

An Expert System for Evaluation of Human Mental Resources: Holistic and Developmental Approach

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Abstract—The main disadvantage of expert systems for evaluation of human mental resources is that they measure mainly partial characteristics of individuality ignoring the holistic nature of a personality. Attempts to implement a comprehensive assessment of a person as a rule lead to the elaboration of time-consuming battery of tests. In this paper we investigated the possibilities of a Holistic and Developmental Expert System (HDES) for time-saving evaluation of human mental resources. The HDES is developed on the basis of INT-Test Design Software. As distinct from other expert systems, the proposed system allows to realize holistic (all the set of behavior characteristics) and developmental approach (from 15 to 70 years of age) to the assessment of human potential. Based on comparative analyses of existing expert systems as well as theoretical and statistical analyses, we selected only those indicators which enable us quickly and efficiently to measure human mental resources of different levels: from temperament to motivation. The given multi-purpose expert system assesses 43 selected indexes of individual behavior. The preliminary results show that all the scales possess a high level of reliability and validity.

Keywords—Expert systems for evaluation of human mental resources; human mental resources; self-evaluation; holistic and developmental approach

I. INTRODUCTION

The progress of modern human society considerably depends on mental resources of each man. Mental resources are mental formations ensuring the positive development of a person. The main function of mental resources consists in regulation of 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 overcome a large variety of stresses, to get life satisfaction. It must be emphasized that not all features of individuality belong to mental resources but only those which a person recognizes as useful for mobilizing his/her activity aimed at achieving a success in challenge situations [17].

For obtaining comprehensive and multi-dimensional assessment of human mental resources a large variety of behavioral/performance measures (paper-and-pencil as well as computerized) are usually used.

A brief review shows that there are many computerized test batteries which may be suitable for assessing individual mental

resources. However, it must be noted that existing methods enable us to solve the problem only partially. Some computerized test batteries assess only personality traits [1, 2, 3, 11, 12], while the others evaluate cognitive functions [5, 6, 8, 18], and the others estimate the skills required to work in a specific field of activity [4, 13].

For instance, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) detects pathological personality traits (negative affectivity, detachment, antagonism, disinhibition, psychoticism) [1].

The Advanced Multi-dimensional Personality Matrix – Big 5 Personality Test (AMPM – R3) evaluates only some personality traits, such as Emotional Stability, Extroversion, Openness, Agreeableness, and Conscientiousness [2].

The Minnesota Multiphasic Personality Inventory (MMPI) is designed to assess major patterns of personality and emotional disorders [3].

The Advanced Cognitive Health Assessment Battery (MindStreams) measures only cognitive level of mental resources: memory, executive functions, visual spatial and verbal functions, attention, information-processing speed, and motor skills [5, 6].

The Multi-dimensional Intelligence Test (MIT) assesses several aspects of intelligence: logical reasoning, math skills, language abilities, spatial relations skills, knowledge, and the ability to solve novel problems [8].

Test of the Multi-dimensional Emotional Intelligence Quotient (MEIQ-R7) assesses the ability to understand sentiments in oneself and to handle one's feelings in a productive manner, as well as the ability to understand what it takes to motivate others [7].

Some expert systems such as Customer Service Profile (CSP) and Salesperson Personality Profile (SPPP) revealed whether a test-taker's skills and personality traits are suitable for work in the Customer Service field [4, 13]. The list goes on.

The main disadvantage of cited above computerized test batteries is that they measure partial characteristics of individuality ignoring the holistic nature of a personality.

Another drawback is the existing expert systems are considered only to be a means of diagnosis, but not a means of growth and self-development of individual mental resources.

Moreover, the process of testing is usually time-consuming, which leads to distorted results.

That is why the development of a new computerized holistic developmental expert system is an urgent task. The object of our work is to develop the such an expert system.

A. Knowledge Base

Mental resources determine not only the well-being and person's health, but also high achievements and a high level of adaptation to different environments. They cover all the levels of human. Depending on the context, some individual characteristics can favor the efficiency, whereas other personal peculiarities can block or decrease the performance. The ignoring of any level can lead to incomplete, distorted or incorrect results. Such results don't permit a person to analyze one's individual mental resources and to reorganize internal resources in accordance with life requirements.

