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ASSESSMENT OF PSYCHOPHYSIOLOGICAL AND PSYCHOLOGICAL PROFILES OF PILOTS TO ENHANCE THEIR PROFESSIONAL RELIABILITY

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Introduction. The relevance of the study is determined by the need to develop modern methodological approaches to enhancing the professional reliability of pilots performing flights on Russian-made aircraft in various regions of the world.

Objective. To comprehensively assess the psychophysiological and psychological characteristics of pilots and pilot cadets in order to identify qualities associated with successful military-professional performance.

Materials and methods. The study involved 24 instructor pilots from a training aviation regiment (mean age 28.9 ± 3.2 years, mean flight hours — 576.9 ± 455.9 h) and 11 second-year pilot cadets from Southeast Asia (SEA) (mean age 23.8 ± 1.6 years, mean flight hours — 85.5 ± 27.4 h). Heart rate variability assessment was performed by means of variational cardiointervalography using the hardware-software system “VNS-Ritm”. Psychophysiological parameters (simple sensorimotor reaction, reaction to a moving object, critical flicker fusion frequency, complex sensorimotor reaction) were determined using the hardware-software system “NS-PsychoTest” (Neurosoft); attention characteristics — using the black-red Schulte–Platonov tables. In addition, a psychological assessment was performed using the methods “Coordinates”, “Landolt Rings”, “Number-Letter Combinations”, the questionnaires “MLO-Adaptivity”, Eysenck Personality Inventory (EPI), and “Communication and Organizational Skills”. Mathematical and statistical processing of the obtained data was performed in IBM SPSS Statistics 12.

Results. A comparative analysis of psychological, psychophysiological, and physiological parameters between cadets and pilots was performed. A hierarchy of professional activity motives was identified: service to the country was prioritized by 91.7% of pilots and 81.8% of cadets; cadets were more oriented toward material stability (90.9%). In the assessment of psychophysiological parameters, pilots, compared to cadets, showed a significantly higher critical flicker fusion frequency (45.0 and 40.7 Hz, $p = 0.013$, respectively) and organizational skills (15 and 13 points, $p = 0.047$, respectively), as well as more pronounced parasympathetic regulation of heart rate ($p \leq 0.05$). Significant correlations were recorded between total flight hours and heart rate variability ($r = -0.475$; $p \leq 0.01$) and between simulator training performance and vagosympathetic balance ($r = 0.401$; $p \leq 0.05$).

Conclusions. The study established that the successful performance of flight activity is determined by not only baseline intellectual parameters but also psychophysiological qualities, such as high parasympathetic regulation of heart rate, speed of visuomotor responses, attention stability, and spatial thinking ability. These qualities change over the course of professional activity, which confirms the need for their targeted development and consideration in professional psychological selection and flight training systems.

Keywords: pilot; pilot cadet; professional reliability; professional activity motive; psychophysiological qualities; heart rate variability

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ИССЛЕДОВАНИЕ ПСИХОФИЗИОЛОГИЧЕСКИХ И ПСИХОЛОГИЧЕСКИХ ХАРАКТЕРИСТИК ЛЕТЧИКОВ В ЦЕЛЯХ ПОВЫШЕНИЯ ИХ ПРОФЕССИОНАЛЬНОЙ НАДЕЖНОСТИ

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Введение. Актуальность исследования определяется необходимостью разработки современных методических подходов к повышению профессиональной надежности летчиков, выполняющих полеты на самолетах российского производства в различных регионах мира.

Цель. Комплексная оценка психофизиологических и психологических характеристик летчиков и курсантов-летчиков, направленная на выявление качеств, связанных с успешностью военно-профессиональной деятельности.

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Материалы и методы. В исследовании приняли участие 24 летчика-инструктора учебного авиационного полка (средний возраст $28,9 \pm 3,2$ года, средний налет — $576,9 \pm 455,9$ ч) и 11 курсантов-летчиков второго года летной подготовки из Юго-Восточной Азии (ЮВА) (средний возраст составил $23,8 \pm 1,6$ года, средний налет — $85,5 \pm 27,4$ ч). Оценка регуляции сердечного ритма проведена методом вариационной кардиоритмографии с помощью аппаратно-программного комплекса «ВНС-Ритм». Психофизиологические параметры (простая сенсомоторная реакция, реакция на движущийся объект, критическая частота световых мельканий, сложная сенсомоторная реакция) определяли с помощью аппаратно-программного комплекса «НС-ПсихоТест» ООО «Нейрософт»; характеристики внимания — с использованием черно-красных таблиц Шульте — Платонова. Кроме того, выполнено психологическое обследование с применением методик «Координаты», «Кольца Ландольта», «Численно-буквенные сочетания», опросников «МЛЮ-Адаптивность», Личностный опросник Айзенка (EPI), «Коммуникативные и организаторские склонности». Математико-статистическая обработка полученных данных осуществлялась в IBM SPSS Statistics 12.

