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Russian Psychological Journal

Russian Psychological Journal is a peer-reviewed open access journal that publishes original research papers on all aspects of psychology and education.

It was founded by the Russian Psychological Society in 2004.

Russian Psychological Journal is published quarterly in both printed and online versions. English versions of metadata are available for all the full-text articles submitted in Russian. Since 2019, the journal publishes the full-text articles both in Russian and English.

All manuscripts submitted to the journal undergo a double-blind peer review process involving at least two experts.

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The mission of Russian Psychological Journal is to advance knowledge and practice in all areas of psychology through publishing scholarly, research-based, peer-reviewed articles that meet quality standards and help test, expand, or build psychological theory and contribute to psychological practice.

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The journal is intended not only for researches, scholars, students, and practitioners, but also for general readers with an interest in the state-of-the-art and most recent developments in psychology and education.

Russian Psychological Journal welcomes submissions from established researchers, young scholars, educators, and practitioners making significant contributions to thematic fields of the journal.

The journal is included in the current list of peer-reviewed scientific publications approved by the Higher Attestation Commission (VAK RF) in the following scientific specialties: 19.00.00 – psychological science. It is also included in the Russian Science Citation Index (RSCI), Ulrichsweb, ResearchBib, Directory of Open Access Journals (DOAJ) and other academic databases.

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CONTENTS

MEDICAL PSYCHOLOGY

Solodukhin A. V., Yanitskii M. S., Seryi A. V.
Towards a Choice of Correctional Computer Programs for Cognitive Rehabilitation in Cardiac Patients..... 5

Yaltonskii V. M., Abrosimov I. N., Andrushkevich T. D., Shashurina E. M.
Parameters of the Subjective Pattern of Disease in Rheumatoid Patients..... 15

GENERAL PSYCHOLOGY, PSYCHOLOGY OF PERSONALITY, HISTORY OF PSYCHOLOGY

Bityutskaya E. V., Lebedeva N. A., Tsalikova Yu. R.
Effects of the Moderated Stress Exposure on the Short-Term Memory Capacity in Cadets..... 27

Gnedykh D. S.
Assessing the Equivalence of Computerized and Conventional Versions of Psychological Tests..... 44

EDUCATIONAL PSYCHOLOGY

Bredun E. V., Balanev D. Yu., Vaulina T. A., Krasnoryadtseva O. M., Shcheglova E. A.
Temporal Characteristics of Students as Cognitive Diagnostic Characteristics: The Context of Adaptive Education..... 60

SOCIAL PSYCHOLOGY

Fedotova V. A.
Determinants of Hardiness among Representatives of Three Generations in Modern Russia..... 74

PAPER SUBMISSION GUIDELINES..... 92

UDC 159.9.015 **doi**: 10.21702/rpj.2020.1.1 ***Systematic review***

Towards a Choice of Correctional Computer Programs for Cognitive Rehabilitation of Cardiac Patients

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Abstract
Introduction. The present review aims to examine computer programs used in psycho-correctional practice for cognitive rehabilitation of cardiac patients. Currently, there is a high prevalence of cognitive disorders among the elderly population in Russia. The disease has an impact on cognitive functioning of cardiac patients, which leads to difficulties in social adjustment and reduces their quality of life. In this regard, assessing the performance of existing computer programs for cognitive rehabilitation of cardiac patients is important.
Theoretical Basis. This paper presents an overview of the main criteria for choosing cognitive rehabilitation programs for patients suffering from cardiac diseases, as well as characteristics of cognitive rehabilitation. The analysis of previous studies enabled the authors to develop a number of recommendations and restrictions for using cognitive rehabilitation programs.
Results and Discussion. The authors (a) provide a description of the structure of cognitive impairment in cardiac patients, (b) describe specific patterns of cognitive impairment in cardiac patients, and (c) concentrate on impairments of frontal lobe functions, including goal choice, concentration, and attention switching. The following platforms are currently used for cognitive rehabilitation: Constant Therapy, Cognifit, Brain +, My Aphasia Coach, Lingraphica, Prologue2go, Tactus therapy, Soch Genie, Lumosity, Neuro Nation, Memorado, Wikium, Brain Apps, and B-trainika. When choosing a correctional computer program, it is important to take into account the presence of a flexible system of settings and modular architecture, as well as the possibility of changing the complexity of tasks in accordance with the degree of cognitive impairment in patients.
Conclusion. This paper may be of interest to physicians, medical psychologists, defectologists, and programmers when choosing or developing the programs for cognitive rehabilitation of cardiac patients.

Keywords
cognitive functions, cognitive rehabilitation, cognitive dysfunction, methodological principles, mobile applications, computer systems, technology platforms, programming, computer programs, cardiac diseases

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Highlights

- When choosing a program for cognitive rehabilitation, it is important to take into account the presence of a flexible system of settings.
- When choosing a program for cognitive rehabilitation, it is important to take into account the degree of cognitive impairment.
- It is recommended to pay attention to the presence of a flexible modular architecture in correctional computer programs.

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Introduction

Currently, diseases of the cardiovascular system prevail in the structure of general disease incidence and disability of the population (Makarov, Maksimov, Shapovalova, Stryapchev, & Artamonova, 2019). Medical assistance for cardiac patients has improved significantly, which has affected the increase in life expectancy. However, old age is associated with a number of changes occurring in the human body, including an increase in cognitive deficit. The all-Russian program for the study of epidemiology of cognitive disorders in the elderly ('Prometheus') accompanied by examination with the use of the Mini-Mental State Examination (MMSE) scale and the Clock Drawing Test (CDT) covered 3210 patients (mean age, 69.5 ± 5.5 years). The findings indicate that 2677 (83.4 %) individual participants had memory complaints. Neuropsychological examination confirmed cognitive disorders in 2190 individual participants (68.2 %). The findings from the study carried out with the use of the Mini-Mental State Examination (MMSE) scale indicated that 810 individual participants (25.2 %) had a pronounced cognitive decline (Starchina, 2017). This speaks in favour of a high prevalence of cognitive impairment in the elderly Russian population.

Diagnostics and correction of cognitive disorders in cardiac patients is important, because these mental disorders may lead to difficulties in basic processes of life and social adjustment. The question arises, what are the methods that can be used for correction of cognitive impairment? Currently, there are no clear criteria for the choice and application of cognitive rehabilitation programs, which makes it difficult to find the most effective computer training among many alternatives. Thus, it seems important to analyze and evaluate the existing computer programs for cognitive rehabilitation for cardiac patients.

Theoretical Basis

Cognitive functions are the functions in the brain that provide rational cognition of the world, including: attention, perception, gnosis, memory, praxis, as well as thinking, intelligence, and speech, as more complex cognitive processes (Lokshina, 2015). Cognitive dysfunction manifests

itself as a decrease in the processes of obtaining, processing, and analyzing information in result of pathology in the cerebral hemispheres (Yakhno, Zakharov, & Lokshina, 2005). There is a potential for spontaneous cognitive rehabilitation, for example, in functional cognitive disorders associated with cerebral vascular insufficiency, intoxication, depression, and other disorders. However, the use of cognitive rehabilitation programs that accelerate this process and help patients adapt to new living conditions is important for cognitive rehabilitation.

Previous studies report that when choosing computer programs with an intuitive interface for elderly individuals with cognitive impairment, it is necessary to take into account their decreased perception, impaired motor skills, and mental processes (Lu & Yueh, 2015; Lu, Lin, & Yueh 2017). For example, the decrease in perception requires thoughtful use of visual design, scenery or animated images (Shawn Green et al., 2019).

Other principles for choosing computer programs relate to the consideration of auditory feedback, tactile feedback, and the presence of memory prompts (Binder et al., 2015; Harada, Sato, Takagi, & Asakawa, 2013; Sauve, Renaud, Kaufman, & Duplaa, 2015; Werner, Werner, & Oberzaucher, 2012). The presented works suggest the following five basic principles that should be considered when choosing and applying programs for cognitive education of elderly patients with cognitive impairment: (1) provide clear, multi-sensory instructions and appropriate interaction with them; (2) when compiling tasks, use the content and topics that are familiar to users from everyday life; (3) apply several different tasks corresponding to the training of various cognitive abilities; these tasks should be easy to perform and have various modes of operation; (4) give the opportunity to provide feedback on the results of training; and (5) involve users and persons concerned to evaluate the design.

In order to improve the quality of patient trainings, the following parameters should be taken into account when choosing a correction program (de Melo-Neto, Stroppa-Marques, & de Campos Gomes, 2016): (a) *Difficulty levels*. The tasks should be organized according to three levels of difficulty (easy, medium, and difficult). (b) *Interruption criteria*. It is recommended for to create interruption criteria at each of the three difficulty levels, which may provide a format of adaptation to patient performance. Adaptation is used to reduce the consequences of fatigue in patients and increase their motivation to participate in cognitive training. (c) *Number of attempts*. Most tasks should include elements classified as a 'second attempt' or 'second stimulation'. They should be preceded by a series of interventions (instructions/tips/cognitive strategies) aimed at improving the efficiency of completing tasks.

Previous studies evaluating the impact of cognitive training on cognitive recovery suggest that trainings mainly involve patients with mild to moderate cognitive impairment (Al-Thaqib et al., 2018; Gates et al., 2019; Orgeta et al., 2015). In rare instances, cognitive training programs involve patients with mild dementia (Küster et al., 2016; ten Brinke, Davis, Barha, & Liu-Ambrose, 2017). The duration of the training session should be from 20 minutes to 2.5 hours depending on a patient's age, the degree of cognitive impairment, and the presence of concomitant diseases. The duration of the course is from 2 weeks to 2 months, 2–5 lessons per week (Bahar-Fuchs et al., 2017; Barbera, et al., 2018; Bott et al., 2018; Heffernan, et al., 2019; Küster et al., 2016; Motter, Grinberg, Lieberman, Iqnaibi, & Sneed, 2019; Naismith, Redoblado-Hodge, Lewis, Scott, & Hickie, 2010; ten Brinke, Best, Crockett, & Liu-Ambrose, 2018; Walton et al., 2019). Cognitive training can be carried out both in the form of independent work, and in combination with physical exercises (Lipardo & Tsang, 2018; Sobol et al., 2018; Yu et al., 2018). The findings of studies suggest

Russian Psychological Journal, 2020, Vol. 17, No. 1, 5–14. **doi**: 10.21702/rpj.2020.1.1

significant improvements in cognitive functions in patients with mild cognitive impairment and a slight dynamics of cognitive recovery in groups of patients with moderate cognitive impairment (Bahar-Fuchs, Martyr, Goh, Sabates, & Clare, 2019; Ge, Zhu, Wu, & McConnell, 2018; Kudlicka, Martyr, Bahar-Fuchs, Woods, & Clare, 2019; Peretz et al., 2011; Turunen et al., 2019; Zhang et al., 2019a, 2019b). Cognitive recovery was insufficient for mild dementia patients. However, cognitive training had a positive effect on their psycho-emotional state. Thus, at the moment there is a significant amount of research that has proven the efficiency of such trainings for cognitive rehabilitation, which indicates that evaluating the available programs for cognitive rehabilitation is very important.

Results and Discussion

Frontal lobe disorders are principal disorders among vascular cognitive disorders caused by cardiological diseases (Vakhnina, 2014).

Operating (executive, regulatory) functions include the following three parameters: (a) *Goal choice* as the ability to voluntarily choose and set a goal for the activity. Impairment of this ability leads to the decrease in the activity of mental processes and the level of motivation, as well as to emotional indifference. (b) *Concentration* as the ability to perform behavior and cognitive activity in accordance with the goal. Moreover, concentration implies the ability to inhibit motivations that are less important in a current situation. If this function is impaired, a patient's behavior becomes impulsive, he/she is often distracted from the activity plan, and the degree of criticism of is reduced. (c) *Attention switching* as the ability to change the paradigm of activity under changed conditions, to move from an already achieved goal to a new one. Impairments of this function lead to inertia and perseverations in ongoing activities.

Cognitive disorders that occur in cardiovascular diseases are accompanied by one or more of the above stated parameters. The studies indicate that these disorders are observed in patients with arterial hypertension, discirculatory encephalopathy, and coronary heart disease after coronary artery bypass grafting (Vakhnina, 2014; Petrova, Prokopenko, Eremina, Mozheiko, & Kaskaeva, 2015). Thus, according to the results of a survey of 122 patients with coronary artery disease aged from 37 to 70 years, carried out in the Federal Center for Cardiovascular Surgery, Krasnoyarsk, indicated that the average score by the frontal dysfunction scale (FAB) after coronary bypass grafting was 15.2 ± 1.17 ($p < 0.001$). After 6 months, the average score increased to 15.8 ± 0.09 ($p < 0.001$). However, patients did not achieved normal scores of 16.2 ± 1.33 ($p = 0.001$), which were before surgery (Petrova et al., 2015). The results of the studies indicate the need for rehabilitation of impaired executive functions in cardiac patients.

Large-scale studies aimed at evaluating the programs for cognitive rehabilitation of cardiac patients using computer technology in Russia have not yet been conducted. Currently, there is evidence for the effectiveness of both independent cognitive trainings and their combination with the use of microcirculatory and nootropic drugs (Shapovalova, 2002; Zakharycheva, Moroz, & Drozdova, 2006). The question arises, how should we choose the most effective computer-based cognitive training for cognitive rehabilitation of cardiac patients?

The following platforms used for cognitive rehabilitation are available to Russian users: Constant Therapy, Cognifit, Brain+, My Aphasia Coach, Lingraphica, Prologue2go, Tactus therapy, and Soch Genie. These programs are available for download and can be used for the recovery of both mild to moderate cognitive impairment (Cognifit, Brain +, and SochGenie) and severe post-stroke

Russian Psychological Journal, 2020, Vol. 17, No. 1, 5–14. **doi**: 10.21702/rpj.2020.1.1

disorders, including aphasia and apraxia (Constant Therapy, My Aphasia Coach, Lingraphica, Prologue2go, and Tactus therapy).

The following platforms are used for training cognitive functions: Lumosity, Neuro Nation, Memorado (Memorado: memory training), Wikium, Brain Apps, and B-trainika. These applications can be used individually and require only registration. This makes them accessible to all categories of the population, regardless of social status.

We studied the results of the use of these programs in the rehabilitation process to choose the most useful for the correction of cognitive disorders in cardiac patients.

The Proloque2Go program is intended for the rehabilitation of severe post-stroke disorders, as well as for the development of language skills. The application is used by individuals with autism, Down syndrome, cerebral palsy, Angelman syndrome and other patients with severe speech disorders. This program is recommended for the recovery of cognitive functions and speech impairment in children (Tvardovskaya & Efremov, 2018).

The Tactus therapy program is used for speech rehabilitation, including reading skills and speech perception. It is recommended for corrective work with adolescents and adults suffering from speech disorders. There is no Russian version of this program, which makes it difficult for using by Russian users (Shamardina, 2018).

The Lumosity application is a widely-distributed program for training cognitive functions. Developers note the high efficiency of this game application when training memory, attention, speed, and accuracy of decision-making. However, the study, which involved 128 individuals aged 18 to 35 years, showed the absence of statistically significant differences between the results with the Lumosity application and common computer games (Kable et al., 2017). On the one hand, the results from this study confirm the improvement of cognitive functions after trainings. However, the effect for the presented program is not unique.

The Wikium online platform is another available simulator, based on the techniques of neuropsychologists. Currently, Wikium is recommended both for the recovery of mild cognitive disorders, as well as severe ones caused by cerebral infarction (Zlobina, Epaneshnikova, & Zinov'eva, 2018). A similar online platform B-trainika is also used to train cognitive functions. Moreover, this program can be recommended to improve the cognitive activity of students (Usamov, Shabazova, & Namaeva, 2019).

The CogniFit program stimulates and enhances cognitive functions using memory training games, various puzzles, logical, educational, and training tasks. The application uses psychometric tests in order to assess the level of cognitive impairment and provide an appropriate training program. Working with this application helps train memory, attention, concentration, executive functions, thinking, planning, coordination, and many other important cognitive functions. This program was developed on the basis of a number of studies examining the impact of psychocorrectional programs on the cognitive functions in the elderly (Shatil, Mikulecká, Bellotti, & Bureš, 2014; Gard, Hölzel, & Lazar, 2014; Shatil, 2013).

Thus, the Wikium and CogniFit programs are the most relevant applications for cardiac patients. These programs are available in Russia; they are intended for cognitive rehabilitation and training of various cognitive parameters and have a flexible settings system for a specific user.

The examination of corrective computer applications and the requirements for their use enabled authors to develop and take out a patent for the aPHASIA Program for the Neurorehabilitation of Individuals with Dynamic Aphasia after Stroke and Other Brain Injuries (Trubnikova, Seryi,

Yanitskii, Solodukhin, & Barbarash, 2018). The program consists of 6 blocks aimed at cognitive disinhibition in patients with dynamic aphasia and frontal lobe syndrome. Given the frequent impairment of operating functions in patients suffering from cardiac diseases, we can predict its effectiveness in the rehabilitation of severe cognitive disorders in patients with discirculatory encephalopathy and in those with coronary heart disease who have severe cognitive impairment after coronary artery bypass grafting. This program follows the above stated principles of the development and application of computer programs, which enables its effective use in neurorehabilitation practice.

Conclusion

When choosing corrective computer programs for cognitive rehabilitation of cardiac patients, the following conditions should be considered: (1) The presence of a flexible settings system, which makes it possible to adapt tasks for a specific user and characteristics of his/her cognitive impairment. (2) The choice of a cognitive training or a program should depend on the degree of cognitive impairment. (3) The presence of a flexible modular architecture that enables patients and physician to carry out rehabilitation work, both independently and jointly, while storing all the information on the server or in the database.

The conditions stated above provide us an opportunity for choosing the most optimal program for the diagnosis and correction of cognitive impairment in cardiac patients.