To develop time-saving diagnostic expert system we should select the most informative indicator underlying of individual differences.

A set of individual mental resources is not formed by chance. It is not a conglomeration of separate characteristics (split approach). The emergence of mental resources is caused by the mutual influence of heredity and environment, and are considered a synergy or compensation of genetically determined properties (holistic approach).

As was established, there are certain complexes of mental resources which are united by common mental mechanisms. Each complex has its own behavioral manifestations [14, 16].

For instance, the individuals with pronounced extraverted complex (extraversion, field dependence and impulsivity) are sociable. They quickly and recklessly put forward a great number of often-false hypotheses and perform erroneous actions. They trust external impressions rather than internal ones in their individual behavior [16].

The persons with more expressed psychotic complex (psychoticism, field independence, and wide range of equivalence) more aggressive, more prone to manipulation, rely mainly on their own experience, ignoring the other people's opinion [16].

Individuals with more represented neurotic complex (neuroticism and intolerance of unrealistic experience) are characterized by emotional instability and low self-esteem. They prefer to perceive current events mainly as the expected and the usual [16].

Based on the analysis of scientific literature and our own experimental data we have chosen 43 indicators [9, 14, 16, 17 et al.]. We have selected only those indicators that reflect the most significant characteristics of implicative model of mental resources [17].

As is known, the basis of this model is the temperament, which is neurophysiological foundation of human mind and behavior. Temperament is presented by the following indices: ergonicity, tempo, plasticity, emotionality, and activity in motor, intellectual or social sphere of activity; general activity, and adaptability [9].

Fundamental personality dimensions also having a considerable genetic component include extraversion/introversion, neuroticism/emotional stability, psychoticism/soft-heartedness [16].

Character covered hyperthymicity, stuckness, emotivity, pedanticity, anxiety, cyclothymicity, demonstrativeness, excitability, dystimicity, and exaltiveness [10].

Present cognitive styles as basic ways of mental information processing are: field dependence, field independence, narrow range of equivalence, wide range of equivalence, flexibility of cognitive control, rigidity of cognitive control, impulsivity, reflectivity, concrete conceptualization, abstract conceptualization, tolerance of unrealistic experience, and intolerance of unrealistic experience [16].

Intelligence (IQ level) was measured with speed and precision of simple logical problems.

Motivation was assessed by achievement motivation indicator, accessibility motivation (orientation to accessibility of professional activity), and value motivation (orientation to personal value of professional activity).

Thus, the total list for statistical treatments includes 43 indexes: 14 temperamental characteristics, 10 character traits, 3 personality dimensions, 12 cognitive styles, IQ-level, and 3 motivation indicators.

B. Interface Engine and User Interface

The Holistic and Developmental Expert System (HDES) is designed for express-estimation of individual mental resources of different levels of organization: from temperament, personality dimensions, character traits, cognitive styles, intelligence to motivation.

The purpose of HDES is to increase the productivity of human mental resources by self-analysis, awareness of one's own psychological traits as a useful tool for achieving of certain (positive) results, and awakening of needs in self-acceptance and self-development.

Question type of the test battery is self-evaluation of mental resources on five-point Likert scale. Among psychological methods self-report techniques remain a dominant means of personality assessment due to their economy, ease of use, and interpretation. To reduce measurement errors caused by social desirability, self-report techniques were used in conjunction with the registration of a complex choice reaction time.

Estimated completion time for express-evaluation of human mental resources is 30 minutes.

The HDES is useful for professional psychological express-estimation of basic human mental resources, personnel administration, matching of the educational technology, expertise and monitoring of the education process and professional activity, as well as the gathering of psychological data.

The proposed expert system (HDES) has already received Official registration certificate for computer programs No 2016618632 "Diagnostic complex express-evaluation of

individual mental resources”, dated 08.08.2016, Russian Federation. We used in the development of the Holistic and Developmental Expert System the works protected by copyright such as MSSQL Express, MS Chart, and INT-test Design Software. The INT-test Design Software was in details described in our previous paper [15].

