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Russian Psychological Journal

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The Study of Personal Characteristics of Cancer Patients Who Have Had the Disease COVID-19

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Abstract

Introduction. Cancer patients in the context of the pandemic experienced additional distress. Their psychoemotional state was influenced by factors such as the threat of COVID-19 infection, delayed treatment, postponement of planned operations, deterioration of their condition against the background of comorbid pathology and chemotherapy. Due to the continuing threat of the emergence of new strains of coronavirus infection, the study of the psychological characteristics of patients with mono- and comorbid cancer does not lose relevance. The purpose of this study was to investigate the personal characteristics, value-semantic orientations and other psychological features reflecting psychological adaptation to prolonged distress in groups of cancer patients who have and have not had a coronavirus infection. **Methods.** The study was conducted on the basis of the Federal State Budgetary Institution "NMIC of Oncology" of the Ministry of Health of the Russian Federation (Rostov-on-Don) in the period from spring 2021 to autumn 2023; 112 cancer patients aged 18 to 62 years took part in it (the average age was 42 years, 64% of them were women, 36% were men), 48% of them suffered COVID-19. The following psychodiagnostic techniques were used: SCL-90-R, Lazarus coping test, 5PFQ, D.A. Leontiev's life sense orientations test, M. Rokich's "Value Orientations" technique, the WHO-100 scale. The one-way ANOVA (Analysis of Variance) and post-hoc analysis (Tukey's test) were used for statistical processing of the obtained results. **Results.** The fact of the transferred disease COVID-19 is associated with a change in the hierarchy of values, the expression of volitional qualities and flexibility in solving life difficulties: in the group of cancer patients who suffered COVID-19, the values of "love",

"development", "breadth of views", "sensitivity" are significantly more pronounced; in the personal sphere, the poles of irresponsibility and practicality are expressed. **Discussion.** The results obtained complement the existing data on the features of the value-semantic and personal sphere of cancer patients with comorbid pathology. **Conclusion.** The conducted theoretical and empirical research can be useful for psychologists, medical and social workers who provide assistance to cancer patients and their families.

Keywords

cancer, comorbidity, pandemic, COVID-19, anxiety, distress, value-semantic sphere

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Introduction

In March 2020, the COVID-19 outbreak affected more than 200 countries and territories (Dai et al., 2020). The psychological consequences of COVID-19 for the general population and for cancer patients in particular were manifested in the high prevalence of symptoms of depression, anxiety and post-traumatic stress (Liu et al., 2020; Romito et al., 2020; Al-Shams et al., 2020; Acevedo-Ibarra et al., 2022).

The COVID-19 pandemic has led to severe distress with a high potential for traumatic effects. For many people, the pandemic and social isolation have provoked the activation of non-constructive behavioral reactions and psychological conditions, which is especially true for those who are vulnerable due to other biological or psychological problems, in particular, cancer. As has been demonstrated in a number of studies, these stressors are factors that increase the pre-existing burden of cancer (Yelnikova, 2020; Chia et al., 2021; Romito et al., 2020; Muls et al., 2022; Ostrovsky, Ivanova, 2020).

The survey results showed that cancer patients recognize the need for psychological help and support, but 75% did not apply for it until the time of the survey. Participation in socio-psychological research and surveys often initiated the subsequent referral of patients to specialists for advice and helped alleviate the psychological burden of cancer and stress (Romito et al., 2020).

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The economic and political consequences of a pandemic can both accompany and displace the psychological problems of patients. There is no doubt that there is a need to develop clinical and psychological care services for vulnerable groups (Ibáñez-Vizoso et al., 2020). The underestimation of the problem, as well as the lack of resources to solve it, can subsequently lead to an even greater increase in the need for psychological and psychiatric care (Ho et al., 2020). In the case of cancer patients, lost time can significantly change the course of the disease and increase the severity of its burden, which may subsequently affect the quality and timing of remission.

According to a number of studies, in the context of a pandemic, on average 1 out of 7 cancer survivors and 1 out of 9 healthy people from the control group reported depressive symptoms, the intensity of which reached a borderline level; the severity of symptoms of depression and anxiety in cancer patients who had experience seeking psychiatric help before the pandemic was expected to be higher (Al-Shamsi et al., 2020; Caliandro et al., 2023; Ng et al., 2020). The factor that aggravated the anxiety-depressive symptoms, among others, was information about an increase in mortality from COVID-19 on the background of chemotherapy (Gregucci et al., 2020; Lee et al., 2020). After getting acquainted with such information, many patients refused treatment for the underlying disease, which significantly reduced their chances of achieving a relatively rapid and stable remission.

The causes of mental disorders in coronavirus include, among others, intoxication and oxygen starvation due to the development of pulmonary insufficiency (Seledtsov et al., 2020). The psychoemotional impact of the pandemic on cancer patients is diverse and is likely to have long-term consequences (Edge, 2021). Timely diagnosis and psychological help available at the time of severe negative experiences can help in the future to reduce the severity of symptoms and reduce the duration of their treatment. This can improve the quality of life for some patients, and save this life for others (Kadyrov et al., 2020).

Emotional and personal characteristics of cancer patients during the COVID-19 pandemic

The prevalence of anxiety-depressive symptoms in patients suffering from life-threatening diseases, which include cancer and COVID-19, is explained by a number of factors: personal predisposition, peculiarities of the belief system, physical resistance of the body to the effects of damaging factors, etc.

The personality traits of patients – a set of cognitive, emotional and behavioral patterns – influence adherence to treatment and focus on cooperation with medical staff; on the patient's ability to take on some responsibility for the recovery process, which means they can both help and hinder the treatment and recovery processes.

The level of psychological resources that a person can devote to adaptation to the disease and recovery is related to the type of response to the disease. A harmonious type of attitude to the disease is characterized by a higher level of emotional stability, a wider

range of stress coping strategies, as well as personal competencies that are significant in social life (Finagentova, 2010).

It is known that character accentuations exacerbate the perception of negative information (Laskov et al., 2017) and affect the orientation of a person towards recovery (Afanasyeva et al., 2009; Nikitina, 2021; Smulevich et al., 2014). The peculiarities of motivation allow a person to realize his inner potential, to be active, to go beyond the traumatic experience. The level of self-esteem affects the ability to believe in a good outcome and positive predictions. According to Kryukova et al., "people with low self-esteem are more likely to use such types of erroneous thinking as "Catastrophization" and "Exclusion of good" (2018, p. 63), which negatively affects the course and outcome of the disease, manifesting itself in the affective sphere in the form of the development of anxiety-depressive symptoms.

A study conducted by Bäuerle et al. (2021) in Germany demonstrated an increase in the incidence of major symptoms of depression in cancer patients after the outbreak of COVID-19 from 9.3% to 16.7%; an increase in the prevalence of severe generalized anxiety symptoms from 8.0% to 20.7%. 38% of the study participants reported distress before the pandemic, and 54.7% after its onset.

According to the results obtained by a group of scientists from the United States of America (Miaskowski et al., 2020), the statistics on the prevalence of clinically significant symptoms in patients with breast cancer in the context of the COVID-19 pandemic are as follows:

- depression – 71.2%;
- alarm – 78.0%;
- sleep disorders – 78.0%;
- evening fatigue – 55.9%;
- cognitive impairment – 91.5%;
- Post-traumatic stress disorder - 31.6%.

According to the results of a study by Wang et al (2020) conducted among 6213 patients of one of the largest cancer centers in China, 23.4% of respondents were diagnosed with depression, 17.7% with anxiety, 9.3% with post-traumatic stress disorder, and 13.5% with high hostility. The authors found that the most significant risk factors for the development of mental maladjustment of cancer patients against the background of a high risk of coronavirus infection are a history of mental health disorders, frequent episodes of excessive alcohol consumption, uncontrolled anxiety and depression associated with cancer treatment during COVID-19, high levels of fatigue and pain. Despite the widespread prevalence of problems related to mental maladaptation, only 1.6% of patients with these difficulties sought psychological help.

Similar data were obtained by a group of Italian scientists who studied the level of distress in patients with lymphoma during the pandemic. The majority of respondents

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stated that their anxiety increased: 36% of them had high anxiety, 31% had high depression, 43% of respondents had super threshold values according to the integral indicator of the Hospital Anxiety and Depression Scale HADS; 36% had symptoms corresponding to the diagnostic criteria of post-traumatic stress disorder (PTSD). At the same time, the number of requests for psychological help during the COVID-19 pandemic increased more than 4 times (Romito et al., 2020; Caliandro et al., 2023).