Результаты. Проведен сравнительный анализ психологических, психофизиологических и физиологических показателей у курсантов и летчиков. Выявлена иерархия мотивов профессиональной деятельности: служение стране приоритетно для 91,7% летчиков и 81,8% курсантов; курсанты чаще ориентированы на материальную стабильность (90,9%). При оценке психофизиологических показателей обнаружено, что у летчиков, по сравнению с курсантами, достоверно выше критическая частота слияния мельканий ($45,0$ и $40,7$ Гц, $p = 0,013$ соответственно) и организаторские склонности (15 и 13 баллов, $p = 0,047$ соответственно), а также отмечается более выраженная парасимпатическая регуляция сердечного ритма ($p \leq 0,05$). Зафиксированы достоверные корреляции общего налета часов с вариабельностью сердечного ритма ($r = -0,475$; $p \leq 0,01$) и успешности тренажерной подготовки с вагосимпатическим балансом ($r = 0,401$; $p \leq 0,05$).

Выводы. В ходе исследования установлено, что успешность летной деятельности определяется не только исходным уровнем интеллектуальных показателей, но и психофизиологическими качествами: высокой парасимпатической регуляцией сердечного ритма, скоростью зрительно-моторных реакций, устойчивостью внимания и способностью к пространственному мышлению. Эти качества изменяются в процессе профессиональной деятельности, что подтверждает необходимость их целенаправленного развития и учета в системах профессионально-психологического отбора и летной подготовки.

Ключевые слова: летчик; курсант-летчик; профессиональная надежность; мотив профессиональной деятельности; психофизиологические качества; вариабельность сердечного ритма

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INTRODUCTION

Preserving pilots' professional health and enhancing the reliability of their performance are key elements of flight safety in modern aviation [1, 2]. Given the increasing use of Russian-made aircraft systems in various regions of the world and under diverse climatic and geographic conditions, this aspect is becoming highly relevant [3, 4]. In the view of the wide geographic scope of flights, particular attention of aviation physicians should be paid to the pilot as the weakest link in the "pilot–aircraft–environment" ergatic system [5–7].

The professional reliability of pilots is ensured by a broad range of factors, such as the state and dynamics of their somatic health; the level of professional training and flying skills; genuine motivation to perform flight duties and the overall level of military-professional orientation; physiological characteristics that ensure resistance to extreme dynamic and altitude-related flight factors; and psychophysiological and psychological characteristics along with adaptive capabilities that enable the

necessary level of professional performance under conditions of time pressure and a high intensity of mental workload [8–12].

In view of the above, the priority areas of scientific research in the field of flight safety are: the study of psychophysiological characteristics of flight work and the professionally important qualities required of flight personnel; the investigation of psychophysiological and psychological characteristics of pilots and their correspondence to the flying profession; and the establishment of prognostically valuable methodological approaches for the assessment and development of professionally important qualities and special abilities, which creates a fundamental basis for determining pilot professional reliability [13–15].

The research results in this area are of practical importance at all major stages of a pilot's professional career: during the professional psychological selection of candidates for flight training; at the training stage in an educational institution during the acquisition of basic flying skills; at the stage of flight training in an operational

aviation unit and professional development of the pilot as a specialist [16–19].

In order to enhance the professional reliability of pilots from Southeast Asia (SEA) operating Russian-made aircraft, research is being conducted to improve the medical support of flight personnel, including an assessment of the current state of professional psychophysiological selection and its further improvement [3].

The study purpose is to carry out a comprehensive assessment of psychophysiological and psychological characteristics of pilots and pilot cadets, aimed at identifying criteria associated with successful performance of their military-professional activity.

MATERIALS AND METHODS

The study involved 24 instructor pilots (hereinafter referred to as pilots) from a training aviation regiment (mean age 28.9 ± 3.2 years, mean flight hours — 576.9 ± 455.9 h) and 11 pilot cadets (hereinafter referred to as cadets) in their second year of flight training from SEA (mean age 23.8 ± 1.6 years, mean flight hours — 85.5 ± 27.4 h). Physiological, psychophysiological, and psychological examination of pilots and cadets was conducted in 2025 under conditions of routine daily activity in the aviation unit on non-flying days.

Examination of flight personnel was conducted using valid physiological, psychophysiological, and psychological methods. Functional state assessment included evaluation of cardiac autonomic regulation via variational cardiointervalography. Recordings were performed using the VNS-Ritm hardware-software complex (Neurosoft, Russia), which enables high-resolution analysis of heart rate variability and autonomic balance indices.

Psychophysiological parameters were studied by recording simple sensorimotor reaction (SSMR), reaction to a moving object (RMO), critical flicker fusion frequency (CFFF), complex sensorimotor reaction (CSMR), and attention characteristics using the black-red Schulte–Platonov tables. For the psychophysiological examination, the hardware-software system “NS-PsychoTest” (Neurosoft, Russia) was used [20–23].

Psychological examination of flight personnel was conducted in accordance with the methodological complex developed by specialists of the Research Department of Medical and Psychological Support of the Kirov Military Medical Academy for the assessment and identification of qualities necessary for personality formation, successful training in educational institutions, and effective professional activity of military personnel [24]. To investigate the characteristics of the intellectual sphere, adapted questionnaires and survey methods were used, such as “Coordinates”, “Landolt Rings”, and “Number-Letter Combinations” (NLC). Personality traits were assessed using the MLO-Adaptivity, Eysenck Personality Inventory (EPI), and Communication and

Organizational Skills (COS) questionnaires. An expert survey of squadron commanders of the training aviation regiment was conducted regarding the successful performance of military-professional activity of cadets, mastery of flight practice, and training on aviation simulators [25–27].

