Ideo-Dynamic Diagnostic Expert Systems

The Self-evaluation of Own Mental Resources

E.V. Volkova[1(✉)], V.M. Rusalov[1], and M.N. Nilopets[2]

[1] Institute of Psychology, Russian Academy of Sciences, Moscow, Russia
volkovaev@mail.ru, roussa@rambler.ru
[2] Moscow Medical Center of Information Technologies, Moscow, Russia
nilmiknik@mail.ru

Abstract. The purpose of this paper is to describe the expert systems of mental resources assessment using different methods of self-evaluation of hierarchical structure of individuality such as nomothetic, ideographic, and ideo-dynamic diagnostics. These expert systems were designed on the basis of INT-Test Design Software. The nomothetic method requires a big sample of participants and permits us to obtain only an averaged, statistical pattern but not a structure of individual mental resources of a person. The ideographic method is a study of a single person, in our case it is a modification of the nomothetic method due to the extension of a rank scale by including additional qualitative estimates (an opened scale method). The ideo-dynamic method describes an internal organization of mental resources of a single person by pairwise comparison procedure. The data obtained on the same person in different expert systems of individual mental resources assessment revealed the highest level of test-retest reliability for the ideo-dynamic method. The lowest level was for the nomothetic method.

Keywords: Nomothetic Diagnostics Expert Systems · Ideographic Diagnostics Expert Systems · Ideo-dynamic diagnostics expert systems · Human mental resources · Self-evaluation

1 Introduction

Evaluation and development of human mental resources is a priority problem of the contemporary society, because it has a direct relation to the problem of improving the quality of human life.

There are so many new computerized test batteries [1, 5, 8, 9, 14, 15, 19, 25] that may be suitable for assessing individual mental resources, a complete review of which would occupy the whole volume of the paper (MicroCog [16, 22], MindStreams [10, 11], CogScreen [1, 3], MMPI [12–14], et al.).

The study was supported by RSF Grant (project №. 14-28-00087), Institute of Psychology RAS.

Y. Bi et al. (eds.), *Proceedings of SAI Intelligent Systems Conference (IntelliSys) 2016*, Lecture Notes in Networks and Systems 15, DOI 10.1007/978-3-319-56994-9_6

For instance, CogScreen is an instrument that could detect subtle changes in cognitive function of pilot in critical flight situations. This expert system compares a pilot report with norm-based reports [1, 3].

The "MindStreams" is a well-known "Advanced Cognitive Health Assessment" battery that compares the test scores of a person (memory, executive function, visual spatial and verbal function, attention, information-processing speed, and motor skills) within a certain normative database (age and education) [10, 11].

In order to obtain comprehensive and multidimensional assessment of human mental resources, it is necessary to use a variety of objective personality tests (based on both self-report and informant ratings), projective and implicit tests, and behavioral/performance measures. As Cattell showed convincingly, we should identify personality traits through multiple measurement media including subjective ratings or life-record data (L-Data), subjective self-report questionnaire data (Q-data), and objective test data (T-data). The choice of specific media of measurement has critically important implications for psychometric properties such as reliability and validity [6, 7].

Although there are methods, including objective test (T-data) measures of mental resources, self-report techniques remain the dominant form of personality assessment, whether administered on a computer screen or scored online [4, 15]. Their economy, ease of use, and interpretation provide advantages that often outweigh benefits of other approaches to individual mental resources assessment.

The purpose of the present paper is to compare the test-retest reliability of three Expert Systems (nomothetic, ideographic, and ideo-dynamic) of self-evaluation of hierarchical structure of human mental resources on the same sample of participants using original software.

Nomothetic Diagnostics Expert Systems (NDES) derives from the assumption that the causal assertions, formulated on the basis of a thorough study of one group (population) of subjects, can be applied to other populations. The single individual is viewed as a totality of fixed situation-independent attributes. The assessment of mental resources is based on statistical tools – the normal distribution. Instead of describing the ways, in which a person achieves success in its true sense, mental resources are reduced to a single dimension, on which individuals are arranged according to their outcome in a series of comparisons. The set of inter-individual differences determines thus the level of mental resources ascribed to the individual. Prediction of the success of a person is realized on the basis of probabilistic explanation of mental phenomena.