Thus, an analysis of the results of international studies on the characteristics of personal response to the disease and the prevalence of anxiety and depressive symptoms in cancer patients during the COVID-19 pandemic showed the presence of common trends: increased affective symptoms, most pronounced in a group of people with a history of psychopathological symptoms and dominant maladaptive attitudes. The frequency of requests for psychological help from cancer patients differs from country to country and is presumably related to the general awareness of people about psychological support: low among respondents from China (Yang et al., 2023), high among respondents from Germany, Italy (Molinari et al., 2012; Sampogna et al., 2021), USA (O'hea et al., 2020), as well as the inclusion of psychological services in health insurance (many patients in need of psychological help cannot afford it for financial reasons).

Features of cancer patients' response to life-threatening diseases during the COVID-19 pandemic: post-traumatic stress disorder and post-traumatic growth

Cancer patients are considered to be more psychologically vulnerable to distress. On average, by the time they seek help from an oncologist again, most patients have high rates of post-traumatic stress disorder (PTSD) (Bergfeld, 2017).

Symptoms of post-traumatic stress disorder in the context of the pandemic of a new coronavirus infection, according to the results of a study conducted in Italy, were detected in 36% of patients with lymphoma; high levels of PTSD were recorded in the age group from 18 to 50 years, among women PTSD was more common than among men (Romito et al., 2020).

In a longitudinal study of the mental health of the Chinese population conducted during the coronavirus pandemic on a sample of 1,738 healthy participants, it was noted that, despite a significant decrease in the level of psychological tension recorded during repeated testing conducted 4 weeks after the outbreak of COVID-19, the average group results of respondents obtained in both surveys indicated severe symptoms of PTSD (Wang et al., 2020).

The traumatic nature of experiences in conditions of cancer is explained, among other things, by the prolongation of the fear of death. The latter acquires a "chronic character" due to the lack of connection with a "visible" danger or a certain event, unlike a situation of military operations or a catastrophe (Tarabrina et al., 2010).

According to Trusova A.D. and Faustova A.G., "comprehensive fear arising in conditions of man-made and biological natural disasters or due to deadly diseases can be designated as a specific category in the cluster of existential psychological traumas" (2021, p. 357).

Studies examining the condition of people affected by various epidemics in the pre-epidemic period show that the level of post-traumatic stress was higher in quarantined people compared to those who were not isolated (Brooks et al., 2020). The degree of manifestation of symptoms of post-traumatic stress depended on the duration of quarantine (Ostrovsky, Ivanova, 2020; Reynolds et al., 2008).

"... Mental post-stress disorders ... act as a trigger for a variety of somatic diseases, the growth of which is predicted in the coming years" (Aronov et al., 2021, p. 67). Researchers suggest that in the years following the end of the pandemic, people become aware of their traumatic experiences and may feel the depletion of psychological resources, which will lead to an increase in requests for psychological and medical help (Alekhin et al., 2021).

According to Vasilyeva et al., comorbid PTSD complicates the treatment and adaptation of patients (2020). Nikitina D.A. (2021), in her work on post-traumatic stress in people with a life-threatening disease, notes that the message of diagnosis itself is a high-intensity stressor, the occurrence of which is accompanied by an experience of fear of death, fear of the appearance of cognitive dysfunctions, identity disorders. Thus, cancer patients in the conditions of COVID-19 faced the fear of death twice: at the time of the announcement of the diagnosis and during the pandemic, which could lead to retraumatization. At the same time, life experience related to adaptation to an oncological diagnosis could contribute to the formation of optimal stress-coping behavior in the context of the COVID-19 pandemic.

Experiencing distress and being in conditions of uncertainty have different effects on a person, depending on his general condition and the internal resources spent on adaptation. It is known that against the background of mortal danger, a maladaptive type of attitude towards the disease can form, accompanied by destructive forms of behavior (Yelnikova, 2020). At the same time, with sufficient resources (including psychosocial support), so-called post-traumatic growth is possible - positive personal changes associated with overcoming emotional and physical difficulties in the treatment of the disease, indicating an increase in psychological stability of the individual.

The absence of spiritual changes and low rates of autosympathy are associated with lower rates of post-traumatic growth (Darabos et al., 2021; Trusova and Faustova, 2021) and may also be symptoms of a patient's depressive state, indicating maladaptation (including the process of "freezing in trauma"). Awareness of new opportunities in life, high social status, as well as a change in self-perception contribute to post-traumatic growth: if the attitude towards illness as a severe ordeal changes by changing the focus of perception to "illness as a way of development", post-traumatic growth is possible (Yelnikova, 2020). Existential resources are also important in the process of post-traumatic

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growth: the search for and finding meaning in life are important conditions for it (Tedeschi & Calhoun, 2004; Jaspers, 2013).

Distress can weaken a person's emotional and physical condition. At the same time, the idea of safety as the opposite of distress and a necessary factor of post-traumatic growth depends on the perception, characteristics and properties of a person, her moral values, rules of behavior and communication, as well as their assessment system (Pukhareva, 2016). The above indicates the need for an individual approach to the psychological support of cancer patients in the context of the COVID-19 pandemic and the effects of other additional traumatic factors.

For a more detailed study of the psychological characteristics of cancer patients, taking into account the fact of COVID-19 disease, we planned and conducted an empirical study.

Methods

In the period from spring 2021 to autumn 2023, a psychodiagnostic study of cancer patients was conducted on the basis of the National Research Institute of Oncology of the Ministry of Health of the Russian Federation (Rostov-on-Don); 112 respondents aged 18 to 62 years took part in it (the average age was 42 years, out of of these, 64% were women, 36% were men), 48% of them had suffered COVID-19, 52% denied the fact of coronavirus infection in the previous 6 months.

The following research methods were used: the SCL-90-R questionnaire, the R. Lazarus coping test, 5PFQ, the "Test of meaning-life orientations" by D.A. Leontiev, the M. Rokich "Value Orientations", the WHO-100 scale.

For statistical processing of the results obtained, one-factor ANOVA analysis of variance (categorization factor: COVID-19 in the anamnesis no earlier than 6 months relative to the time of psychodiagnostics), as well as a posteriori Tukey analysis for nonequilibrium sample sizes were used.

Results

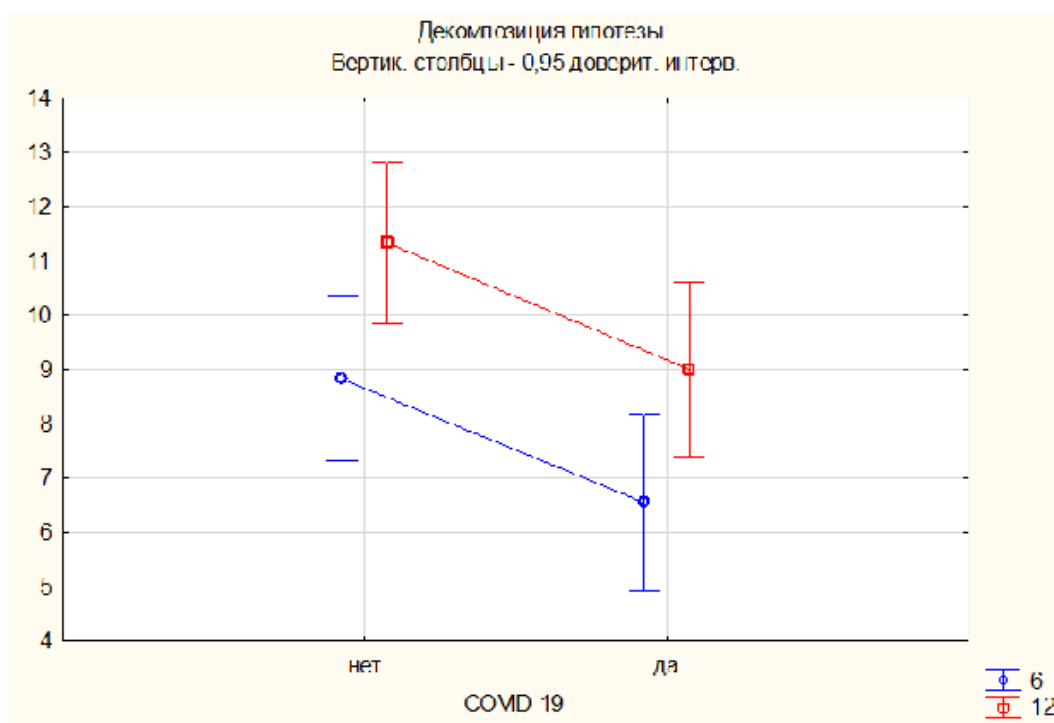
According to the results obtained during the ANOVA univariate analysis of variance, there were no significant differences in quality of life indicators measured using the WHO-100 scale ($F = 0.68$, $\text{Effect}_{df} = 25$, $\text{Error}_{df} = 43$, $p = 0.8$), as well as in the severity of psychopathological symptoms, measured using the SCL-90 questionnaire, in cancer patients who had and had not had COVID-19 ($F = 0.6$, $\text{Effect}_{df} = 16$, $\text{Error}_{df} = 43$, $p = 0.9$). The lack of results can be explained by the presence of the influence on the quality of life of the main factor – cancer.