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UDC 159.9.072 **doi**: 10.21702/rpj.2020.1.2 ***Original research article***

Parameters of the Subjective Pattern of Disease in Rheumatoid Patients

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Abstract
Introduction. A patient's subjective pattern of disease (SPD) is considered both as a result of his/her adjustment to disease and as an instrument of personal self-regulation in disease. Modern clinical psychology actively investigates this psychological construct, which expands available knowledge obtained in the process of determining psychological factors of the treatment process. The present study appears to be the first that examines rheumatoid patients using a SPD multilevel model, which focuses on illness perceptions and coping with it.
Methods. The study sample consisted of 80 patients with rheumatic diseases aged 18–52 years, 50 % of whom were patients with rheumatoid arthritis (RA) and 50 % of whom were patients with systemic lupus erythematosus (SLE). The study used the following techniques for assessing the structure and content of various levels of the subjective pattern of disease: (a) the Symptoms Check-List-90-Revised (SCL-90-R), (b) the Brief Inventory of Illness Perceptions, and (c) the technique for psychological assessment of coping with stressful and problematic events.
Results. In the comparison groups, significant differences were observed on the scales of illness perceptions ('illness understanding', 'course of illness', 'control of illness', 'control of treatment'), the scales of coping behavior ('search for social support', 'acceptance of responsibility'), and the scales of 'somatization', 'depression', and 'anxiety'. The correlations indicate associations among the parameters of various levels of the subjective pattern of disease in patients in both groups.
Discussion. The parameters of the subjective pattern of disease in patients with systemic lupus erythematosus indicate their desire to recognize and overcome uncertainty and unpredictability of their disease. However, this does not reduce their emotional involvement in the problem. The subjective pattern of disease in patients with rheumatoid arthritis is characterized by a worse understanding and control of disease, as well as by emotion-focused coping strategies aimed at distancing from anxiety-related experiences associated with their disease.

Keywords
rheumatic diseases, rheumatoid arthritis, systemic lupus erythematosus, subjective pattern of disease, illness perceptions, coping behavior, coping, personality adjustment, self-regulation, patient psychology

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Highlights

- Rheumatic diseases represent a universal model for the psychological study of adjustment to chronic diseases.
- Both groups of patients have similar indices of the SPD sensory level, which may be explained by a multisystem and diffuse course of rheumatic diseases.
- Indices of the SPD emotional level indicate a high level of readiness for an anxious-phobic response among patients with SLE.
- Associations between the SPD cognitive and behavioral levels indicate the following: (a) Subjective perceptions of SLE patients is focused on illness understanding, its course, and control. (b) Coping of RA patients is characterized by ignoring coping resources and a low level of control of illness.

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Introduction

Rheumatic diseases are of particular interest to modern clinical psychology, being both a conventional and still promising subject for research. First, this may be explained by a mixed and understudied etiology of this nosological group, which does not exclude the role of psychological factors in the onset and aggravation of collagenosis (Vorob'eva, Aseeva, Solov'ev, Koilubaeva, & Glukhova, 2019). For example, considering rheumatoid arthritis along with neurodermatitis, duodenal ulcer, and other diseases in terms of the so-called 'holy seven' psychosomatic diseases (Alpysova & Subbota, 2017) has become traditional. On the other hand, rheumatic diseases manifest themselves with diffuse symptoms in multiple organs, which often do not have a vivid manifestation and are accompanied with painful and constraining bodily sensations for a long period of life. Therefore, rheumatic diseases represent a clear model of chronic somatic disease, which implies a special type of personal adjustment to disease and limitations (including social and psychological) in functioning associated with it (Grekhov et al., 2009).

Increasingly, the process of adjustment to disease is associated with such psychological and integrative constructs as the subjective pattern of disease (Vasserman, Chugunov, & Shchelkova, 2019), patient compliance (Abrosimov & Yaltonskii, 2018), and the quality of life (Mesnikova & Senyuta, 2016). Studying these clinical and psychological characteristics in rheumatoid patients is important for expanding our knowledge of depressive disorders and other comorbid psychopathological disorders of the affective spectrum (Marchenko, Seravina, Kovalevskaya, Vel'tishchev, & Lisitsyna, 2009). And finally, despite the successes and achievements of modern high-tech medicine (Solov'ev, Mesnyankina, & Aseeva, 2019), some rheumatic diseases remain widespread among the general population, which makes them some kind of everyday occurrences (Berezina, 2011). At the same time, their poorly localized and implicit initial symptoms remain without proper regard. All this is caused by the fact that monitoring, timely and adequate treatment of rheumatic diseases remains

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insufficient among the population (Khamitov, Khismetova, Goremykina, Tanysheva, & Kotlyar, 2019). Therefore, studies in this field are very important (Begun & Borshchuk, 2013).

Illness perceptions (Yaltonskii & Abrosimov, 2011) and disease-related coping behavior (Kudryashova, Saraikin, & Ivanov, 2017) are key clinical and psychological constructs that modern clinical psychology considers as determining the nature and results of personal self-regulation in disease. Along with bodily and emotional experience Russian researchers most often consider these characteristics in terms of the subjective pattern of disease associated with an individual's self-regulation in disease (Rasskazova, 2012). The subjective pattern of disease (SPD) consist of the following levels: (a) sensory – intraceptive experience associated with disease and its treatment, (b) emotional – affective content of disease-related experiences, (c) intellectual – cognitive representations of disease, ideas about its causes and consequences, and (d) motivational – an individual's actions to overcome disease or to adjust to it. Currently, there is a lack of integrative psychological studies involving rheumatoid patients that concentrate on the subjective pattern of disease, the role of illness perceptions, and disease-related coping behaviour.

The aim of this study is to investigate the multi-level structure of the subjective pattern of disease in patients with rheumatoid arthritis and systemic lupus erythematosus.

Research objectives were as follows: (1) to assess the characteristics of the SPD sensory and emotional levels, (2) to describe structural characteristics of the SPD cognitive and motivational levels, and (3) to analyze the associations among the SPD parameters.

Methods

The study sample consisted of 80 patients of V. A. Nasonova Research Institute of Rheumatology. Comparison groups were as follows: (1) the RA group – 40 patients with rheumatoid arthritis (3 males) and (2) the SLE group – 40 patients with systemic lupus erythematosus (5 males). The mean age of the study participants was 34.00 ± 17.46 years.

The characteristics of the SPD sensory and emotional levels were measured using the 'somatization', 'anxiety', and 'depression' scales of the Symptoms Check-List-90-Revised (SCL-90-R) (Tarabrina, 2001). The Brief Inventory of Illness Perceptions was used to describe the structural characteristics of the SPD cognitive level (Yaltonskii, Moskovchenko, Sirota, & Yaltonskaya, 2017). The structural characteristics of the SPD motivational level were measured using the technique for psychological assessment of coping with stressful and problematic events (Vasserman et al., 2019). The SPSS, a statistical package software version 20, was used for data processing. For statistical analysis the Mann–Whitney U-Test and Spearman correlation tests were used.

Results

The compared groups of patients had no statistically significant differences in the SPD sensory and emotional levels on the 'somatization' scale. Moreover, the values of this scale exceeded the normative values in both groups (SLE – 1.67 ± 0.71; RA – 1.50 ± 0.58; normative values – 0.69 ± 0.65), which indicates a high probability of distress in patients, which is associated with internal bodily experience of disease and its treatment. The values of the 'depression' scale do not exceed the normative interval in both groups (SLE – 1.23 ± 0.61; RA – 1.10 ± 0.68; normative values – 0.68 ± 0.59). This suggests a moderate degree of depressive experiences and their cognitive and somatic correlates. Statistically significant differences between the two groups were observed on the anxiety scale ($p = 0.001$). This parameter exceeded the normative value

Russian Psychological Journal, 2020, Vol. 17, No. 1, 15–26. **doi**: 10.21702/rpj.2020.1.2

in the group of patients with systemic lupus erythematosus (SLE – 1.30 ± 0.80; normative values – 0.58 ± 0.53), which indicates the presence of anxiety, as well as its cognitive components, including the feeling danger under uncertainty. Figure 1 shows the results of this stage of the study in more detail.

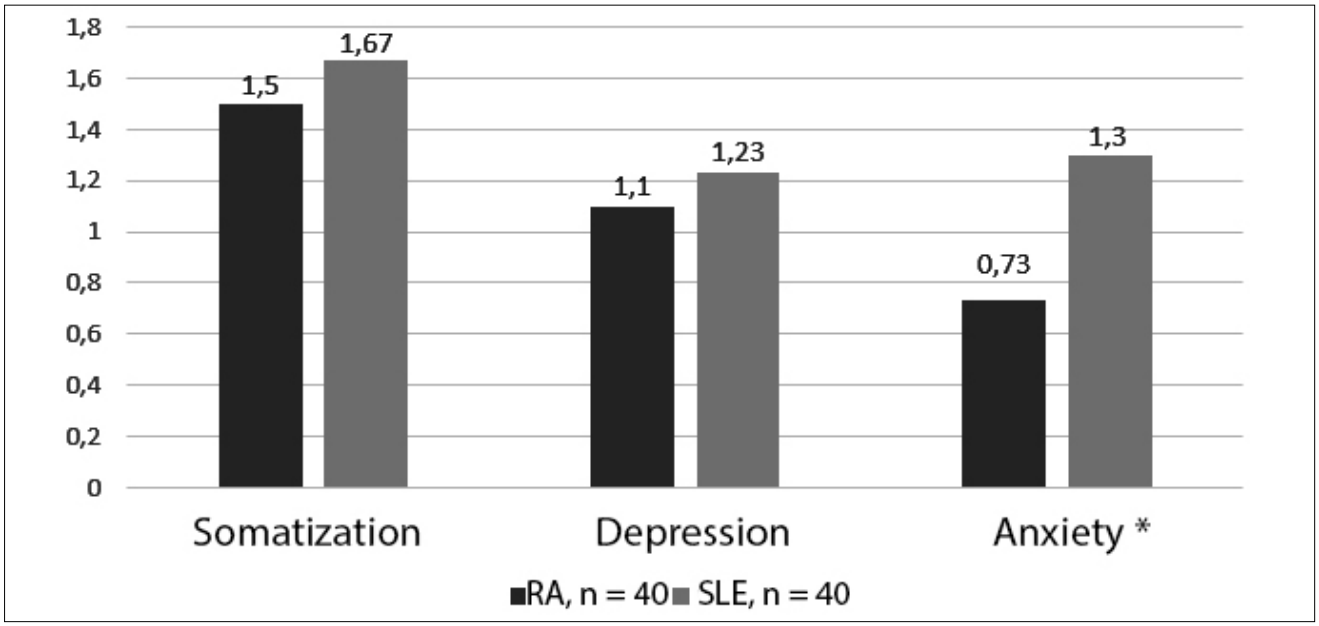

Figure 1. Comparative analysis of the SPD sensory and emotional levels in the compared groups by the Mann–Whitney U-Test, n = 80

*Legend: * – scales with statistically significant differences, $p \leq 0.05$.*

The study of the SPD cognitive level showed that the compared nosological groups had structural differences in illness perceptions. The RA patients represent rheumatoid arthritis as a long-term illness with well-recognized symptoms. Patients with systemic lupus erythematosus are also concerned with their disease and its course. However, they understand it better. We observed statistically significant differences between the compared groups on the scales of 'course of illness', 'control of illness', and 'control of treatment'. Table 1 shows the results of this stage in more detail.

Coping strategies of 'flight/avoidance' and 'search for social support' were the most pronounced characteristics of the SPD motivational level in both groups. In doing so, the 'distancing' strategy was leading in the RA group; the 'problem solving planning' strategy was leading in the SLE group. We should note that all characteristics of coping behavior did not exceed the normative data in both groups. This indicates their moderate realization, which generally improves adaptive functioning (Vasserman et al., 2019). We also observed statistically significant differences between the two groups on the scales of 'search for social support' (SLE – 51.44 ± 9.49; RA – 48.20 ± 8.47; $p = 0.49$) and 'acceptance of responsibility' (SLE – 48.90 ± 10.18; RA – 44.25 ± 12.61; $p = 0.46$). These characteristics were more pronounced in the SLE group. Figure 2 shows the results of this stage of the study in more detail.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 15–26. **doi**: 10.21702/rpj.2020.1.2

Table 1
Significant differences in the RA and the SLE groups by the Mann–Whitney U-Test, n = 80

Illness perceptions	SLE n = 40 Me ± SD	RA n = 40 Me ± SD	Significance of differences, P
Consequences of illness	6,72 ± 2,66	7,17 ± 2,54	
Course of illness	8,80 ± 2,43	7,57 ± 3,25	p = 0,011
Control of illness	6,53 ± 2,29	5,42 ± 2,84	p = 0,049
Control of treatment	6,91 ± 2,39	5,77 ± 2,82	p = 0,018
Identification	6,74 ± 2,45	7,45 ± 2,56	
Concern	7,43 ± 2,70	8,12 ± 2,57	
Illness understanding	7,53 ± 2,69	6,05 ± 3,27	p = 0,019
Emotional response	6,45 ± 2,94	6,85 ± 2,51	
Threat	45,16 ± 10,70	48,82 ± 11,64	

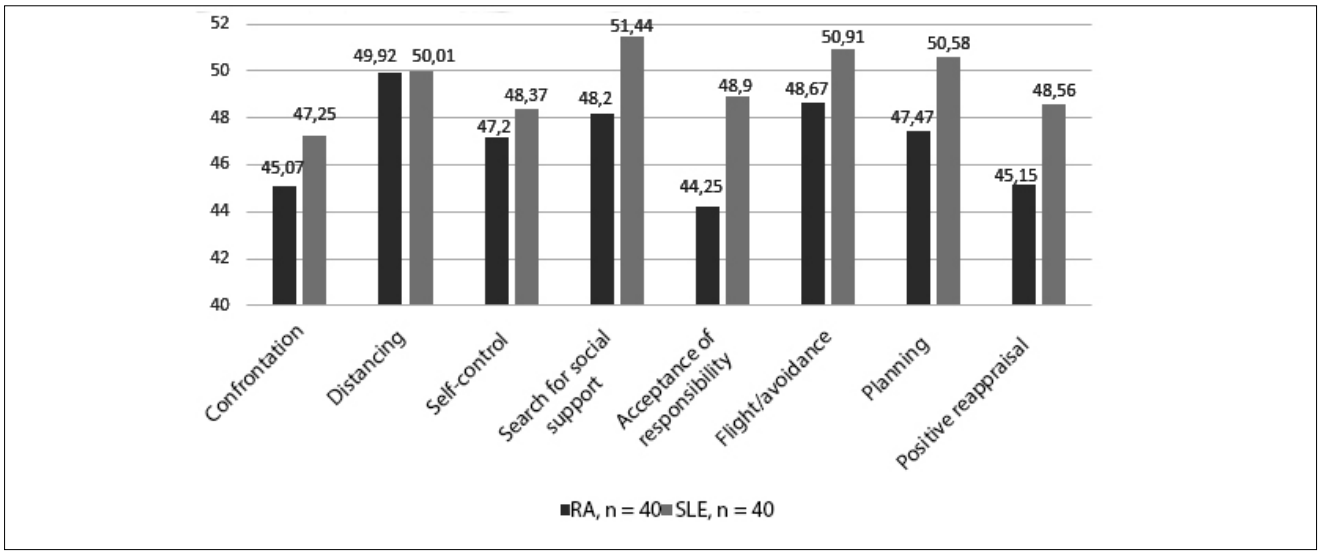

Figure 2. Comparative analysis of coping behavior in the compared groups by the Mann–Whitney U-Test, n = 80

*Legend: * – scales with statistically significant differences, p ≤ 0.05.*

The correlation analysis showed associations among the parameters of the subjective pattern of disease in the two comparison groups. Multiple positive correlations between characteristics of illness perceptions and the parameters of the SPD sensory, emotional, and motivational levels were found in the group of patients with rheumatoid arthritis. Fewer positive and negative correlations between the parameters were found in the group of patients with systemic lupus erythematosus. Therefore, illness perceptions exhibit a trend to correlate with the SPD emotional level in this group. Table 2 shows the results of the correlation analysis in more detail.

Table 2
Correlation analysis of the SPD parameters in each group, Spearman's correlation coefficient

	Rheumatoid arthritis, n = 40					
	Consequences of illness	Course of illness	Identification	Concern	Emotional response	Threat
Somatization	r = 0,494, p = 0,001	r = 0,340, p = 0,032	r = 0,455, p = 0,003	r = 0,378, p = 0,016	r = 0,510, p = 0,001	r = 0,649, p = 0,001
Depression	r = 0,318, p = 0,045	r = 0,331, p = 0,037			r = 0,314, p = 0,049	r = 0,324, p = 0,041
Anxiety	r = 0,344, p = 0,030					r = 0,320, p = 0,044

	Confrontation	Search for social support	Flight/ avoidance	Planning
Consequences of illness	r = 0,351, p = 0,026			
Control of illness		r = 0,433, p = 0,005		
Anxiety			r = 0,397, p = 0,011	r = –0,350, p = 0,027
Systemic lupus erythematosus, n = 40				
	Concern	Illness understanding	Emotional response	Threat
Distancing		r = –0,363, p = 0,009		
Depression	r = 0,363, p = 0,009		r = 0,438, p = 0,001	r = 0,416, p = 0,001
Anxiety			r = 0,361, p = 0,009	r = 0,343, p = 0,030

Discussion

Departing from a multi-level model of the SPD in rheumatoid patients, this study expands our knowledge of this psychological construct. In particular, it seems important to describe the characteristics of the SPD sensory level, which is insufficiently covered in psychological literature. Both groups of patients with rheumatoid arthritis and systemic lupus erythematosus demonstrate the presence of distress in the context of existing bodily or sensory experience of disease (Tsvetkova, 2012). Both diseases are characterized by an unpredictable non-linear dynamics with remission and relapse periods, as well as body manifestations that are unclear or invisible at the initial stage (Kulik, Barzilovich, & Minchenko, 2012). This increases the level of personal uncertainty (Lifintseva, Derkach, & Shtolde, 2018) and affects the quality of life and other characteristics of personal adjustment to disease (Yaltonskii & Abrosimov, 2014). The absence of significant differences indicates the similarity of the diffuse internal bodily (including proprioceptive) experience among the patients of both groups, despite the existing clinical specifics of these diseases. However, the development and differentiation of the sensory level may be considered as a core factor that underlies the SPD consistency (Vasilenko & Mangushev, 2018). This, in turn, determines the importance of taking this parameter into account for psychocorrection of rheumatoid patients.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 15–26. **doi**: 10.21702/rpj.2020.1.2

As a rule, rheumatoid patients have high dysfunctional indices of the parameters of affective spectrum disorders (Lisitsina et al., 2018). The findings of this study indicate moderate levels of depressive feelings and contrasting trends in the indices of anxiety at the SPD emotional level in both groups. Compared to patients with rheumatoid arthritis, patients with systemic lupus erythematosus are characterized by greater willingness to anxious behaviors towards possible and unpredictable dangers of their disease. According to the biopsychosocial model, often used in modern clinical psychology, these results may be explained by various factors, including sociocultural ones (Neznanov, Kotsyubinskii, & Mazo, 2018). As mentioned above, rheumatoid arthritis, which is perceived as everyday occurrences, as well as the high level of uncertainty of systemic lupus erythematosus, its unclear image for the patients themselves and their environment (Vorob'eva & Aseeva, 2017) may play an important role in the emotional response to disease.