A person is always a unique case and the knowledge of general laws of a reference group can be rendered useless when trying to forecast the behavior of a single individual. Allport pointed out justifiably, when working in the clinic with a person, the knowledge of human nature in general or information on norms group is virtually useless, and often harmful [2]. Groups may differ in social status, education level, ethnicity, gender, age and other characteristics. Therefore, the test results may vary. Thus, when using NDES for diagnosing mental human resources, we obtain a measure of correspondence of the individual's mental resources with the averaged parameters of the reference group, rather than the structure of the mental resources of the individual as a unique subject.

Another disadvantage of the NDES is measurement errors caused by individual's social desirability. Answering the items of a test or a questionnaire, a person inevitably

compares himself/herself with other members of their reference group and, as a rule, gives socially desirable answers.

Ideographic Diagnostics Expert Systems (IDES) differs fundamentally from the NDES, because there is no need for a sample. This IDES does not require mean characteristics of the group, correlations, factors, etc. The IDES allows us to obtain the data on the uniqueness of a person. In our case, it is a modification of the nomothetic method due to the extension of a rank scale by including additional qualitative estimates (an opened scale method).

The Ideo-Dynamic Diagnostics Expert System (IDDES) is based on the Rosenzweig concept [23] of a stable internal implicit ideo-dynamic structure of psychological features in human mind. This method is a modification of our ideographic method where only one person is under study and the scale is a consequence of qualitative pairwise comparisons of certain characteristics of mental resources. On the one hand, the IDDES has signs of the IDES allowing us to examine the uniqueness of a person, his/her individual mental resources. On the other hand, it keeps the requirements of data reliability and validity, inherent in the standard statistical systems for big populations.

2 The Components of Diagnostics Expert Systems

2.1 Knowledge Base

The term "resources" is interpreted differently in various fields of science and practice. Therefore, before comparing NDES, IDES, and IDDES in terms of evaluation of individual mental resources, we shall define our understanding of this concept.

The general interpretation of the concept "resources" is a quantitative measure of the possibilities of performing any activities; it is a set of conditions which allow us to get the desired result through certain transformations.

Mental resources are mental constructs ensuring the positive development of a person. The most important function of mental resources is to regulate human behavior and activities aimed at achieving a success in a challenge situation. A high level of mental resources allows a person to reach outstanding achievements, to successfully cope with the life's demands and with a large variety of stresses, to get life satisfaction.

We consider human mental resources as phenomenon of mental experience. "Mental resources" can be described as a set of the following attributes:

(a) substantive characteristics of individuality;
(b) stability of their manifestations;
(c) regulation of the individual's activity;
(d) connection with efficiency of activity in challenge situations;
(e) connection with a particular situation and a specific task;
(f) representation in the individual's mental experience.

The system of mental resources has a hierarchical structure with various functions, such as corporal (body image of Me), emotional, motivational, volitional, intellectual, communicative, axiological (including esthetic and spiritual abilities). Individual

mental resources have different levels of organization from temperament, personality traits, intelligence, and creativity to higher spiritual attributes.

It should be noted that not all characteristics of individuality belong to mental resources but only those which are useful for mobilizing his/her activity aimed at achieving a success in challenge situations.

The conceptualization process plays the most important role in the system of individual mental resources by providing analysis of a situation, its explanation and interpretation. Through the conceptualization process, a person allocates resource value to his/her characteristics of individuality for achieving of certain (positive) results [17, 18, 24].

Based on the analysis of published data and the results of our own empirical research [17, 18, 24] the following model of human mental resources can be suggested. This model implies involvement of properties of a lower level into a higher-level property (Fig. 1).

