Cognitive functions and professional status in the open population of Russia/Siberia among adults aged 25–44 years

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Objective: *to establish associations of cognitive functions (CFs) and professional level in an open population of Novosibirsk aged 25–44 years.*

Patients and methods. *The subject of the study was a random representative sample of one of the Novosibirsk districts population aged 25–44 years (463 men, mean age 35.94±5.957 years, and 546 women, mean age 36.17±5.997 years) in 2013–2016. CFs were screened using: A.R. Luria 10 words learning task – immediate and delayed recall after the interfering task; Bourdon Test (BT); exclusion of "the fifth extra" test; verbal fluency test (naming animals in 1 min). Education level and professional status were assessed according to the criteria of the WHO international program MONICA protocol.*

Results and discussion. *The analysis showed that the management and engineering and technical staff (ETS) coped significantly better with cognitive tests than manual labor workers. The analysis of memory using the A.R. Luria test showed that the differences in the first recall of 10 words between manual labor workers and managers reached 0.849 words, in the mean number of correctly remembered words it reached 0.735 words, and in delayed recall – 1.096 words ($p<0.05$). Attention assessment using BT revealed that the number of letters crossed out in 1 min was higher among the management staff compared to the manual labor workers, reaching 4.978 characters ($p<0.05$). ETS scores in this test were close to the management staff scores ($p<0,0001$). Also, a tendency to a smaller number of mistakes made by managers and ETS compared to workers was revealed in the BT. In the analysis of semantic associations in the verbal fluency test the differences in the number of animals named per 1 min reached 3.007 animals between manual labor workers and managers. Similar differences were observed between manual labor workers and ETS ($p<0.05$). Abstract reasoning evaluation using the "the fifth extra" test showed that managers and ETS excluded a greater number of words that did not correspond to the logical series (i.e., they showed the best result in this test) than manual labor workers ($p<0.05$). ETS and management staff showed best performance in cognitive tests compared to manual labor workers of the same educational level.*

Conclusion. *A quantitative association has been established between a low professional level, level of education and a decrease in cognitive functions among people aged 25–44 years.*

Keywords: *cognitive functions; cognitive impairment; profession; education; population; adults.*

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INTRODUCTION

Cognitive impairment is defined as a state in which "a person has problems with remembering, learning something new, concentrating attention or making decisions that affect his / her daily life" [1].

Cognitive impairment places a significant socioeconomic burden on society, which is likely to increase as the population ages [2]; for example, people with cognitive impairment stay in hospital more than three times longer than those who were hospitalized for some other conditions [3].

On average, about one third of people with Alzheimer's disease or associated dementia are hospitalized at least once a year, and those who have been hospitalized at least once have about 1.5 to 2 hospitalizations per year [4]. The total number of people with cognitive impairment is expected to reach 75.6 million by 2030 and almost triple (to 135.5 million) by 2050 [5]. Some factors may be related to cognitive function, for example: marital status [6], socio-demographic data [7], lifestyle [8], health [9], including education and professional activity [10].

Despite the fact that most people spend a significant part of their lives at work, it is not yet known enough about the exact relations between professional activity and cognitive functioning [11]. Two areas of research have shown that professional activity can be related to cognitive functions. First, the neurocognitive abilities of people with higher mental work requirements were better than those of their colleagues who had less demanding work [12]. Secondly, people with less psychologically demanding work have proved more vulnerable to the development of clinical conditions that seriously impair cognitive functions (for example, Alzheimer's disease and Parkinson's disease) [13].

Since one of the practical tasks facing modern medicine is to identify those types of professional activities that contribute to the better preservation of human memory and thinking in old age, it is vital to understand how occupation affects cognition and what preventive strategies can help maintain cognition with age.

Therefore, the aim of our study was to investigate the relationship between cognitive function and professional level in an open population aged 25–44 years.

MATERIALS AND METHODS

The object of our study was a random representative sample of the population of Novosibirsk at the age of 25–44 years screened in 2013–2016 within the framework of the budget theme №АААА-А17-117112850280-2. Individuals of 25–44 years old, 463 men (mean age 35.94±5.957 years) and 546 women (mean age 36.17±5.997 years) were examined. The study was approved by the Local Ethics Committee of NIITPM.

