

## THE CRITERION "STRENGTH – WEAKNESS" OF THE NERVOUS VOCATIONAL SYSTEM IN APTITUDE OF WORKERS INVOLVED IN HAZARDOUS ACTIVITIES

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**Summary.** The principal aim of the paper is to make a physiological and hygienic assessment of the criterion "strength-weakness" of the nervous system in vocational aptitude of workers involved in hazardous activities. Interpretation of findings was carried out by means of generally recognized physiological consistency, where, according to Ya. Streliau, it was established that the optimal value of the criterion "strength-weakness" of the nervous system was 100%. In accordance with the study, the criteria for nosological diagnosis of people working under highly dangerous conditions were suggested. It was established that most people matched psychophysiological criteria. At the same time, the indeterminate number of people was considered as conditionally suitable for work (6%) and non-suitable (1%). The findings are considered as an experiment of confirmed principles of medicine as well as a ground for practical application of the criteria for nosological diagnosis under conditions of laboratory of clinical occupational pathology and psychophysiological expertise.

**Key words:** *strength of nervous system, highly dangerous occupations, job specification, chromoreflexometry, occupationally significant functions.*

### Introduction

The strength of nervous processes is one of key basic features of the nervous system which provides stable functioning of the human body in achieving the goal of different types of activity, working practice, in particular [1]. A physiological sense of the strength of the nervous system consists in a specific peculiarity of the cerebral cortex cells which are characterized by ability to function consistently (non-stop) under conditions of extremely high or long-term excitation. This physiological phenomenon is closely associated with the integral indicator of functional status of the central nervous system, that is intellectual capacity which, in its turn, reflects a joint vector of changes of such psychophysiological functions as memory, attention and thinking [2].

Thus strength of the nervous system is of a great importance for workers, whose activities are connected with significant personal and

collective hazards as well as it is used to estimate vocational aptitude.

### 2 PURPOSES, SUBJECTS and METHODS:

**2.1. Purpose:** To make a physiological and hygienic assessment of the criterion "strength – weakness" of the nervous system in vocational aptitude of workers involved in hazardous activities.

### 2.2. Subjects & Methods

The criterion "strength – weakness" of the nervous system was estimated according to results of nervous system index assessment in concordance with generally recognized L.O. Kopytova's method [2], whose principal is based on the ability of the nerve cells to stand long – term concentrated stress in multiple action of an irritant.

Interpretation of the findings was based on generally accepted physiological characteristic which, according to Ya. Streliau's formula, makes it possible to establish that the optimal value of the criterion "strength – weakness" of the nervous system is 100 %. This value means that the reverse reaction to external irritant in the initial series of signals was equal to the reaction of final series of signals, that was indicative of appropriate state ' of the nervous system of the patient under

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study. The value of the index of nervous system strength, which is lower than 100 %, suggests increased criterion "strength – weakness" of the nervous system in the involved patient resulting from development of inhibitory process. The value of the index which is higher than 100 % is considered as inability of the nervous system of an individual to react immediately to external irritant due to predominance of inhibitory process.

Individual assessment of findings as well as population one was made due to the criterion of "normal" Gaussian distribution, according to which the fitting criterion involved values of nervous system strength which were in the range from 60 to 140 %.

Statistical methods of processing the studies were carried out using parametric and nonparametric analysis

#### **Conflict of interests**

There is no conflict of interests.

### **3. RESULTS AND DISCUSSION**

Highly dangerous occupations include the types of activities associated with individual and (or) collective risk of injuries, poisoning and other damages resulting in loss of health [3].

This group of occupations comprises those ones, which, according to the legislative records [4, 5] and findings of own job specific studies, include: highly explosive activities performed by locksmiths, electricians, electric welders; activities associated with nervous emotional tension which accompanies work of shift engineers, boiler house and steam turbine operators; activities associated with the use of fire – arms which are typical for "fighter" occupation; activities associated with petroleum pipe – line and gas pipeline servicing which are carried out by engineers and electric welders; fire hazardous work which squad fighters and commanders deal with; working at height, which according to employment duties are carried out by "shop – assistant", bricklayers, carpenters, elevator operators and others; activities at high voltage which are typical for electric generator repairmen, electromechanicians, electricians; activities associated with motor vehicle driving.

On the basis of specific significance of nervous system strength index, the quantitative analysis was carried out in accordance with the following criteria: type of activities, occupation, labor experience, age, sex.