At the same time, during the a posteriori analysis of Tukey, the features of the value orientations of cancer patients who had and had not had COVID-19 were revealed.

In cancer patients who have had COVID-19 (M2), significantly higher positions in the hierarchy of terminal life values are occupied by love (spiritual and physical intimacy with a loved one; $M_1 = 8.8$, $M_2 = 6.6$, $p = 0.045$) and development (self-improvement, constant physical and spiritual improvement; $M_1 = 11.3$, $M_2 = 9.0$, $p = 0.038$), compared with cancer patients who did not have COVID-19 (M_1) (Fig. 1).

Figure 1

Results of variance and a posteriori analyses of the severity of terminal values in cancer patients who have and have not had COVID-19 disease (Tukey's Test for Post-Hoc Analysis after One-way ANOVA)



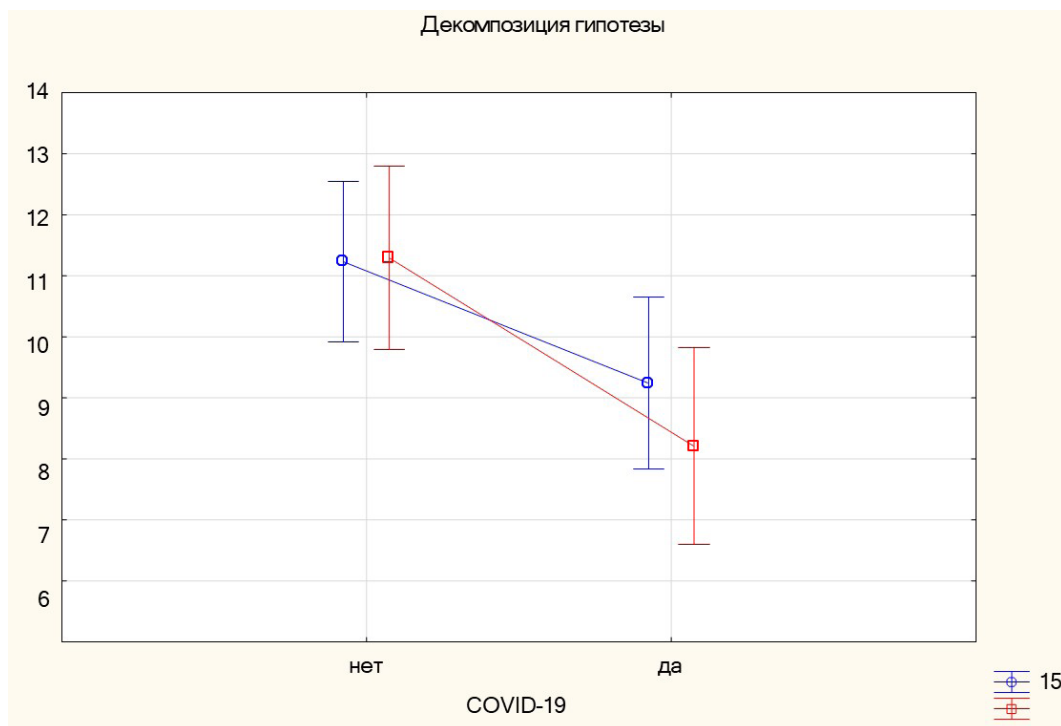
Note. Designations: 6 – value orientation "Love" (spiritual and physical intimacy with a loved one), 12 – value orientation "Development" (self-improvement, constant physical and spiritual improvement).

In the hierarchy of instrumental life values, cancer patients who have had COVID-19 have significantly higher positions in the value orientations of "Breadth of views" (the ability to understand someone else's point of view, respect other tastes, customs, habits); ($M_1 = 11.3$, $M_2 = 9.0$, $p = 0.042$), as well as "Sensitivity" (caring) ($M_1 = 11.3$, $M_2 = 8.2$, $p = 0.007$), compared with cancer patients who were not ill with COVID-19 (Fig. 2).

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Figure 2

Results of variance and a posteriori analyses of the severity of instrumental values in cancer patients who have and have not had COVID-19 disease (Tukey's Test for Post-Hoc Analysis after One-way ANOVA).

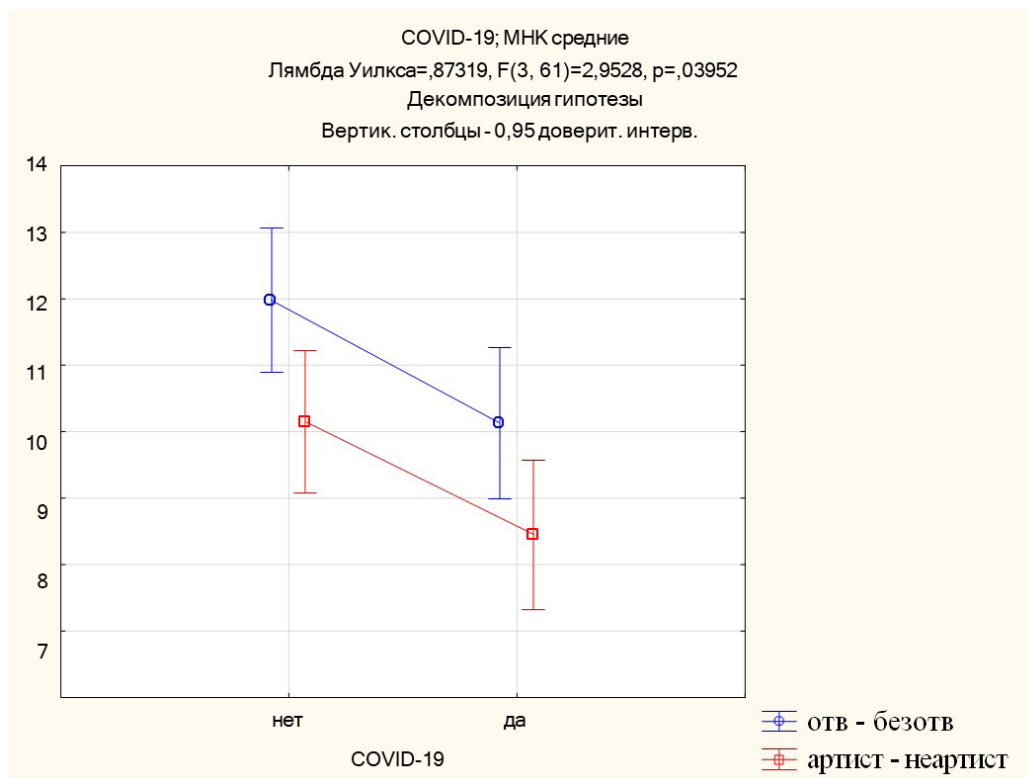


Note. Designations: 15 – breadth of views (the ability to understand someone else's point of view, respect other tastes, customs, habits); 18 – sensitivity (caring).

A study of the personal characteristics of cancer patients demonstrated that the pole of irresponsibility is significantly more pronounced in cancer patients who have had covid; this result may be associated with a decrease in volitional qualities under the influence of two life-threatening diseases at once ($MS = 55.0$, $F = 5.5$, $p = 0.02$; $M1 = 10.2$, $M2 = 8.5$, $p = 0.03$) (Fig. 3).

Figure 3

Results of variance and a posteriori analyses of the severity of personality traits in cancer patients who have and have not had COVID-19 disease (Tukey's Test for Post-Hoc Analysis after One-way ANOVA).



Note. Designations: «отв - безотв» – pole "Responsibility - Irresponsibility"; «артист - неартист» – pole "Artistry - Inartistic" (according to the 5PFQ).

The pole of practicality (including the indicator "Inartistic"; $M_1 = 10.2$, $M_2 = 8.5$, $p = 0.03$), also more pronounced in patients with covid cancer, may be associated with their greater conservatism, less flexibility and greater adaptability to everyday life ($MS = 664.3$, $F = 5.5$, $p = 0.02$; $M_1 = 46.5$, $M_2 = 40.1$, $p = 0.02$) (Fig. 3).

