Computerized testing of cognitive functions

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Summary

In the paper authors refer about new developed psychological method which is used in psychological assessment of military specialists in the Army of the Czech Republic. Statistical data about the method and norms for individual categories in which the test sensitively distinguish (for example military drivers, military guards, members of foreign missions) are shown. The test is modern, constructed as a tool which gives results in complex. It measures both the level of the efficiency of cognitive operations under stress conditions and also make possible to obtain some information about selected personality characteristics – for example motivation, self-regulation, the strategy of solution procedures. Statistic correlation to intellect and to some selected clinical factors (for example neurotical symptoms) are also shown. The test is constructed as a visual searching CAT with the changing organization of experimental conditions.

The human resources of all organizations are the most important and valuable because it depends on them how the other resources will be used. Militaries are the organizations where the use of the human potential has long tradition. However, as the time goes the demands on different professions have changed and increased also in the postmodern time. The right selection of proper people for important duties and the prediction of their individual success especially in stressful situations became the crucial things.

In such defined problem the success of its effective solving is connected mainly with the quality of selective methods. By the way, the develop of the right psychological diagnostic methods(tools) that respects all demands of present and future, is very difficult.

We know that generally known trouble of the psychological diagnostic results from the character of mental events: the direct observation is impossible and they are also very variable (not only in inter-individual but also in intra-individual differences). There are only two characteristics in the field of mental events that can be directly measured: the frequency of appearance and the duration of these events. The other quantitative signs (grade, degree, extent, intensity level) can be measured only by non-direct measurement of external appearances of

mental processes and conditions (Brichcin, M., 1999). Besides of that: all psycho-diagnostic tests are used for practical usage, but they put the probands into artificial situations. That is why the new theoretical knowledge how to control and regulate human activities is used, searching intermediary relations between situational demands and concrete mental processes. It is not about the simulation external situations, but about influence the specific demands on internal factors and functions, that are the object of the diagnostic work (Brichcin, M., 1999).

In our report we want to show one particular approach to the tasks that military psychologists face in their everyday praxis. We present the new test that measure cognitive processes under stress condition. This test was developed in the Central medical psychology department in the Central Military Hospital Prague. The test will be in these days offered on psychological market by means of the firm Testcentrum, the Czech branch of Hans Huber and Hogrefe Verlag.

During the procedure of develop new diagnostic tool we used both modern knowledge of the test construction and very accurate description of demands which is laid to armies in the new millenium.

Concerns new test, we knew that we have to make identification of the important conditions of mental efficiency in the stress situations. Simultaneously our main aim was to develop modern adaptive test which respect progress in the field of psychometric methodology. Principles of the cognitive psychology and new experiences with self-directedness regulation of mental processes were the theoretical starting point. Duration of time period between presentation of stimulus and announcement of found target is influenced not only by promptness, perception and attention functions, but also short-time (operational) memory, learning ability, will and intellect (the searching strategy).

In addition to we tried to afflict more observed factors in one test. That is why we were not concentrated only on global psychological factors, but also on special functions: first of all on operational memory, self-regulation, stress resistance, adaptability, flexibility, ability to produce the heuristic procedures of tasks solving.

In the field of demands on up to date military we went from many strategic studies, that on the threshold of the 21st century define the basic visions of militaries of the new millennium; creating the test we respected then the specific demands on the soldier professional, as they were formulated in these studies. It is obvious the soldiers of the 21st century will face new demands. These demands are based on the fact that the character of the missions will be changed and on very demanding operating with new, sophisticated military technology. Speaking about the missions, it is expected that the soldiers will be deployed in the regions where different ethnic groups are and the culture conflict can occur. These missions will demand high level of flexibility, integrity and hardiness of the whole staff. The new technologies will be based especially on basal widespread of computerization of many activities, on the development of sophisticated devices and preponderance of digitalization of informational environment. The essential break point will manifest in the field of information: especially in *coding and decoding of the signs.* These information will in their diversification, the level of encumbrance and

changeableness in time mean new complexity of tasks which quantity an importance will rise exponencionally (Rumsey MG, 1999).

First rate ability to manage these and other orders in rapidly changing military environment will be from the psychological point of view connected with level and quality of many inner factors. Some of these factors can be emphasized. Getting on that the duty of modern soldiers will be more complex, less proceduralized we can come to prompt and quality judgement connected with irrevocable decision, very often nonstandard. It is obvious that the most important elements will be cognitive level, analytic intelligence and mental operations, stability and reliability of general mental performance under stress conditions, ability to generate strategies of problem solving, the decision processes, aim- focused-motivation and discipline.