To assess the performance of cadet training on L-39NG aviation simulators, expert assessments by instructor pilots were used, assigned based on the results of cadet actions during flight and simulation of emergency situations in accordance with established protocols. During simulator sessions, engine failures and failures of individual control elements were simulated.

Mathematical and statistical processing of the data obtained was performed in IBM SPSS Statistics 12 using descriptive statistics, Spearman’s rank correlation analysis, ANOVA, and comparative analysis (using the Mann–Whitney test). In all cases, the measure of statistical significance of computation results was the significance level not exceeding the null hypothesis probability of 0.05 ($p \leq 0.05$).

RESULTS

At the first stage of research, the level of military-professional orientation and motivation for military service and flight work in cadets and pilots was studied to assess social maturity of the personality, main motivational preferences, and motivational readiness for service.

The analysis of motivational preferences showed a high military-professional orientation of flight personnel. One of the most important motives for military service cited by 9 (81.8%) cadets and 22 (91.7%) pilots was service to the country and people, which reflects patriotism aimed at the common good of the country.

The subsequent study of the motives for military service between cadets and pilots found the following differences. In 10 (90.9%) cadets, the highest rank is occupied by salary stability, followed by the prestige of the flying profession in 7 (63.3%) individuals, service conditions in 6 (54.5%) cadets, and the desire to be useful to society in 5 (45.4%) cadets. The lowest positions in the assessment of professional orientation are occupied by career advancement opportunities, education acquisition, and social benefits in 4 (36.4%) cadets.

Among experienced pilots, the second-ranked motivational preference was the desire to be useful to society, reported by 9 (37.5%) individuals, followed by salary stability in 8 (33.3%), career advancement opportunities, social guarantees and benefits in 6 (25.0%), prestige and living conditions in 5 (20.8%), and education acquisition opportunities in 4 (16.7%) participants.

Thus, in pilots, the motivational sphere is dominated by patriotism and socially significant motives, and only then followed by material incentives. Among cadets,

factors such as financial stability and the prestige of the profession come to the fore.

In the course of further research, a comparative analysis of psychophysiological, intellectual, and personality parameters in the samples of examined cadets and pilots was performed using the Mann–Whitney test.

The results of the comparative analysis of physiological parameters of heart rate using cardiointervalography in the groups of cadets and pilots are presented in Table 1.

During the comparative analysis, statistically significant differences ($p \leq 0.05$) were identified between the groups of cadets and pilots for a number of cardiointervalography parameters. Thus, in pilots, the values of heart rate variability and variation range were lower, indicating greater stability of heart rate. Higher values of the autonomic balance index and autonomic rhythm index, as well as lower power values of low-frequency waves in pilots, indicate greater parasympathetic activity of the

autonomic nervous system and reduced sympathetic influence on heart rate compared to cadets. With a higher value of the regulatory system stress index (according to Baevsky) in pilots, as well as in cadets, the stress index was rated as “normal”.

The results of the comparative analysis of intellectual and personality parameters in the groups of cadets and pilots are presented in Table 2.

An analysis of the values of intellectual parameters in cadets and pilots found that the differences between the groups were close to statistical significance. Pilots had higher performance scores on the “Coordinates” method ($p \leq 0.089$) and the “Landolt Rings” method ($p \leq 0.067$), as well as higher reliability scores on the “Number-Letter Combinations” method ($p \leq 0.097$), indicating a more accurate assessment of object position in space, higher parameters of distribution, switching, and stability of attention, and a higher pace of mental processes in pilots compared to cadets.

Table 1. Comparative analysis of cardiorhythmography parameters in cadets and pilots

Parameter	Cadets, $n = 11$	Pilots, $n = 24$	Level of statistical significance, p
Standard deviation of R-R interval durations (SDNN), ms	58.0 [41.0; 69.0]	40.0 [32.7; 52.2]	0.033
Stress index of regulatory systems, arbitrary units	97.4 [50.5; 147.0]	151.6 [108.7; 270.4]	0.030
Variation range, ms	216.0 [175.0; 265.0]	164.0 [127.0; 187.7]	0.025
Autonomic balance index, arbitrary units	150.2 [96.7; 264.5]	290.15 [198.9; 377.9]	0.030
Autonomic rhythm index, arbitrary units	5.04 [3.8; 7.0]	7.1 [5.3; 11.1]	0.022
Power of low-frequency waves, ms^2	1066 [536.0; 2092.0]	464.5 [267.8; 934.0]	0.027

Table prepared by the authors based on their own data

Note. Data are presented as median and interquartile range $M_e [Q_1; Q_3]$.