Investigation of the state of cognitive functions (CF) under screening conditions involved performing a 10-word memorization test (A.R. Luria's test unified for screening purposes) [14], followed by their reproduction after interfering tasks (recall), performing a correction test (letter modification of the Bourdon test used for screening purposes), as well as a Concept Exclusion Test (verbal version) with fixation of its execution time [15] (Table 1).

Table 1. **Tests used to assess CFs in younger adults during population-based screening**

Test	CF assessment
10-word memorization test by A.R. Luria, followed by recall after an interfering task	Auditory short-term memory, long-term memory, memory productivity
10-words memorization test by A.R. Luria, 1st recall	Attention
Proofreading test	Psychomotor speed, persistence and visual attention activity
"5th Extra" Concept Exclusion Test	Thinking
The speech activity test in the form of naming of animals within 1 min. (Animal Naming test)	Evaluation of semantically mediated associations

Similar methods of performing a proofreading test, Animal Naming test (speech activity test) and performing a 10-word memorization test were tested when performing population screening as part of the international HAPIEE (Health, Alcohol, and Psychosocial factors in Eastern Europe – Determinants of Cardiovascular Diseases in Eastern Europe) project [16]. The use of the above-named tests made it possible to assess the state of memory, concentration of attention and features of thinking in the context of population screening. Relation of the participants to an occupational group was assessed according to the criteria proposed earlier for use in the WHO MONICA (Monitoring Trends in CVD Morbidity and Mortality, and Their Determinants) International Program [17].

Statistical processing of the study results was carried out using a free (freeware) statistical package "R" with a set of libraries [18]. The normality of the distribution of analyzed quantitative data, such as, for example, scores obtained during psychometric testing, was determined by the Kolmogorov–Smirnov test. The data in the tables are presented as a median (Me) with lower and upper quartiles [25%; 75%]. Categorical indicators are presented as absolute and relative values (n,%). In a number of cases, an arithmetic mean with a 95% confidence interval was calculated for CFs (in the tables and in the text they are represented as M (95% CI). The next step was to analyze associations of CF with non-conventional CVD risk factors in Novosibirsk population. If the trait met the normal distribution criteria, a single-factor variance analysis and a multi-rank Duncan test were used. Their choice is due to their high sensitivity, absence of necessity to know the law of distribution of the population studied, the use of alternative variables in the analysis, as well as the ease of application. Associations of the lower and upper quartiles [Q25–Q75] of individual CFs with non-conventional RF of the CVD were checked by means of conjugation tables using the Person's' _2 criterion. The differences were considered statistically significant at the level of at least 95% ($p<0.05$) [19].

RESULTS

The assessment of CF in young people according to their professional status revealed statistically significant differences between individuals engaged in physical labor, compared with engineering and technical workers and managers (Tables 2 and 3). When analyzing the properties of memory, it was revealed that during the first recall of 10 words in the Luria test (this indicator can also serve to assess the degree of concentration), the best indicators were among the management team (especially, among top managers – 7.1±1.029 words), in comparison with people engaged in physical labor (the worst among workers of moderate and light physical labor – 6,162±1,191 words). The differences between the compared groups were statistically significant ($F=5.537$, $p<0.0001$) (Table 2). At the same time, the differences between workers of moderate physical labor and managers (Δ) were the greatest and reached 0.849 words (S.E.=0.247; p=0.022; 95% CI = -1.642 – -0.057) (Table 3). In the study of another indicator of memory, reflecting direct memorization of information – the average number of correctly memorized words (with three presentations), the same patterns were revealed. The best results were among the management staff (especially, among top managers – 8,356±0.871 words), compared with people engaged in physical labor (the worst among workers of moderate physical labor – 7,622±1,134 words). The differences between the groups were statistically significant ($F=5.093$, $p<0.0001$) (Table 2). At the same time, the differences between workers of moderate physical labor and managers reached 0.735 words (S.E.=0.188; p =0.004; 95% CI = -1.339 – -0.130) (Table 3).

The same patterns were revealed when analyzing another indicator of memory – delayed recall. The best indicators of delayed recall were among the management team (especially among top managers – 8.533±1.717 words), compared with blue-collar professions (the worst among workers of moderate physical labor – 7.514±1.924 and heavy physical labor – 7.429±1.453 words)/ The differences between the compared groups were statistically significant ($F=4.046$, $p<0.0001$) (Table 2). At the same time, the differences between workers of moderate physical labor and managers were the greatest and reached 1.096 words (S.E.=0.287; p=0.005; 95% CI = -2.018 – -0.174) (Table 3).