Development of the test was made in the Central Medical Psychology Department of the Central Military Hospital Prague. The test followed on the results of individual psychological examinations of person (N =700) that was made by method „Numeric Square“. This method belongs to category of searching tasks.

The method is based on searching for specific signs (numbers). The test is divided in to five sub-tests. Sub-tests 1,3,5 have no time limits: proband searches for the specific sing until he is successful. Sub-tests 2 and 4 evoke the stress situation because they have time limits. The proband have to find a target in certain time and if he is not successful he obtains a new sign. The sub-tests last the same time 6 min., so the whole test takes 35-40min. The CAT system is used to administration and evaluation of the test.

For the collection of research data 2000 in age-homogenic group of men from different military platoons of the Army of Czech Republic were tested. From the military professions were chosen: military drivers, military guards, and soldiers which were applying for participation in missions.

We can mention only some results we discovered by testing.

First at all it was approved that the processes of „Visual Scanning“ were intentionally regulated. It means that simple behavioural explanation of these processes should not be adequate. The solution of „Searching Tasks“ is quite difficult mental activity that cannot be simply described as a human reaction on presented stimuli. For the interpretation of “Visual Scanning” processes have to be used the new knowledge of „Cognitive Psychology“. It was approved again that we could not interpret the parameters of performance during the searching tasks only in relation to the functions of perception and attention. Only the complex cognitive operations and learned intellectual skills are used during the searching for certain objects that are in covered visual field.

During the analysis of time duration of searching for the targets in the structure of the numeral square we found out that the individuals - disregarding their individual differences - had found the target localized in the upper left part side of the square much faster (in shorter time) than the objects situated in opposite part of the square (Fig. 1a). We also found out another even

impactiver fact: the longest time duration took to find numbers that represent the highest values. It means it lasted much longer to find the number that began with 9 than the numbers that began with 1. (Fig. 1b) We explain this fact this way: if a man have to find some objects or symbols in unknown visual field he usually starts to scan the field according to his „Reading Habits“ and along with this he puts the semantic meaning to signs he percepts. We can expect that people regulate their cognitive activities in different occupational or life situations analogously as in „Visual Scanning“. This discovery should be used during the construction and usage of the simulators. On the other side if the person does not search the objects according to some system we can expect that this person has low effective cognitive functions or that he suffers from some neuropsychological disorders.

The main information we acquired from the average number of found targets. These objects were found or were not found in 5 sub-tests (Fig. 2). First and foremost it was approved that if the sub-tests had been repeated the number of found objects had risen up. On the other hand if the period of targets presentation was limited (while the time duration of the sub-test was stable) the number of found objects decreased. These changes were congruous in all tested groups. The differences were only in dimension of discovered changes. Very good results were seen by SFOR soldiers: they found most of the objects when the period of targets presentation was no limited, they have the lowest score in not found objects (in period with limits) and the lowest difference between the individual performance. When the sub-tests were repeated the group of drivers made the best improvement. Group of „Guarding Service“ made the smallest improvement.

The average time that was needed for searching of the objects is another important indicator of changes in cognitive processes „Visual Scanning“ which were tested by this method (Fig. 3). The differences between groups in average time of searching for objects were 15,4%. But if the conditions during the test were changed the differences were 36,0%. We have to emphasize that if the mental load increased the number of found objects was smaller; but on the other hand the speed of searching of the objects was faster. This apparently paradoxical statement proves: in situation with higher mental demands the majority of tested individuals were able to increase their motivation, to make their cognitive processes more effective. It is interesting the SFOR group had the shortest time of finding objects both in the sub-tests without limits and in the sub-test with limits.

Thanks to the computers we could record the times parameter of every single person. That is why we could evaluate the variability of individual time parameter in every sub-test (Fig. 4). This possibility is important because the parameter of the variability of time fluctuation is an objective indicator of the dynamics of psychological (emotional) states. About the sensibility of this method refers the fact the method disclosed the differences of average values of time-parameter between the groups. People from the SFOR group were according to the variability of this indicator on the first place (in the tests without limits) and second (in the tests with limits). It meant that their emotional states was much less variable in comparison to another groups of men. The lowest emotional stability was found by Guarding Service and the Castle Guard manpower. The difference between guard groups and SFOR were 19,7% and 19,1%.

Interpretation and analysis of the test are based on - except of two rough scores - 16 quantitative records (Fig. 5).