There were no significant differences in the severity of life-meaning orientations ($F = 0.2$, $Effect_{df} = 6$, $Error_{df} = 70$, $p = 0.9$) and coping strategies ($F = 0.9$, $Effect_{df} = 8$, $Error_{df} = 73$, $p = 0.48$) depending on the transferre covid over the past 6 months.

Discussion

According to the results of the study, the following psychological characteristics of cancer patients who have and have not suffered from COVID-19 disease were revealed.

The value-semantic sphere of cancer patients who have had COVID-19, compared with cancer patients who have not had COVID-19, is characterized by dominance in the hierarchy of terminal life values of "love" and "development"; in the hierarchy of instrumental values – "breadth of views" and "sensitivity". Their personal sphere is characterized by the dominance of the pole of irresponsibility, which may be associated with a decrease in volitional qualities under the influence of two life-threatening diseases at once, as well as the pole of practicality, which may indicate a more pronounced conservatism, rigidity in decision-making. Thus, the described characteristics are sensitive to the comorbidity of cancer and coronavirus infection.

There were no significant differences in the severity of coping strategies, life orientations, psychopathological symptoms and quality of life in patients, depending on the fact of COVID-19 disease.

There are not enough studies in the modern literature that could confirm or refute the observations we have received. There are known studies that have studied the differences between the described characteristics in conditions of exacerbation of life-threatening diseases and remission. In the work of Bergfeld A. Yu. (2017), it was shown that the level of neuropsychic resistance to stress is higher in women in remission, because they are characterized by using an effective way to deal with stress – they analyze a problematic situation and try to find the optimal solution, while avoiding analysis and distraction to external objects are not effective in dealing with stress. In the study of cancer-affected women in remission, "direct links of emotional intelligence and quality of life, feedback links of emotional intelligence and alexithymia, alexithymia and coping strategies, quality of life and coping strategies, and direct and feedback links of emotional intelligence and coping strategies were confirmed" (pp. 75-76). Nikitina (2021) showed that patients' belief in the value and importance of their Self is an important part of coping strategies with intense stress.

The scientific literature presents the results indicating an aggravation of psychopathological symptoms in conditions of comorbidity of cancer. According to the results of a study conducted by Ho et al. (2020), prolonged emotional stress during the pandemic could provoke psychopathological symptoms in people who do not suffer from psychiatric diseases and worsen the mental state of those who already had similar disorders. The researchers found that during the pandemic, psychiatric patients had significantly increased levels of anxiety, depression, stress, anger, impulsivity and suicidal thoughts; more than a third of the identified symptom complexes met the diagnostic criteria for PTSD.

The absence of significant differences in the severity of the characteristics studied by us in the groups of cancer patients who have and have not undergone coronavirus

infection may be due to the fact that they change in a similar way in the presence of one life-threatening disease, and remain stable under conditions of addition of a comorbid background. The results may also be influenced by the fact that the respondents stayed in the oncological hospital during the study period. The expectation of surgery, as well as the early postoperative period, create an additional background of psycho-emotional stress.

Thus, in order to increase the reliability of the results obtained, it is necessary to continue the study.

Conclusion

The novelty of the work consists in a broad overview of the problem: the description of emotional and personal characteristics, as well as the characteristics of the response of cancer patients to life-threatening diseases during the COVID-19 pandemic.

According to our results, the fact of COVID-19 disease is associated with a change in the hierarchy of values, the expression of volitional qualities and flexibility in solving life difficulties, the described characteristics are sensitive to the comorbidity of cancer and coronavirus infection.

The features of the quality of life, life-meaning orientations, the intensity of coping strategies, as well as the severity of psychopathological symptoms in cancer patients do not change significantly under the conditions of the addition of a comorbid background (COVID-19).

To date, there is no doubt that "with an increase in neuropsychiatric resistance to stress, the risk of continuing the disease decreases, and with a decrease in resistance to stress, it increases, i.e. the disease can become protracted (metastasis, relapse)" (Bergfeld, 2017, pp. 74-76). Thus, increasing the individual's resistance to the effects of distress should become one of the targets of psychological support for cancer patients in the context of the COVID-19 pandemic.

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Perceptual Set Effect in Preschool and Early School-Aged Children Shaped by the Ponzo and Müller-Lyer Illusions

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Abstract

Introduction. A perceptual set is a specific psychological mechanism that shapes the perception of objects based on prior experience, current goals, and the conditions of perception. Previous studies have shown that both realistically different and illusorily distorted objects can create a perceptual set effect in adults. The aim of this study is to experimentally verify the formation of the perceptual set effect in children using the Müller-Lyer and Ponzo illusions, in comparison with the presentation of segments that differ in length. **Methods.** The sample consisted of 26 children with an average age of 6.45 years. The stimulus material was presented in three series: real-different segments (with actual size differences), the Ponzo illusion, and the Müller-Lyer illusion. Each series included 10 setup stimuli and 5 pairs of equal segments to assess the perceptual set effect. Prior to the main experiment, all children underwent diagnostics of visual perception maturity and were divided into two groups based on their level of visual perception constancy maturity. **Results.** Statistical analysis of the experimentally obtained data revealed a perceptual set effect in children with a high level of visual perception constancy maturity, observed in both the series with real-different segments and the Müller-Lyer illusion. Children with low constancy maturity did not exhibit a perceptual set effect. The Ponzo illusion did not produce a perceptual set effect in either group of children. **Discussion.** The results obtained should be regarded as new evidence supporting the idea that the Ponzo and Müller-Lyer illusions belong to distinct categories of illusions.

Keywords

perceptual set effect, Müller-Lyer illusion, Ponzo illusion, visual perception constancy, size estimation

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Introduction

The Perceptual Set Effect is commonly defined as the tendency of an individual to perceive and respond in a certain way (Uznadze, 2001; Uznadze, 1958; Bruner, 1957; Luchins & Luchins, 1970). The term "perceptual set" has evolved to encompass a variety of meanings. One approach to studying perceptual set focuses on its connections with activities, actions, and operations, and also allows for the differentiation of various types of sets, such as target set, operational set, and others (Asmolov, 1979; Arbekova & Gusev, 2017). The perceptual set effect refers to the inaccurate perception of physical properties of objects (such as size, length, weight, brightness, etc.) influenced by the subject's prior experience. In experiments, such prior experience is often induced by presenting a series of stimuli with a fixed physical parameter (for example, a large object on the right and a small one on the left, or a light object in the right hand and a heavy one in the left hand). In the critical trial, two equal objects are presented, and the assimilation or contrast effect is observed in the subjects. The prevalence of these effects depends on both the stimulus parameters and the subject (McKenna, 1984). However, the perceptual set effect does not always occur; in some cases, the set does not appear at all (Uznadze, 1961). The concept of perceptual set is described in various ways, but all approaches share the common idea of perceptual set as the result of cognitive activity (rather than merely receptor adaptation), involving operations such as comparison, generalization, and memorization of stimuli (Baindurashvili, 1986; Deco & Schürmann, 2000; Kostandov et al., 2009; Imedadze, 2023).

Perceptual similarity enhances the size contrast effect, as demonstrated by N. Bruno (2008) in his study of the Müller-Lyer illusion. Bruno proposed that perceptual set distortion is not only due to the characteristics of the visual system, as some researchers have suggested (Jahoda, 1971; Shoshina et al., 2010), but is also influenced by learning and attention processes (Bruno et al., 2008). Kappers and Bergmann Tiest (2014) replicated Bruno's findings, showing that variations in the stimulus set reduce the contrast effect. They argued that cognitive processes involving higher cortical areas play a key role in the formation of perceptual set. In the works of V. M. Allakhverdov, the perceptual set is proposed as a regularity in the functioning of consciousness mechanisms, reflecting a tendency to adhere to a chosen hypothesis (Allakhverdov, 2000). The introduction of irrelevant variables (such as the format in which information is presented) is known to diminish the effect of the set, both perceptually and in Luchins' tasks (Tukhtieva, 2011; Tukhtieva, 2014). The author attributes this result in Luchins' tasks to an increase in conscious control when parameters unrelated to the task are altered – such as changing colors and adding letters and numbers to circles of varying sizes in a series, where the primary distinction among the circles lies in their size.