Fifth level	Conceptualization
Fourthlevel	Values of life, motivation, higher spiritual needs
Third level	Intelligence, creativity, abilities, cognitive styles
Second level	Personality traits
First level	Temperament

Fig. 1. Implicative model of human mental resources

Every person has both explicit, publicly declared mental resources and vaguely or poorly perceived implicit mental resources. We believe that the implicit characteristics of mental properties are more stable than the explicit characteristics. The explicit characteristics vary widely, by "adjusting" to socially desirable behavior accepted in a social group. The implicit properties (as opposed to the explicit ones) represent the functioning of the deeper layers of the individual mental experience, including pre-speech and even pre-language level [20, 21].

2.2 Interface Engine and User Interface

The IDDES of human mental resources was developed based on INT-test Design Software that in details was described in our previous paper [26].

The IDDES software works on IBM-compatible computers running operating systems Windows XP 7, 8. The program code was made in a MS Visual Studio 2010 using VB.NET and C# programming languages, drawing on the Net Framework 3.5.

To evaluate the structure of the individual mental resources, the "method of paired comparisons" was used in conjunction with the registration of a complex choice reaction time. It enables us to reduce measurement errors caused by social desirability responses because the person under study focuses on analysis of his/her own inner mental world. Before performing the task, the list of items and their explanation was presented.

The computer screen randomly displays the pairs of psychological properties. A person should as quickly as possible choose one psychological trait of the two presented that is more expressed in him/her mental world (values, personality traits, abilities, character, temperament, etc.). A shorter choice reaction time shows, in our opinion, a quicker and more confident processing of information in the mind of the subject, which allowed us to ascribe to this property to a higher rank.

For example, the test participant is to choose which life value for him is more important now: his/her family or health? Or what does he dislike in other people more: laziness or greed?

One pair is followed by another, and so on, until the entire list is exhausted, and each property is compared with any other. As a result of pairwise comparisons, the computer program creates a hierarchy of properties for each level of individuality, starting from temperament to the highest spiritual needs.

The sets of mental properties can be voluntarily changed depending on the goal of research. Empirically, it was revealed that a list of mental properties should contain, as a rule, no more than 20 items for a separate level of individuality. The matter is that an increase in the number of items in the matrix increases considerably a total number of paired comparisons. If the number of items 20, then a person has to choose 190 times which takes about 10 min. Before performing the task, the list of items was presented and the meaning of each item was explained [24].

3 The Results of Test-Retest Reliability

To compare the test-retest reliability of three Expert Systems (nomothetic, ideographic, and ideo-dynamic) of self-evaluation of hierarchical structure of human mental resources, test-retest studies were carried out within an interval of 2–3 weeks.

The stability of the hierarchical structure of mental abilities was tested on 21 persons. The stability of life values was evaluated on 19 persons. The stability of other properties of mental resources (personality traits, moral attitudes, temperament, character, etc.) was measured on 17 persons.

The number of the subjects who took part in test-retest studies was limited since different subjects demonstrated similar results stability of mental resources structure.

In this paper, the stability of mental resources structure was presented, as an example, only for one the same person using different expert systems. Participant was Slava, 35 years of age, male, student of psychology, evening second education.

3.1 The Nomothetic Diagnostics Expert Systems of Mental Resources Assessment (Self-evaluation of Hierarchical Structure of Abilities)

The results presented in Tables 1 and 2 showed that the ranks of the first and second studies of abilities differed significantly.

The instruction was the same for both studies. The subject was to self-evaluate his own abilities by five-point Likert scale.

Coefficient of test-retest rank correlation was 0.46.

Table 1. Hierarchical structure of abilities in test study (NDES)

A list of abilities	Slava_February 4, 2015		
	Rank	Score	Complex choice reaction time (ms)
Curiosity	1	5	1547
Verbal	2	4	1110
Attentiveness	3	4	1188
Intellectual	4	4	1343
Erudition	5	4	1672
Coordination of movements	6	4	1891
Communicative	7	4	1984
Literary	8	4	2250
Natural-science	9	3	1219
Memory	10	3	1265
Organizational	11	3	1281
Pedagogical	12	3	1687
Artistic	13	3	2187
Mathematical	14	3	2812
Foreign languages	15	2	1500
Entrepreneurial	16	2	1437
Engineering	17	2	1344
Design	18	2	1313
Sports	19	2	1266
Musical	20	1	2079