From the point of view of the psychological diagnostics of the individual are the differences between groups obviously not so important as the differences between the individuals within one group. The discriminative power of the method we can evaluate according to the range of minimal and maximal values and the size of standard deviation of individual parameters (Fig. 6).

We compared our method with another, in frame of correlation studies. The biggest correlation coefficient was found with tests of intelligence - Raven, WMT and OTIS and with the test of operational memory and attention (TOPP) (Fig. 7). The low correlation was found in questionnaire methods - TCI, SCL, PPP.

The test of cognitive processes in stressful situations we found as a very useful and reliable method; it is sensible for diagnosis and analytic evaluation of effort during the stressful situations of an individual. The test can be used by professionals, who select the soldiers for the military professions. If we compare the results we got from the test with the group of neuropsychological patients we will obtain a new approval of our hypotheses that it is possible to diagnose organic disorders.

Fig. 1a **The sequence of found targets – according to average searching time /</**

N = 2161

	11	22	33	44	55	66	77	88	99	00	
1	20		2	22	19		10	7	24	29	a.
2	8	5	39		31				1		b.
3	9	4							38		
4	6	25							11		
5									33	40	
6	23	16							26		
7	15	3							27		
8	14	37							30	28	
9				17	34	13				21	c.
0		12	36		18	35			32		d.
	i.	j.							y.	z.	

82

The sequence of numerical symbols according to the ordinal numbers of the found targets (see above)

averages in rows: a.=16,6 b.=16,8 c.=21,3 d.=26,6
averages in columns: i.=13,6 j.=14,6 y.=24,7 z.=29,5

Fig. 1b **The sequence of found targets – according to average searching time**

average target searching time	sequence according average time	numerical symbols found
7,54	1	16
7,56	2	37
8,33	3	34
8,74	4	44
8,92	5	27
9,09	6	62
9,57	7	63
9,60	8	80
9,62	9	12
9,64	10	42
9,99	11	33
10,14	12	41
10,15	13	40
10,37	14	45
10,48	15	75
10,53	16	90
10,74	17	19
11,01	18	89
11,74	19	29
12,48	20	91
12,50	21	86
12,75	22	72
12,79	23	56
13,07	24	22
13,25	25	98
13,55	26	43
13,87	27	85
14,32	28	23
14,52	29	18
14,66	30	87
14,65	31	76
14,85	32	54
15,22	33	51
16,39	34	64
16,89	35	96
17,35	36	92
17,46	37	94
17,52	38	93
17,78	39	97
18,60	40	95

Fig.2 **Number of found and not-found targets**

Groups (N)		Parameters signs (see "Abbreviations) DG 1	DG 2	DG 3	DG %	DG 4	DG 7		
1.	Castle Guard N = 391	**M** **s**	27,51 6,59	25,09 7,84	2,79 3,88	10,14	4,17 5,57	21,50 7,90
2.	Guarding duty N = 533	**M** **s**	27,75 6,22	25,78 7,76	2,29 4,32	8,25	3,57 5,28	20,81 7,92
3.	SFOR N = 174	**M** **s**	30,89 5,51	27,99 6,72	3,22 3,78	10,42	4,17 6,02	19,29 6,90
4.	Drivers (conscripts) N = 789	**M** **s**	28,16 5,67	25,73 6,85	2,73 4,13	9,69	4,48 5,28	20,87 7,05
5.	Drivers N = 92	**M** **s**	28,02 5,99	25,23 7,34	3,09 3,60	11,03	3,89 3,60	22,67 8,22
6.	Other bodies A = 176	**M** **s**	30,96 6,12	29,24 7,49	1,98 4,28	6,40	4,25 5,04	17,39 7,18

Abbreviations:

DG 1 : number of found targets in sub-tests WITHOUT limits
DG 2 : number of found targets in sub-tests WITH limits
DG 3 : sumarization of individual changes: DG 1 minus DG 2
DG % : percentual formularization of changes DG 3 (100%=DG 1)
DG 4 : difference in number of targets found in V. sub-test minus I. sub-test
DG 7 : number of not-found targets in sub-tests WITH limits
N : number of people in groups; M : average values
s : standard deviations