A perceptual set can be formed not only through the use of genuinely different objects but also via illusions or by imagining such objects (Kostandov et al., 1998; Valerjev & Gulan, 2013; Karpinskaia et al., 2018; Grigolava, 1987). This suggests that what matters more in creating a set effect is not the actual physical difference between stimuli, but rather the subjective perception of that difference. Despite this, few experiments have specifically explored the perceptual set effect based on illusions. It is well-established that different types of illusions are likely associated with various psychophysiological mechanisms (Coren et al., 1976; Menshikova, 2012; Menshikova, 2013; Karpinskaya & Lyakhovetskii, 2014; Karpinskaia et al., 2023). The strength of the illusory effect can vary depending on the presentation context or the individual characteristics of the subject.

The strength of the illusory effect and the persistence of the perceptual set effect vary across age groups. Preschool and early school-aged children, like adults, are susceptible to the effects of set (Romanova-Afrikantova et al., 2023; Leibowitz & Judisch, 1967; Brislin, 1974). However, conducting experiments with preschool children can be challenging due to the need for a clear understanding of instructions and the ability to provide coherent responses. Few studies have investigated cognitive illusions and the perceptual set effect in children, and those that do typically focus on children as young as 5 or 6 years old. At this age, key mechanisms of visual perception, such as perceptual (subjective) constancy, are likely to be developing, which may contribute to changes in the strength of visual illusions (Rozhkova et al., 2005; Ognivov, 2008; Romanova-Afrikantova et al., 2023). The perceptual set effect is also linked to mechanisms of perceptual constancy (Kezeli et al., 2021). It has been shown that the perceptual set effect is less pronounced in children aged 7–10 years compared to those aged 11–18 years and 19–68 years (Cunningham, 1965; Pope et al., 2015). Similarly, the strength of geometric illusions changes with age (Leibowitz & Judisch, 1967; Brislin, 1974; Rival et al., 2003). In our previous study, we

examined the strength of the Ponzo illusion in preschool and early school-aged children and found that the magnitude of the illusory distortion was related to both age and the development of perceptual constancy (Romanova-Afrikantova et al., 2023). Given that the strength of the Ponzo and Müller-Lyer illusions varies with different levels of perceptual constancy maturity, we hypothesized that these differences would also be evident in the formation of the perceptual set effect.

Aim of the study

The aim of this study is to investigate the perceptual set effect on both real and illusory stimuli (specifically, the Ponzo and Müller-Lyer illusions) in preschool and early school-aged children.

Methods

Participants

The study included 26 children (15 girls and 10 boys) aged 5 years and 6 months to 8 years and 6 months, with an average age of 6.45 years. All participants were typically developing, and all were right-handed.

Stimulus material

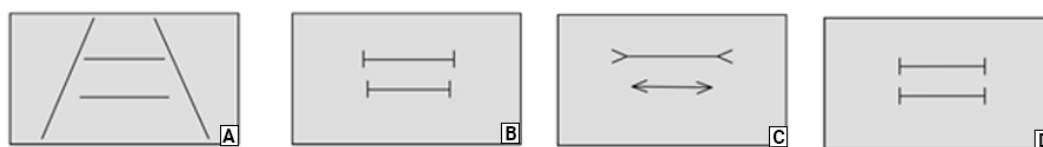
На этапе формирования установочного эффекта использовались три вида стимулов:

1. The Müller-Lyer illusion: two identical horizontal segments are positioned one above the other. The upper segment is flanked by arrows pointing outward, while the lower segment is flanked by arrows pointing inward toward the segment's endpoints (Fig. 1C).
2. The Ponzo illusion: two identical horizontal segments are positioned one above the other between two vertical lines that converge toward the top of the screen (Fig. 1A).
3. A pair of segments bounded by vertical serifs, differing in actual size: the upper segment is 5–30 mm longer than the lower one (Fig. 1B).

During the stage of assessing the strength of set distortion, control stimuli that did not induce any illusory distortion were used: two equal horizontal segments positioned one above the other and bounded by vertical serifs (Fig. 1D).

All stimulus types featured a pair of central horizontal segments. The segments were black and displayed on a white screen, with lengths ranging from 50 to 500 mm, and all lines had a thickness of 1 mm.

Figure 1
Stimulus Material



Note. *A – Ponzo illusion, B – segments with actual size differences, C – Müller-Lyer illusion, D – control stimuli with equal size differences.*

Research procedure

Before taking part in the main experiment, participants were assessed for their level of visual perception development.

For the assessment, we used the 'Methodology for Assessing the Level of Visual Perception Development in Children Aged 5 to 7.5 Years,' a revised and comprehensive test developed by M. Frostig (Bezrukikh, & Morozova, 1996). We used Subtest 3, 'Constancy of Contours,' which is designed to assess the perceptual constancy (Morozova, 2008). Subtest 3 involves recognizing a central geometric figure presented in varying sizes, tones, textures, and spatial positions. A circle and a square are used as the central figures to be identified.

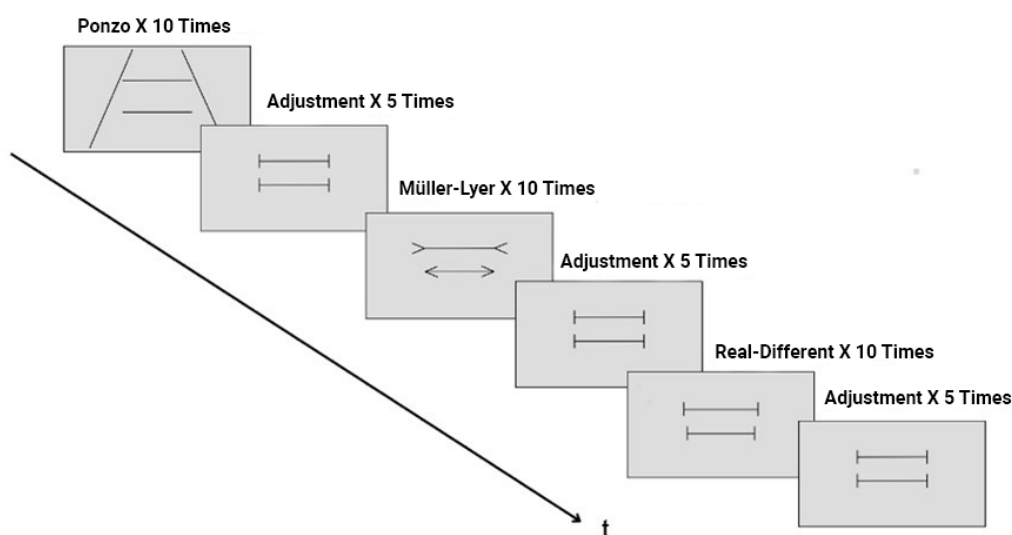
Based on the results of the perceptual constancy assessment, the subjects were divided into two groups: the group with a conditionally low level of constancy maturity (group of children with lower maturity), consisting of children who scored 10 points or fewer, and the group with a conditionally high level of constancy maturity (group of children with higher maturity), consisting of children who scored more than 10 points.

The original software developed by the authors was used in the experiment. Each participant was presented with three series of stimuli on the monitor of an HP Envy 17-n153nr laptop (Figure 2).

Each series consisted of 10 setup stimuli (Fig. 1A, B, or C) and five pairs of equally sized segments (Fig. 1D) to assess the perceptual set effect. The order of presentation of the series for each participant was determined randomly, with a 1-minute pause between series.

During the formation phase of the perceptual set effect, participants were asked to view stimuli presented sequentially on the screen. The presentation time for each setting stimulus was 1 second, with a 1-second pause between presentations. The total duration of the experiment was approximately 7 minutes per participant (excluding the time for level of visual perception development assessment).

Figure 2
Example of Stimulus Presentation Order to the Subjects



For the verbal assessment of control stimuli with equal size differences, the method of adjustment was used: the participant was asked to make the segments equal by giving verbal instructions to the experimenter to decrease or increase the length of the lower segment. As soon as the participant believed the segments were equal, they would say 'stop,' and the next pair of stimuli would appear on the screen. The length difference between the segments was fixed. The strength of the perceptual set effect was calculated as the difference in length between the lower and upper segments, expressed as a proportion of the upper segment's length. "Negative values of the set effect strength indicate an assimilation set effect (where the length of the upper segment of the neutral stimulus is greater than that of the lower segment, as in the stimuli from the formation phase), while positive values indicate a contrast set effect.

The statistical significance of the set effect was assessed at the $p < 0.05$ level using the Wilcoxon test. Data processing was conducted using Prism 10 for macOS (Version 10.1.1, 270) (GraphPad Software, La Jolla, CA, USA). The data are presented as mean \pm standard deviation.

Results

The group with a conditionally high level of constancy maturity included 17 children, while the group with a conditionally low level of constancy maturity consisted of 9 children.