As for memory indicators, engineers and technicians occupied an intermediate position between persons engaged in manual labor and management personnel: the first recall of 10 words – 6.719±1.261, direct memorization of a series of 10 words (with three presentations) – 8.222±0.946, and delayed recall – 8,444±1,419 words, $p<0,0001$) (Table 2). In the test of the first recall of 10 words, the differences between engineering and technical workers and workers of light physical labor reached 0.552 words (S.E.=0.121; p=<0.0001; 95% CI = -0.939 – -0.164). In the test with direct memorization of a series of 10 words, the differences between engineering and technical workers and workers of light physical labor reached 0.388 words (S.E.=0.092; p=0.001; 95% CI = -0.684 – -0.093) (Table 3). As for the delayed recall of 10 words, the differences between engineering and technical workers and workers of moderate physical labor reached 0.93 words (S.E.=0.255; p=0.01; 95% CI = -1.750 – -0.111) (Table 3). The group of students in terms of memory indicators was close to the group of engineering and technical workers.

In the study of attention, it was revealed that when assessing the number of letters crossed out in the proofreading sample within 1 minute, the best indicators were among the man-

Table 2. CFs evaluation depending on the professional status in younger adults

CF	Occupational status	n	M	σ	SE	95% CI		F	p
						Lower	Upper		
A.R. Luria's 10-word memorization test: 1st recall	Senior Managers	30	7.100	1.029	0.188	6.716	7.484	5.537	<0.0001
	Mid-level managers	39	6.872	1.301	0.208	6.450	7.294		
	Managers	87	7.011	1.105	0.118	6.776	7.247		
	Engineers and technicians	292	6.719	1.261	0.074	6.574	6.864		
	Workers of heavy physical labor	14	6.286	1.541	0.412	5.396	7.175		
	Workers of moderate physical labor	37	6.162	1.191	0.196	5.765	6.559		
	Workers of light physical labor	173	6.168	1.343	0.102	5.966	6.369		
	Students	3	6.667	1.155	0.667	3.798	9.535		
	Pensioners, disabled workers	4	6.500	1.000	0.500	4.909	8.091		
A.R. Luria's 10-word memorization test: average number of memorized words	Senior Managers	30	8.356	0.871	0.159	8.030	8.681	5.093	<0.0001
	Mid-level managers	39	8.291	0.925	0.148	7.991	8.590		
	Managers	87	8.356	0.777	0.083	8.191	8.522		
	Engineers and technicians	293	8.222	0.946	0.055	8.114	8.331		
	Workers of heavy physical labor	14	7.619	1.246	0.333	6.899	8.339		
	Workers of moderate physical labor	37	7.622	1.134	0.186	7.244	8.000		
	Workers of light physical labor	173	7.834	1.015	0.077	7.682	7.987		
	Students	3	8.111	1.071	0.619	5.450	10.773		
	Pensioners, disabled workers	4	7.917	1.198	0.599	6.010	9.823		
A.R. Luria's 10-word memorization test: delayed recall	Senior Managers	30	8.533	1.717	0.313	7.892	9.174	4.046	<0.0001
	Mid-level managers	39	8.487	1.374	0.220	8.042	8.933		
	Managers	87	8.609	1.358	0.146	8.320	8.899		
	Engineers and technicians	293	8.444	1.419	0.083	8.280	8.607		
	Workers of heavy physical labor	14	7.429	1.453	0.388	6.590	8.267		
	Workers of moderate physical labor	37	7.514	1.924	0.316	6.872	8.155		
	Workers of light physical labor	173	8.023	1.451	0.110	7.805	8.241		
	Students	3	7.333	1.528	0.882	3.539	11.128		
	Pensioners, disabled workers	4	7.500	1.291	0.645	5.446	9.554		
Proofreading sample: letters crossed out within 1 min.	Senior Managers	30	20.500	4.462	0.815	18.834	22.166	3.710	<0.0001
	Mid-level managers	39	21.103	3.878	0.621	19.845	22.360		
	Managers	87	21.621	4.679	0.502	20.624	22.618		
	Engineers and technicians	293	20.959	4.518	0.264	20.440	21.479		
	Workers of heavy physical labor	14	16.643	6.512	1.740	12.883	20.403		
	Workers of moderate physical labor	37	18.595	3.848	0.633	17.312	19.877		
	Workers of light physical labor	173	19.948	5.368	0.408	19.142	20.754		
	Pupils	3	16.667	2.887	1.667	9.496	23.838		
	Pensioners, disabled workers	4	17.250	2.630	1.315	13.065	21.435		
Proofreading sample: unrecognized, or mistakenly crossed out letters	Senior Managers	30	2.833	2.230	0.407	2.001	3.666	1.352	0.215
	Mid-level managers	39	2.487	2.553	0.409	1.659	3.315		
	Managers	87	2.828	2.309	0.248	2.336	3.320		
	Engineers and technicians	293	3.078	3.126	0.183	2.719	3.438		
	Workers of heavy physical labor	14	3.857	4.538	1.213	1.237	6.477		
	Workers of moderate physical labor	37	2.919	2.476	0.407	2.093	3.745		
	Workers of light physical labor	173	3.740	3.632	0.276	3.195	4.285		
	Students	3	3.667	2.082	1.202	1.504	8.838		
	Pensioners, disabled workers	4	4.250	2.363	1.181	0.490	8.010		