Functionality of HDES Software is computer testing; collection, storage and processing of data; presentation of the results in different forms such as graphic profile of mental resources, textual interpretation of the data, the results table for a single person and for a group of participants (raw and standardized scores); collection and automatic data processing.

The HDES 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.

The computer screen randomly displays the items of the questionnaires. A person should as quickly as possible to evaluate the expression of his/her individual characteristics on 5-point Likert scale. A shorter choice reaction time allows us to ascribe a property to a higher intensity of the trait under study.

II. RESULTS OF RELIABILITY AND VALIDITY OF QUESTIONNAIRES

The reliability and validity of questionnaires were checked in accordance with usual psychometric procedures. The scales have approximately normal distribution. A detailed description, the procedure and results of psychometric testing questionnaires are presented in [9, 10, 12, 14, and 16].

Temperament properties are measured with the shortened version of the Structure Temperament Questionnaire (STQ-S) which contains 26 items with maximum values (2 items in each scale). Validation and verification of the reliability of the full-version of STQ techniques (150 items) was carried out on the Russian sample of participants: (1937 students aged 18 to 30 years, employees aged 25 to 60 years), Canada (1014 persons), American (104 persons), Poland (51 persons), Chinese (161 persons), Finland (100 persons), Australia (189 persons). All scales, measured the different samples, are highly reliable (are varied from 0.72 to 0.79) and a high level of internal consistency (Cronbach's Alpha ranged from 0.7 to 0.87). The data obtained from the full version of the questionnaire STQ was significantly correlated with the data of a shortened version STQ-S [9].

The fundamental personality dimensions are evaluated with the help of Russian modified, validated, and shortened version of Eysenck PEN-questionnaire [12]. According to the researches [12], the scales had a rather high level of internal consistency. Cronbach's Alpha varied from 0.74 to 0.53 for the scales. The sample was 1026 participants (455 boys and 571 girls) aged 11 to 17 years (14.4 ± 1.5). In our study, we don't use the scale lie/frankness. Therefore, the shortened version of the questionnaire contains 21 items (7 items in each scale).

Character traits are scored with shortened version of the questionnaire. This questionnaire contains 20 items with maximum values from the full-version questionnaire (2 items

in each scale). The shortened version of questionnaire have a high correlation ($r > 0.6$; $p < 0.05$) with full-version of questionnaire which has high reliability (test-retest correlation for all scales $r > 0.7$) and high internal consistency (Cronbach's Alpha for all the scales > 0.7) [10, 14].

The cognitive styles are estimated with the help of a shortened version of Cognitive Personality Styles Questionnaire CPS-Q-S, which contain 24 items with maximum values (2 items in each scale). Shortened version CPS-Q-S scales have a high correlation ($r > 0.6$; $p < 0.05$) with full-version scales CPS-Q [10, 16]. The reliability and validity of full-version was checked on two independent samples (in total, 221 participants aged 16 – 17 years). All the scales had a rather high level of internal consistency. Cronbach's Alpha varied around 0.7–0.9 for different scales [10, 14, and 16].

The motivation questionnaire contains 48 items and 3 scales (24, 12, and 12 items in the scales respectively). The checking reliability revealed the high level of internal consistency of the scales (Cronbach's Alpha was 0.7) [10].

III. CONCLUSION

On the basis of the data obtained, we concluded that the described diagnostic expert system (HDES), based on holistic and developmental approach permits us to realize multifaceted, multidimensional evaluation of mental resources of a person and thus help him/her to reach outstanding achievements, to successfully cope with the life's demands and deal with a large variety of stresses, and to get life satisfaction.

In particular, this expert system can be used in educational setting in order to increase the efficiency of education by adjusting personal characteristics to the requirements of society. For instance, persons with high level of impulsivity, apparently, will cope better with creative tasks, but they will make more mistakes in routine operations.

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