	
Average central delay time, ms	225.67±13.62	62.42	28 %	

Speed indicators of the sensory response are genetically determined and poorly trained. [10]. The speed indicators of simple human visual-motor reactivity are due to the structural-functional characteristics of the motor-tactile and visual analyzers, the psycho-physiological state of the body, and properties of the nervous processes [3, 18]. The latent period of the visually-motor reaction characterizes the speed and quality of the response to the visual stimulus, in other words, reflects the level of activation of the central nervous system. Starting from the mature period of ontogenesis, the average time of neurodynamic parameters increases [7, 11, 16].

Mobility of the nervous system which manifests itself in the speed of information processing varies inversely with age; functional mobility decreases. At the age of 18–19 years, the

number of subjects with a high level of productivity is higher than in 30–31 years [1, 20]. The share of individuals who have signs of fatigue increases with aging. The reliability indicator decreases. The average level of reliability increases in individuals aged 30–31.

The analysis of tabular data shows that the surveyed elderly teachers have the average level of CNS activation (average SVMR time) reflecting the average speed of neuronal processing of simple visual stimuli. The average group SVMR indicator is located on the upper border of the standard indicator which reflects the tendency towards inertia of nervous processes of the central nervous system. The results reflect the overall age dynamics of changes in cerebral speed of processing elementary sensory information.

Comparison with the conclusions of other authors [4, 5] convinces us that we can state the optimal level of adaptive regulation of the cerebral component reflecting the effective level of intracentral interactions which determines the adequate interaction of the organism with the environment under conditions of simplified sensory load. The homeostatic level of the regulatory influence of the CNS described by the indicators of standard deviation and the coefficients of SVMR variation reflects effective stabilization mechanisms of the functional system to a simple visual stimulus. The stability of cerebral homeostasis reflecting the frequency ratios of microparoxysms (the number of omissions) is reflected in relatively high average activity reliability (over 90 %).

Analyzing the design criteria characterizing the level of the functional state of the CNS, we identified the optimal level of cerebral homeostasis which is reflected in the average level of the general functional state and stability of the functional state of the nervous system (FLS and RS indicators fall within the range of conventional norms). The values of the level of functionality (FL) are high which characterizes the optimal functional system reflecting the high success rate of the simple sensorimotor task. We observed relative homogeneity of the indicators of variation chronoreflexometry for a simple visual stimulus (the variation coefficient for average values of indicators (CV) does not exceed 12 %).

The integral monitoring indicator reflecting adaptive and homeostatic indicators of cerebral activity (activity efficiency) corresponds to the upper limit of the average 75 % range of values. Individual values of the index vary from 51 to 89 %. This indicator is the most variable (the variation coefficient for average values of the indicator (CV) corresponds to 21 %).

The complex sensorimotor selection reaction reflects an objective criterion of functional mobility of the cerebral processes. CVMR indicators characterize severity of differentiated cerebral inhibition.

A permanent decrease in the need for cognitive functions can be observed in the elderly or people with chronic diseases [19].

Mild cognitive impairment is a mono- or multifunctional cognitive defect that goes beyond the average age norm but does not cause disadaptation. Mild cognitive impairment occurs when cognitive functions become weaker as compared with the initial higher level (individual norm). As a rule, mild cognitive impairment does not cause difficulties in everyday life and professional activities.

Subjective cognitive impairment is a variant of the norm associated with physiological fluctuations of attention. Attention is determined by a number of factors — motivation, wakefulness, presentations of memorized material, increased workload and / or decreased quantity and quality of rest. Comparison of average CVMR indicators with normative ones identified the inertia of neuronal processes which reflects a reduced ability of switching attention between different types of activity (average values of the group indicator are above the upper limit of the normative indicator by about 10 %).

The mean CVMR values reflect long cognitive processing (analytical-synthetic activity of the cerebral cortex). A more objective indicator reflecting cerebral processing of information about the sensory stimulus is the time of the central delay (the difference between the SVMR and CVMR values). The results are consistent with the average CVMR values reflecting the reduced functional mobility of surveys of elderly teachers. The duration of the “central delay” indicators is almost commensurate with the values of SVMR (the difference between the average values of “central delay” and SVMR is not more than 10 %) which reflects the relatively long analytical processing of sensory information in the cortex due to imperfect differentiation of cerebral processes determining the generalization of motor reflexes and decreased CVMR values. Differential inhibition of conditioned-reflex activity provides a more accurate response to stimuli which contributes to a more effective adaptation of the organism to changing environmental conditions.

Compliance of the average values of the standard deviation of the CVMR with standard indicators and a relatively small number of erroneous reactions (about 11 %) reflect the relative balance of excitatory and inhibitory processes in the central nervous system. The relative stability of cerebral processes with low functional mobility characterizes the reduced conditioned reflex activity.

IV. CONCLUSION

The issues of identifying features of neurodynamic processes and cognitive performance of elderly university teachers still remain unsolved.

The functional state of the central nervous system makes it possible to characterize the cerebral homeostasis which determines the stability of functional systems and suggests that the group of teachers at an average age of 56.2 years has an optimal functional state of the central nervous system.

Neurodynamic processes serve as criteria for adapting to constantly changing social conditions. They are characteristics of mental performance and allow for making conclusions about cognitive processes and complex sensorimotor information processing performance. Long differentiation inhibition (in terms of CVMR) indicates the reduced cognitive performance.

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