Table 3. Comparison of groups by professional status in younger adults, statistically significant differences

CF	Comparison of groups by occupational status		Δ	S.E	p	95% CI	
						Lower	Upper
A.R. Luria's 10-word memorization test: 1st recall	Workers of moderate physical labor	Managers	-0.849*	0.247	0.022	-1.642	-0.057
	Workers of light physical labor	Senior Managers	-0.932*	0.249	0.007	-1.731	-0.133
		Managers	-0.844*	0.165	<0.0001	-1.375	-0.313
		Engineers and technicians	-0.552*	0.121	<0.0001	-0.939	-0.164
A.R. Luria's 10-word memorization test: average number of memorized words	Workers of moderate physical labor	Managers	-0.73468*	0.188	0.004	-1.339	-0.130
		Engineers and technicians	-0.60083*	0.167	0.013	-1.138	-0.063
	Workers of light physical labor	Managers	-0.52198*	0.126	0.001	-0.927	-0.117
		Engineers and technicians	-0.38812*	0.092	0.001	-0.684	-0.093
A.R. Luria's 10-word memorization test: delayed recall	Workers of moderate physical labor	Managers	-1.096*	0.287	0.005	-2.018	-0.174
		Engineers and technicians	-0.930*	0.255	0.010	-1.750	-0.111
Proofreading sample: letters crossed out within 1 min	Workers of heavy physical labor	Managers	-4.978*	1.365	0.010	-9.359	-0.597
		Engineers and technicians	-4.316*	1.297	0.033	-8.479	-0.154
	Workers of moderate physical labor	Managers	-3.026*	0.930	0.043	-6.012	-0.040
"5th Extra" Concept Exclusion Test	Workers of heavy physical labor	Senior Managers	-2.538*	0.753	0.029	-4.956	-0.120
		Mid-level managers	-3.007*	0.725	0.001	-5.335	-0.680
		Managers	-2.491*	0.670	0.008	-4.642	-0.340
		Engineers and technicians	-2.783*	0.637	0.001	-4.827	-0.739
	Workers of moderate physical labor	Senior Managers	-2.021*	0.572	0.016	-3.856	-0.185
		Mid-level managers	-2.490*	0.534	0.000	-4.205	-0.775
		Managers	-1.974*	0.457	0.001	-3.440	-0.507
		Engineers and technicians	-2.266*	0.406	0.000	-3.569	-0.962
		Engineers and technicians	-0.951*	0.223	0.001	-1.668	-0.235
Animal Naming test	Workers of light physical labor	Mid-level managers	-4.190*	1.181	0.015	-7.980	-0.400
		Managers	-3.020*	0.875	0.021	-5.830	-0.210
		Engineers and technicians	-2.631*	0.639	0.002	-4.681	-0.581

Notes: Δ - Mean difference (I-II groups). S.E. - Standard error average. 95% CI - 95% confidence interval for mean (lower and upper CI boundaries are given).

agement staff (especially among middle managers – 21.103± 3.888 symbols), compared with workers of physical labor (the worst result was demonstrated by workers of heavy physical labor – 16.643±6.512 symbols). According to this indicator, engineers and technicians occupied a position close to the management team (20.959±4.518 symbols). The differences between the groups were statistically significant (F=3.71, p<0.0001) (Table 2).