Our findings are consistent with the following results of Nowicka-Sauer et al. (2018): the less SLE patients know about their disease, the higher the levels of anxiety, depression, sleep quality, and pain perceptions are. Moreover, most middle-aged patients have negative illness perceptions, which also increase the probability of increased level of anxiety and pain perceptions (Ulus et al., 2017).

However, the findings of the study of illness perceptions as a factor of the SPD cognitive level contradict the above-stated thesis. Compared to patients with rheumatoid arthritis, the SLE patients are characterized by better understanding of their disease and its long course, as well as higher subjective control of it. Moreover, as we have already noted, SLE is a chronic disease, which is difficult to correct, with remission and relapse periods (Yen & Singh, 2018). Other studies devoted to perceptions of chronic systemic diseases (Karademas et al., 2008) suggests that differences between subjective perceptions and objective realization of some SPD parameters may be a possible reason for this. Patients with recurrent disease, which is rare in the population and introduces a high level of uncertainty in everyday life (such as SLE) need to make more effort to understand and control it (Pakhale et al., 2015). Meanwhile, when patients attempt to understand the mechanisms of their disease and its exacerbation, they comprehend disease severity; although being an instrument of self-regulation, the attempts to control it remain constrained and have a short-term effect. These factors may explain high anxiety scores described above.

The negative correlation between 'distancing' copying and illness understanding in the group of patients with SLE partially confirms this assumption and indicates that they concentrate on emotional experiences associated with disease under a better understanding of its mechanisms.

Findings of the study of coping behavior indicate that it is more effective in the group with systemic lupus erythematosus. Patients from both groups use various moderate coping strategies, which modern authors consider as the adaptive flexibility of defensive coping behavior (Mc Hugh, Mc Feeters, Boyda, & O'Neill, 2016). However, in the RA group, strategies for seeking social support and assuming responsibility are less pronounced, which may reduce the effectiveness of adaptation attempts. Therefore, the lack of motivation (both external and internal) to comply with prescriptions is the leading negative phenomena; this may decrease adherence to treatment (Brijs, Arat, Westhovens, Lenaerts, & De Langhe, 2019). Such forms of stress response as avoidance and confrontation are also highly expressed in this group.

In the group of patients with rheumatoid arthritis correlations indicate a tendency to use external resources to control disease, as well as to use an avoidant behavior style to reduce anxiety, which can lead to a decrease in personal adjustment to disease (Li, He, Wang, & Wang, 2019).

Our findings expand the results obtained by Akhmedova and Shchelkova (2008). The authors found out that compared to the patients with an acute and objectively life-threatening cancer, patients with rheumatoid arthritis use less effective coping strategies. However, the focus changes when comparing this nosological group with other rheumatic diseases. Once again, this speaks in favour of relativity of adaptive copings, which requires an integrated approach to their study.

Generally speaking, the subjective pattern of disease in rheumatoid patients remains an important subject for psychological research. Studying its parameters and associations with processes of personal self-regulation in disease expands the existing theoretical and methodological knowledge of adjustment to disease, as well as targets for psychodiagnostics and psychocorrection. Moreover, qualitative analysis of disease cognitive representations, the content of its personal meaning in a patient's life appears to be most important.

Conclusions:

1. The clinical dynamics of rheumatic diseases is often non-linear and multisystem. This leads to an increase in the level of uncertainty in the disease conditions, which determines a diffuse structure of the SPD sensory level in both groups, as well as a high readiness for anxiety-related response in the group of patients with systemic lupus erythematosus.
2. Compared to patients with systemic lupus erythematosus, the cognitive and motivational levels of the subjective pattern of disease in patients with rheumatoid arthritis are characterized by a lack of understanding of the mechanisms and dynamics of their disease; they also use copying strategies, focused on emotions rather than on solving actual problems.
3. In the group of patients with rheumatoid arthritis, the established correlations indicate an association between illness perceptions and its diffuse bodily image, as well as between avoiding coping strategy and anxiety-related response. In the group of patients with systemic lupus erythematosus, the established correlations indicate an association between illness perceptions and negative emotional experiences.

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Effects of the Moderated Stress Exposure on the Short-Term Memory Capacity in Cadets

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Abstract
Introduction. The effects of moderate-intensity stressors on short-term memory are studied, which is relevant to the professional training of first responders (firefighters) when preparing them for emergencies. This study investigates changes in the capacity of short-term memory under stress. Significant differences were found among memory parameters of fire cadets and students of civilian specialties. To the best of our knowledge, this is the first experimental study of the stress impact on the short-term memory capacity that takes into account professional education and training of the respondents.
Methods. The study comprised 90 respondents, including 50 fire cadets of the Academy of State Fire Service and 40 students of Moscow universities. The subjects were divided into an experimental group and three control groups. Stressful stimuli (disturbing photo- and audio materials) were presented to respondents from two groups; respondents in two other groups were presented with neutral stimuli. The short-term memory capacity before and after the stressful stimulation was assessed with the Digit Span Test. The physiological signals of the subjects were measured during the experiment.
Results. In fire cadets, stress resulted in a significant increase in memory capacity, while memory capacity showed a slight decrease in students. Physiological response to stressful conditions was different between students and fire cadets. Compared to cadets, the baseline muscle tension measures were higher in students. Compared to students, cardiovascular system parameters (systolic wave amplitude, pulse transit time) changed faster in cadets. However, these parameters changed not as substantially as those in students.
Discussion. In fire cadets, memory capacity and its change due to stressful effects were associated with levels of non-verbal intelligence. It might also be mediated by emergency professionals' competencies. The system of selection, psychological training, and counseling of fire cadets in the Academy of State Fire Service is considered to be an important factor in the stability of cognitive functions under stress.

Keywords
short-term memory, memory capacity, stress, Digit Span Test, goal, cognitive appraisal, stressor intensity, self-regulation, arousal, physiological parameters

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Highlights

- Stress causes an increase in the capacity of short-term memory in the majority of fire cadets. It should be noted that future professional activity of fire cadets is closely related to emergencies.
- An increase in short-term memory capacity under stress might contribute to the performance of first responders, rescuers, and firefighters.
- The results are discussed in connection with the professional competencies of first responders and emergency professionals (optimism, positive self-appraisal of their own abilities), as well as with the fire cadets training system, which enables them to maintain self-control and stability when performing professional tasks in challenging situations.

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Introduction

The specificity of professional activities in extreme jobs is determined by the need to work under stress of extreme intensity related to situations of emergency response or disaster cleanup operations. First responders must maintain an adequate perception of reality, make efficient decisions, and act purposefully, which is related to the stability of cognitive functions. Research on cognitive functioning under stress is important, as it is relevant to the professional training of first responders (rescuers) when preparing them for emergencies.

Several investigations demonstrated that short-term (working) memory is associated with resource distribution, attention, and behavior control and determines the efficiency of activity when performing difficult tasks (Barrett, Tugade, & Engle, 2004). Thus, short-term memory might be an essential factor for rescuers' performance under extreme conditions.

Some studies have noted that stress could improve or worsen cognitive functioning. This study aims to investigate memory functioning in fire cadets whose future professional activities are related to emergencies. Therefore, the analysis of factors and mechanisms that may explain the efficiency of task performance under stress is of our primary interest. In this context, we will examine the cognitive appraisal of stress, stressor intensity, and self-regulation.

Cognitive appraisal of stress as an activator

Some studies report that if individuals appraise stress as a challenge, they tend to overcome stressful situations more actively (Lazarus, 1991). Such an appraisal is characterized by the perception of stress as an opportunity to improve one's skills and experiences, to become stronger, etc. A person must be confident that his/her resources are sufficient to achieve success (Tomaka, Blascovich, Kelsey, & Leitten, 1993). The appraisal of stress as a challenge, in turn, mobilizes the person to overcome it and is negatively associated with avoidance (Blascovich & Tomaka, 1996; Tomaka et al., 1993).

A recent meta-review shows that the appraisal of stress as a challenge is associated with a more efficient activity in strenuous conditions (Hase, O'Brien, Moore, & Freeman, 2019). Thus, surgeons with such appraisals better performed surgical procedures and demonstrated better motor skills and attention characteristics (Vine, Freeman, Moore, Chandra-Ramanan, & Wilson, 2013). When practicing engine breakdown scenario, the pilots appraising difficult situations as a challenge were able to use relevant information more effectively and to land more safely (Vine et al., 2015).

Some studies tested a hypothesis that the appraisal of stress and individual physiological states may be associated. It was shown, for example, that a positive attitude towards stress, where the situation is perceived as an opportunity to mobilize one's abilities, is associated with a moderate activation of cortisol production (Crum, Salovey, & Achor, 2013). Another study by Jamieson, Mendes, Blackstock, and Schmader involved students preparing for their examinations. Before examinations, they gave arguments for the positive impact of stress on exam performance on the experimental group students. The study results suggested that a positive attitude towards stress determined, firstly, better exam scores among more effectively; on the other hand, this group had higher sympathetic tone levels compared to the control group (Jamieson, Mendes, Blackstock, & Schmader, 2010).

Effects of stressor intensity on cognitive activity

Currently, an inverse U-shaped curve between arousal and cognitive processes, first introduced by Easterbrook in his report (1959), is a very intensely discussed topic. The U-shaped curve describes greater attention efficiency and more effective memory functioning in moderate stress. More recent works defined this concept more precisely; it was postulated that a moderate level of emotional tension could enhance memorizing and reproducing of information, particularly, of emotional information (McGaugh, 2006; Cahill, Gorski, & Le, 2003; Buchanan & Lovallo, 2001). Moreover, speed ratings in cognitive task performance are improved under stress of low or moderate intensity (Hancock & Weaver, 2005). As the level of the excitement increases, the memory of event details decreases due to attention narrowing at memorizing (Buchanan, Tranel, & Adolphs, 2006; Sharot & Phelps, 2004).

The U-shape curve investigations are related, specifically, to the factors that mediate it. For example, different patterns could be observed for positive or negative emotions of the same intensity. This data supports the idea that the level of arousal alone cannot fully explain cognitive functioning under stress (Mather, 2007; Sharot & Phelps, 2004; Levine & Pizarro, 2004; Levine & Burgess, 1997; Bargh & Cohen, 1978). Furthermore, a mediating role of emotional regulation was described. Persons who suppress their emotions (in their everyday life or following the instructions of the experiment), memorized the emotional content of events worse (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004).

Self-regulation and cognitive activity

The issues of the efficiency of cognitive functioning are discussed in studies of self-regulation. To explain individual characteristics of self-regulation, they use the concept of functional states, which is related to performance efficiency and optimal goal achievement (Leonova & Kuznetsova, 2015). Functional states are especially important in emergencies, as they determine the results of professional activity (Dikaya, 1999). A 'productive tension' is defined as an

optimal state by contrast with distress, which is considered to be an adverse state (Dikaya & Shchedrov, 1999).

We consider that the conclusion of the purposeful character of activity in successful coping with stress is very important for our study (Dikaya, 1999; Leonova & Kusnetzova, 2015; et al.). In his work Zotov (2011) demonstrated that voluntary regulation of activity could be maintained if a cognitive activity was purposeful. Among stress resistance factors, Bodrov & Oboznov (2000) distinguish the ability to create the estimated images of result achievements and anticipative schemes, which is associated with goal-setting. Based on empirical data, S. A. Shapkin shows that the achievement of goals related to high performance (achievement strategy), even in resource shortage, along with goal achievement, contributes to a favorable mental state. On the contrary, resource-saving (avoidance strategy) leads both to failure in achieving goals and to depletion of resources, as well as to a deterioration in mental state (Shapkin, 1999).

On the whole, despite a large number of investigations on cognitive functioning under stress, there is a lack of studies on samples of professionals or future professionals whose professional activity would be related to stress factors of extreme intensity. We assume that rescuers would attain an optimal functional state under stress, which is defined by L. G. Dikaya and V. I. Shchedrov as 'productive tension'. Stress resistance of memory capacity might be one of such productive state manifestations. In terms of motivation, this is associated with the purposeful character of actions while performing professional tasks. More generally, it is essential to mention the system of screening and psychological training of fire cadets in the Academy of State Fire Service. This general assumption is specified in the following hypotheses of the present study: stress increases short-term memory capacity in fire cadets whose professional activities will be related to emergencies.

Methods

Study participants

A total of 97 responders participated in the study. The analysis did not include data for 7 subjects (3 cadets and 4 students). Thus, we analyzed the data from the sample of 90 responders, including 50 fire cadets of the Academy of State Fire Service and 40 students of Moscow universities: Lomonosov Moscow State University, Russian Foreign Trade Academy, Kutafin Moscow State Law University), studying in various specialties: geography, geology, economics, jurisprudence, etc. The experimental group comprised 30 fire cadets: 15 males, 15 females aged 21 to 24 years. The other participants were randomized in 3 groups of comparison. Table 1 provides detailed age and gender characteristics for all the study participants.

Study Procedure

The study involved four groups of respondents tested at baseline and at the end of the study. Table 1 shows the experiment design.

Table 1
The experiment design and characteristics of respondents

Fire cadets, n = 50	Baseline assessments of the short-term memory (1st series of stimuli, Digit Span Test)	Under stress	Group 1, 30 respondents: 15 males, 15 females aged 21 to 24 (M = 21.8)	Final assessments of short-term memory (2nd series of stimuli Digit Span Test)
		No stress	Group 2, 20 respondents: 10 males, 10 females aged 22 to 24 (M = 21.5)	
Students, n = 40		Under stress	Group 3, 20 respondents: 10 males, 10 females aged 19 to 24 (M = 21.3)	
		No stress	Group 4, 20 respondents: 10 males, 10 females aged 20 to 23 (M = 21.6)	

Respondents in experimental groups were given stressful photo and audio materials. Photo content included on-the-spot pictures of emergencies, bodies of victims, fire accidents, buildings thrown down by earthquakes. In addition to such photos, we presented images with poisonous insects, blood, injection syringes, and needles. Stressful audio content included records of human cries, sound of sirens, baying of dogs, and whipping of children.

Pictures with stressful photo content were presented for 2 minutes before the final short-term memory assessments; at the same time, sounds were transmitted to respondents via headphones. Sounds kept being transmitted during the final assessment procedure (Table 2).

Besides, we presented a neutral video content with images of nature: at the first stage of the study (for one minute) to assess baseline physiological parameters in the initial calm state; at the second or third and final stages of the study (for one minute, as well) a similar video content was presented for relaxation (Table 2).

Table 2
Study Procedure

Stages of the study	Groups without stress		Groups under stress		
1	Neutral video content	Physiological state measurement	Neutral video content	Physiological state measurement	
2	Digit Span Test	Physiological state measurement	Digit Span Test	Physiological state measurement	
3	Neutral video content		Neutral video content		
4	–		Stressful photo and audio content		
5	Digit Span Test	Physiological state measurement	Stressful audio content	Digit Span Test	Physiological state measurement
6	Neutral video content		Neutral video content		

All the respondents were informed that they would take part in the study of memory using stressful content. They were, furthermore, informed on the possibility of withdrawing from the study at any time during the experiment, in case it becomes annoying or uneasy. The experiment participants were also informed that we might use their results in a generalized form. None of our respondents refused to participate in the study.

Assessment of the physiological state of study subjects

The physiological state of study subjects was assessed using biological feedback (Reacor BFB). The biofeedback system included: a computer (to monitor and control the procedure progress), a patient display (to present visual stimuli), a Reacor patient block (comprises four general polygraph channels), and sensors set to record physiological signals.

Using BFB, we evaluated whether the subjects exposed to stressful stimuli were in a state of physiological tension (arousal) and whether the subjects from the groups without stressful stimuli exposure were in a neutral (quiet) state. For that purpose, we recorded physiological parameters throughout the whole experiment time; after that, we compared the data representing physiological parameters collected at three stages of the study. Table 2 summarizes the study procedure at all the stages.

During the study, we recorded the following physiological parameters: heart rate, circumflex electromyogram (CEMG), *systolic wave* amplitudes, and the pulse transit time from the heart to

the periphery (PTTHP) were registered using the photoplethysmography (volumetric blood flow). The significant difference in two or more of the mentioned parameters suggested that the participant was in a state of physical tension. Heart rate was measured using electrocardiography (ECG) as a number of heartbeats per minute. The heart rhythm was recorded using sensors with clip electrodes placed on radial arteries of arms. A neutral electrode was used, as well. Also, to evaluate the physiological state with the circumplex electromyography (CEMG), electric signals due to the muscular contractions of trapezius muscle were recorded.

Seven subjects from the 1st and the 3rd groups, exposed to stressful factors, were excluded from the further analysis (3 cadets and 4 students) due to the lack of signs of physiological tension state, according to the measurement results. All other participants from the groups with stress were in a state of physiological tension. Meanwhile, participants from the groups without stress did not show signs of tension.

Short-term memory measurement

Baseline and final assessments of short-term memory capacity were carried out using the Digit Span Test, where respondents were presented with numerical series gradually increasing in a number of characters (Jones & Macken, 2015). Different numerical series were used for assessments in groups with and without stress. An example of stimuli is presented below (Fig. 1).

The following instructions were given to subjects on display: 'Random numerical series containing from 4 to 10 elements will be presented to you on display, starting with the shortest. When the display turns green, please, immediately say aloud the numbers in the order, they were demonstrated'.

Baseline assessment 1st Digit Span Test series presentation		Final assessment 2nd Digit Span Test series presentation	
1st presentation		1st presentation	
1.	2587	1.	1540
2.	48752	2.	65742
3.	951236	3.	274918
4.	7541238	4.	9546320
5.	74125895	5.	45157621
6.	105786428	6.	628741038
7.	4582168732	7.	7514682054
2nd presentation		2nd presentation	
1.	8542	1.	4928
2.	75423	2.	86547
3.	158634	3.	105682
4.	2690267	4.	4210856
5.	95486327	5.	84751026
6.	791742250	6.	359405482
7.	3521404861	7.	1815497201

Figure 1. Digit Span Test, presented to participants

Data processing procedure

We calculated short-term memory capacity using the following equation: $V = A + \frac{m}{n}$, where V is short-term memory capacity; A – the longest numerical series reproduced correctly in all presentations; m – number of correctly reproduced numerical series longer than A; n – number of series (here, n = 2). We analyzed only those numerical series that were reproduced correctly in due order.