Table 2. Hierarchical structure of abilities in retest study (NDES)

A list of abilities	Slava_February 24, 2015		
	Rank	Score	Complex choice reaction time (ms)
Pedagogical	1	4	2094
Natural-science	2	3	1593
Attentiveness	3	3	1766
Memory	4	3	1828
Entrepreneurial	5	3	1859
Erudition	6	3	1860
Communicative	7	3	1969
Intellectual	8	3	2125
Literary	9	3	2266
Curiosity	10	3	3719
Coordination of movements	11	2	2281
Organizational	12	2	2015
Foreign languages	13	2	1969

(*continued*)

Table 2. (*continued*)

A list of abilities	Slava_February 24, 2015		
	Rank	Score	Complex choice reaction time (ms)
Design	14	2	1609
Artistic	15	2	1563
Mathematical	16	2	1250
Verbal	17	1	2984
Musical	18	1	2219
Sports	19	1	1922
Engineering	20	1	1156

3.2 The Ideographic Diagnostics Expert Systems of Mental Resources Assessment (Self-evaluation of Hierarchical Structure of Abilities)

The data obtained showed (Tables 3 and 4) that the hierarchical structure of abilities differed only slightly in retesting.

Table 3. Hierarchical structure of abilities in test study (IDES)

A list of abilities	Slava_March 20, 2015		
	Rank	Score	Complex choice reaction time (ms)
Curiosity	1	5*	3063
Intellectual	2	5	2203
Communicative	3	5	2328
Pedagogical	4	5	5171
Attentiveness	5	4	1750
Memory	6	4	1781
Literary	7	4	1954
Erudition	8	4	1984
Entrepreneurial	9	4	3219
Natural-science	10	3	5297
Coordination of movements	11	3	2172
Design	12	2	3218
Artistic	13	2	2969
Organizational	14	2	2891
Sports	15	2	2813
Foreign languages	16	2	2375
Verbal	17	2	2125
Mathematical	18	2	1828
Musical	19	1	1938
Engineering	20	1	1890

Table 4. Hierarchical structure of abilities in retest study (IDES)

A list of abilities	Slava_April 24, 2015		
	Rank	Score	Complex choice reaction time (ms)
Curiosity	1	5**	4562
Pedagogical	2	5*	2312
Verbal	3	5*	5141
Attentiveness	4	5	2062
Intellectual	5	5	2281
Literary	6	4	1594
Memory	7	4	2547
Organizational	8	3	1297
Entrepreneurial	9	3	1687
Design	10	3	1703
Erudition	11	3	2250
Foreign languages	12	3	2266
Coordination of movements	13	3	3438
Artistic	14	3	5500
Communicative	15	3	5516
Natural-science	16	2	3594
Sports	17	2	1813
Mathematical	18	2	1453
Musical	19	1	1968
Engineering	20	1	1469

The instruction in this case was the following: The subject was to self-evaluate his own abilities by five-point Likert scale modified by including two additional qualitative values (an opened scale method). One asterisk* meant extra expressed. Two asterisk** meant extremely expressed.

Coefficient of test-retest rank correlation was 0.65. As is seen from the Tables 3 and 4, the reliability of self-evaluation changed, but the hierarchical structure of abilities remained rather stable.

3.3 The Ideo-Dynamic Diagnostics Expert Systems of Mental Resources Assessment (Self-evaluation of Hierarchical Structure of Abilities)

The data obtained on the same person in IDDES of self-evaluation of abilities revealed the highest level of test-retest reliability. The instruction was as follows: compare two abilities and choose which one of them is greater expressed. Each ability was compared with all others by pairwise comparison procedure (ipsative method).

Coefficient of test-retest reliability was 0.89. The stability of hierarchical structure of abilities was the highest in this case (Tables 5 and 6).