Table 2. Comparative analysis of psychophysiological, intellectual, and personality indicators in cadets and pilots

Parameter	Cadets, $n = 11$	Pilots, $n = 24$	Level of statistical significance, p
Productivity according to the "Coordinates" method, score	16.0 [13.0; 18.0]	19 [14.0; 22.0]	0.089
Productivity according to the "Landolt Rings" method, score	15.0 [11.0; 17.0]	18 [12.7; 22.5]	0.067
Reliability according to the "Number-Letter Combinations" method, arbitrary units	0.9 [0.8; 0.96]	0.94 [0.89; 0.98]	0.097
Organizational skills according to the "Communication and Organizational Skills" method, score	13 [12; 15]	15 [14; 17]	0.047
Critical flicker fusion frequency, Hz	40.7 [37.3; 43.3]	45 [41.7; 48.2]	0.013

Table prepared by the authors based on their own data

Note. Data are presented as median and interquartile range $M_e [Q_1; Q_3]$.

Statistically significant differences ($p \leq 0.05$) between the groups were shown for the critical flicker fusion frequency index and the “Organizational Skills” scale of the COS method, reflecting higher levels of functional state, performance, and organizational abilities in the pilot group (Table 2).

Based on the results obtained in the total sample of cadets and pilots ($n = 35$), a Spearman's rank correlation analysis was performed to study the relationship between psychophysiological parameters of functional state and external criteria, such as total flight hours (EC-1) and aviation simulator training performance (EC-2). The results of the correlation analysis between heart rate regulation parameters and EC-1 are presented in Figure 1.

The presented results of the correlation analysis revealed a statistically significant relationship between the values of the external criterion EC-1 and cardiointervallography data.

Thus, the parameter of flight hours in cadets and pilots has a statistically significant direct moderate-strength correlation with the following parameters: mean duration of cardiac R-R intervals ($r_s = 0.516$, $p \leq 0.05$), mode amplitude ($r_s = 0.340$, $p \leq 0.05$), stress index of regulatory systems ($r_s = 0.462$, $p \leq 0.01$), autonomic balance index ($r_s = 0.432$, $p \leq 0.01$), and autonomic rhythm index ($r_s = 0.540$, $p \leq 0.01$). These correlations reflect the following dynamics of physiological parameters with increasing flight hours and flight experience: an increase in R-R interval duration, heart rate amplitude, and autonomic regulation balance. A statistically significant inverse correlation was also established between the flight hours of cadets and pilots and the following parameters: heart rate variability ($r_s = -0.475$, $p \leq 0.01$), mode values ($r_s = -0.468$, $p \leq 0.01$), autonomic regulation ($r_s = -0.476$, $p \leq 0.01$), power of low-frequency ($r_s = -0.340$, $p \leq 0.05$) and high-frequency ($r_s = -0.510$, $p \leq 0.01$) waves. Attention switchability showed a

negative correlation with total flight hours ($r_s = -0.322$, $p \leq 0.05$). The observed correlations show that, with increasing flight hours, the physiological parameters of heart rate, autonomic regulation, and adaptation to stress and flight load stabilize.

The parameter of simulator training performance (EC-2) in cadets and pilots was statistically significantly positively correlated with the vagosympathetic balance coefficient, defined as the ratio of low-frequency wave power to high-frequency wave power ($r_s = 0.401$, $p \leq 0.05$), and also showed a statistically non-significant negative correlation with high-frequency wave power ($r_s = -0.315$, $p \leq 0.1$). Together, these findings indicate the predominant influence of the sympathetic nervous system during cadet training on flight simulators, which involves practicing flight skills and actions under various, including complex, flight conditions and equipment failures.

Subsequently, Spearman's rank correlation analysis was performed to evaluate the relationship between the results of psychophysiological and psychological examination and the number of flight hours and simulator training performance in the groups of cadets (Fig. 2) and pilots (Fig. 3).

The conducted analysis showed that the external criteria EC-1 and EC-2 in pilots had a statistically significant direct moderate-strength correlation with parameters of attention switching and stability, working memory, and thinking speed when working under forced pace and time pressure: the NLC method with EC-1 and EC-2 ($r_s = 0.423$ and $r_s = 0.418$, respectively, $p \leq 0.05$). At a level close to statistical significance, a correlation was found between complex sensorimotor reaction speed and EC-2 ($r_s = 0.412$, $p \leq 0.1$); statistically significant inverse correlations were also revealed between EC-1 and EC-2 and reaction times according to the CFFF method ($r_s = -0.451$, $p \leq 0.05$ and $r_s = -0.671$,