Fig. 3 **Times of target searching**

Groups (N)	Parameters signs (see. "Abbreviations)		DG 8	DG 9	DG 10	DG %
1.	Castle Guard A = 391	**M** **s**	133,8 32,0	85,7 12,0	48,0 27,0	35,95
2.	Guarding duty A = 533	**M** **s**	132,3 33,8	85,8 11,1	46,5 29,3	35,15
3.	SFOR A = 174	**M** **s**	118,4 21,0	82,7 7,3	35,6 18,3	30,07
4.	Drivers (conscripts) A = 789	**M** **s**	130,1 27,4	84,3 8,3	45,8 24,5	35,20
5.	Drivers A = 92	**M** **s**	131,8 29,6	84,3 7,1	47,5 21,1	36,04
6.	Other bodies A = 176	**M** **s**	117,9 23,3	83,8 10,4	34,1 20,3	28,92

Abbreviations:

DG 8 : target searching times in sub-tests WITHOUT limits
DG 9 : target searching times in sub-tests WITH limits
DG10 : sumarization of individual changes: DG 8 minus DG 9
DG % : percentual formularization of changes DG10 (100%=DG 8)
N : number of individuals in groups; M : average values
s : standard deviations

Fig. 4 **Variability of searching times**

			DG 11	DG 12
1.	Castle Guard	**M**	66,6	26,0
		s	22,0	9,9
2.	Guarding duty	**M**	66,9	26,5
		s	24,5	8,0
3.	SFOR	**M**	55,9	24,7
		s	15,2	4,6
4.	Drivers (conscripts)	**M**	65,3	25,4
		s	20,9	5,1
5.	Drivers (other)	**M**	64,0	24,3
		s	21,0	4,0
6.	Other bodies	**M**	56,5	25,8
		s	18,0	6,6

Abbreviations:

DG11 : variability of times in sub-tests WITHOUT limits
DG12 : variability of times in sub-tests WITH limits
M : average values
s : standard deviations

Fig. 5 **Kvantitative results of individual assessment by T Z D K O method**

selection of 16 indicators

1 DG 1 - number of found targets in sub-tests WITHOUT limits
2 DG 2 - number of found targets in sub-tests WITH limits
3 DG 3 - sumarization of individual changes: DG 1 minus DG 2
4 DG 4 - difference of occurrences in two sub-tests V-I
5 DG 5 - total number of faults in sub-tests WITHOUT limits
6 DG 6 - total number of faults in sub-tests WITH limits
7 DG 7 - number of not-found targets in both sub-tests WITH limits
8 DG 8 - average target searching time in sub-tests WITHOUT limits
9 DG 9 - average target searching time in sub-tests WITH limits
10 DG10 – difference of average times DG8-DG9
11 DG11 – average variability of times in sub-tests WITHOUT limits
12 DG12 - average variability of times in sub-tests WITH limits
13 DG13-1-difference in target occurrences in sub-tests II-IV
14 DG16-1-difference in average searching times in sub-tests II-IV
15 DG17-1-difference in variability of times in sub-tests II-IV
16 DG30 – listing of self-evaluation

Fig. 6 **Descriptive statistics of the whole sample**

N = 2155

	Mean	Median	Std. Deviation	Minimum	Maximum
DG 1	28,3290	28	6,1424	10	54
DG 2	25,9736	25	7,5489	7	57
DG 3	2,6701	3	3,8147	-10	21
DG 4	4,1032	4	5,3475	-13	26
DG 5	0,5243	0	1,6668	0	61
DG 6	0,5201	0	1,2151	0	41
DG 7	20,8047	20	7,7748	1	54
DG 8	1297,79	1249	301,3896	662	4696
DG 9	846,5030	837	98,2548	559	2201
DG10	450,4529	402	260,8397	-58	3742
DG11	646,0153	606	219,3965	237	2746
DG12	256,4789	247	69,5300	127	1765
DG131	-2,1911	-2	5,6611	-22	17
DG161	73,9972	65	125,3925	-566	1877
DG171	26,3380	13	120,3329	-755	2298

Fig. 7 **Some correlations of T Z D K O method**

N = 2155

	TOPP	VMT	OTIS	RAVEN
TZDKO – occurrences of found targets **SUB-TEST I**	0,48	0,30	0,29	0,34
SUB-TEST II	0,46	0,21	0,27	0,38
SUB-TEST III	0,46	0,27	0,25	0,38
SUB-TEST IV	0,48	0,24	0,23	0,25
SUB-TEST V	0,46	0,26	0,17	0,32
DG 11	-0,45	-	-	-
DG 12	-0,048	-	-	-
DG 7	-0,46	-	-	-

Abbreviations:

DG 11: variability of times in sub-tests WITHOUT limits
DG 12: variability of times in sub-tests WITH limits
DG 7: total number of not-found targets in both sub-tests