At the same time, the differences in this indicator between workers engaged in heavy physical labor and managers were the greatest and reached 4.978 letter symbols (S.E.=1.365; p=0.010; 95% CI = -9.359 – -0.597). There were also differences in the number of letters crossed out in the proofreading sample within 1 min. between heavy manual workers and engineering and technical workers – 4.316 words (S.E.=1.297; p=0.033; 95% CI = -8.479 – -0.154). The same parameter differed by 3.026 words between managers and workers of moderate physical labor (S.E. = 0.930; p = 0.043; 95% CI = -6.012 – -0.040) (Table 3). When studying another indicator of attention, errors made in the proofreading sample test (i.e., unrecognized or mistakenly crossed out letters in the form), similar patterns were revealed, which, however, did not reach the level of statistical significance (F=1.352, p<0.215) (Table 2). Managers made fewer mistakes (the smallest number of mistakes was made by middle managers – 2.487±2.553 symbols), compared with workers of blue-collar professions (most mistakes were made by workers of heavy physical labor – 3.857±4.538 symbols) (Table 2). The degree of concentration among students, according to the results of the proofreading sample test, turned out to be low and approached that of workers of heavy physical labor (the number of letters crossed out in the proofreading sample within 1 minute – 16.667±2.887, and mistakes made in the proofreading sample test – 3.667±2.082 symbols) (Table 2).

In the study of semantically mediated associations, the test of speech activity (naming animals within 1 min., Animal Naming test), revealed that the largest number of animals within 1 min. (the best indicator of the test) was given by managers (especially, middle managers – 26.641 ± 5.887 animals), and engineering and technical workers (25.082±6.368 animals). Workers of moderate physical labor performed this task worst of all; within 1 min. they named a total of 21,838±6,982 animals. The differences between the groups were statistically significant (F=4.136, p<0.0001) (Table 2). In Animal Naming test the most significant difference (by 3.007 words) was between middle managers and workers of heavy physical labor (S.E.=0.725; p=0.001;

95% CI = -5.335 – -0.680) (Table 3). The same difference was noted between workers and managers of other levels, as well as engineering and technical workers (Table 3).

The assessment of thinking in the Concept Exclusion Test ("5th extra") also revealed statistically significant differences between professional groups (F=7.451, p<0.0001). It was found that the largest number of words that did not correspond to a logical sequence (i.e. the best result of this test) was selected by middle managers (15.436±1.373 words), and engineering and technical workers (15.212±1.755 words). The smallest number of words that did not correspond to a logical series was chosen by workers of heavy physical labor – 12.429±5.273 words, thus showing the worst result of this test (Table 2). Also, the differences in the number of words that did not correspond to a logical series between light manual workers and middle managers were the greatest and reached 4.19 words (S.E.=1.181; p=0.015; 95% CI = -7.980 – -0.400). The same parameter differed by 2.631 words between engineering and technical workers and light manual workers (S.E.=0.639; p=0.002; 95% CI = -4.681 – -0.581) (Table 3).

The results of the speech activity test and the assessment of the number of words that did not correspond to a logical sequence in the Concept Exclusion Test among students turned out to be low. In this group, the results approached those of workers of heavy physical labor (for the number of animals mentioned within 1 min – 19.0±5.196, and for selected words that did not correspond to a logical series – 14.333±2.082 words) (Table 2).

Additionally, an analysis of the combined impact of professional status and educational level on the state of CF in young people was carried out in order to separate the influence of education and profession in the study sample (Table 4).

In the group of managers and workers of moderate physical labor, depending on their educational level, differences were revealed only in one indicator of CF: the first recall in the A.R. Luria test with memorization of 10 words, and the number of correctly chosen words in the "5th Extra" Concept Exclusion Test, respectively. At the same time, engineering and technical workers and workers of light manual labor turned out to have significantly more differences in CF indicators, depending on their education. So, for engineers, differences were revealed in four parameters of CF: in the A.R. Luria test with memorization of 10 words (first recall, average number of words and delayed recall of words), and the number of animals named within 1 min. For workers of light physical labor, differences were noted already in seven parameters of CF: in the A.R. Luria test with memorization of 10 words (first recall, average number of words and delayed recall of words), in proofreading test (the number of letters scanned within 1 min and the number of letters crossed out within 1 min), in the number of animals named within 1 min, as well as in the number of correctly selected words in "5th Extra" Concept Exclusion Test (Table 4).