Figure 3 illustrates the strength of the perceptual set effect as a function of the type of setting stimuli and the subjects' level of perceptual constancy maturity. Although subjects

were presented with equal segments during the test phase, under the influence of the perceptual set effect, they tended to adjust the length of the lower segment, making it shorter than the upper segment.

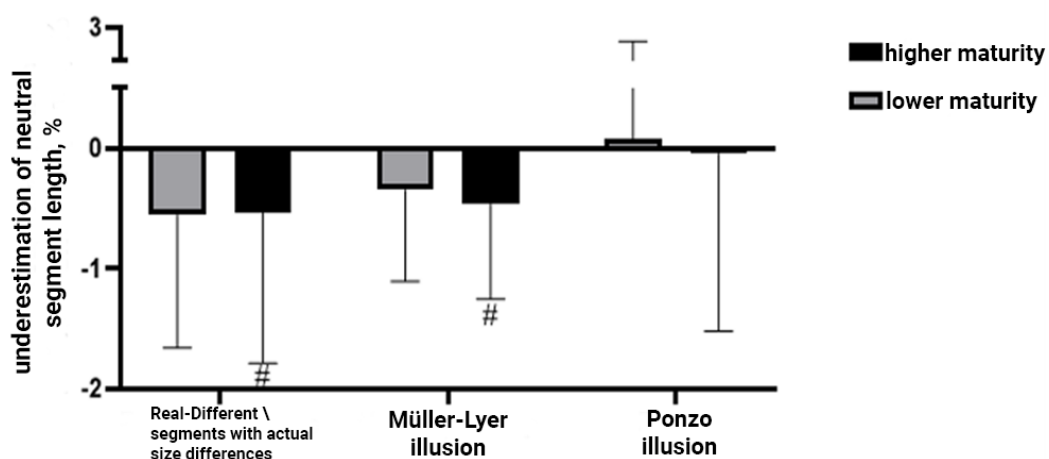
The stimulus series using segments with actual size differences demonstrated a perceptual set effect ($-0.54 \pm 1.21\%$, $W(26) = -2$, $p = 0.0215$). When the children were divided into two groups based on their visual constancy maturity, the group of children with higher maturity exhibited a set effect ($-0.54 \pm 1.25\%$, $W(18) = -39$, $p = 0.0488$), whereas the group of children with lower maturity showed no set effect ($-0.55 \pm 1.10\%$, $W(9) = -13$, $p > 0.05$).

The series of stimuli creating the Müller-Lyer illusion also resulted in perceptual set formation ($-0.43 \pm 0.78\%$, $W(26) = -75$, $p = 0.0061$). Similar to the case with the segments with actual size differences, the group of children with higher maturity in perceptual constancy exhibited a set effect ($-0.46 \pm 0.79\%$, $W(18) = -32$, $p = 0.0234$), whereas the group of children with lower perceptual constancy maturity showed no set effect ($-0.35 \pm 0.76\%$, $W(9) = -13$, $p > 0.05$).

The Ponzo illusion did not produce a significant set effect in the subjects ($-0.003 \pm 1.59\%$, $W(26) = -2$, $p > 0.05$). Additionally, no attitudinal effect was observed in either of the groups with different levels of visual constancy maturity: ($-0.045 \pm 1.47\%$, $W(17) = 0$, $p > 0.05$ for the group with high constancy maturity and $-0.007 \pm 1.89\%$, $W(9) = -1$, $p > 0.05$ for the group with low maturity).

Figure 3

Perceptual Set Effect Strength Based on Stimulus Type and Subjects' Perceptual Constancy Maturity



Note. # – $p < 0.05$. Mean \pm Standard Deviation.

Discussion

We obtained data that confirm earlier findings on Uznadze's classical set formation in preschool and early school-aged children, where stimulus segments with actual size differences are used to create a perceptual set effect. Consistent with previous studies, we observed a persistent perceptual set effect (Ashkinazi, 2007; Kostandov et al., 2005; Kostandov et al., 2008).

A perceptual set effect was formed in children based on the Müller-Lyer illusion, whereas no perceptual set effect was observed based on the Ponzo illusion. Given that Müller-Lyer and Ponzo illusions may involve different mechanisms of formation and manifest differently depending on age (Karpinskaya & Lyakhovetsky, 2014; Coren et al., 1976; Rozhkova et al., 2005), we can hypothesize a connection between the absence of a perceptual set effect and the mechanisms underlying illusory perception formation. However, further verification is needed. Pollack (1964) demonstrated that the strength of the Müller-Lyer illusion was influenced by how it was presented. In the classical presentation method (where the illusion and full image are shown at once), children were susceptible to the illusory effect. However, when a tachistoscope was used to sequentially present separate segments and arrows that created the Müller-Lyer illusion, the illusory effect was found to depend on prior experience and the development of cognitive functions (Pollack, 1964). Our findings align with Pollack's results: children with higher visual constancy maturity, in contrast to those with lower maturity, are more susceptible to the perceptual set effect induced by the Müller-Lyer illusion.

The lack of a perceptual set effect when using the Ponzo illusion in children may be due to the fact that the mechanisms associated with this illusion have not yet fully developed in children. It is likely that hyperconstancy effects (Romanova-Afrikantova et al., 2023) and the relatively limited influence of prior experience (Reese, 1963) contribute to this absence.

We found no significant difference in the strength of the perceptual set effect caused by the Ponzo illusion between groups of children with varying levels of visual constancy maturity. This can primarily be explained by the fact that, in general, we did not observe a set effect of the Ponzo illusion in children. Future research should explore the hypothesis that the phenomenon of perceptual hyperconstancy, which accounts for greater illusory distortion in older preschool children compared to younger school-aged children (Romanova-Afrikantova et al., 2023; Ognivov, 2008; Shallo & Rock, 1988), may help explain the resistance of children's perception to the formation of a perceptual set using the Ponzo illusion.

Conclusion

We conducted a study on the perceptual set effect using both real-different segments (segments with actual size differences) and illusory stimuli (Ponzo and Müller-Lyer illusions)

in preschool children. Our findings confirmed the possibility of creating a perceptual set effect in children with real-different segments and provided new insights into how the perceptual set effect manifests when physically equal segments are presented in the Müller-Lyer illusion. The investigation into the relationship between the magnitude of the perceptual set effect and the maturity of visual perception constancy revealed that children with a higher level of visual constancy maturity are more susceptible to the perceptual set effect. However, the segments within the Ponzo illusion did not produce a perceptual set effect in preschool children

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Nataliia I. Romanova-Afrikantova conducted the experiment, statistical analysis, and prepared the text of the article.

Valeriya Yu. Karpinskaia designed the study and prepared the text of the article.

Vsevolod A. Lyakhovetskii designed the study, conducted statistical analysis, and prepared the text of the article.

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NATALIIA I. ROMANOVA-AFRIKANTOVA, VALERIJA YU. KARPINSKAIA, VSEVOLOD A. LYAKHOVETSKII
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Conflict of Interest Information

The authors have no conflicts of interest to declare.

Adolescent Deviance in Online Communities

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Abstract

Introduction. The article explores the characteristics of adolescent deviant behavior in online communities. This study is the first to examine the specific role dispositions of adolescents prone to online deviance. We analyzed the mechanisms through which real-world personalities transform in the digital environment, leading to the development of both normative and deviant digital identities. Our research focus was on teenagers, as they represent the most vulnerable group, with their value systems undergoing reformation in the real world while their new social experiences are shaped online. **Methods.** In the study, which involved a survey of 158 adolescents in both real and virtual spaces, the following methodologies were used: "Propensity for bullying in the Internet space" (Luchinkina, 2019); individual personality orientation diagnostic methodology (modified by N.P. Fetiskin); locus of role conflict diagnostic methodology by P. P. Gornostai. **Results.** Adolescents with an egoistic orientation are more prone to engage in online deviant behaviors such as harassment. Conversely, adolescents with a cooperative orientation are less likely to exhibit deviant behaviors, including verbal insults, harassment, disclosure of personal information, threats of physical violence, and social isolation. The desire for new online experiences, combined with a reduced interest in real-life interactions, contributes to both socially acceptable and deviant online roles. In contrast, adolescents with a marginalized orientation are more likely to engage in deviant behaviors such as harassment, insults, using fake names and profiles, social isolation, disclosing personal information, and making threats of violence. Furthermore, a correlation has been established between the locus of role conflict and specific forms of online deviant behavior. **Discussion.** Cultural factors play a significant role in shaping individual online

behavior patterns, influencing attitudes, values, and behavioral responses. Online activity can range from normative to deviant, with each influencing cognitive processes and online behavior.