Obtained data were processed using the IBM SPSS Statistics, Version 22. We used the Kruskal–Wallis H test, Wilcoxon match-pairs rank test, Mann–Whitney U test, Spearman's rho test, and Cohen's effect size d-coefficient. The effect sizes were determined as small (d = 0.2), medium (d = 0.5), and large (d = 0.8) (Cohen, 1988).

Results

In the first series of the Digit Span Test under neutral conditions, the obtained results were comparable in all the four groups (Kruskal–Wallis H test: H = 3.374; p = 0.337).

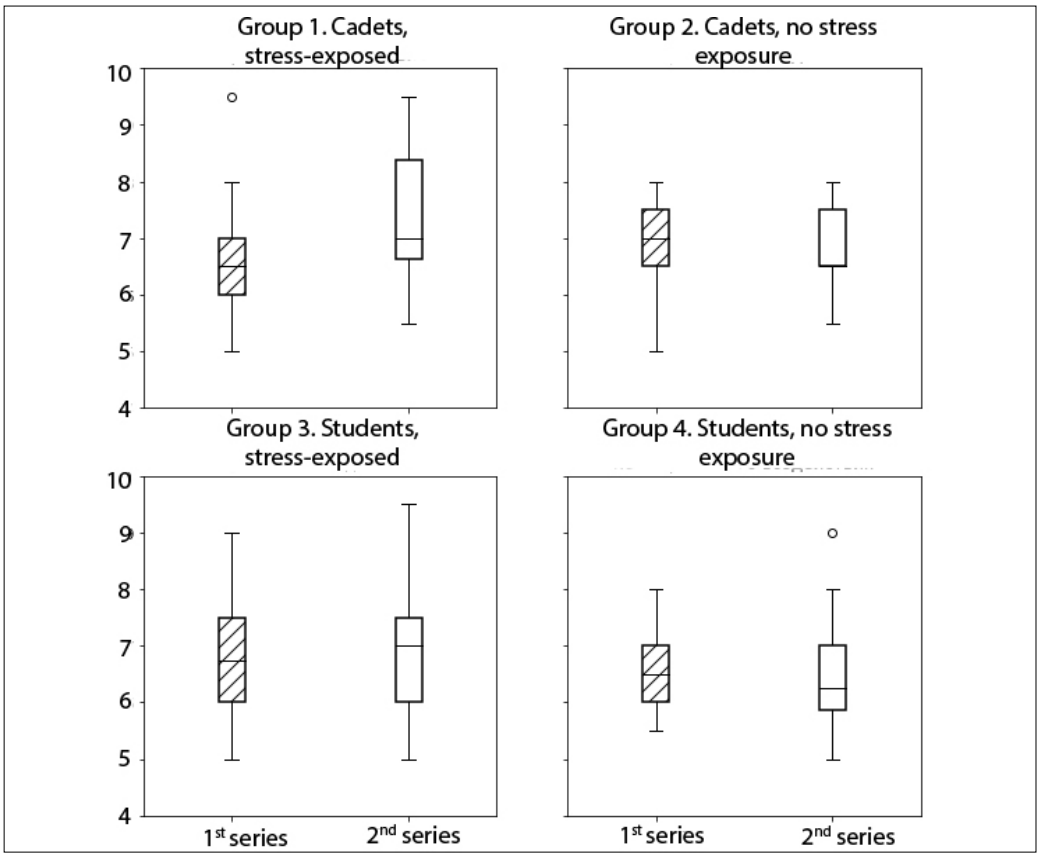

Figure 2. Median and interquartile ranges in the 1st and 2nd series of the Digit Span Test for each group

Vertical: Short-term memory capacity. Horizontal: Results of the 1st and 2nd series of the Digit Span Test

Digit Span Test diagnostic findings are summarized in Table 3 and Figure 2, were results of the 1st and the 2nd series of tests are compared for each study group separately. Findings from the 2nd series indicated that fire cadets had better results when carrying out the Digit Span Test under stress (Wilcoxon match-pairs rank test, p = 0.001). According to Cohen's effect size d-coefficient, the obtained effect size was medium (d = 0.7232). Learning cannot explain these results, as the fire cadets carrying out the Digit Span Test without stress for the second time did not improve their results.

Table 3
Digit Span Test results for each group of participants

Descriptive statistics	1st series (Digit Span Test)			2nd series (Digit Span Test)			Difference between series	Wilcoxon match-pairs rank test (the difference between 1st and 2nd series))	
	M	SE	SD	M	SE	SD	M	z	p
Group 1.Fire cadets, under stress	**6,53**	0,17	0,96	**7,30**	0,21	1,16	0,77	–3,265	**0,001**
Group 2. Fire cadets, no stress	6,88	0,16	0,70	6,78	0,16	0,73	–0,10	–0,485	0,628
Group 3. Students, under stress	6,78	0,23	1,02	6,70	0,23	1,04	–0,08	–0,751	0,452
Group 4. Students, no stress	6,60	0,16	0,74	6,50	0,23	1,03	–0,10	–0,605	0,545

Table 4
Generalized data of the Digit Span Test

Changes in short-term memory capacity, 2nd series of the test	Group 1. Fire cadets, under stress		Group 2. Fire cadets, no stress		Group 3. Students, under stress		Group 4. Students, no stress	
	Qty	Qty (%)	Qty	Qty (%)	Qty	Qty (%)	Qty	Qty (%)
Short-term memory capacity increased	20	66.67	5	25	5	25	7	35
No changes	4	13.33	8	40	7	35	6	30
Short-term memory capacity decreased	6	20	7	35	8	40	7	35

We observed a non-significant decrease of results by the memorizing test in students of both groups (under stress and with no stress) and in fire cadets from the 2nd group (without stress). No difference between males and females was found.

Table 4 shows the generalized data demonstrating intragroup changes in short-term memory capacity in the 2nd series of the study compared to the 1st one. We should note that in the experimental group of cadets, carrying out the 2nd Digit Span Test series under stress (group1), short-term memory capacity was increased in 66.7 % of respondents and decreased in 20 % of them; 13.3 % of cadets had no changes in short-term memory capacity. We obtained the following results in the second group of cadets (without stress): short-term memory capacity was increased in 25 % of respondents and decreased in 35 % of them; 40 % of respondents had no changes in short-term memory capacity.

In the third group (students under stress), short-term memory capacity was increased in 25 % of respondents and decreased in 40 % of them; 35 % of respondents had no changes in short-term memory capacity. In the fourth group (students without stress), the equal proportion of respondents (35 %) demonstrated a decrease and an increase in short-term memory capacity in the 2nd series of the test; 30 % of respondents had no changes in short-term memory capacity.

Tables 5 and 6 provide the data for physiological parameters in two groups of respondents exposed to the stressful factors at three stages of the experiment. Students demonstrated higher baseline muscular tension compared to fire cadets ($z = –1.99$; $p = 0.047$; Cohen's d-coefficient = 0.669). Systolic wave amplitude measures (blood flow measurements in small vessels) during the 1st series of the Digit Span Test ($z = –2.222$; $p = 0.026$; Cohen's d-coefficient = 1.41) and the pulse transit time in cadets were lower ($z = –2.743$; $p = 0.006$; Cohen's d-coefficient = 0.665) compared to students; during the 2nd series of the Digit Span Test pulse transit time measures were also lower in cadets ($z = –2.278$; $p = 0.023$; Cohen's d-coefficient = 0.6605). However, the analysis of

differences in the state measures under neutral vs. stressful conditions demonstrated that SWA measures changed more pronouncedly in students (z = –2.131; p = 0.033) compared to cadets.

Table 5

Physiological parameters in fire cadets and students in exposure groups (group 1 and group 3) at different stages of the study

Stages	ECG – I; HR (beats/ min)			Finger L; SWA (pm)			Finger L; PTT (msec)			FL; EMG (uV)		
	M	M ± SD		M	M ± SD		M	M ± SD		M	M ± SD	
		LL	UL		LL	UL		LL	UL		LL	UL
Baseline, fire cadets	88.57	66.40	110.73	0.53	0.31	0.75	185.04	151.68	218.40	7.84	4.24	10.44
Baseline, students	86.05	72.42	100.67	1.06	0.56	1.56	198.75	172.97	224.54	11.10	8.26	13.89
Digit Span Test, neutral conditions, fire cadets	88.15	78.29	98.01	0.53	0.42	0.64	181.13	165.45	196.81	7.95	5.10	10.14
Digit Span Test, neutral conditions, students	91.7	81.48	99.17	1.29	0.75	1.83	197.24	167.99	226.50	10.51	8.21	12.82

Table 5
Physiological parameters in fire cadets and students in exposure groups (group 1 and group 3) at different stages of the study

Stages	ECG – I; HR (beats/ min)			Finger L; SWA (pm)			Finger L; PTT (msec)			FL; EMG (uV)		
	M	M ± SD		M	M ± SD		M	M ± SD		M	M ± SD	
		LL	UL		LL	UL		LL	UL		LL	UL
Digit Span Test, stress exposure, fire cadets	113.80	95.00	132.94	0.30	0.15	0.45	167.97	142.95	192.65	23.76	20.20	27.33
Digit Span Test, stress exposure, students	117.56	101.23	133.33	0.52	0.16	0.89	180.24	153.82	206.17	27.79	24.95	29.54

Notes: EKG – electrocardiography: *HR* – heart rate; *SWA* – systolic wave amplitude; *PTT* – pulse transit time; *EMG* – electromyography; *M* – mean; *SD* – standard deviation; *LL* – lower limit; *UL* – upper limit.

Table 6
Differences in physiological parameters between fire cadets and students in the stress exposed groups

	Cadets	Students	Mann–Whitney U test	Z	Asymptotic significance levels (two-tailed)
Delta 1 Heart Rate, M	–0.41	5.03	191.000	–2.159	0.031
Delta 1 SWA, M	0.00	0.23	227.500	–1.438	0.151

Table 6
Differences in physiological parameters between fire cadets and students in the stress exposed groups

	Cadets	Students	Mann–Whitney U test	Z	Asymptotic significance levels (two-tailed)
Delta 1 PTT, M	–3.91	–1.51	249.000	–1.010	0.313
Delta 1 EMG, M	0.12	–0.59	254.500	–0.901	0.368
Delta 2 Heart Rate, M	25.65	26.48	296.000	–0.079	0.937
Delta 2 SWA, M	–0.23	–0.77	192.500	–2.131	**0.033**
Delta 2 PTT, M	–13.16	–17.00	300.000	0.000	1.000
Delta 2 EMG, M	15.81	17.28	269.000	–0.614	0.539

Notes: Delta 1 – the difference between baseline findings and the 1st series of the Digit Span Test under neutral conditions; *Delta 2* – the difference between 1st and 2nd series of the Digit Span Test (memorizing under neutral or stressful conditions).

Discussion

Our hypothesis was partly confirmed: compared to memory capacity measured under neutral conditions, stress exposure caused an increase in the capacity of short-term memory in 67 % of fire cadets. Thus, the obtained results suggest that the majority of cadets may increase their cognitive activity under stress. These findings agree with other studies of the inverse U-shaped

curve between physiological tension and performance efficiency, where it was shown that a moderate amount of stress exposure exerts a mobilizing effect (Easterbrook, 1959; McGaugh, 2006; Hancock & Weaver, 2005). Further, we would like to try to explain differences in results obtained in the groups of cadets and students. There are some possible explanations:

1. The two groups could be at different levels of the inverse U-shaped curve. This level could be moderate for fire cadets, which resulted in less pronounced physiological responses and better memorizing, and high for students, which, however, did not lead to a decrease in the memory performance. Table 5 shows that physiological responses differed in fire cadets and students; this difference requires more detailed consideration. Thus, our findings indicate that already during the 1st Digit Span Test series, the cadets were mobilized. That is why the small vessel circulation measures did not drastically change during the 2nd series of test, as it was observed among the students.

2. There is a difference in the motivational and emotional regulation of an aroused physiological state. Fire cadets are able to maintain their cognitive performance at a high level under stress. In terms of motivation, it is associated with the purposefulness of activity, desire to help others, and save lives. In terms of professional competences, it is associated with optimism, positive self-appraisal, and vigor (as components of the appraisal of a situation as a 'challenge'). Moreover, to solve these tasks, cadets were prequalified with medical and psychological screening. They also train themselves to keep calm when performing motor or cognitive tasks under stress (Bityutskaya, Eliseeva, & Shoigu, 2015). Therefore, compared to students, cadets may be more inclined to active problem-solving under stressful conditions (Gurenkova et al., 2007).

While the majority of fire cadets had increased short-term memory capacity, it was decreased in 20 % of cadets; 13 % of cadets had no changes in short-term memory capacity. To explain this fact, we carried out an extension study. In so doing, we based upon the research of self-regulation, which considered short-term memory functions in their associations with intelligence and thinking (Barrett et al., 2004; Velichkovskii, 2016). We analyzed correlations between non-verbal intelligence levels of fire cadets, measured using the *Raven's Progressive Matrices* test, and the results of the 2nd Digit Span Test series. Spearman's rho test was 0.585 ($p = 0.01$). The group of fire cadets who demonstrated an *increase* in short-term memory capacity under stress included those with average levels of intelligence (5 %), above-average levels of intelligence (55 %), and high levels of intelligence (40 %). The majority of fire cadets with *decreased* or *unchanged* short-term memory capacity (60 %) had average levels of intelligence; 30% of them had below-average levels of intelligence. 10 % of fire cadets with *decreased* or *unchanged* short-term memory capacity had high levels of intelligence. This analysis suggests that self-regulation efficiency in stressful situations may be considered in terms of both short-term memory functioning and intellectual characteristics.

Conclusion

The findings from this study of changes in short-term memory capacity under stressful conditions indicated that short-term memory capacity was increased in 67 % of fire cadets and decreased in 20 % of them; 13 % of fire cadets had no changes in short-term memory capacity.

For a more detailed assessment of physiological states of respondents under stressful conditions, further researches in this field should use additional methods, such as the assessment of salivary cortisol.

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GENERAL PSYCHOLOGY, PSYCHOLOGY OF PERSONALITY, HISTORY OF PSYCHOLOGY

UDC 159.9.07 **doi**: 10.21702/rpj.2020.1.4 ***Systematic review***

Assessing the Equivalence of Computerized and Conventional Versions of Psychological Tests

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Abstract

Introduction. This paper (a) discusses the theoretical and methodological evidence for the equivalence of computerized and conventional versions of psychological tests, (b) analyzes the studies investigating psychometric parameters of computerized versions of conventional tests, and (c) examines contradictions in approaches to assessing the equivalence of the two test forms. This paper represents a first effort in structuring the main problems in establishing the equivalence of paper-and-pencil and computer-based testing, as well as in finding ways and means to overcome them. Much attention is devoted to minimal and sufficient mathematical and statistical tools for assessing the equivalence of the two test forms.

Theoretical Basis. The main problems associated with assessing the equivalence of computerized and conventional tests include the following: (a) the level of cultural and informational competence of respondents, (b) anxiety, (c) social environment, (d) motivation for testing, (e) difficulties in creating the same conditions for paper-and-pencil and computer-based testing (L. N. Babanin, Y. P. Chua, M. Russell, P. Květon et al.). Researchers most often choose the following procedures for assessing the equivalence of the two versions of psychological tests: (a) comparison of the main statistical parameters (mean values, variances, etc.) and (b) assessment of construct validity and reliability of the computer-based versions of psychological tests.

Results and Discussion. The analysis of research methodology for assessing the equivalence of computerized and conventional versions of psychological tests focuses on a variety of approaches to (a) the use of mathematical and statistical methods for assessing psychometric parameters of computer-based versions of conventional tests, (b) the choice of research design, (c) considering specific characteristics of the situation of computer-based testing. It is necessary to formulate specific and structured requirements for the procedure for assessing the equivalence of computerized and conventional versions of psychological tests. The author suggests recommendations for the main sections of such requirements related to (a) the procedure for conducting empirical research, (b) mathematical and statistical methods, and (c) control of the factors specific to computer-based testing that may have impact on the results of equivalence assessment.

Keywords

psychological tests, psychometric parameters, equivalence of tests, mathematical and statistical methods, computerization of tests, computer-based testing, computer psychodiagnostics, research methodology, validity, test reliability

Highlights

- The lack of the standardized assessment of psychometric equivalence of paper-and-pencil and computer-based tests is a methodological issue.
- The standardized procedure for assessing the equivalence of paper-and-pencil and computer-based tests should impose uniform requirements for research design, as well as for methods of mathematical and statistical data processing.
- To consider specific factors of a computer-based testing situation, researchers are advised to use observation cards or questionnaires for identifying the level of computer literacy in respondents, their motivation and attitudes towards computer-based psychodiagnostics.

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Introduction

The increased pace of life, large amount of information, and a wide range of technical possibilities dictate the need for time savings during psychological research. As a result, computer-based testing replaces paper-and-pencil (conventional) formats of psychological tests, which makes it possible to remotely collect information and to automate the processing of data. Various services, including Google forms, online survey services, and specialized programs are used for that purpose. In most cases the replacement of a paper-and-pencil format by a computer-based one is reduced to a simple action – the text of a questionnaire (or another kind of stimulus materials) is presented in an electronic format and sent to all the respondents. In a similar way, the norms used for interpreting paper-and-pencil tests are applied to their computer-based counterparts.

Researches have investigated the issues of the equivalence of computer-based and conventional tests for a long time. Mazzeo, Druesne, Raffeld, Checketts, & Muhlstein (1992) argue that special studies of the comparability of indicators of these formats need to be conducted. Previous studies in this field introduced a number of fundamental contradictions regarding psychometric parameters that should be assessed. Hypothetically, the validity of the two test forms will be equivalent, if the two test forms are proved to be equivalent (George, Lankford, & Wilson, 1992; Ford, Vitelli, & Stuckless, 1996). However, L. M. Honaker made the point that validity indices from a paper-and-pencil version cannot be automatically transferred to a computer-based one (Honaker, 1988). Such cases require additional validity assessments (Russell, Goldberg, & O'connor, 2003). Anastasi and Urbina (2009, p. 93) agree with him saying, '... the reliability and validity of the test can vary depending on the format of presentation'. Baturin and Melnikova (2011a, 2011b) note that the procedure for creating a computer-based version of a conventional test is not a simple process of copying stimulus materials from one format to another, but its *modification*, which implies the process of its processing. A number of other scholars share this opinion, saying 'the computer-based version is a completely independent test, which use is possible only after

the assessment of group norms and other psychometric characteristics' (Vasserman, Iovlev, & Chervinskaya, 2010, p. 23). Moreover, some researchers suggest that the coincidence of scores from paper-and-pencil and computer-based testing does not mean that both form measure the same psychological construct, as supported by a number of personality tests (Meade, Michels, & Lautenschlager, 2004). Despite the fact that this issue has drawn attention at the end of the 20th century, not all researchers, as we will show, carry out a complete assessment of the psychometric parameters of computer-based tests. The mathematical and statistical methods for analyzing their equivalence are quite diverse. The choice of these methods is often not explained by authors.