As it was proved by observations, nervous system strength indices in representatives of different occupations of increased risk were different (*Table 1*). In workers dealing with highly explosive activities it was  $94.54 \pm 1.91$  %, in people

involved in nervous emotional tension it was  $109.65 \pm 8.30$  %, in workers engaged into activities associated with fire – arms –  $95.79 \pm 1.33$  %, in people whose work was associated with petroleum pipe – line and gas pipeline servicing –  $92.72 \pm 8.30$  %, in workers dealing with fire hazardous work –  $101.24 \pm 4.90$  %, in steeplejacks –  $102.73 \pm 1.26$  %, in people working at high voltage –  $104.46 \pm 2.36$  %, in drivers –  $120.51 \pm 10.83$  %, in people working underground –  $96.49 \pm 5.35$  %.

The analysis of the findings based on nervous system strength index has made it possible to establish that its most sustainable values are typical for workers who are engaged into the following safety criteria: fire hazardous, at height, at high voltage, underground. The average value of the criterion "strength – weakness" of the nervous system in representatives of these activity types was within the range from  $96.49 \pm 5.35$  % to  $104.46 \pm 2.36$  %.

According to individual features, this group of workers is able to react adequately in case of emergency situations and they can stand long – term intensive activities.

It was clarified that the upper deviation from sustainable value of the index of nervous processes strength (100 %) was observed in workers dealing with motor vehicle driving, nervous emotional tension activities, highly explosive activities, activities associated with fire – arms, petroleum pipe – line and gas pipeline servicing.

Herewith, the upper deviation ( $p < 0.01$ ) in value of the index of nervous process strength from sustainable value was observed in workers involved into motor vehicle driving ( $120.51 \pm 10.83$  %) that is obviously indicative of predominant inhibitory process in this group of people which conclusively results in complicated activation and prompt response to change of circumstances. This phenomenon is focused to consider these specialists as representatives of increased attention group on the part of management team and psychophysiologicalists. Preventive measures aimed at training of psychophysiological functions directly associated with nervous system character, that is memory and attention, are useful. Based on the principal of reverse reaction, training will lead to improved functional condition of cortex cells and, consequently, will aid in optimization of important (central) element of providing of operational activity.

Significant deviation from optimal value, according to the criterion "strength – weakness"

**Table 1**

Value of nervous system strength index in workers involved in different activities associated with increased risk (M ± m %, n = 809)

Activity type	Indices	p
Highly explosive activities	94.54 ± 1.91	>0,05 – < 0,01
Nervous emotional tension activities	109.65 ± 8.30	
Activities associated with fire – arms	95.79 ± 1.33	
Pipeline servicing	92.72 ± 5.13	
Fire hazardous work	101.24 ± 4.90	
Working at height	102.73 ± 1.26	
Working at high voltage	104.46 ± 2.36	
Motor vehicle driving	120.51 ± 10.83	
Underground activities	96.49 ± 5.35	

of the nervous system, was observed in the group of workers dealing with petroleum pipe - line and gas pipeline servicing (92.72 ± 5.13 %, p < 0.05). Low values of the index of nervous processes strength are indicative of unstable nervous system in these workers, which is observed in the form of exhaustion associated with early development

connection of the value of the criterion "strength – weakness" of the nervous system with specific occupational activity was studied. The control group enrolled workers, whose activity was not associated with hazards, accountants in particular.

As it had been proved by observations (the findings are presented in *Table 2*) the index of

**Table 2**

Value of the index of nervous system strength in representatives of different occupations, whose activity is associated with increased risk (M ± m %, n=716)

Occupations	Indices	p
Senior personnel	102.40 ± 3.32	>0,05 -<0,01
Technician	106.00 ± 6.79	
Locksmith	108.52 ± 4.12	
Shop – assistant	100.82 ± 3.86	
Bricklayer	101.51 ± 5.02	
Engine driver	117.36 ± 11.43	
Craftsman	103.97 ± 4.29	
Engineer	100.64 ± 2.19	
Electric fitter	104.58 ± 2.34	
Electromechanician	103.87 ± 2.04	
Electric welder	106.22 ± 7.36	
Electrician	94.27 ± 4.77	
Driver	120.03 ± 14.84	
Equipment operator	98.87 ± 2.43	
Fighter	99.58 ± 3.00	
Accountant and economist	94.84 ± 5.60	

of inhibitory process in cortex cells. This group of workers is recommended to undergo preventive measures concerned with optimization of work – rest ratio as well as adaptogenic and sanogenic actions focused on improvement of body persistence to unfavorable workplace factors associated with pipeline servicing. Special attention should be paid to introduction of psychohygienic measures directed to increase mental toughness of these workers, which, like back response principal, will contribute to optimization of functional condition of cortex cells.