Keywords

adolescent, deviant behavior, cyber-aggression, personality traits, real and virtual spaces, role dispositions, locus of role conflict, Internet space, insults, social isolation

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Introduction

The integration of information and communication technologies into all aspects of life marks a significant stage in scientific and technological progress. As communication processes become digitized, individuals are increasingly engaging with digital environments on a deeper level. This engagement may lead to the emergence of a new superstructure: the digital personality, which could either be a persona created by a real person or one generated by artificial intelligence, functioning as a chatbot and interacting with other entities in the digital realm (Brykov, 2023; Grebenyuk, 2020). Both the virtual persona created by a human and the digital persona generated by AI remain largely unexplored.

The research problem lies in identifying the mechanisms through which the real personality transforms in the digital environment, focusing on the mechanisms responsible for the development of both normative and deviant digital superstructures. Adolescents are the most vulnerable group, with their value systems being restructured in the real world, while, due to their age, they are simultaneously forming new social experiences in the online space. The desire to explore new experiences leads adolescents to experiment not only with socially acceptable roles but also with deviant ones (Soldatova, Rasskazova & Chigarkova, 2020; Sobkin & Fedotova, 2021). The novelty of the research lies in uncovering the connection between adolescents' deviant online behavior and their individual personality orientation, as well as the characteristics of role conflict.

The article **aims** to explore the role-specific dispositions of adolescents inclined toward deviant online behavior.

Research on adolescent deviant behavior remains inconclusive, with no consensus on its causes, forms, mechanisms, prevention strategies, or specific manifestations in the online environment. Additionally, there is no widely accepted framework for

identifying the personal attitudes of adolescents prone to deviant online behavior. While adolescence is often characterized by unstable relationships and internal conflicts, these factors alone cannot fully account for why some adolescents engage in destructive behavior (Bogdanovich & Delibalt, 2020; Bogomazova, 2022; Lazouski, 2020; Ryabov & Bochenkova, 2021; Solomatina, 2021; Fontalova & Turganova, 2019; Skornyakova, 2022; Ralnikova, 2015).

Modern psychology offers various perspectives on the phenomenon of deviant personality behavior. One approach views deviation as the result of stress-induced disruptions in mental adaptation, which activate defense mechanisms. The key concept in this approach is the 'adaptive mental boundary', which defines the limits of an individual's ability to adapt to external changes without compromising mental and physical health. Deviation, in this context, is seen as a disruption in the dynamic interaction between the individual and their environment (Rasskazova et al., 2019). Deviant adaptation may manifest as the fulfillment of personal needs without regard for the expectations and needs of others (Zhikhareva, Luchinkina & Kolchik, 2021; Zhikhareva, Luchinkina & Kolchik, 2021; Serkina & Yudeeva, 2023; Agosta, 2010; Dvoryanchikov, 2020; Eshelman, 2018).

While existing theoretical approaches are valuable, it is important to note that they are primarily designed for adults who have already developed psychological adaptation mechanisms and social experience. Consequently, adults tend to exhibit protective responses in times of crisis. In contrast, adolescents have underdeveloped defense mechanisms. Their violations of social norms may stem from insufficient understanding of these norms or a lack of a supportive environment. Unlike adults, where deviant behavior often results from failed adaptation, in children and adolescents, deviations themselves can create adaptation difficulties and disrupt the socialization process.

Special attention should be given to studying adolescents' adaptation processes in online communities, where teenagers often adopt non-normative roles due to the lack of established and clearly defined social norms. Internet activity serves as a mechanism for these adolescents' inclusion in the online community (Alekhin & Grekova, 2019; Zekeryaev, 2019; Luchinkina & Fazilova, 2021; Soldatova, Rasskazova & Chigarkova, 2020; Soldatova & Yarmina, 2019). In our study, Internet activity refers to the extent of a teenager's desire to 'settle' in virtual space. It includes the amount of time spent online, the number of online friends, and the activity level of their page (such as visits, post updates, and views).

Methods

The study was conducted in both real and digital environments. The following psychodiagnostic techniques were used: «Propensity for bullying in the Internet space» (Luchinkina, 2019); individual personality orientation diagnostic methodology (modified by N. P. Fetiskin); locus of role conflict diagnostic methodology by P. P. Gornostai.

A total of 158 adolescents, aged 14 to 16 years, participated in the study.

Results

It was found that most adolescents do not exhibit high levels of online deviant behavior.

We measured the averages for each form of online behavior, which are presented in the table below (Table 1).

Table 1

Mean values of the study results on forms of online deviant behavior (cyberbullying)

Type of online deviant behavior	Mean value	Form of online deviant behavior	Mean value
Cyberstalking	5.21	Use of a fake name	5.24
Verbal insults	5.2	Disclosure of personal information	4.95
Harassment	4.86	Social isolation	5.03
Slander	5.24	Threats of physical violence	4.95

The forms of deviant behavior, such as the use of a fake name and slander, received higher scores, with an average of 5.24 out of 15. However, the averages for all other forms of online deviant behavior do not exceed one-third of the maximum possible score. Overall, the data suggests that teenagers tend to avoid maladaptive online behaviors and are not generally predisposed to cyber aggression, bullying, shaming, etc. Nevertheless, some individuals exhibit higher levels of deviant behavior.

The results of the adolescents' personality interactive orientation revealed the following distribution: 16% of respondents showed a high level of egoistic orientation, 65% had an average level, and 19% displayed a low level. In terms of cooperative orientation, 25% exhibited a high level, 56% had a medium level, and 19% showed a low level. For marginal orientation, the distribution was as follows: 4% at a high level, 33% at a medium level, and 63% at a low level. Analysis of the prevailing types of orientation showed that the cooperative type was dominant in 45% of adolescents, the egoistic type in 37%, the marginal type in 14%, and 4% had an undefined primary type of orientation.

The research presented in this paper identifies the specific features of adolescent role-playing behavior associated with deviant online activity. The internal locus of role conflict, manifested in adolescents' desire for self-assertion and the assertion of their own identity, even when in conflict with social roles, is closely tied to their need for independence and self-expression (Luchinkina, 2022). An external locus of role conflict

was identified in 34% of respondents. Thus, role behavior aligns with social expectations, and when it contradicts individual identity, it leads to the formation of internal conflict. In 29% of adolescents, no clear predominance of either type of conflict locus was observed.

Correlation analysis

Correlation analysis of the study results showed a statistically significant positive direct correlation between egoistic orientation and harassment ($r = 0.199$; $p < 0.05$). Thus, it can be inferred that individuals with a higher level of egoistic orientation are more likely to engage in harassment in virtual spaces.

There is a statistically significant negative correlation between the 'Cooperative orientation' scale and the 'Verbal insults' scale ($r = -0.252$, $p < 0.05$). The correlation is negative, indicating that the higher the level of cooperative orientation, the less likely a person is to engage in offensive behavior in virtual space.

There is a statistically significant negative correlation between the 'Cooperative Orientation' scale and the 'Harassment' scale ($r = -0.241$, $p < 0.05$). This inverse correlation suggests that the higher the level of cooperative orientation, the less likely a person is to exhibit tendencies toward harassment in virtual spaces.

A statistically significant negative correlation was also found between the 'Cooperative orientation' scale and the 'Disclosure of personal information' scale ($r = -0.245$; $p < 0.05$). Thus, adolescents with a pronounced cooperative orientation are less likely to publicly disclose personal information in virtual space. An inverse correlation was found between the 'Cooperative orientation' scale and the 'Social isolation' scale ($r = -0.273$, $p < 0.01$). This negative relationship suggests that the higher the level of cooperative orientation, the less likely a person is to exhibit tendencies toward social isolation in virtual spaces.

There is a statistically significant negative correlation between the 'Cooperative Orientation' scale and the 'Threats of Physical Violence' scale ($r = -0.242$, $p < 0.05$). This suggests that individuals with higher levels of cooperative orientation are less likely to exhibit a propensity for making threats of physical violence in virtual spaces.

A significant positive correlation was identified between the 'Marginal Orientation' scale and the 'Cyberstalking' scale ($r = 0.361$, $p < 0.01$). This indicates that adolescents with a pronounced marginal orientation are more likely to engage in stalking behavior in virtual spaces. A statistically significant positive correlation was also found between the 'Marginal Orientation' scale and the 'Verbal Insults' scale ($r = 0.242$, $p < 0.05$). This suggests that individuals with higher levels of marginal orientation are more likely to exhibit a tendency toward using verbal insults in virtual spaces.