Diverse opinions regarding psychometric parameters of computerized tests that require verification are partly explained by the lack of clear standardized instructions for the procedure for establishing the equivalence between paper-and-pencil and computer-based versions of psychological tests. Certain recommendations regarding the development of psychodiagnostic tools make it possible to structure the information accumulated in this area and facilitate the work of psychologists and other specialists in this field. A series of articles by Baturin and Melnikova (2009–2011); American Educational Research Association, American Psychological Association, & National Council on Measurement in Education (1999) (AERA, APA, NCME) seem to be a good example. Assessing the equivalence of paper-and-pencil and computerized tests is a specific area of psychodiagnostics, which requires certainty and standards.

Obviously, the computerization of paper-and-pencil tests will be a massive process in the future. At the same time, researchers and scholars are growing concerned about the validity of computer-based versions of paper-and-pencil tests. Thus, there is a need to standardize and control the process of converting paper-and-pencil tests to computerized formats.

This paper discusses the experience of assessing psychometric parameters of computerized versions of conventional psychological tests, concentrates on the minimum set of mathematical and statistical methods for assessing the equivalence of the two test form, and suggests the need to formalize the procedure for establishing specific conditions of computer-based testing (directly during the assessment of equivalence) and their subsequent accounting when interpreting the results.

Theoretical Basis

Researchers and scholars actively discuss the influence of various factors on the process and procedure for computer-based testing. Pointing to factors that can affect the equivalence of the two test forms (experience with various computer-based applications, anxiety, social environment, etc.) Babanin (2010) concludes that the level of general cultural and information competence (level of mastering information technology) is the main one. However, the computer literacy of respondents still does not solve the problem of differences in data when assessing the equivalence of computer-based and paper-and-pencil testing (Russell et al., 2003). When converting paper-and-pencil tests to computer-based formats, the conditions for computerized tests should fully correspond to those for their paper-and-pencil counterparts (time for presenting stimulus materials, possibility of correcting answers, strict/non-strict order of answers, etc.). This is one way to increase the equivalence of these formats.

The choice of mathematical and statistical data analysis methods is the next point that requires special attention. What measures can be considered necessary and sufficient to verify the psychometric equivalence of computerized and paper-and-pencil testing?

The Guidelines for Computer-based Tests and Interpretations (APA, 1986) contains the main statistical methods and indicators that determine the psychometric equivalence of computer-based and conventional test forms, including descriptive statistics (mean values, variances, distributions, and rank orders), construct validity, and reliability. Nevertheless, when assessing equivalence the authors do not always observe all these points and use additional types of analysis in certain cases (i.e. Bartram, 1994; van de Looij-Jansen, Goldschmeding, & Jan de Wilde, 2006; Květon, Jelínek , Vobořil, & Klimusová, 2007; Chua, 2012). So what determines the choice of methods for assessing psychometric characteristics of computer-based versions of conventional psychological tests? What is the minimum list of methods that are sufficient to prove the equivalence of paper-and-pencil and computer-based test formats, or the independence of the computer-based format as a tool?

Table 1 provides an overview of studies of the equivalence of computer-based and paper-and-pencil testing over the past 20 years. The analysis criteria were as follows: (a) research design, (b) use of certain statistical methods to process the results, (c) explanations for their choice or purposes of their use, and (d) specific characteristics of computer-based testing procedure (observation of respondents during computer-based testing, additional questionnaires to identify the attitudes of study participants to computer-based testing if it is carried out via the Internet, etc.).

Results and Discussion

As can be seen from Table 1, when comparing computer-based and paper-and-pencil formats of the same test, researchers consider different aspects. By accepting the fact that a computer-based test is valid, some of them only assess its reliability. The others consider it sufficient to carry out correlation analysis and comparison of means to prove equivalence. Still others prefer to immediately assess all the psychometric parameters of a computer-based test form. Can the choice of statistical methods depend on specific characteristics of stimulus materials? It seems that if the technique consists of questions (statements) and answer options (like a questionnaire), then converting a paper-and-pencil test to a computer-based format will not entail serious changes. Some researchers have come to this conclusion. Thus, reliability of multiscale tests is preserved when they were converted from a paper-and-pencil form to a computerized one (Romek & Satin, 2000). On the other hand, if stimulus materials represent a creative task, or the technique involves working with pictures, graphic symbols, and is time-limited, etc. (i.e. some cognitive tests), psychometric parameters of computer-based formats of such tests require a more responsible processing. The table shows that this logic does not always underlie the choice of statistical methods for assessing the equivalence of the two test form.

Moreover, there is a variety of approaches to research design when assessing the equivalence of the two test form (computer-based and conventional). Thus, Romek and Satin (2000), van de Looij-Jansen et al. (2006) use intergroup comparisons (when one group takes only a paper-and-pencil test and another – only a computer-based one) (see also Andersson, Kaldo-Sandström, Ström, & Strömgren, 2003; Vecchione, Alessandri, & Barbaranelli, 2012). Ermakov (2016) and Kibalchenko, Ustinov, & Shapovalov (2004) use intragroup comparisons, when representatives of the same group take both paper-and-pencil and computer-based tests after a certain period of time (also see Hays & Mccallum, 2005). Both intergroup and intragroup comparisons are also used (Květon et al., 2007; Kononova & Nakhaeva, 2013). Each of the assessment options described above has its advantages and disadvantages.

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
V. G. Romek, D. K. Satin, 2000	Eysenck Perso-nality Questi-onnaire (Q; TUL; VERB; PERS) Self-confidence Test (Q; TUL; VERB; PERS)	Intergroup comparison Remotely (via the Internet); in the presence of a specialist	Comparing the factorial structures of the test; reliability index (Cronbach's a); comparing means and variances; test-retest reliability	Comparing reliability; assessing the difference between the norms	Data on the procedure for considering specific characteristics of a situation of computer-based testing are not provided	Psychometric characteristics of tests are preserved; reliability is not reduced
I. A. Kibal'-chenko et al., 2004	Assessment of Interests in Primary School Children (Q; TUL; VERB; PERS) Map of Giftedness (Q; TUL; VERB; PERS)	Intragroup comparison	Spearman correlation coefficient	Assessing test-retest reliability	Data on the procedure for considering specific characteristics of a situation of computer-based testing are not provided	High-level representative reliability of computer-based versions; computer-based versions can be used instead of paper-and-pencil ones

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
B. V. Iovlev et al., 2006 (Iovlev, Novozhilova, Chervinskaya, & Shchelkova, 2006)	Neurotic Personality Questionnaire (Q; TUL; VERB; PERS)	Intragroup and intergroup comparison	Ranking of average means of questionnaire scales in each group; correlation analysis	Not provided	Data on specific characteristics of a situation of computer-based testing are not provided	Paper-and-pencil and computer-based versions are equivalent
P. M. van de Looij-Jansen et al., 2006	Youth Health Monitor Rotterdam, YMR (Q; TUL; VERB; PERS)	Intergroup comparison; in the presence of a teacher	Two-way analysis of covariance (ANCOVAs)	Comparing the results of paper-and-pencil and computer-based tests	Data on specific characteristics of a situation of computer-based testing are not provided	The majority of test scores have no significant differences

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
P. Květon et al., 2007	Bourdon Test (*GS*; TL; NVERB; COG)	Intergroup comparison	One-way analysis of variance; Tukey test for pairwise comparisons; Cronbach's α	Comparing the results of paper-and-pencil and computer-based tests; comparing reliability	To consider the influence of conditions different designs of computer-based tests were used	Paper-and-pencil and computer-based tests substantially differ from each other
P. Květon et al., 2007	Test of Concen-tration of Atten-tion, TCA (*GS*; TL; NVERB; COG)	Intragroup and intergroup comparison; in the presence of a specialist	General Linear Model (GLM); Test of Between-Subjects Effects from the Multi-variate GLM; Tukey test for pairwise comparisons; correlation analysis	Assessing the influence of testing order (C-P; P-C; P-P; C-C)*** and its form on the results; assessing reliability	Data on specific characteristics of a situation of computer-based testing are not provided	Test forms are not equivalent. Specific effects of the form and order of testing were found to affect test results

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
Y. P. Chua, 2012	Yanpiaw Creative-Critical Styles test, YBRAINS (Q; TUL; VERB; COG)	Intragroup and intergroup comparison	Independent samples t-test; split-plot ANOVA; test-retest reliability (Pearson product moment coefficients); Cronbach's a	Impact of the effect of testing and the test form on results; test-retest reliability; comparing reliability	Data on specific characteristics of a situation of computer-based testing are not provided	High validity of both test forms; the paper-and-pencil version turned out to be more sensitive to testing time and motivation for testing

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
P. Žitný et al., 2012 (Žitný, Halama, Jelínek, & Květon, 2012)	Test of Intellect Potential, TIP (GS; TL; NVERB; COG) Vienna Matrices Test (GS; TL; NVERB; COG)	Intragroup and intergroup comparison	Correlation analysis; Fisher z-transformation; Cohen's d effect size on the basis of independent samples t-test	Comparing means of test scores depending on gender and place of residence; comparing criterion and construct validity	Data on specific characteristics of a situation of computer-based testing are not provided	Construct validity of all test forms is proved; the results of the computer-based version of the test are comparable to those of a conventional one
V. N. Kononova, I. V. Nakhaeva, 2013	Color Mirror (PM; MT; TUL; NVERB; PERS)	Intergroup and intragroup comparison; in the presence of a specialist	Phi correlation coefficient, chi-square; correlation analysis	Analysis of the ratio of test scores; test-retest reliability	Individual interaction with a psychologist during testing	Testing forms are not fully equivalent

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
O. V. Mitina, V. V. Sorokina, 2015 (Mitina & Sorokina, 2015)	Schwartz Value Inventory, SVI (Q; TUL; VERB; PERS)	Intergroup comparison; in the presence of a psychologist	Cronbach's α; Student's t-test; Mann–Whitney U test; Levene's test of equality of variances; correlation analysis	Assessing reliability; comparing the results in subsamples by gender; assessing the validity of the computer-based version	Data on specific characteristics of a situation of computer-based testing are not provided	Psychometric reliability and validity of the computer-based version is proved
S. S. Ermakov, 2016	Raven's Standard Progressive Matrices Plus, SPM+ (GS; TL; NVERB; COG)	Intragroup comparison	Correlation coefficient; Student's t-test	Assessing test-retest reliability; assessing differences between groups	Data on specific characteristics of a situation of computer-based testing are not provided	Computer-based version of the test can be considered a counterpart of its paper-and-pencil version

Table 1
Comparing computer-based and paper-and-pencil (conventional) psychodiagnostic tests: An analysis of existing studies

Author, year	Psycho-diagnostic test, brief description of stimulus materials*	Research design**	Mathematical and statistical data processing methods	Aim of mathe-matical statistical analysis	The proce-dure for consi-dering specific characteristics of computer-based testing (observation or survey)	The main conclusions concerning the equivalence of the two test forms
K. V. Sugo-nyaev et al., 2018	SIT-30 test, a shortened and modified version of the Short Indicative Test (Q; GS; TL; VERB; NVERB; COG)	Intergroup comparison; Internet version; in the presence of a specialist (both tests)	Correlation and factorial analysis, comparing of means, measures of variability, and instantaneous reliability; comparing item discrimination and difficulty coefficients, their factor loadings on the general factor	Comparing testing results from a controlled and uncontrolled Internet formats.	Data on specific characteristics of a situation of computer-based testing are not provided	Psychometric characteristics of test performance via the Internet are not inferior to those calculated under controlled testing

Note: * Q – questionnaire, *GS* – graphic symbols, signs, figures; *PM* – projective technique; *MT* – manipulation technique; *TL* – time-limited testing; *TUL* – time-unlimited testing; *VERB* – verbal test; *NVERB* – non-verbal test; *COG* – cognitive characteristics; *PERS* – personal characteristics;
** research design by the following parameters: intragroup/intergroup comparison; remote testing/in the presence of a psychologist (if the article provides the data);
*** C – computer-based version of the technique; *P* – paper-and-pencil version of the technique.

Moreover, in our opinion, intragroup comparisons make it possible to control the influence of a respondent's personality when he/she takes both paper-and-pencil and computer-based tests. This kind of influence can manifest itself in an intergroup design situation, when the difference in results can be explained not by the test form but by differences in personal characteristics of two groups of respondents (i.e. if one group comprises more anxious individual participants than another).

When taking computer-based tests additional factors also need to be considered for a thorough assessment of equivalence (Chua, 2012). In this regard, the table included such a criterion for analyzing the content of articles as 'the procedure for taking into account specific characteristics of computer-based testing (observation or survey)'. Even a relatively minor modification in a computer-based test design (i.e. changing a color scheme) can substantially affect the results (Květon et al., 2007). It is also believed that compared to paper-and-pencil tests, taking the computer-based ones is associated with a quite different cognitive load, which leads to 'stratification of the sample, when the worst show even worse results and the best demonstrate even better results' (Ermakov, 2016, p. 203). Moreover, the pre-test and post-test designs may lead to the effect of testing (the experience of passing the pre-test affects the results of the post-test); overlooking this fact researchers may conclude that external conditions affected the results of the post-test (i.e. a computer, if it was the second). To avoid incorrect conclusions related to the effect of testing, Chua (2012) suggested R. L. Solomon's experimental plan for four randomized groups (for details see Solomon, 1949; Campbell & Stanley, 1963; et al.). Another problem associated with taking computer-based tests remotely (via the Internet) is falsification of the results (Sugonyaev, Radchenko, & Sokolov, 2018). It is recommended to recheck such results under controlled conditions (The International Testing Commission, 2006).

A more thorough research design – choosing a number of respondent groups, the sequence of testing series, etc. – requires consideration of all these points. We believe that it will be useful to organize observation of respondents' behaviors when they take computer-based tests. This will help to eliminate the results of respondents demonstrating a high level of anxiety during testing, a low level of motivation or their incompetence when interacting with computer interface (information incompetence). Such an observation can help modify the procedure for computer-based testing or the presentation of stimulus material, if most respondents show difficulties during it. All this may be organized at the stage of programming a computer-based version of a conventional test in order to exclude the influence of some factors on the results of equivalence of its two forms.

Considering the problem of psychometric properties of computer-based versions of conventional tests, K. V. Sugonyaev et al. provides a specific procedure for statistical analysis; we believe that it may help establish the equivalence of the two test forms. The researchers argue that comparing 'measures of central tendency, variability, and simultaneous reliability of integral test scores' (Sugonyaev et al., 2018, p. 8) is insufficient for assessing the comparability of test results. The analysis of test performance at the item level – similarity/difference in the 'distribution of coefficients of item difficulty and discrimination, as well as in the patterns of item factor loadings on the general factor' (Sugonyaev et al., 2018, p. 18) – may be a method designed to prove the equivalence of the two test form. Thus, the authors attempted to explain and prove the necessary minimum of statistical methods for assessing the equivalence between the computerized and paper-and-pencil tests. In the remaining articles (Table 1), as a rule, the researchers do not explain the choice of methods of mathematical and statistical analysis (as

well as the research design (intergroup/intragroup)) from the point of view of their sufficiency for assessing equivalence. And yet, as the conditions for taking a computer-based test differ from those for a paper-and-pencil one, and taking into account all the factors listed above that can influence the performance of a computer-based test, we suggest not abandoning the idea of assessing the validity and reliability of computerized versions of conventional tests.

The analysis of studies related to assessing the equivalence of computer-based and pencil-and-paper tests allows us to conclude that most of them are published by foreign experts. Despite numerous programs for computer-based psychodiagnostics (Mel'nichuk & Sergeev, n.d.; Budko, Mishin, & Tregubova, 2007), few Russian studies address the procedure for assessing psychometric properties of computer-based versions of conventional tests. To make matters worse, a small number of articles examine the quality of assessing the equivalence of computerized versions and their conventional paper-and-pencil counterparts.

Conclusion

Without a doubt, psychometric parameters of computer-based versions of conventional tests should be assessed. Therefore, *distinct requirements for the procedure for such assessments and standardized instructions for specialists involved in programming computer-based versions of conventional tests represent an important aspect of research*.

Obviously, brief instructions presented in the Guidelines for Computer-based Tests and Interpretations (APA, 1986), or the detailed however inconcrete ones from Standards for educational and psychological testing (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999) are insufficient.

We assume that these recommendations should contain distinct instructions for each of the following sections:

1. Research design requirements necessary for a thorough assessment of the equivalence of paper-and-pencil and computer-based versions of psychodiagnostic tests (number of groups, minimum sample size, sequence of various test forms, time interval between repeated measurements, methods for assessing construct validity, etc.).
2. The list of necessary and sufficient methods of mathematical and statistical data processing that help establish the equivalence between paper-and-pencil and computer-based tests.
3. Description of factors that may affect the results of computer-based and paper-and-pencil tests and recommendations for certain conditions for assessing equivalence. The methods to ensure these factors include observation cards for respondents' behaviors during testing and standardized questionnaires that assess motivation, attitudes towards computer diagnostics, the level of computer literacy, etc. (Testing Motivation Questionnaire (Chua, 2012), Computer Familiarity Questionnaire (Mazzeo et al., 1992)). This will help eliminate the influence of additional variables on the test results and obtain more reliable results when assessing the equivalence of conventional and computer-based psychodiagnostic tests.

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EDUCATIONAL PSYCHOLOGY

UDC 159.9.072.43 **doi**: 10.21702/rpj.2020.1.5 ***Original research article***

Temporal Characteristics of Students as Cognitive Diagnostic Characteristics: The Context of Adaptive Education

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Abstract
Introduction. The article presents the results of an experimental study of the individual temporal characteristics of cognitive space management in students while solving problems.
Methods. The methodological tools are briefly described, including traditional test questionnaires for identifying temporal features of subjective perception of time ('Semantic Time Differential', 'Time Perspective'), as well as modified and original research methods for identifying temporal characteristics of the cognitive activity of subjects in solving spatial problems in a laboratory experiment ('Mental rotation', 'Accuracy').
Results. In a series of laboratory experiments, new research data were obtained on the temporal specificity of the process of constructing a personal cognitive space in students. Using prognostic modeling procedures, we were able to record the presence of structural relationships between the time perception, cognitive characteristics of problem-solving, and stability of academic performance. It was experimentally proved that characteristics of time reaction and effectiveness in completing accuracy tasks and mental rotation tasks act as temporal predictors of levels of students' academic performance.
Discussion. The study revealed the fact that students with a dominant temporal orientation toward the present situation, looking constantly for new stimuli and feelings in the current time, had quite pronounced deficits in the choice of educational strategies based on more long-term and well-defined objective in the future. It was noted, as an important aspect in the personalization of studying, that students must be aware of their own temporal, cognitive and other characteristics of the information processing, and manage on their own their educational environments as appropriate. The possibilities are discussed in using cognitive diagnostic characteristics to predict and timely correct individual trajectories of students' educational paths as part of the adaptive approach to education.