Further, statistically significant differences in certain cognitive parameters depending on education and profession are presented as a median with the lower and upper quartiles. Analysis of the first recall of words in the test with memorization of 10 words revealed statistically significant differences in 3 groups of professions, representatives of which had higher education. So, for managers and engineers, the median of this

Table 4. Comparison of CFs depending on professional status and educational level in younger adults (only statistically significant differences are shown, p<0.05)

Occupational status	CF	Education level	N	Me	Q_{25}	Q_{75}	Rank. avr.	χ^2	df.	p
Managers	**A.R. Luria's 10-word memorization test: 1st recall**	secondary	6	6.00	5.00	6.25	17.75	8.792	2	0.012
		secondary specialized	10	6.50	6.00	7.25	37.90			
		higher	71	7.00	6.00	8.00	47.08			
Engineers and technicians	**A.R. Luria's 10-word memorization test: 1st recall**	secondary	4	6.00	5.25	6.75	92.50	14.641	2	0.001
		secondary specialized	57	6.00	5.00	7.00	112.39			
		higher	231	7.00	6.00	8.00	155.85			
	10-word memorization test, average	secondary	4	7.67	7.67	8.42	98.63	26.057	2	<0.0001
		secondary specialized	57	7.67	6.83	8.33	97.87			
		higher	232	8.33	7.67	9.00	159.91			
	10-word memorization test, delayed recall	secondary	4	9.00	8.25	9.75	175.00	6.395	2	0.041
		secondary specialized	57	8.00	7.00	9.00	122.82			
		higher	232	9.00	8.00	10.00	152.46			
	Animal Naming test	secondary	4	26.50	20.00	34.50	170.38	7.580	2	0.023
		secondary specialized	57	23.00	18.00	27.00	119.61			
		higher	232	26.00	21.00	29.00	153.33			
Workers of light physical labor	**A.R. Luria's 10-word memorization test: 1st recall**	secondary	26	6.00	5.00	7.00	73.50	6.559	2	0.038
		secondary specialized	92	6.00	5.00	7.00	83.01			
		higher	55	6.50	5.00	7.00	100.05			
	10-word memorization test, average	secondary	26	7.33	6.33	8.33	69.81	9.547	2	0.008
		secondary specialized	92	8.00	7.00	8.67	82.29			
		higher	55	8.17	7.25	8.67	103.01			
	10-word memorization test, delayed recall	secondary	26	7.00	6.00	9.00	67.73	9.967	2	0.007
		secondary specialized	92	8.00	7.00	9.00	83.28			
		higher	55	8.00	7.75	9.00	102.34			
	Proofreading (corrective) sample: letters scanned within 1 min	secondary	26	289.00	242.00	320.00	74.00	6.927	2	0.031
		secondary specialized	92	280.50	242.25	349.50	82.26			
		higher	55	312.00	275.50	393.50	101.08			
	Proofreading (corrective) sample: letters crossed out within 1 min	secondary	26	18.00	16.00	21.00	67.71	12.068	2	0.002
		secondary specialized	92	20.00	15.00	22.25	81.68			
		higher	55	22.00	19.00	23.00	105.01			
	Animal Naming test	secondary	26	20.00	16.00	22.00	71.54	5.829	2	0.054
		secondary specialized	92	22.50	19.00	26.00	84.30			
		higher	55	23.50	19.00	28.25	98.83			
	"5th Extra" Exclusion Test	secondary	26	14.00	12.00	15.00	63.98	9.056	2	0.011
		secondary specialized	92	15.00	14.00	16.00	86.25			
		higher	55	15.00	14.00	16.00	99.14			
Workers of moderate physical labor	"5th Extra" Exclusion Test	secondary	11	9.00	3.25	13.75	13.09	4.736	1	0.030
		secondary specialized	26	15.00	12.00	16.00	21.50			