Table 5. Hierarchical structure of abilities in test study (IDDES)

A list of ability	Slava_May 15, 2015		
	Rank	Score	Complex choice reaction time (ms)
Intellectual	1	17	1628
Verbal	2	16	1277
Curiosity	3	16	1532
Memory	4	15	1518
Erudition	5	14	1336
Pedagogical	6	13	1756
Literary	7	13	1827
Attentiveness	8	11	1794
Entrepreneurial	9	11	1952
Communicative	10	11	2068
Natural-science	11	10	1547
Artistic	12	8	1346
Coordination of movements	13	8	1656
Design	14	8	2066
Organizational	15	7	1837
Mathematical	16	3	1281
Sports	17	3	1526
Foreign languages	18	3	1771
Musical	19	2	1696
Engineering	20	1	969

Table 6. Hierarchical structure of abilities in test study (IDDES)

A list of ability	Slava_May 15, 2015		
	Rank	Score	Complex choice reaction time (ms)
Curiosity	1	17	1857
Intellectual	2	16	1792
Erudition	3	16	2062
Pedagogical	4	15	1534
Memory	5	15	1656
Verbal	6	15	1746
Literary	7	13	1673
Artistic	8	12	1546
Natural-science	9	12	2133
Attentiveness	10	11	1648
Communicative	11	10	1925
Entrepreneurial	12	8	2037
Organizational	13	7	2178
Coordination of movements	14	6	2195

(*continued*)

Table 6. (*continued*)

A list of ability	Slava_May 15, 2015		
	Rank	Score	Complex choice reaction time (ms)
Design	15	5	1803
Foreign languages	16	5	1978
Mathematical	17	3	3229
Engineering	18	2	1867
Sports	19	2	2813
Musical	20	0	0

4 Conclusion

The results of comparing the Expert Systems of self-evaluation of hierarchical structure of human mental resources on the same participants revealed the highest level of test-retest reliability for IDDES. High rates of stability (from 0.75 to 0.92) were obtained in all cases for all psychological properties. IDDES gives us the opportunity to explore the unique structure of mental resources of a person, but not group distinctions.

Based on the data obtained, the original consulting and stuff recruiting system can be offered. This new local staff recruiting procedure comprises comparison of psychological properties of candidates with psychological properties of a real person (professional) who reached the heights in his/her professional development (standard of professional activity).

Consider the particular case of nanny selection. A successful nanny was chosen by experts. It was a 46-year-old woman, who for many years successfully cared for children. Her psychological characteristics (mental resources such as temperament, character, abilities, personality traits, values and moral attitudes) were measured by ADDES.

This psychological pattern of this woman served as a standard for choosing future nannies. This staff recruiting procedure proved to be rather successful in nanny selection.

References

1. Kennedy, C.H., Kay, G.G. (eds.): Aeromedical Psychology. Ashgate, Aldershot (2013)
2. Allport, G.W.: Becoming: Basic Considerations for a Psychology of Personality. Yale University Press, New Haven (1955)
3. Jones, D.R.: Aerospace psychiatry. In: Davis, J.R., Johnson, R., Stepanek, J., Fogarty, J.A. (eds.) Fundamentals of Aerospace Medicine., 4th edn, pp. 406–424. Lippincott Williams & Wilkins, Philadelphia (2008). Aviation-related psychological evaluations
4. Boyle, G.J., Helmes, E.: Methods of personality assessment. Humanities & Social Sciences papers. Paper 327 (2009). http://epublications.bond.edu.au/hss_pubs/327