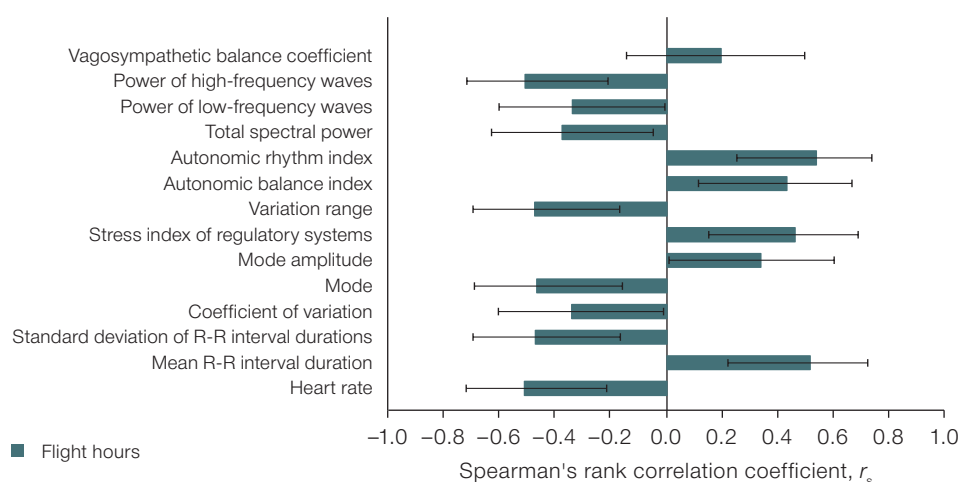


Figure prepared by the authors based on their own data

Fig. 1. Statistically significant correlations ($p \leq 0.05$) between heart rate regulation parameters and total flight hours in cadets and pilots ($n = 35$)

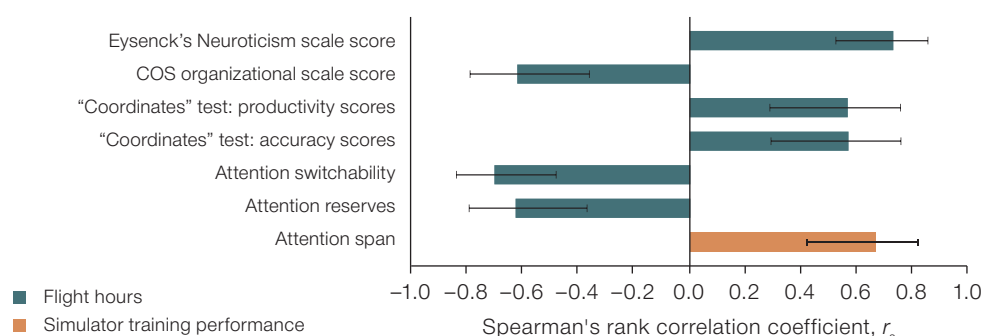


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Fig. 2. Statistically significant correlations ($p \leq 0.05$) of psychophysiological and psychological parameters in cadets ($n = 11$) with flight hours and simulator training performance. COS—"Communication and Organizational Skills" questionnaire

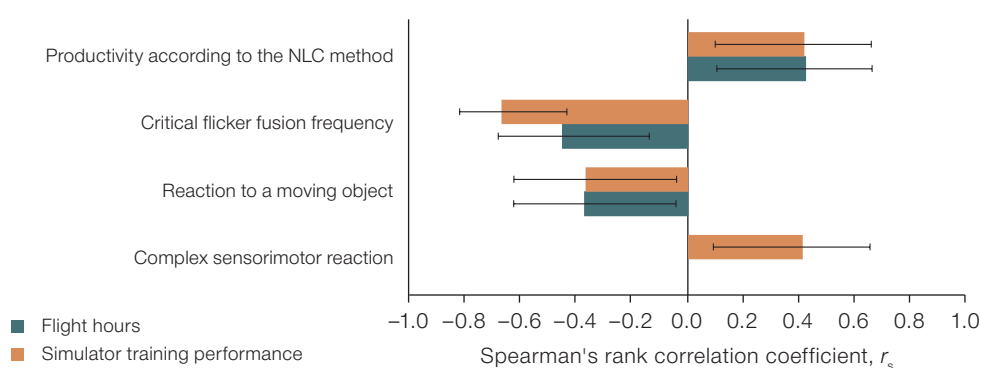


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Fig. 3. Statistically significant correlations ($p \leq 0.05$) of psychophysiological and psychological parameters in pilots ($n = 24$) with flight hours and simulator training performance. NLC—"Numerical-Letter Combinations" test

respectively, $p \leq 0.01$). At the same time, a correlation was also found between EC-1 and EC-2 and parameters of the RMO method ($r_s = -0.371$ and $r_s = -0.369$, respectively, $p \leq 0.1$).

The identified correlations generally suggest that, as pilots' flight skills develop, the requirements for the speed and accuracy of psychomotor reactions, attention, working memory, and thinking increase. These effects are determined by a high level of functional state of the visual analyzer, psychomotor, and mental functions.

In cadets, flight hours in the second year of flight training (EC-1) and simulator training performance (EC-2), similarly to pilots, significantly correlated with attention characteristics. A direct statistically significant correlation was found between EC-2 and attention span ($r_s = 0.662$, $p \leq 0.05$), as well as a near-statistically significant inverse correlation between EC-1 and parameters of attention reserves and switchability ($r_s = -0.626$ and $r_s = -0.702$, $p \leq 0.05$). In addition to the above correlations, in cadets, a near-statistically significant relationship was found between EC-1 and parameters of visual perception of distances and spatial thinking (the "Coordinates" method, $r_s = 0.569$ and

$r_s = 0.566$, $p \leq 0.1$). Flight hours during the second year of training in cadets were significantly correlated with neuroticism scores on the Eysenck Personality Inventory (EPI) ($r_s = 0.730$, $p \leq 0.05$). Moreover, a significant inverse correlation was observed with organizational inclinations scores assessed via the COS questionnaire ($r_s = -0.620$, $p \leq 0.05$).