CF parameter was 7.0 words [quartiles 6.0–8.0], while for light manual workers – 6.5 words [quartiles 5.0–7.0]. The same CF parameter had statistically significant differences in 3 groups of professions whose representatives received secondary specialized (vocational) education. Here, the median of the first recall in the test with memorization of 10 words for managers was 6.5 words [quartiles 6.0–7.25], for engineers this median was 6.0 words [quartiles 5.0–7.0], while for workers of light physical labor, it was 6.0 words [quartiles 5.0–7.0] (Table 4). The groups of engineers and technicians, and light manual workers, whose representatives had a higher education, showed statistically significant differences among themselves in the average number of words named during their direct recall. Here the median for engineers was 8.33 words [quartiles 7.67–9.0], and for light manual workers it was 8.17 words [quartiles 7.25–8.67]. Delayed recall of 10 words after an interfering task by the same persons revealed that for engineering and technical personnel the median was 9.0 words [quartiles 8.0 – 10.0], and for workers of light physical labor it was 8.0 words [quartiles 7,75–9.0]. As for the number of animals named within 1 minute, statistically significant differences were also revealed between engineering and technical personnel, and light manual workers, whose representatives had higher education. In this case, for the former, the median of this test was 26.0 words [quartiles 21.0–29.0], while for the latter it was 23.5 words [quartiles 19.0–28.25] (Table 4). The number of animals named within 1 min. revealed statistically significant differences between engineers and workers of light physical labor, whose representatives had secondary specialized education: for the former, the median of this test was 23.0 words [quartiles 18.0–27.0], while for the latter it was 22.5 words [quartiles 19.0–26.0] (Table 4). The parameters of the proofreading test showing the degree of stability of attention (number of letters scanned within 1 min.) statistically significantly differed among workers of light physical labor depending on the educational level (for higher education, the median was 312.0 letters [quartiles 275.5–393.5], for secondary specialized education – 280.5 letters [quartiles 242.25–349.5], and for secondary education – 289.0 letters [quartiles 242.0–320.0]). The difference was also noted in the number of letters crossed out within 1 min. (for higher education the median was 22.0 letters [quartiles 19.0–23.0], for secondary specialized education – 20.0 letters [quartiles 15.0–22.25], and for secondary education – 18.0 letters [quartiles 16.0–21.0]) (Table 4).

DISCUSSION

Our work (the population study of a representative sample of young people aged 25–44 years) for the first time in Russia / Siberia revealed quantitative changes in memory and attention patterns associated with the profession, depending on the educational level.

The analysis of the population material revealed changes in memory patterns and attention associated with the profession. The Luria test scores reflecting memory characteristics were statistically significantly higher in managers (especially in senior managers compared to those in working professions). The greatest differences (Δ) were revealed in the first recall of 10 words in the Luria test between workers of moderate physical work and managers (0.849 words; p=0.022), in the average number of correctly memorized words between workers of moderate physical work and managers (0.735 words; p=0.004), as well as in delayed recall between workers of moderate physical work and managers (1.096 words; p=0.005).

These results can be explained by the adverse effect on memory of a variety of occupational hazards (for example, the influence of heavy metals, solvents, etc.), the characteristics of lifestyle and the initial level of education in persons of working specialties, compared with managers and engineering and technical staff [20–22]. Also, it can be assumed that the brains of workers, especially of low qualification, have structural features, such as volume and degree of synaptic contacts, which acquire buffering functions in relation to damaging factors acting on the brain (protective effect on CF). Thus, it can be assumed that workers have a lower cognitive reserve, compared to managers and engineers.

During the attention study, it was revealed that when assessing the number of letters crossed out in the proofreading sample within 1 minute, the best indicators were among the management staff, compared with persons engaged in manual labor (the worst results were in heavy physical labor workers). In engineers and technicians, this indicator was close to that of managers ($p<0.0001$). At the same time, the largest differences in this indicator between workers of heavy physical labor and managers reached 4.978 letters (p=0.010). When studying the errors made in the proofreading test, similar patterns were revealed, showing that managers made fewer mistakes compared to those of working professions. However, they did not reach the level of statistical significance ($p<0.215$).