5. Butcher, J.: Computerized personality assessment. In: Graham, J., Naglieri, J., Weiner, I. (eds.) Handbook of Psychology. Assessment Psychology, vol. 10, pp. 165–191. Wiley, Hoboken (2013)
6. Cattell, R.B.: General principles across the media of assessment. In: Cattell, R.B., Johnson, R.C. (eds.) Functional Psychological Testing: Principles and Instruments, pp. 15–32. Brunner/Mazel, New York (1986)
7. Cattell, R.B.: The psychometric properties of tests: consistency, validity, and efficiency. In: Cattell, R.B., Johnson, R.C. (eds.) Functional Psychological Testing: Principles and Instruments, pp. 54–78. Brunner/Mazel, New York (1986)
8. Crook, T.H., Kay, G.G., Larrabee, G.J.: Computer-based cognitive testing. Methods of Comprehensive Neuropsychological Assessment, pp. 1–16 (2008)
9. Crook, T.H., Kay, G.G., Larrabee, G.J.: Computer-based cognitive testing. In: Igor, G., Kenneth, M.A. (eds.) Neuropsychological Assessment of Neuropsychiatric and Neuromedical Disorders, 3rd edn., pp. 84–100. Oxford University Press, Oxford (2009)
10. Doniger, G.M., Simon, E.S.: Construct Validity of Mindstreams Comparison with Paper-Based Tests. Internal Document. NeuroTrax Corporation, New York (2006)
11. Doniger, G.M., Okun, M.S., Simon, E.S., Rodrigues, R.L., Jacobson, C.E., Weiss, D., et al.: Validization of a computerized neuropsychological assessment (Mindstreams) in movement disorders: interin analysis. In: 20th Annual Symposia of the Etiology, Pathogenesis, and Treatment of Parkinson's Disease and Other Movement Disorders, Chicago (2006)
12. Forbey, J., Ben-Porath, Y.: Computerized adaptive personality testing: a review and illustration with the MMPI-2 computerized adaptive version. Psychol. Assess. **19**(1), 14–24 (2007)
13. Forbey, J., Ben-Porath, Y., Gartland, D.: Validation of the MMPI-2 computerized adaptive version (MMPI-2-CA) in a correctional intake facility. Psychol. Serv. **6**(4), 279–292 (2009)
14. Friedman, A.F., Bolinskey, P.K., Levak, R.W., Nichols, D.S.: Psychological Assessment with the MMPI-2/MMPI-2-RF, 3rd edn. Routledge T&F Group, New York (2015)
15. Groth-Marnat, G.: Handbook of Psychological Assessment. Wiley, New York (2009)
16. Helmes, E., Miller, M.: A comparison of MicroCog and Wechsler Memory Scale in older adults. Appl. Neuropsychol. **13**, 28–33 (2006). (3rd edn.)
17. Kholodnaya, M.A.: Intelligence, creativity, learning capability: resource approach (on development of V.N. Druzhinin's ideas). Psychol. J. **36**(5), 5–14 (2015)
18. Kholodnaya, M.A., Volkova, E.V.: Conceptual structures, conceptual abilities and productivity of cognitive functioning: the ontological approach. Proc. Soc. Behav. Sci. **217**, 914–922 (2016)
19. Luxton, D.D., Larry, D., Pruitt, L.D., Osenbach, J.E.: Best practices for remote psychological assessment via telehealth technologies. Prof. Psychol. Res. Pract. **45**(1), 27–35 (2014)
20. Mathews, R.C.: Abstrctness of grammar knowledge: Comments on Perruchet and Pacteau's analysis of synthetic grammar learning. J. Exp. Psychol. **119**(4), 412–416 (1990)
21. Neal, A., Hesketh, B.: Future directions for implicit learning: Toward a classification of issues associated with knowledge representation and consciousness. Psychon. Bull. Rev. **4** (1), 73–78 (1997)
22. Raymond, P., Hinton-Bayre, A., Radel, M., Ray, M., Marsh, N.: Test-rest norms and reliable change indices for MicroCog battery in a healthy community population over 50 years of age. Clin. Neuropsychol. **20**, 261–270 (2006)
23. Rozenzweig, S.: The place of the individual and of idiodynamics in psychology. J. Ind. Psychol. **14**, 3–12 (1958)

24. Rusalov, V.M.: Temperament in the Structure of Human Individuality. Publishing House of the Institute of Psychology Russian Academy of Sciences, Moscow (2012)
25. Schroeders, U., Wilhelm, O.: Computer usage questionnaire: structure, correlates, and gender differences. Comput. Hum. Behav. **27**, 899–904 (2011)
26. Volkova, E.V., Nilopets, M.N.: Flexible and extended IWS (item writing system) as a part of INT-Test design software. In: Proceedings of the Science and Information Conference 2015, London, pp. 781–785 (2015)