Keywords
temporality, predictor, subjective perception, time perception, academic performance, temporal perspective, cognitive tasks, mental rotation, time of reaction, cognitive strategies

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Highlights

- Individual originality of the students' temporal management of the cognitive space (characteristics of time of reaction and effectiveness of the cognitive tasks performance) serves as a cognitive diagnostic pattern of the individual behavior adequacy to the temporal space of cognitive environment and its specified requirements.
- Students with typological differences in the dominant temporal orientation and cognitive strategies choice in a real situation of solving spatial problems are pronouncedly different in their academic performance stability.
- Temporal differences in subjects of the educational process can be considered as a significant basis for the need for a variety of temporal options in educational technologies, especially in the context of exploding digitalization in modern education.

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Introduction

According to experts, effective implementation of innovative educational technologies in a modern university implies the building of individual trajectories of students' professional training along with other flexible changes in the organization of the educational process. To a large extent, the effectiveness of teaching modern students depends on the development of such meta-professional competencies as the willingness and ability to self-organize their own activities, the ability to choose optimal cognitive strategies in research, educational, and scientific activities. Today it is clear that in the development of individual educational trajectories, the cognitive characteristics of a person cannot be ignored, such as temporal features reflecting the details of time structures and the chronotopic orientation in the person's life. (Bredun, Krasnoryadtseva, & Shcheglova, 2018). Many interesting details have been reported about the psychological nature of a phenomenon of subjective perception of time, since the term 'temporary perspective' has been firstly used by L. Frank (Frank, 1939). The authors of the article do not purport to present a rigorous transspective analysis of the genesis of ideas about this phenomenon in psychological science. However, researchers should be mentioned, who's work allowed the authors to determine the research focus in their conception of the temporal orientation structure. Those are classic works by P. G. Zimbardo, who defined a phenomenon of the perspective as a personality construct depending on the attitude to time (Zimbardo & Boyd, 2010; Zimbardo & Boyd, 1999). In recent investigation very interesting findings were obtained, that is:

– The relationship between the accuracy of temporary solutions and the ability to synchronize the internal rhythm with the rhythm that the environment offers (Grondin, 2010; Wearden, 2003; Wittmann, Dinich, Merrow, & Roenneberg, 2006).

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

– The relationship between subjective time and perception, attention, and memory has been established (Matthews & Meck, 2016).

– Some age- and interindividual differences in manifestations of temporality were determined (Droit-Volet, Wearden, & Zélanti, 2015; van Heerden, 2016).

The authors of the article paid special attention to the studies where various aspects of the influence of social time on human life were investigated (Thomas, Didierjean, Maquestiaux, & Goujon, 2018; Arstila & Lloyd, 2014; Bolotova, 2006; Gorobets, 2011; Gorkaya, 2014; Khmelevskaya, 2012).

Thus, the analysis of the current state and exploration trends in the investigations of temporal characteristics of the human lifeworld made it possible to pose a research task to identify possible temporal predictors of the level of academic performance at a student age. In adolescence the time perspective is closely related to the student's real and educational achievements, since it includes professional self-determination, future achievements, setting educational and professional goals and tasks. Of particular interest are research data obtained by N. D. Gordeeva, suggesting that in subjects focused more on the speed of execution than on accuracy when solving cognitive problems, cognitive processes tend to slow down (Gordeeva, 1995). Based on this fact we postulated a research hypothesis that the speed of cognitive problems solving could serve as a temporal predictor of academic performance. The results of the verification of this hypothesis are presented in this article.

Methods

We evaluated the temporal characteristics of subjective perception of time using such methods as 'Semantic Time Differential' (Vasserman, Trifonova, & Chervinskaya, 2009), and the test 'Temporal Perspective' (Zimbardo Time Perspective Inventory – ZPTI) F. Zimbardo (Zimbardo & Boyd, 2010). The chosen methods allow to study cognitive, emotional components of time and the duration of experienced subjective phenomena of time (Zimbardo & Boyd, 1999).

To identify the temporal characteristics of the cognitive activity of subjects in spatial problems solving, the method 'Mental rotation' was used as described by R. N. Shepard and J. Metzler (Cooper & Shepard, 1973; Shepard & Metzler, 1971) in the modification of D. Yu. Balanev (Klochko, Krasnoryadtseva, & Balanev, 2016). This version of the technique gives a possibility to build perceptual space not on a 2D plane but in the three-dimensional space, using a 3D modeling technology, which permits to display a mental movement as a spatial motion. This procedure is aimed to assess the spatiotemporal characteristics of the process of solving a cognitive task.

The experimental procedure involves displaying a series of paired stimuli on a computer screen. In each pair of objects, one is slewed around the other, and research subjects must decide if stimulus objects were identical or not and using a graphic pen check one of two answers: 'different' or 'identical'. Each participant must solve a total of 96 tasks.

A technique *Accuracy* (Klochko et al., 2016) is an experimental procedure, aimed to identify the relationship between the spent time and accuracy in solving experimental problems. The purpose of the procedure is to measure the spatial and temporal characteristics of the procedural and cognitive activity of a person.

The procedure involves displaying a series of stimuli that represent ellipses characterized with different positions in the screen space, different diameters, and different center locations. Research subjects are instructed to indicate as accurately as possible the center of stimulus figures on the screen with a pen. The experimental procedure takes 20 minutes.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

As the academic performance index an arithmetic average of grade scores in disciplines mastered by bachelor students during at least 3 years of study (average grade score).

The experimental group consisted of 150 students Tomsk State University, studying at the Faculty of Historical and Political Sciences, at the Institute of Applied Mathematics and Computer Science, and at the Biological Institute.

Results

Based on empirical data and using prognostic modeling procedures, we hypothesized structural relationships between the time perception, cognitive characteristics of problem-solving, and academic performance.

To build a predictive model that describes the influence of time perception on university academic performance, we have carried out a multiple regression analysis. The average student performance grade, which was calculated as the arithmetic mean of the grade scores received by students for exams during their studies at the university, was a dependent variable. The parameters measured by the Semantic Time Differential and Temporal Perspective methods (N = 20) were chosen as independent variables. The algorithm for including independent variables in the regression equation was realized using a step-by-step method of 'exception'. As a result, a regression model was obtained (p = 0.003), which included 8 predictors (Tables 1, 2, 3). According to the obtained model, 44 % of the variance of the average grade score variable is accounted for the influence of such predictors as 'future', 'perceptibility of the past time', 'activity in the present time', 'structure of the present time', 'perception of the present time', 'emotions for the future time', 'the scale of the future time', and 'the perceptibility of the future time'. Regression coefficients (Table 3) show that predictors 'future', 'scale of the future time', 'structure of the present time', 'perceptibility of the present time' correlate positively with the dependent variable 'average grade score', while such predictors as 'perceptibility of the past time', 'activity in the present time', 'emotions for the future time', and 'perceptibility of the future time' correlated negatively.

Table 1
Results of the regression analysis

Revise for the model				
Model	R	R-square	Adjusted R-square	Standard error of estimate
1	0.663[a]	0.440	0.319	0.61493

a. Predictors: (constant), the perceptibility of the future time, the perceptibility of the present time, the future, the structure of the present time, the scale of the future time, the perceptibility of the past time, the activity in the present time, the emotions for the future time.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

Table 2
Results of the regression analysis

ANOVA[a]

Model		Sum of squares	D. of ass.	Mean Square	F	*P value*
1	Regression	10.997	8	1.375	3.635	0.003[b]
	Rest	13.991	37	0.378		
	Total	24.988	45			

a. Dependable variable: average grade score;

b. Predictors: (constant), the perceptibility of the future time, the perceptibility of the present time, the future, the structure of the present time, the scale of the future time, the perceptibility of the past time, the activity in the present time, the emotions for the future time.

The obtained prognostic model shows that respondents who structure their present from the perspective of a future-orientated position can be more successful in learning, as a rule (with better academic performance). While students who are more focused on the present time or future, prone to abstract images full of emotions rather than to specific goals and actions, will be less successful in learning (lower academic performance).

Since the assessment of the studying achievements includes not only a general grade score but the stability of academic performance grades, as well, we divided the students in this study into 7 groups according to the results of the total of examinations depending on the stability/ instability of academic achievements: group 1 – different ways of instability; group 2 – unstably successful ('5', '4' or non-appearance); group 3 – stably unsuccessful; group 4 – a steady decline in success; group 5 – stably mediocre; group 6 – a steady increase in success; group 7 – stably successful.

To study the influence of cognitive abilities demonstrated in solving mental rotation problems on the stability of students' academic performance, a regression analysis was performed, where the stability variable played the role of a dependent variable (response), and the speed and accuracy indicators recorded in a time of mental rotation problems solving were predictors. As a result, a regression model was obtained (p = 0.000), which characterizes the quadratic dependence of the stability of academic performance on the accuracy of performing mental rotation tasks (Table 4 and Fig. 1).

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

Table 3
Results of the regression analysis

Coefficients[a]

Model		Non-standardized rates		Standardized rates	t	*P value*
		B	Standard Error	Beta		
1	(Constants)	3.802	0.889		4.278	0.000
	Future	0.507	0.208	0.330	2.438	0.020
	Perceptibility of the Past	–0.244	0.138	–0.365	–1.768	0.085
	The Present Activity	–0.385	0.140	–0.727	–2.752	0.009
	The Present Structure	0.229	0.117	0.320	1.954	0.058
	Perceptibility of the Present	0.424	0.156	0.760	2.716	0.010
	Emotions of the Future	–0.391	0.142	–0.816	–2.750	0.009
	Scale of the Future	0.315	0.131	0.664	2.407	0.021
	Perceptibility of the Futureы	–0.351	0.116	–0.433	–3.026	0.004

a. Dependent variable: average grade score.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

Table 4
Revise for the model and parameters estimates

Dependent variable: stability

Equation	Revise of the model					Parameter estimates		
	R-square	F	D. of ass. 1	D. of ass. 2	*P value*	Constant	b1	b2
Square	0.143	10.976	2	132	0.000	5.062	–2.688E–7	6.473E–15

Independent variable – accuracy.

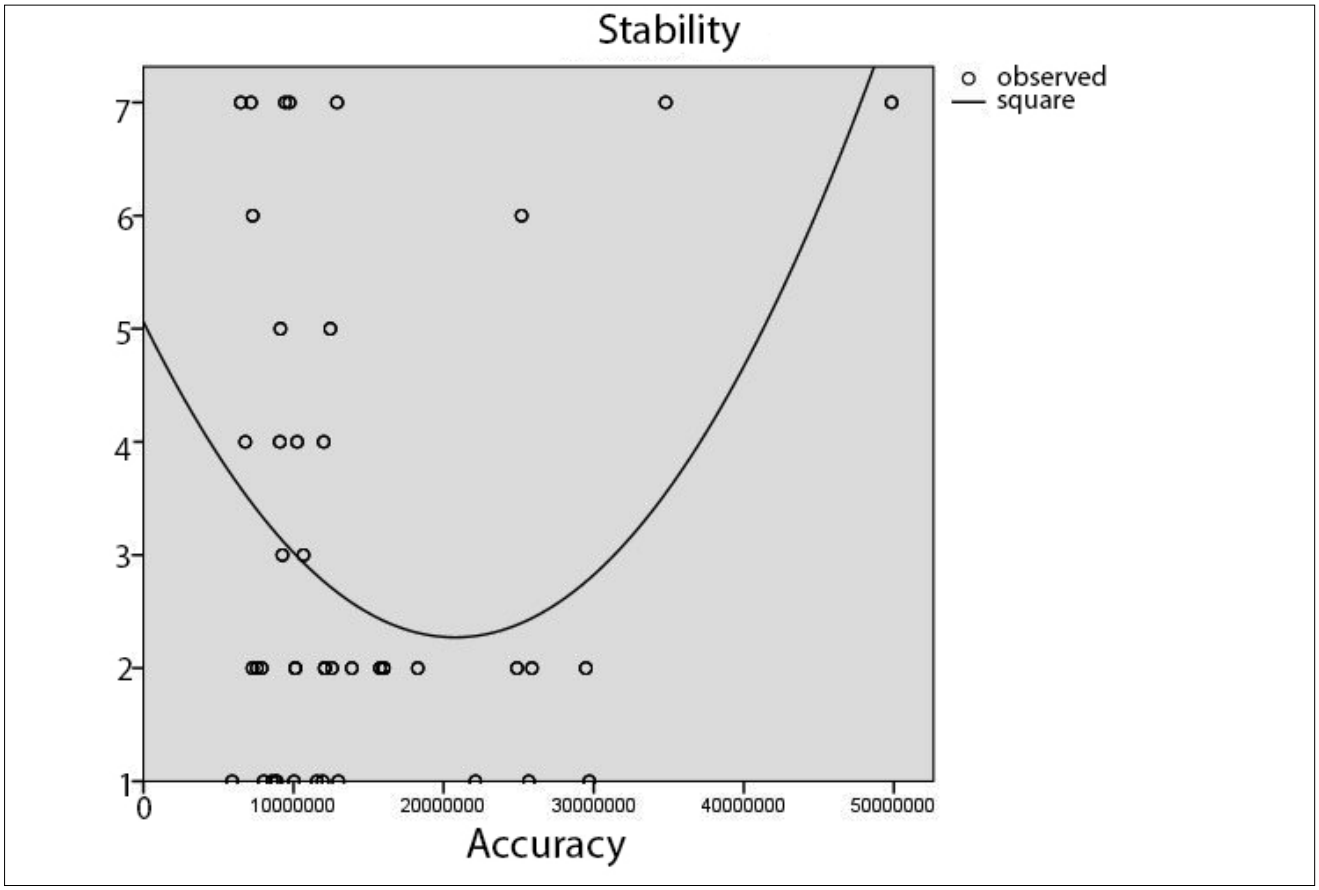

Figure 1. Regression model characterizing the dependence of the stability of academic performance on the accuracy of the mental rotation tasks completing

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

The obtained regression model suggests that students with stable academic performance demonstrated low or high accuracy in tasks completing, while an average accuracy in tasks completing was characteristic for students with academic performance instability and unsteady results in examinations.

A detailed analysis of the results of laboratory experiments in selected groups of students with different academic performance stability revealed that cognitive characteristics tend to influence the academic performance of students and, in particular, the apparent learning stability. The results of this analysis, specific features in the mental rotation tasks completing (speed and accuracy characteristics), demonstrated by students with different academic performance stability are presented in diagrams (Figures 2, 3, 4).

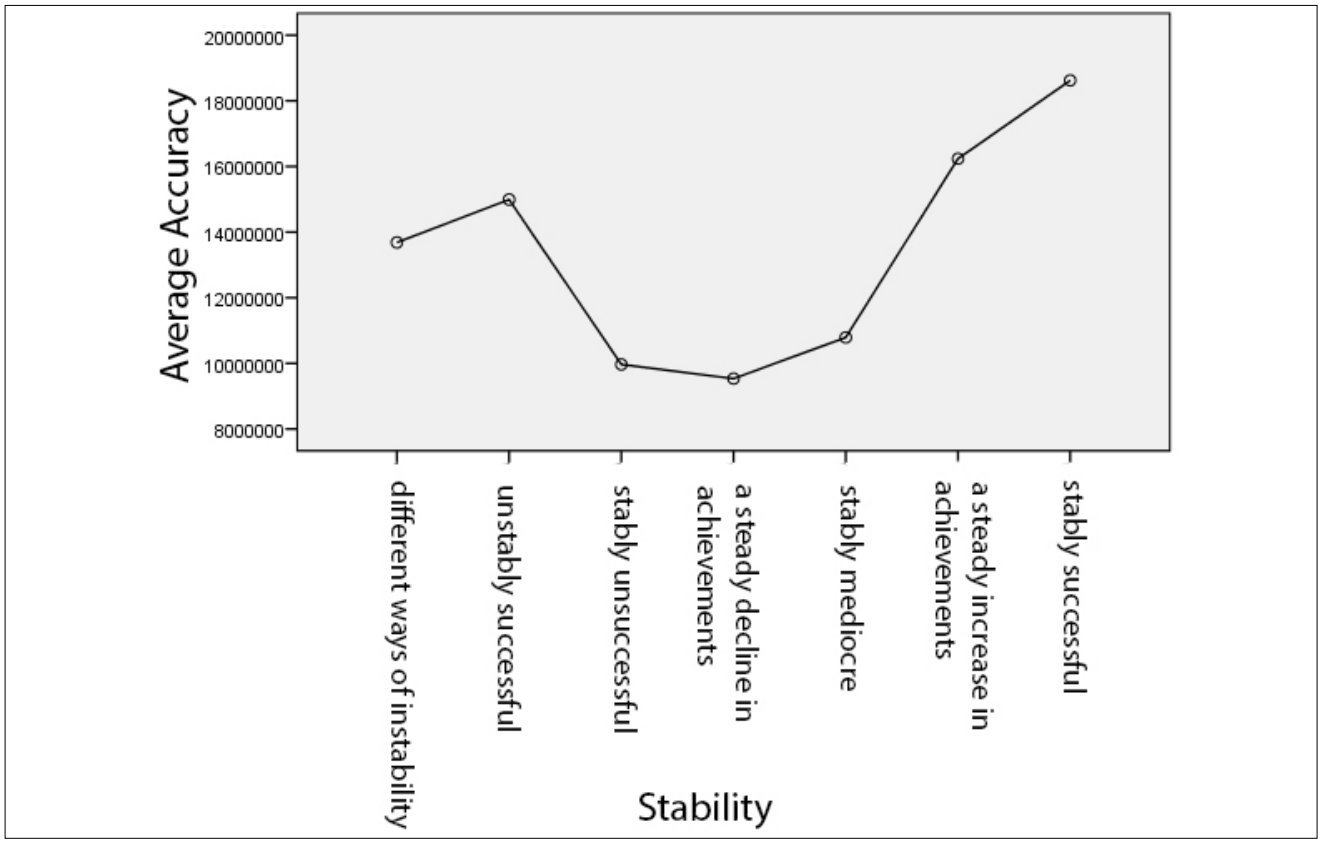

Figure 2. Results of the average speed of accuracy cognitive tasks completing in groups of students with different academic performance stability

The obtained data (Fig. 4) suggest that respondents assigned to the groups of steadily declining performance, stably unsuccessful, and stably mediocre academic performance spent significantly less time on cognitive tasks compared to other respondents. It should also be noted, that students with consistent 'excellent' or 'good' grades (stably successful) performed the proposed accuracy tasks the most slowly of all students.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

When the more complicated on cognitive mental rotation tasks were offered, the results turned out to be somewhat different.