Such attention changes may be attributed to a higher level of cognitive reserve in managers and engineering workers, compared to those engaged in physical labor, as well as a lower impact of occupational harms. These include the harmful effects of various chemical and physical environmental factors [20, 21]. Their harmful effects on CF (neurotoxicity) can be both short-term and long-term when the effects are due to multiple exposure to low levels of these factors. The number of animals named within 1 minute in the speech activity test differed most significantly (by 3.007 words) between middle managers and workers of heavy physical labor (p=0.001). Similar differences were noted between workers and managers of other levels, as well as engineering and technical workers. These data are confirmed in the clinical study of Vagapova D.M. (2019) [22]. Such results can also be explained by the mutual influence of the initial cognitive reserve, educational level, and presence of adverse environmental factors (physical or chemical) on CF state [20, 21, 23]. The analysis of the population material revealed that the largest number of words that did not correspond to the logical series (i.e., the best result in the exclusion test) was selected by middle managers and engineering workers, compared to workers of heavy physical labor who chose the lowest number of wrong words. The work of Sazonova A.L. (2014) showed that education is a social indicator, which is one of the most important parameters characterizing the social status of young people (25–44 years old) [24]. Our results showed that managers and engineers with higher and, in part, secondary specialized education, demonstrated better cognitive performance in tests than persons of physical labor of the same educational level. The past decade in the Russian Federation was accompanied by contradictory trends in the change of the educational status of young people. An increase in the level of education was observed in all its types (to a lesser extent, in secondary vocational education) [24]. However, at the same time, there is deterioration in most of the quality indicators of education, including the level of knowledge and personal characteristics of students, and the possibility of their self-realization [24]. All of this can affect the results

of cognitive testing. In the course of our work, we identified statistically significant differences between individual professional groups, depending on their educational level. They concerned the results obtained in A.R. Luria's 10-word memorization test (the first recall, average number of memorized words and delayed recall), in proofreading (the number of letters scanned within 1 min and the number of letters crossed out within 1 min), the number of animals named within 1 min, as well as the number of correctly selected words in the "5th Extra" Concept Exclusion Test. At the same time, the largest number of these differences was found among workers of light physical labor, and the smallest – in the group of managers of the same educational level. The latter performed best in cognitive testing. Statistically significant differences were also found between the engineers and technicians, whose representatives had secondary specialized and higher education, and light manual workers of the same educational level: the former coped with the test tasks better than the latter.

A possible explanation of the above=stated associations of memory and attention with occupational status may provide a cognitive reserve hypothesis. According to the cognitive reserve hypothesis, some individuals have the ability to tolerate age-related changes and disease-related pathology in the brain without developing clinical symptoms or signs of disease, and there is a relationship between cognitive reserve and education, occupational complexity, reading ability, IQ and, respectively, cognitive impairment [23]. Cognitive reserve is believed to be the result of changes in the brain itself caused by changes in its structure and data processing [25]. According to Stern Y. (2006) [26], cognitive reserve can take two forms: (1) neural reserve, in which existing brain networks are more effective or have greater throughput, may be less susceptible to impairment; and (2) neural compensation in which alternative networks can compensate for pathological impairment of the pre-existing networks.

There is an assumption that pathological "pre-nosological" changes in the brain may exist long before the appearance of clinically significant manifestations of cognitive impairment [27]. The presence of a "threshold" or "threshold dose" is implied, stating that an initially high cognitive reserve will limit clinical manifestations of the pathology of the nervous system until the "threshold" level of brain pathology is reached. In this case, cognitive reserve can no longer compensate for pathomorphological brain changes. The theory of cognitive reserve implies that it can be implemented both through protective and compensatory mechanisms. Individuals with higher cognitive reserve (with higher educational and occupational status) will have lower prevalence and frequency of cognitive impairment, especially dementia disorders, including Alzheimer's disease [28–30].

The quantitative results of the population-based study of cognitive functions, which we obtained, suggest that mental and physical stimulation of the brain (in managers and engineers) throughout life, contributes to an increase in the cognitive reserve, allowing them to maintain cognitive functions in old age, as well as protecting against the development of cognitive impairment or slowing their appearance [33].

Conclusions

1. The decrease in memory among workers, in comparison with managers, in the Luria 10-word memorization test, first recall, reached 0.849 words, in the average number of correctly memorized words – 0.735 words, and in delayed recall – 1.096 words ($p<0.05$).

2. In the study of attention, the proofreading test revealed that the number of letters crossed out within 1 min. was higher for the management team than for workers, reaching 4.978 letters ($p<0.05$).

3. Semantically mediated associations in workers in the speech activity test were lower than in managers and engineering workers, reaching 3,007 animals named within 1 min. ($p<0.05$).

4. When analyzing thinking in the Concept Exclusion Test ("5th – extra"), a greater number of words that did not correspond to a logical series (i.e., the best result in this test) were selected by managers and engineering and technicians, compared with workers ($p<0.05$).

5. It was revealed that managers and representatives of engineering and technical personnel had the best CF performance in comparison with workers of the same educational level.

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Conflict of Interest Statement

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