Thus, the changes observed in cadets highlight the importance of developing visual perception, attention, and spatial thinking for successful flight performance. The increase in experience and complexity of flight work is associated with emotional experiences, mood instability, and a decreased need for collective interaction.

DISCUSSION

The presented study was exploratory in nature. To address one of the research tasks, a comprehensive physiological, psychophysiological, and psychological examination of pilots and pilot cadets was conducted to identify features of their functional state associated with successful performance of educational and professional activities. It should be noted that although the

obtained results are preliminary, they provide informative evidence that substantiate further research with determination of its practical significance and practical implementation.

The conducted socio-psychological study of the motivational sphere of the examined cadets and pilots recorded a high level of military-professional orientation. One of the most important motives for professional activity cited by flight personnel is service to the country and people, which reflects patriotism. The motivational sphere of pilots is characterized by the dominance of socially significant incentives. In cadets, financial stability and prestige of the activity come to the forefront. The revealed transformation of the motivational sphere from external orientations (financial stability and prestige) in cadets to internal ones (service to society) in pilots is consistent with data from Russian studies on the moral qualities of flight personnel. Voron et al. noted that Russian cadets also exhibit predominantly socially-oriented motivations [28–31]. International publications show that the professional development of pilots is accompanied by profound changes in their motivation for flight work — from physical adaptation and external regulation of behavior to cognitive-sensory efficiency and socio-professional competence [32, 33].

The correlation analysis of heart rhythm regulation and external criteria (flight hours and simulator training performance) in the total sample of cadets and pilots ($n = 35$) revealed a statistically significant relationship between the external criteria and parameters of attention switchability and cardiointervalography. With increasing flight hours and flight experience, an increase in R-R interval duration, heart rate amplitude, and autonomic regulation balance was noted. With increasing flight hours in flight personnel, the physiological parameters of heart rate, autonomic regulation, and adaptation to stress and flight load stabilize. The parameter of simulator training performance in cadets and pilots was significantly correlated with the vagosympathetic balance coefficient, which is confirmed by our previous work on the relationship between integral parameters of heart rate variability and cognitive functions in pilots. The study determined that the parameter of regulatory systems activity has strong statistical correlations with attention span ($r = -0.62$; $p \leq 0.01$) and its distribution ($r = -0.57$; $p \leq 0.01$) when performing cognitive tasks under emergency situation simulation conditions. At the same time, pilots with higher simulator training results demonstrated moderate tension of adaptation mechanisms with preservation of professional performance, while less experienced pilots showed signs of overstrain [34]. These results emphasize the predictive value of autonomic regulation parameters for assessing pilots' readiness to perform effectively under complex flight conditions.

The comparative analysis revealed statistically significant differences between the groups of cadets and pilots in terms of a number of cardiointervalography parameters. The data from instructor pilots indicate greater parasympathetic activity of the autonomic nervous system and reduced sympathetic influence on heart rate compared to cadets. With a higher value of the regulatory systems stress index (according to Baevsky) in pilots, as well as in cadets, the stress index is rated as "normal". The obtained results are fully consistent with the concept of physiological norm and adaptation by Baevsky [21], as well as with recent retrospective studies of pilots' adaptive capabilities [13, 20].

The comparative analysis of intellectual parameters in cadets and flight specialists demonstrated that the differences between the groups did not reach statistical significance; however, pilots showed a pronounced tendency toward a more accurate assessment of object position in space, higher parameters of distribution, switching, and stability of attention, and a higher pace of mental processes compared to cadets.

With increasing flight experience, pilots demonstrate greater levels of speed and accuracy in psychomotor responses, attention, working memory, and thinking, reflecting a high level of functional state of the visual analyzer, psychomotor processes, and mental functions. The correlations observed in cadets highlight the importance of developing visual perception, attention, and spatial thinking for successful flight performance. The increase in experience and complexity of flight work is associated with emotional experiences, mood instability, and a decreased need for collective interaction.

CONCLUSIONS

The obtained results indicate a fairly balanced system of professional psychological selection of candidates for flight training. This is confirmed by the effectiveness of the socio-psychological component of selection, the stress index according to cardiointervalogram data, which was practically identical and within the physiological norm in both cadets and pilots, as well as the absence of statistically significant differences in intellectual parameters. At the same time, a number of mental and psychophysiological characteristics of flight personnel were identified that correlate with the level of functional state of the organism, are important for direct flight work, and are modifiable during the course of flight activity and improvement of flying skills. These include distribution, switching, and stability of attention, working memory capacity, the ability to accurately determine the position of objects in space, the speed and accuracy of psychomotor responses, and the level of visual perception. This indicates the need to emphasize these characteristics

in the system of professional selection measures for candidates for flight training, as well as to develop the corresponding qualities in flight personnel during training in educational institutions and during the first years of service in aviation units.

In this regard, the next research stage will involve expanding the sample to include pilots with different levels of professional training and cadets in their first

and second years of flight training, as well as those undergoing theoretical training. The study will investigate the psychophysiological characteristics of flight work and the development of professionally important qualities in flight personnel. These findings are expected to contribute to improving selection approaches and medical support for pilots, as well as enhancing their professional reliability.