Nine types of activities associated with increased hazards are carried out by representatives of 15 occupations. Thus, under conditions of physiological hygienic experiment,

nervous processes strength characterizing the group of senior personnel involved into activities concerned with significant nervous emotional tension, was 102.40 ± 3.32 %. In other groups under study, where activity was associated with other risk factors in relation to individual and collective safety, the corresponding index of the criterion 'strength – weakness' of the nervous system was the following: in technicians – 106.00 ± 6.79 %, in locksmiths – 108.52 ± 4.12 %, in shop - assistants – 100.82 ± 3.86 %, in bricklayers – 101.51 ± 5.02 %, in engine drivers – 117.36 ± 11.43 %, in craftsmen – 103.97 ± 4.29 %, in engineers – 100.64 ± 2.19 %, in electric fitters – 104.58 ± 2.34, in electromechanicians – 103.87 ± 2.04 %, in electric welders – 106.22 ± 7.36 %, in

electricians –  $94.27 \pm 4.77\%$ , in drivers –  $120.03 \pm 14.84\%$ , in equipment operators –  $98.87 \pm 2.43\%$ , in fighters –  $99.58 \pm 3.00\%$ . In the control group representatives, which included accountants and economists, the average index of nervous processes strength was  $94.84 \pm 5.60\%$ .

The comparative analysis of the findings is indicative of the fact that the upper deviation from average values is observed in the group of the drivers. The index value of  $120.03 \pm 14.84\%$  ( $p < 0.05$ ) suggests some peculiarity of this psychophysiological function in these people which consists in their inability to be involved into activity immediately. In this case it is difficult for a worker to react rapidly to change of circumstances that is considered as a risk factor of individual and general safety.

As it has been proved by means of the study, the second risk group of relatively individual and group safety is represented by engine drivers, whose index of nervous processes strength is  $117.36 \pm 11.43\%$  ( $p < 0.05$ ). This value is not significantly lower than that one of drivers that is indicative of inability of the representatives of this group to react rapidly to change of external circumstances. This fact makes it possible to consider engine drivers as risk group workers.

The opposite findings associated with low index of nervous processes strength were observed in electricians, where it was  $94.27 \pm 4.77\%$  ( $p < 0.05$ ). This is an objective basis to regard instability of the nervous system in representatives of this group resulting in easy fatigability. The activities of electricians are connected with the risk of injury by high frequency current. Increased fatigability, in its turn, is a direct factor of impaired attention that increases injury risk. Therefore, in accordance with hygienic criteria, working conditions of electricians should be optimized; introduction of adequate mode- rest regime is particularly required.

The index of nervous processes strength in electricians is almost equal to the value of that one in the control group, that is  $94.84 \pm 5.60$  ( $p > 0.05$ ), represented by accountants and economists.

In representatives of other groups under study the index of the criterion "strength – weakness" of the nervous system was higher, in the range from  $98.87 \pm 2.43\%$  (equipment operator) to  $120.03 \pm 14.84\%$  (driver). This consistency of formation of functional condition makes it possible to conclude that for the majority of people, working under conditions of increased danger, normal type of CNS reaction is typical (90 %

and for some workers – "backed - up" one (9 %, drivers and engine drivers predominantly). "Inhibitory" reaction type was observed in fewer people (1 %, electricians).

In the following the comparative analysis of dependence of value of the index of nervous processes strength on occupational experience, age and sex of workers was carried out (Fig. 2–4).

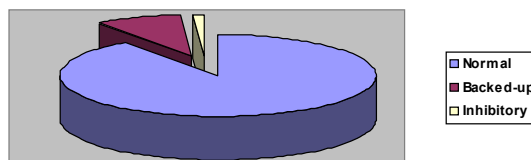


Fig. 1. Reaction type in workers dealing with hazardous activities ( $P \pm p\%$ ,  $n=716$ )

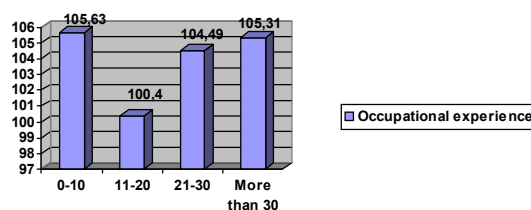


Fig. 2. Value of the index of nervous processes strength depending on occupational experience

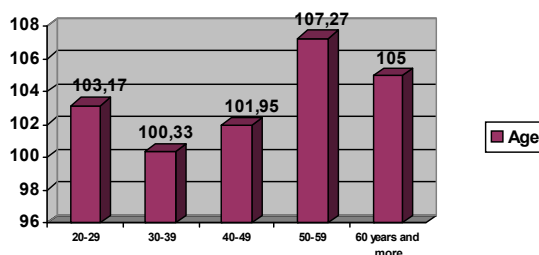


Fig. 3. Value of the index of nervous processes strength depending on age ( $M \pm m\%$ ,  $n=800$ )