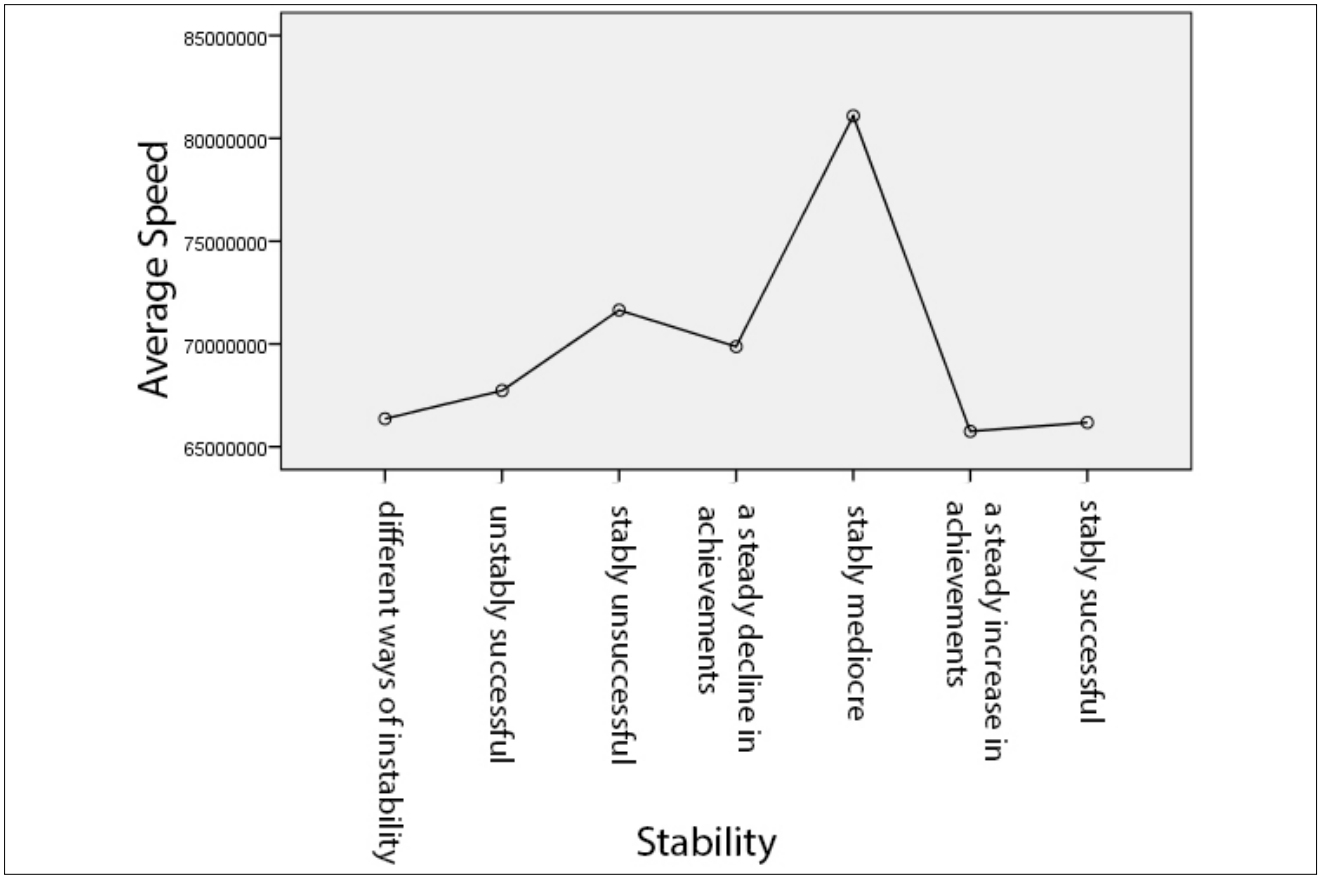

Figure 3. Average speed of cognitive mental rotation tasks completion in groups of students depending on the academic performance stability

The analysis of obtained data suggested that students with the stably mediocre academic performance throughout the entire period of studying at the university spent much more time to complete cognitive mental rotation tasks compared to students assigned to other groups (stably successful, unstably successful, different ways of instability, and with a steady increase in success). At the same time, the students with stably mediocre performance make very few errors compared to other groups, with the exception of students who demonstrate a decrease in performance (Fig. 4). Respondents whose academic performance decreases over time had also few errors in cognitive mental rotation tasks, compared to students of other groups. The most number of errors in cognitive mental rotation task, compared to the other groups, made those students who demonstrated instability in studying and received various grades on exams (from 'unsatisfactory' to 'excellent'), as well as students who passed all exams with only 'excellent' (rarely 'good') grades, or did not appear at an exam when they were not firmly confident in their preparedness (Fig. 4).

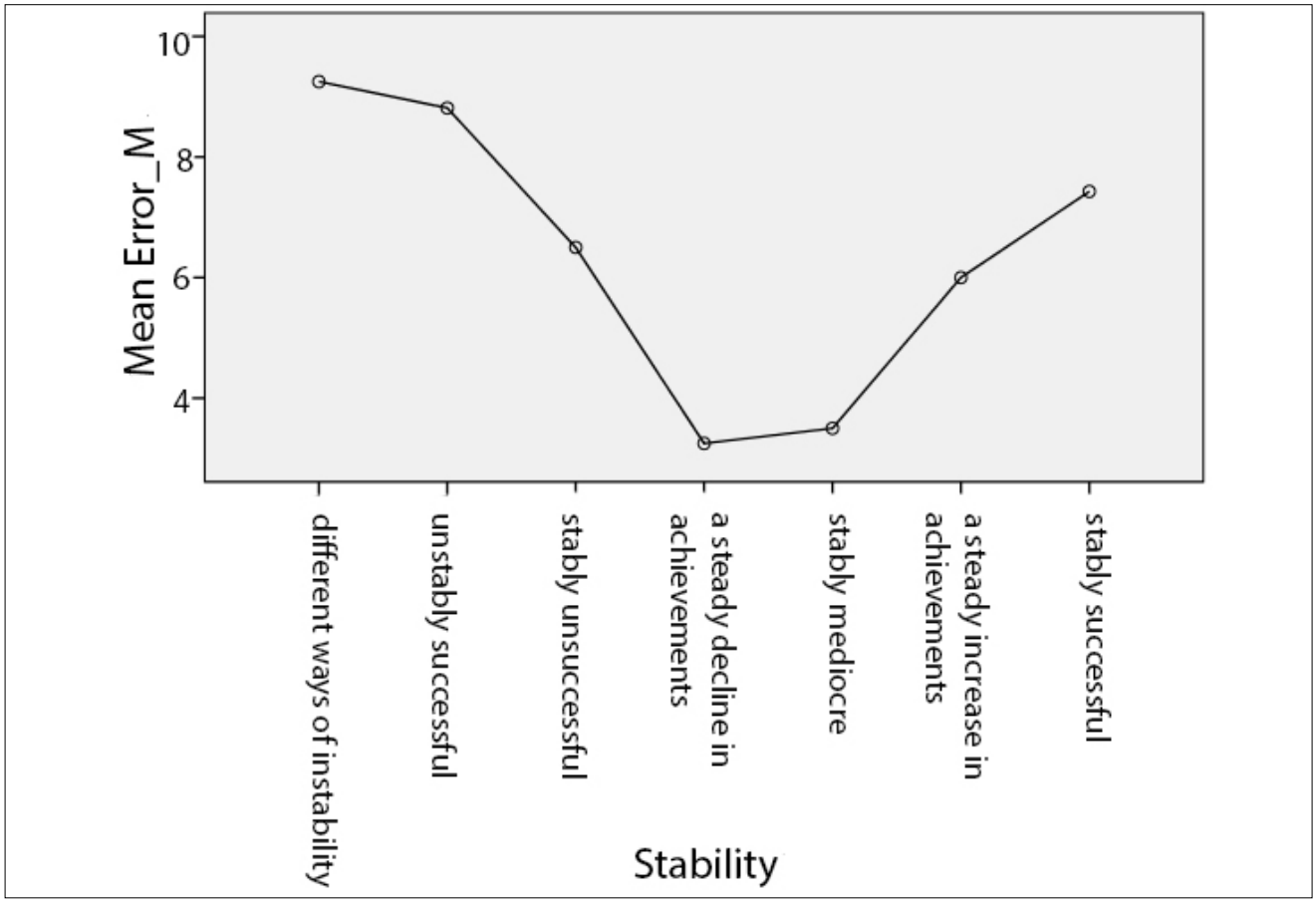

Figure 4. Number of errors while completing cognitive mental rotation tasks in groups of students with different academic performance stability

Thus, solving more complicated cognitive tasks (mental rotation tasks, which are more complicated compared to accuracy tasks) respondents, assigned to groups of low academic performance, spent more time to complete the task. Respondents, assigned to groups with higher academic performance, on the contrary, needed less time to solve mental rotation tasks and more time, in comparison with other groups, to solve accuracy tasks. Moreover, the group of 'ubstably successful' made the most number of errors, while the least academically successful and 'stably mediocre' successful respondents coped with the mental rotation tasks best of all.

It is important to note that in both experimental procedures the speed of presenting tasks depended on the respondent himself so that they performed tasks in the rhythm the most convenient for them. Students who have low or mediocre academic performance spent as much time on solving cognitive tasks as they needed, analyzing each task at their own pace. This allowed them to achieve greater success compared to other respondents. In turn, academically successful students were focused more not on the result, but on the speed, on their ability to finish the task as fast as possible. Perhaps they have analyzed the tasks during the first rounds, and

Russian Psychological Journal, 2020, Vol. 17, No. 1, 60–73. **doi**: 10.21702/rpj.2020.1.5

the solution to the subsequent ones was an integrative process when each subsequent stimulus was compared with those presented earlier. And therefore, the participant devoted little time to complete each problem, relying on the experience gained, which led to a large number of errors, since all the stimuli in this experiment had different cognitive loads.

Discussion

The use of experimental techniques made it possible to obtain factual research material that clearly illustrates the individual temporal identity in the process of organizing cognitive space by students in a situation of a real solution of spatial problems. The trends of the influence of temporal characteristics such as the speed and accuracy in completing cognitive tasks on the academic performance stability of students are revealed. Thus, it can be concluded that the temporal characteristics of students can be considered as prognostic cognitive diagnostic characteristics of academic performance.

It has been experimentally proved that having different temporal characteristics, students are not always able to meet the temporal space of the cognitive environment and the requirements that it imposes. The speed of information processing, the time spent on studying the material, or solving a problem can be one of the determining factors of academic performance. In this regard, it can be assumed that if a student spends as much time studying the material as he needs, he can demonstrate a higher level of success. Thus, facilitating the development of one's ability to structure their cognitive activity on their own is ineffective without taking into account their personal temporal characteristics.

Particularly noteworthy, from our point of view, is the fact that students with a dominant temporal orientation toward the present and characterized by their constant looking for new incentives and sensations in the current time have pronounced deficiencies in the choice of educational strategies based on long-term and well-determined goals for the future. It seems that the orientation of the main professional educational programs of students on the development of their readiness and ability to formulate and solve strategic tasks of their life (including professional) will increase students' self-organization in the current time.

The fact of temporal differences in the subjects of the educational process can be considered as another reason for the need for a variety of options for educational trajectories. Each type of educational technology implies a certain temporality, without taking into account the great variety of dominant modalities of the time subjective perception in students. In this regard, an important aspect of the personalization of education is the ability of a student to understand his/her own temporary, cognitive, and other peculiar characteristics of information processing to be able to organize an educational environment independently. Understanding of cognitive characteristics permits to identify individual differences in information processing, as well as to organize educational support to predict individual trajectories of students' educational paths. The more so, as the number of unsuccessful students, demonstrating a low ability for self-adjustment in the educational environment, continues to be rather high. One of the most promising areas of the practical application of the obtained research results is the adaptive approach to education, actively developed in the context of exploding digitalization of modern education (Borba et al., 2017; Gibson, 2017; Nguyen, Hsieh, & Allen, 2006; Zitter, De Bruijn, Simons, & Cate, 2011; Pavlov, 2017). Adaptive education could be understood as a tool able to improve the quality of educational experience through its personalization. Unlike traditional

educational systems, adaptive education is a way to create a model that highlights individual differences of each student (Nakic, Granic, & Glavinic, 2015; Kochetkova & Kytmanov, 2016; Toktarova, 2017; Shershneva, Vainshtein, & Kochetkova, 2018). The expansion of personalized students' characteristics generated by analysis of psychological, temporal, cognitive, and other data will make it possible to reorient the educational process to real individualization and adjust individual educational trajectories of students taking into account indicators of the dynamics of cognitive characteristics.

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SOCIAL PSYCHOLOGY

UDC 159.9.072.43:316.6 **doi**: 10.21702/rpj.2020.1.6 ***Original research article***

Determinants of Hardiness among Representatives of Three Generations in Modern Russia

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Abstract

Introduction. Generational differences have been scarcely investigated. The factors that help individuals to cope with stressful factors and increasing tension are worth consideration in the context of present-day reality. This study addresses the predictors of hardiness in different generations of Russians.

Methods. A sample of respondents from various regions of the Russian Federation, aged from 18 to 75 years, took part in the empirical study of values, subjective economic well-being, and hardiness factors. The study used the following techniques: (a) the PVQ-R technique for measuring individual values, (b) the Test of Hardiness by D. A. Leont'ev, (c) the Subjective Economic Well-being technique by V. A. Khashchenko, and (d) the Meaning-in-Life Orientations test (MOL) by D. A. Leont'ev), the modified version of the Purpose-in-Life test (PIL).

Results. Representatives of generation Y have a higher overall level of hardiness. The external locus of control influences hardiness in all the three examined generations. This influence is positive for generations X and Y, and negative for baby boomers. Economic anxiety has a negative impact on hardiness in representatives of generations X, Y, and baby boomers. The values of individualism – 'independence: thinking' and 'achievement' – influence hardiness in representatives of generations X and Y.

Discussion. Increased dissatisfaction with financial situation, the inability to save money, and increased economic anxiety decrease the level of hardiness in Russians. The increase in financial well-being can contribute to an increase in hardiness across all the groups of respondents. Independence in the choice of actions, ambitious goals in life, the desire to be successful, and the need for feeling safe and secure increase the ability to withstand stress among representatives of generations X and Y.

Keywords

hardiness, individual values, meaning-in-life orientations, economic attitudes, intergenerational differences, generation X, generation Y, baby boomers

Highlights

▸ Generational differences should be considered in terms of basic socio-psychological characteristics, including the hardiness of generations, values, meaning-in-life orientations, and economic attitudes.

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- An individual's ability to cope with life difficulties depend on value-meaning guidelines and on satisfaction with his/her financial situation.
- Hardiness includes involvement, risk taking, and control.
- Hardiness models differ among representatives of three generations in modern Russia.

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Introduction

It is of prime importance to study the factors that help individuals to cope with stress and increasing tension in present-day reality. Previous studies indicate that faster adaptation to new living conditions, less pronounced cultural shock and a subjective level of stress are associated with increasing level of hardiness (Vanakova, 2014; Kabanchenko, 2017; Klimov, 2011a, 2011b, 2010; Postnikova, 2016). Given the rate of social development, economic instability and instability of political relations, it is extremely important to identify factors and personality characteristics that contribute to the development of hardiness among representatives of different generations of Russians. It is worth noting that this psychological construct have been studied actively as a separate phenomenon and in its association with other psychological categories. However, concern over this problem was only recently brought into a focus of Russian studies.

In a broad sense, hardiness is a reflection of life energy that enables individuals to interact with the environment and contributes to the 'subjective feeling of vitality and energy' that determines, in R. Emmons's opinion, the subjective feeling of personal well-being (Bogomaz & Balanev, 2009). D. A. Leont'ev notes that it is hardiness that enables individuals to endure permanent anxiety that accompanies the choice of the future (uncertainty) rather than the past (immutability) in a situation of existential dilemma (Kuzmina & Moroz, 2010; Leont'ev, 2011). S. Muddy argues that high-hardiness individuals learn to see more and more opportunities and ways to solve life problems in constant changes (Bogomaz & Balanev, 2009; Kobasa, Maddi, & Kahn, 1982).

Hardiness is a personality trait that enables individuals to transform stressful life events into new opportunities; it is associated with the desire to preserve personal values that constitute the core of personality. Such aspects of hardiness as psychological survivability and enhanced efficiency are associated with the ability to change less stable personal values depending on situations (Khromov, 2012). In 2010, a study was conducted aimed at investigating associations between hardiness and frustration (Kuzmina & Moroz, 2010). The authors confirmed the hypothesis that individuals with high-level hardiness are characterized by a search for a constructive way out of a frustration situation; they also observed the following patterns:

1. Individuals with high-level hardiness are characterized by an impunitive type of way out of a frustration situation.
2. The higher the level of hardiness is, the higher the level of social adaptation is.

Additionally, the authors empirically established associations between hardiness and self-appraisal.

This suggests that the more confident in themselves individuals are, the higher the level of hardiness is. The analysis of associations between hardiness and communication skills suggested the following patterns: (a) There is a positive association between hardiness and competent communication. (b) There is a negative association between hardiness and aggressive and protective ways of communication. This means that life-resistant individuals are characterized by competent behavior in a communication situation; aggressive and protective ways of communication are not inherent in them.

The associations between hardness and human self-regulation were also investigated. Direct significant associations indicate that the higher the level of hardness is, the higher the level of self-regulation is. In other words, individuals show independence, flexibly and adequately responds to changes in external conditions. The study of associations between meaning-in-life orientations and hardness showed direct correlations. This suggests that hardness is also associated with a high level of meaningfulness, effectiveness, and emotional intensity of an individual's life (Khromov, 2012).