References

1. Ponomarenko VA, Alekseenko MS, Dolgov AA. Psychophysiological components of professional reliability of pilot. *Flight Safety Issues*. 2018;6:3–18 (In Russ.). EDN: [QTYBBP](#)
2. Blagin AA. *Professional health of military pilots*. Professional health of military personnel: materials of the All-Army scientific and practical conference (on the 100th anniversary of the birth of Professor I.D. Kudrin). St. Petersburg; 2023 (In Russ.).
3. Kryukov EV, Ivchenko EV, Blagin AA, Ovchinnikov DV, Annenkov OA. Prospects for improving flight safety and professional reliability of Vietnamese pilots operating Russian-made aircraft. *Military Medical Journal*. 2025;346(1):56–63 (In Russ.). EDN: [IJOPCD](#)
4. Klyuchanskaya SA. Prospects for cooperation between Russia and the countries of South-East Asia in strategic areas. *Security Index*. 2011;17(2):55–85 (In Russ.). EDN: [QWHLRD](#)
5. Nikiforov DA. The current state of the concept of reliability of a human operator of ergatic systems. *Life Safety*. 2024;4(280):13–21 (In Russ.). EDN: [RAWPLI](#)
6. Razinkin SM, Dvornikov MV. *Physiology and hygiene of a pilot in extreme conditions*. Moscow: Scientific book; 2019 (In Russ.). EDN: [YFMFRE](#)
7. Medenkov AA. Taking into account the pilot's capabilities and abilities in the flight safety system. *Flight Safety Problems*. 2021;8:3–26 (In Russ.). <https://doi.org/10.36535/0235-5000-2021-08-1>
8. Blagin AA, Lapshina TA, Emelyanov YuA, Bacovets DV, Dudina EA. Moderate hypoxia tolerance by military females in different phases of their ovarian-menstrual cycle. *Kremlin Medicine Journal*. 2024;2:64–7 (In Russ.). <https://doi.org/10.48612/cgma/4b2h-5829-gr7x>
9. Lapshina TA, Blagin AA, Emelyanov YuA, Bacovets DV. *Assessment of static muscular endurance of the lower extremities in female military personnel*. Professional health of military personnel. Materials of the All-Army scientific and practical conference (on the 100th anniversary of the birth of Professor I.D. Kudrin). St. Petersburg; 2023 (In Russ.). EDN: [GMFYLR](#)
10. Blagin AA, Lapshina TA, Dang QH. Dynamics of doppler ultrasonography data from arteries of the lower extremities and brain in the course of static ergometric test. *Aerospace and Environmental Medicine*. 2023;57(3):37–41 (In Russ.). <https://doi.org/10.21687/0233-528X-2023-57-3-37-41>
11. Blagin AA, Vinogradov AS, Chermeyanin SV. *Psychophysiological training of state aviation personnel for flights exposed to multi-vector accelerations*. Aviation medicine: past, present, future. Proceedings of the XI All-Russian scientific and practical conference with international participation dedicated to the 85th anniversary of the Department of Aviation and Space Medicine of the Federal State Budgetary Educational Institution of Higher Professional Education Russian Medical Academy of Postgraduate Education of the Ministry of Health of the Russian Federation. Moscow; 2024 (In Russ.). EDN: [WEIKPR](#)
12. Chistov SD. Vestibular factors of spatial disorientation during aviation flight and methods of flying personnel training. *Military Medical Journal*. 2017;338(9):80–2 (In Russ.). EDN: [YRRJCH](#)
13. Annenkov OA, Ovchinnikov DV, Ivakov YuM, Sinelnikov SN, Bakovets DV. Assessment of adaptive capabilities of pilots during flight training and performance: a retrospective study. *Marine Medicine*. 2025;11(2):135–43 (In Russ.). EDN: [RUUSTQ](#)
14. Batishcheva GA, Chernov YuN, Goncharova NYu, Ushakov IB, Zasyadko KI. *Evaluation of adaptive reactions of flight personnel in the conditions of professional activity*. Proceedings of the XXIII Congress of the Physiological Society named after I.P. Pavlov with international participation. Voronezh; 2017 (In Russ.). EDN: [XXZGSL](#)
15. Zhdanko IM, Isaenkov VE, Vorona AA, Filatov VN, Nikiforov DA. Professional reliability of military pilots: medical and social-psychological aspects. *Military Medical Journal*. 2016;337(6):30–6 (In Russ.). EDN: [WLBOWT](#)
16. Rybnikova MN, Pisarenko JuJe. Formation and development of professionally important qualities of aviation specialists in the training process. *Institute of Psychology of the Russian Academy of Sciences. Organizational Psychology and Labor Psychology*. 2025;10(1):116–30 (In Russ.). EDN: [KTLXNA](#)
17. Vetsitskaya SM, Malchinsky FV. *Personal qualities in the professional psychological selection of candidates for military pilot training*. Aerospace medicine, aviation psychology, and