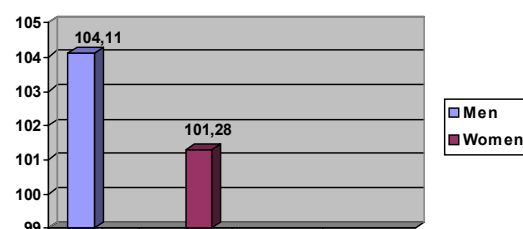


Fig. 4. Value of the index of nervous processes strength depending on sex ( $M \pm m\%$ ,  $n=810$ )

It was established that value of the index of nervous processes strength in people with different occupational experience in hazardous activities was in the range from  $100.40 \pm 2.23\%$  to  $105.63 \pm 2.14\%$  ( $p > 0.05$ ).

The index of nervous processes strength depending on age of workers tended to be

increased: in workers aged from 20 to 29 this index was  $103.17 \pm 4.15$  %, aged from 30 to 39 –  $100.33 \pm 1.81$  %, aged from 40 to 49 -  $101.95 \pm 1.90$  %, aged from 50 to 59 -  $107.27 \pm 3.23$  %, aged 60 and older –  $105.00 \pm 3.16$  %. These differences were not statistically significant ( $p > 0.05$ ).

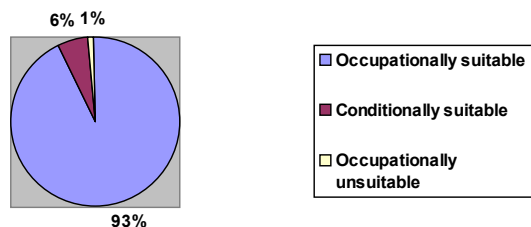
The index of the criterion "strength – weakness" of the nervous system in men was somehow higher than that one in women ( $104.11 \pm 1.36$  % and  $101.28 \pm 2.61$  %, respectively), but these differences were not statistically significant ( $p > 0.05$ ).

Particularly, it should be noted that among all people under study dealing with highly hazardous activities, the average population values were within normal physiological range according to all criteria used. This fact is considered as background for qualitative carrying out of work activity along with health maintenance and prevention of workplace injuries and individual as well as group accidents.

Thus, there were no significant regularities in formation of the principal peculiarity of the nervous system, that is its strength, depending on occupational experience, age and sex.

In addition, significant impact on formation of the main psychophysiological function resulted from such criterion features as activity type and type of specific occupation associated with individual or collective danger.

Due to the final individual analysis of the role of nervous processes strength it was proved that among all workers dealing with different types of activities associated with high risk, 93 % of people under study met the requirements of vocational aptitude according to the criterion "strength – weakness" of the nervous system, 6 % of people were conditionally suitable that resulted in reduction of term to the next examination from two years (for suitable ones) to one (Fig. 5). Occupationally unsuitable people were represented by only 1 %.



**Fig. 5.** Vocational aptitude of workers dealing with high risk activities ( $P \pm p$  %,  $n=809$ )

The obtained results correspond to modern concepts of the role of the criterion "strength-

weakness" of the nervous system in the formation of professional suitability. Substantially extends our scientific understanding of the role of psychophysiological functions in the success and safe production activities in the performance of hazardous work [3, 6].

**Conclusions**

1. The criterion "strength – weakness" of the nervous system is considered as a principal characteristic of vocational aptitude of workers involved in highly hazardous activities. It reflects qualitative and quantitative characteristics of neurodynamics.

2. Cortex neurodynamics, which is assessed by means of nervous system strength index, is closely associated with activity type and corresponding occupation of a worker and does not depend on his or her professional experience, age and sex.

3. The majority of the patients, who are engaged into highly hazardous activities, meet occupational requirements according to the criterion "strength - weakness" of the nervous system (93 %). The group of 'conditionally suitable' workers was represented by 6 % of people under study and the one of "occupationally unsuitable" workers – only by 1 %.

4. The upper deviations from population optimum were observed in people involved in occupations associated with motor vehicle driving, that is drivers and engine drivers, who are characterized by "backed – up" reaction type, when a person is unable to react immediately to change of circumstances.

5. The second group of workers with opposite character of reaction was represented by people dealing with petroleum pipe – line and gas pipeline servicing as well as electricians. These workers were characterized by inhibitory reaction type which was observed in the form of easy fatigability of cortex cells.

The set of corrective measures for representatives of these groups under study should include improvement of functional condition through training of occupationally significant psychophysiological functions as well as optimization of work – rest ratio focused on prevention of early fatigue.

In the article states the facts of the research and their results, which allows the use of physiological and hygienic assessment of the criterion "strength – weakness" of the nervous system in vocational aptitude of workers involved in hazardous activities.

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