Despite a number of works on associations among hardiness and different psychological constructs, the studies of the factors that shape hardiness, especially in the intergenerational perspective, are still lacking. It is worth noting that the events of recent years (the economic crisis, terrorist threats, technological disasters, unstable political relations, etc.) are powerful factors influencing individuals. These events have led to the fact that there is a general decrease in the sense of protectiveness and security. Science needs to understand the psychological characteristics and prerequisites that determine an individual's successful adaptation to a rapidly changing world. The ability to cope with life difficulties depends on personal potential, the degree of personal maturity, subjective economic well-being, and value-meaning guidelines. Thus, this study aims at identifying predictors of hardiness in different generations of Russians. The determinants are individual values, meaning-in-life orientations and factors of subjective economic well-being.

The typology of generations in modern science

Representatives of each generation are people united according to a certain age range and significant life events that they experienced at their critical stage of development, or, in other words, at the age of personality formation (Khomyakova, 2011; Shamis & Antipov, n.d.; Haeberle, Herzber, & Hobbs, 2009; Macky, Gardner, & Forsyth, 2008; Mannheim, 1952; Rudolph, Rauvola, & Zacher, 2018; Yusoff & Kian, 2013). Representatives of generations are characterized by similar history, personality type, and their behaviors influenced by this history (Murphy, Gibson, & Greenwood, 2010; Ozkan & Solmaz, 2015; Yang & Guy, 2006).

In most contexts, current scholarly works consider the concept of generation in terms of the theory of W. Strauss and N. Howe (Astashova, 2014; Strauss & Howe, 1991), which combines the basic approaches of sociology, social psychology, and developmental psychology. This approach argues that the time period for each generation is determined by the category of values, instead of the dates of birth.

Differences among generations in modern Russia

Representatives of generation Y are individualists who want to stand out for their individualities and are aimed at achieving their own goals. They focus on themselves slightly less than representatives of generation Z (Artsimovich, 2017; Ozkan & Solmaz, 2015). They are ready for

Russian Psychological Journal, 2020, Vol. 17, No. 1, 74–91. **doi**: 10.21702/rpj.2020.1.6

changes, willing to take risks, and have flexible thinking. However, they are influenced by brands and fashion (Volkova & Chiker, 2016; Gurova & Evdokimova, 2016). Similar to representatives of generation X, representatives of generation Y appreciate the balance between work and personal life. However, intense leisure is important for them (Anderson, Baur, Griffith, & Buckley, 2017; Wong, Wan, & Gao, 2017; Yusoff & Kian, 2013).

Representatives of generation X, as well as representatives of generation Y, are ready for changes, willing to take risks to achieve goals; they manifest themselves as individualists (Volkova & Chiker, 2016; Gurova & Evdokimova, 2016; Yusoff & Kian, 2013). Family values are important for them. Thus, they are not ready to sacrifice their leisure hours (Williams, Page, Petrosky, & Hernandez, 2010; Yusoff & Kian, 2013).

Baby boomers are characterized by such traits as collectivism, optimism, and independence. They appreciate traditions and are sympathetic to other people. They grew up in an era of prosperity and optimistic views and were inspired by the feeling that they represent a special generation that can change the world (Yusoff & Kian, 2013). In addition, baby boomers are characterized by the cult of youth and health, as well as religiosity (Chernikov, 2014; Volkova & Chiker, 2016).

Methods

The aim of this study is to determine the factors that have the greatest impact on hardiness in different generations of Russians. The subject of the study includes values, meaning-in-life orientations, and subjective economic well-being as predictors of hardiness in different generations of Russians. The study used the following techniques:

1. ***The Subjective Economic Well-being technique*** (Postnikova, 2016; Khashchenko, 2005, 2011). This technique represents a questionnaire consisting of 26 statements with five possible responses, for which 1 corresponds to 'I do not agree with the statement' and 5 corresponds to 'I completely agree'. Further, in accordance with the answer key, the values were calculated for such factors as optimism/pessimism, economic anxiety, subjective income adequacy, financial deprivation, and current family welfare. We have chosen this questionnaire because it provides ample opportunities in the analysis of rich and diverse empirical experience in the field of relationships, objective living conditions and human well-being, the 'economy' of well-being and happiness, subjective indicators of well-being, value and meaning aspects of material achievements. The Subjective Economic Well-being questionnaire provides an opportunity to study the fundamental problem of the ratio between objective and subjective assessments of economic living conditions on the basis of new methodology.

2. ***The Hardiness Test*** (Kuzmina & Moroz, 2010; Leont'ev & Rasskazova, 2006) by D. A. Leont'ev is a modified Hardiness Survey developed by the American psychologist S. Muddy (Anderson et al., 2017). This technique is a questionnaire consisting of 45 statements with four possible responses, for which 1 corresponds to 'I do not agree with the statement' and 4 corresponds to 'I completely agree'. Further, in accordance with the answer key, values were calculated for such factors as involvement, control, and risk taking.

3. ***The PVQ-R technique*** for measuring individual values (Khomyakova, 2011; Schwartz, Butenko, Sedova, & Lipatova, 2012). Schwartz's theory of basic values underlay hundreds of studies over the past few years. Initially, this technique examined associations among 10 basic values (power, achievement, hedonism, stimulation, independence, universalism, caring, traditions, conformism, security), or 4 meta-values, and various attitudes, ideas, opinions, behaviors, personality traits

Russian Psychological Journal, 2020, Vol. 17, No. 1, 74–91. **doi**: 10.21702/rpj.2020.1.6

and etc. In 2011, Schwartz developed a new technique, which already contained 19 values. The refined theory is compatible with the initial structure of 10 wider constructs, since these 19 values cover the same motivational continuum. The study used the format of the PVQ questionnaire for which each of the items was limited to a single sentence. The items describe the individual goals, aspirations or desires, which implicitly indicate the importance of a particular value. The values of respondents are derived from the implicit values of those whom they consider to resemble themselves. The response scale contains the following 6 alternatives: 0 corresponds to 'he/she doesn't resemble me at all', 1 – 'he/she doesn't resemble me', 2 – 'he/she doesn't resemble me too much', 3 – 'he/she resembles me a little', 4 – 'he/she resembles me', 5 – 'he/she resembles me very much'. In the article entitled A Refined Theory of Basic Individual Values: Application in Russia S. Schwartz et al. provided evidence for the refined theory. The findings were obtained from a survey of 15 samples of students (N = 3909) and adults (N = 2150) in Finland, Germany, Israel, Italy, New Zealand, Poland, Portugal, Switzerland, Turkey, and the USA.

4. ***The Meaning-in-Life Orientations test (MOL)*** (Klimov, 2010; Leont'ev, 2011). This technique is a questionnaire consisting of 20 pairs of opposite statements. The respondent's task is to choose one of two statements and to assign it one of three marks (1, 2, 3), depending on the level of his/her confidence in this choice (or '0' if both statements are equally true). Further, in accordance with the answer key, values were calculated for five scales: goals in life, life process, life effectiveness, internal locus of control, and external locus of control.

Respondents

Data collection was carried out from 2018 to 2019. The sample consisted of 621 representatives of generation Y (born in 1984–2000), 418 representatives of generations X (born in 1963–1984), and 291 respondents born in 1943–1963, the so-called baby boomers. The sociological approaches of Yu. A. Levada, V. V. Gavrilyuk, and N. A. Trikoz and the psychological approaches of E. M. Shamis and A. Antipov (Artsimovich, 2017; Shamis & Antipov, n.d.) underlay our classification of generations.

Results

Hardiness factors

Table 1 shows descriptive statistics and intergenerational differences in hardiness factors by the Kruskal–Wallis test.

We observed significant differences among generations by two components of hardiness. The levels of involvement and risk taking are higher among the representatives of generation Y. Young Russians with a developed component of involvement enjoy their own activities; they are constantly busy, try to keep abreast of everything that happens, and like to meet new people. The level of risk taking is higher among Russians aged 35 to 55 years. Representatives of generation X are annoyed by events due to which they are forced to change their daily routine; they believe that a bird in the hand is worth two in the bush, live a full life, and almost always can affect the result of what is happening around.

The overall level of hardiness is higher among representatives of generation Y – Russians aged 19 to 34 years. Young respondents are confident in their decisions, like to be constantly busy, prefer to set difficult goals and achieve them, can easily get close to new people; their own lives seem meaningful and interesting to them.

Table 1

Intergenerational differences in hardiness factors (the Kruskal–Wallis test)

Scale	Representatives of generations Y		Representatives of generations X		Baby boomers	
	Mean value	Standard deviation	Mean value	Standard deviation	Mean value	Standard deviation
Involvement	**33,7***	0,99	**29,1***	0,63	**31,4***	0,95
Control	**27,9**	1,24	**26,4**	1,12	**23,3**	1,05
Risk taking	**11,4****	0,86	**12,8****	0,08	**9,7****	0,52
Overall hardiness	**73,0**	0,94	**68,3**	0,88	**64,4**	0,73

Determinants of hardiness among representatives of different generations of Russians

The multiple regression analysis enabled us to determine factors that influenced the formation of hardiness among representatives of different generations of Russians. Tables 2, 3, 4 demonstrate a model of hardiness, and factors (values, economic attitudes, meaning-in-life orientations) that determine hardiness among representatives of generation Y.

Table 2

Meaning-in-life orientations and hardiness: the regression analysis (generation Y)

Independent variables	Dependent variables		
	Goals in life	Internal locus of control	External locus of control
Involvement β	0,47**	0,07	0,33
Control β	0,62*	0,35*	0,26
Risk taking β	0,22	–0,39	0,27*

Russian Psychological Journal, 2020, Vol. 17, No. 1, 74–91. **doi**: 10.21702/rpj.2020.1.6

Table 2

Meaning-in-life orientations and hardiness: the regression analysis (generation Y)

Independent variables	Dependent variables		
	Goals in life	Internal locus of control	External locus of control
Hardiness β	0,48	0,39*	0,36**
R^2	0,67	0,13	0,23
F	11***	5,4*	8,3**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

Such meaning-in-life orientations as internal locus of control and external locus of control had an impact on shaping hardiness among representatives of generation Y. An individual's freedom of choice, the ability to shape his/her own life in accordance with his/her own goals and objectives, the ability to control his/her life, and the understanding that individuals should control their own lives by themselves affect the ability to withstand stress, while maintaining internal balance.

Table 3

Economic attitudes and hardiness: the regression analysis (generation Y)

Independent variables	Dependent variables				
	Economic optimism/ pessimism	Current family welfare	Financial deprivation	Subjective income adequacy	Economic anxiety (financial stress)
Involvement β	0,09	0,18	–0,53**	0,94	0,37
Control β	–0,17	–0,09	0,20	0,22	0,09
Risk taking β	0,15	0,27	0,05	0,09	–0,64*

Hardiness β	0,24	0,39	–0,33*	–0,05	–0,72**
R^2	0,19	0,04	0,32	0,11	0,23
F	9,7*	11*	21,8**	6*	9,2**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

The findings indicate negative regression associations with such economic attitudes as financial deprivation and financial stress. The higher the level of hardiness of young Russians is, the lower financial deprivation and the level of financial stress are. Lack of cash facilities, worries about the financial position in the future, and situations when cash facilities does not meet basic needs negatively affect hardiness among young Russians aged 18 to 34 years.

Table 4

Values and hardiness: the regression analysis (generation Y)

Independent variables	Dependent variables				
	Independence: thinking	Hedonism	Achievement	Power: dominance	Personal security
Involvement β	0,21	0,62*	0,09	0,25	0,63
Control β	0,71**	0,17	0,23	0,60**	–0,57
Risk taking β	0,55*	0,23	0,37	0,38	–0,22*
Hardiness β	0,34*	0,47	0,25*	0,78**	0,05
R^2	0,42	0,13	0,12	0,31	0,15
F	13,07**	5,5*	6,7*	25**	7,4**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

Russian Psychological Journal, 2020, Vol. 17, No. 1, 74–91. **doi**: 10.21702/rpj.2020.1.6

The regression analysis indicates that such individual values as independence in decision-making, planning activities independently of others and external circumstances, freedom of choice, ambitious goals in life, and the desire to be successful and authoritative make impact on hardiness of young Russians.

Tables 5, 6, 7 show the hardiness factors for representatives of generation X.

Table 5

Values and hardiness: the regression analysis (generation X)

Independent variables	Dependent variables					
	Independence: actions	Independence: thinking	Achievement	Reputation	Personal security	Benevolence: care
Involvement β	0,08	0,27	0,70	0,28	0,06	0,13
Control β	0,24	0,39*	0,05	0,12	0,18	0,76**
Risk taking β	0,68**	0,56	0,12	–0,33*	0,21	0,35
Hardiness β	0,21*	0,18	0,24*	0,23	0,87**	0,24
R^2	0,5	0,13	0,12	0,09	0,15	0,9
F	16**	5,5*	6,7*	8*	7,4**	15,7**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

An individual's independence in the choice of actions, his/her ambitious goals in life, the desire to be successful, and the need for feeling safe and secure increase his/her ability to withstand stress.

Table 6

Meaning-in-life orientations and hardiness: the regression analysis (generation X)

Independent variables	Dependent variables				
	Goals in life	Life process	Life effectiveness	Internal locus of control	External locus of control
Involvement β	0,39*	0,38	0,29	0,33	0,48
Control β	0,13	0,43*	0,76**	0,78	0,09
Risk taking β	0,46	0,17	0,05	0,05	0,74
Hardiness β	0,58**	–0,25	0,17	0,45	0,44*
R^2	0,31	0,11	0,17	0,14	0,39
F	10**	7,8**	8,4**	7,2*	6*

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

External locus of control (positive impact) and financial stress (negative impact) influence hardiness among representatives of generation X – Russians aged 35–55 years. Additionally, such meaning-in-life orientations as goals in life increase the level of hardiness among the respondents. Goals in life and representation about self as a strong personality with sufficient freedom of choice, which enables individuals to live in accordance with their goals, objectives, and meanings, affect hardiness of representatives of generation X, their ability to cope with stressful situations and shape adaptive defense mechanisms.

Table 7

Economic attitudes and hardiness: the regression analysis (generation X)

Independent variables	Dependent variables		
	Current family welfare	Financial deprivation	Economic anxiety (financial stress)
Involvement β	0,23	–0,34*	0,08
Control β	0,69*	0,57	0,22
Risk taking β	–0,78	–0,37**	0,14
Hardiness β	0,09	0,18	–0,59**
R^2	0,13	0,12	0,15
F	5,5*	6,7*	7,4**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

High-level financial deprivation and economic anxiety reduce the level of hardiness among representatives of generation X, and more precisely, has a negative impact on such hardiness factors as 'involvement' and 'risk taking'.

Hardiness factors among representatives of the baby boomer generation

Table 8

Meaning-in-life orientations and hardiness: the regression analysis (baby boomer generation)

Independent variables	Dependent variables				
	Goals in life	Life process	Life effectiveness	Internal locus of control	External locus of control
Involvement β	0,07	0,22*	0,28	0,19	0,08
Control β	0,46	0,05	0,49*	0,48	0,29
Risk taking β	0,09	0,48	–0,33	0,87**	0,18
Hardiness β	0,35	0,46	0,38**	0,62*	–0,55*
R^2	0,04	0,13	0,14	0,24	0,31
F	9,3	17,9*	8,9**	15,9**	12,04*

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

A highly emotional meaningful life, freedom of choice, and the desire to live in accordance with one's own values and attitudes contribute to the development of hardiness. At the same time, low-level external locus of control or, in other words, lack of confidence in the ability to control the events of one's own life negatively affect hardiness.

Russian Psychological Journal, 2020, Vol. 17, No. 1, 74–91. **doi**: 10.21702/rpj.2020.1.6

Table 9

Economic attitudes and hardiness: the regression analysis (baby boomer generation)

Independent variables	Dependent variables		
	Economic optimism / pessimism	Financial deprivation	Economic anxiety (financial stress)
Involvement β	0,05	–0,82***	–0,25
Control β	0,12	0,04	0,38
Risk taking β	0,17	–0,28	–0,04
Hardiness β	–0,34*	0,60	–0,52**
R^2	0,41	–0,71**	0,16
F	12,08*	16,3*	21,4**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

Table 10

Values and hardiness: the regression analysis (baby boomer generation)

Independent variables	Dependent variables				
	Independence: actions	Social security	Personal security	Traditions	Benevolence: care
Involvement β	0,76**	0,04	0,22	0,68*	0,16
Control β	0,39*	0,13	0,59**		0,42
Risk taking β	0,22	0,09	0,41		–0,43*
Hardiness β	0,64**	0,37*	0,18		0,68**
R^2	0,7	0,14	0,11	0,18	0,15
F	12**	7,1*	8,3*	13,3**	7,2**

*Note: *** – p < 0.001, ** – p < 0.01, * – p < 0.05.*

Economic pessimism and financial deprivation negatively affect the development of hardiness among the representatives of the baby boomer generation. Growth in well-being leads to increased hardiness.

The order in society, confidence in the strength of the country, the desire to take care of beloved ones, help others, independence in choosing actions and actions increase the level of hardiness in respondents aged 56 to 75 years.

Discussion

The findings of this study indicate that the overall level of hardiness is higher among representatives of generation Y – Russians aged 19 to 34 years. Young respondents are confident in their decisions, like to be constantly busy, prefer to set difficult goals and achieve them, can easily get close to new people; their own lives seem meaningful and interesting to them. The study of determinants of hardiness in three generations of modern Russia has shown that external locus of control influences hardiness in all the three generations of modern Russia. However, it has a positive impact on generations X and Y and a negative one on baby boomers. Moreover, such values of individualism as 'independence: thinking' and 'achievement' influence hardiness in generations X and Y. The level of economic anxiety has a negative impact on hardiness among representatives of generations X, Y and baby boomers. Dissatisfaction with their financial situation and the growth of economic anxiety reduce the level of hardiness of all three generations of Russians. The growth of material well-being can increase the level of hardiness of all groups of respondents.

Studying human hardiness and its factors in various age groups is extremely important today, because society becomes increasingly stressful, with its rapid socio-economic changes, instability, and loss of value guidelines. As a unity of attitudes towards influences, challenges, and engagement, hardiness provides the motivation necessary for health-saving behavior. In this study determinants of hardiness were individual values, meaning-in-life orientations, and subjective economic well-being. The ability to cope with life difficulties and stressful factors depends on personal potential, value-meaning guidelines, and material well-being. Representatives of generation Y (young Russians aged 18 to 34 years) are currently characterized by the highest level of hardiness due to the dominance of the factors of 'involvement' and 'control'. This study expands our theoretical and empirical knowledge about the conditioning of hardiness by the socio-psychological context and economic attitudes. More research into adaptive capabilities of representatives of various generations is still necessary.

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