- military ergonomics: formation, status, and development prospects. Proceedings of the All-Russian scientific and practical conference dedicated to the 90th anniversary of the Research Center (AKM and VE). Moscow; 2025 (In Russ.). EDN: [FGIXKH](#)
18. Barinov SV, Korsunov SV. *The main content of theoretical fundamental training and practical flight training of cadets at the Higher Military Aviation School of pilots*. IX International Scientific and Practical Conference of Young Scientists dedicated to the 58th anniversary of Yuri Gagarin's flight into space. Conference proceedings of the scientific-practical conference. Krasnodar; 2019 (In Russ.). EDN: [ABFDGE](#)
 19. Krachko EA, Krasilnikov GT, Khvostova SL. *Psychophysiological aspects of professional training of flight school cadets*. Personality of a cadet: psychological characteristics of being. Collection of materials of the IX All-Russian scientific and practical conference (with foreign participation). Krasnodar; 2018 (In Russ.). EDN: [MKSPTZ](#)
 20. Annenkov OA, Ovchinnikov DV, Ivakov YuM, Dudina EA. Dynamics of the pilots' functional state during professional activities. *Medical Science and Education of Ural*. 2026;27(1):67–71 (In Russ.). EDN: [SDWBIW](#)
 21. Baevsky RM, Chernikova AT. The problem of physiological norm: a mathematical model of functional states based on the analysis of heart rate variability. *Aerospace and Environmental Medicine*. 2002;36(6):11–7 (In Russ.). EDN: [SAAWAJ](#)
 22. Blaginin AA, Budnikov SV, Slesarenko MM. Features of medical and psychological rehabilitation of aviation specialists. *Kremlin Medicine Journal*. 2024;4:91–5 (In Russ.). <https://doi.org/10.48612/cgma/4p3v-xzg-52nh>
 23. Blaginin AA, Gornov SV, Shchegolkov AM, Gornov BB, Ovinnikov AA. *An innovative method for assessing the psychophysiological readiness of a pilot to perform professional actions*. Modern contradictions and directions of development of aviation and space medicine. Proceedings of the scientific and practical conference dedicated to the 60th anniversary of the Department of Aviation and Space Medicine of the Military Medical Academy named after S.M. Kirov. St. Petersburg; 2018 (In Russ.). EDN: [VTPKTQ](#)
 24. Chermnyanin SV, Yusupov VV, Korzunin VA, Dorofeev II, Fedotkina IV. *Professional and psychological support in military educational institutions of higher education*. Professional selection and medical and psychological support of military personnel: collection of scientific papers of the Military Scientific School. St. Petersburg; 2025 (In Russ.). EDN: [ASRWKX](#)
 25. Bak FK, Bily AM, Sysoev VN. *Forecasting the success of professional activity in the Armed Forces of the Socialist Republic of Vietnam*. Psychophysiology of professional human health. Proceedings of the All-Russian scientific and practical conference dedicated to the 25th anniversary of the Department of Military Psychophysiology of the Military Medical Academy. St. Petersburg; 2022 (In Russ.). EDN: [OTMERS](#)
 26. Ivanov AV, Bubeev YuA, Nguyen HQ. Psychophysiological features of the dynamics of group indicators of blood pressure and complex sensorimotor reactions in assessing the professional health of flight personnel. *The Human Factor: A Social Psychologist*. 2024;4(52):156–66 (In Russ.). EDN: [BEYQAF](#)
 27. Raspopin EV. Standardization of the Eysenck personality inventory (EPI). *Modern Science: Actual Problems of Theory & Practice*. 2025;11:85–7 (In Russ.). EDN: [ZGHYMI](#)
 28. Vorona AA, Gander DV, Ponomarenko VA. *Theory and practice of psychological support for flight operations*. Moscow: Voenizdat; 2003 (In Russ.). EDN: [QXJFRT](#)
 29. Zasyadko KI, Vonarshenko AP, Soldatov SK, Bogomolov AV, Yazlyuk MN. Analysis of professionally important qualities of flight instructors and possibilities of their development. *Aerospace and Environmental Medicine*. 2020;54(1):52–6 (In Russ.). <https://doi.org/10.21687/0233-528X-2020-54-1-52-56>
 30. Lukinova MG, Shcherbakova EA. Professionally important qualities of third-year cadets: structure of personal qualities. *South Russian Journal of Social Sciences*. 2019;20(1):152–64 (In Russ.). <https://doi.org/10.31429/26190567-20-1-152-164>
 31. Goryunov RG, Shchepka VN. Formation of professionally important qualities of future military pilots. *Modern Humanities Success*. 2020;5:40–6 (In Russ.). EDN: [ANVEDI](#)
 32. Bor R, Eriksen C, Hubbard K, King R. *Pilot selection: psychological principles and practice*. London: Routledge; 2020. <https://doi.org/10.4324/9780429491948>
 33. Martinussen M, Hunter DR. *Aviation psychology and human factors*. Boca Raton: CRC Press; 2018.
 34. Annenkov OA, Blaginin AA, Ivchenko EV, Ovchinnikov DV, Lyashedko SP. Prospects for applying eye tracking in functional state assessment of pilots. *Extreme Medicine*. 2026;28(2):306–14 (In Russ.). <https://doi.org/10.47183/mes.2025-422>

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