A significant positive correlation was identified between the 'Marginal Orientation' scale and the 'Use of a Fake Name' scale ($r = 0.327$, $p < 0.01$). This suggests that adolescents with a pronounced marginal orientation are more likely to use a fake name in virtual spaces.

A statistically significant positive correlation was found between the 'Marginal Orientation' scale and the 'Disclosure of Personal Information' scale ($r = 0.242$, $p < 0.05$). This suggests that individuals with a pronounced marginal orientation are more likely to disclose the personal information of others in virtual spaces. Additionally, a significant positive correlation was established between the 'Marginal Orientation' scale and the 'Social Isolation' scale ($r = 0.362$, $p < 0.01$). This indicates that the higher an individual's level of marginal orientation, the more likely they are to exhibit a tendency toward social isolation in virtual spaces.

A significant positive correlation was identified between the 'Marginal Orientation' scale and the 'Threats of Physical Violence' scale ($r = 0.402$, $p < 0.01$). This suggests that individuals with a predominant marginal orientation are more likely to exhibit a propensity for issuing threats of physical violence in online spaces.

A significant positive correlation was identified between the 'Locus of Role Conflict' scale and the 'Slander' scale ($r = 0.323$, $p < 0.01$). This suggests that individuals with an internalized locus of role conflict are more likely to experience vilification on social networks compared to those with an externalized locus of role conflict.

A significant positive correlation was identified between the 'Locus of Role Conflict' scale and the 'Threats of Physical Violence' scale ($r = 0.323$, $p < 0.01$). This indicates that individuals with an internal locus of role conflict are more likely to exhibit tendencies toward threats of physical violence on social networks compared to those with an external locus of role conflict.

Discussion

The conclusion regarding the prevalence of high levels of cooperative or egoistic orientation among internet-active adolescents is open to debate. Considering adolescents' tendency to form groups in the real world, the phenomenon of isolation in the online environment presents an important area of research interest.

In studies examining adolescents' communicative activities in online spaces, it is noted that communication is the leading activity during adolescence. It is important for adolescents to expand their social circles and gain the approval of their peers, as well as establish authority among them (Soldatova et al., 2020; Luchinkina, 2022).

Egoistic orientation on the Internet, according to researchers, may be linked to the developmental characteristics of adolescence. During this stage, adolescents begin to actively explore their identity and emphasize their individuality. As their personal needs rapidly expand, this drives them to seek greater satisfaction of these needs (Bogdanovich & Delibalt, 2020). Moreover, current research emphasizes the impact of egocentrism on the development of certain difficulties in interactions with peers. Difficulties in peer interactions may manifest as a need to protect oneself from mistreatment by others (Brykov, 2023; Luchinkina & Fazilova, 2021). Marginal orientation, in turn, despite the emotional characteristics of this age, is less typical for adolescence.

An analysis of adolescent online behavior patterns showed a nearly equal distribution between conformists and non-conformists. The study confirms that an internalized locus of role conflict is correlated with manifestations of online deviant behavior, including slander and threats of physical violence. This indicates that role dispositions are crucial in shaping such behavior in adolescents. Данное исследование опирается на работы современных авторов (Serkina & Yudeeva, 2023), которые подчеркивают влияние ролевых диспозиций на онлайн-девиацию. It is also important to consider cultural factors that influence individual online behavioral traits, including attitudes, values, and behavior patterns (Lazouski, 2020; Ryabov & Bochenkova, 2021). Users' online behavior spans from socio-culturally normative to deviant, which influences their cognitive processes and actual actions (Zhikhareva, Luchinkina & Kolchik, 2021). The study confirms the interdependence between individual personality traits and online activity, as well as the influence of context and multiple online identities on online behavior (Fontalova & Turganova, 2019).

The behavior associated with roles is shaped by social expectations and the drive to meet them (Lazouski, 2020). In our view, role disposition refers to a set of social roles specific to an individual, developed through internalization, consolidation, and growth within activity and interaction.

The practical significance of the study lies in the effective identification of role dispositions in adolescents prone to online deviance. By considering the unique characteristics of adolescence, as well as contradictions in interpersonal relationships and internal conflicts, the study provides insights into how a maladaptive social role is formed.

Conclusion

1. Online deviant behavior in the form of harassment is characteristic of adolescents with an egoistic orientation. This may be due to the fact that individuals with an egoistic orientation seek to fulfill their personal needs for self-assertion at the expense of others. One deviant way of achieving this satisfaction in virtual reality is through harassment. Furthermore, the nature of social networks allows for partial anonymity and the complete absence of physical contact, which in turn provides an easy way to fulfill self-assertion needs.

2. The opposite trends are observed in adolescents with a cooperative orientation. These adolescents do not exhibit forms of deviant online behavior such as verbal insults, harassment, disclosure of personal information, social isolation, or threats of violence. Adolescents with a cooperative orientation aim to maintain constructive relationships with others and seek to form new social connections. They are characterized by empathy and an interest in collaborative activities. These traits influence their choice of adaptive behavioral strategies in both real and virtual spaces.

3. The results of the study indicate a correlation between marginal orientation and

specific forms of online deviant behavior, including harassment, insults, the use of the fake names and profiles, social isolation, disclosure of personal information, and threats of physical violence. Key characteristics of personalities with marginal orientation include infantilism, impulsivity, lack of self-control, and imitateness. These personality traits may contribute to the development of maladaptive behavior.

4. The correlation between the locus of role conflict and forms of online deviant behavior was identified. Individuals with an internalized locus of role conflict are more likely to engage in deviant form of behaviors such as slander and threats of physical violence. These individuals tend to assert their role identity, even when it contradicts societal expectations.

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Problematic Behavior of Companion Dogs: Significant for Humans, Significant for Society

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Abstract

The relationship between a dog and a person as a predictor of the occurrence of behavioral disorders. Currently, the issue of problematic behavior of companion dogs is becoming particularly relevant. The most important reason for the insufficient adaptation and socialization of dogs in society, ineffective training, and a decrease in the quality of life of animals is the lack of a scientifically based concept for identifying the causes of behavioral disorders and their elimination. It is noted that it is necessary to study early socialization, the formation of the type of attachment between the dog and the owner as a predictor of possible anxious or aggressive behavior. **The purpose of the study.** The study of behavioral disorders in domestic companion dogs. The article provides an analysis of 132 modern studies on various aspects of problematic behavior. **The occurrence and impact of behavioral disorders in dogs.** There is a correlation between aggressive and anxious behavior of dogs with the type of attachment and the way of communication with the owner. The neuroticism of the owner and the avoidant type of attachment are one of the key factors in the formation of behavioral signs of anxiety in a dog. For animals with anxiety disorders, a decrease in life expectancy, an increase in the frequency of aggressive manifestations, and a violation of communication with the owner are shown, which ultimately leads to a decrease in the quality of life in the "owner-dog" dyad. **Identification of behavioral problems in dogs.** Biochemical methods for

the diagnosis of behavioral disorders are based on the analysis of the concentration of serotonin, cortisol, oxytocin and dopamine in biological fluids and dog hair. Physiological methods of diagnosing behavioral disorders are based on the assessment of ECG and thermometry. Surveys of dog owners and instrumental and behavioral test samples are also used.

Keywords

companion dog, problematic behavior, anxiety of dogs, aggressiveness of dogs, behavioral problems of dogs, identification of behavioral problems, zoopsychology

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Introduction

Behavioral difficulties in pets, their causes, assessment of well-being and prediction of animal behavior are important problems for humans and society that are relevant in modern research. The complexity of assessing the welfare of pets is determined by the context of human and animal life and interaction, the possibility of its changes and response to social and cultural norms.

Consideration of these factors – primarily aggressive and impulsive behavior – is necessary both to assess the possibility of transferring a dog to a family and to predict the possibility of animal abandonment, disruptive behavior, etc.

Determining the level of well-being of companion pets in research is considered as a complex multifactorial interdisciplinary task. Since the behavior of pets, their level of adaptability and attitude towards them is a direct marker of the level of well-being (human welfare & animal welfare), the increase in the number of news about dog attacks on people may be a sign of destabilization of society. In the Russian Federation, more than 330000 human dog bites are registered annually, and the percentage of bites by domestic dogs prevails. An uncontrolled aggressive dog poses one of the biggest threats from animals in urban agglomerations. This aspect of behavior is especially relevant for

human-dog interaction, since it is aimed at maintaining social contacts. The development of approaches to the assessment and prediction of behavioral problems of dogs and their impact on human well-being, taking into account the social context, is a problem that needs to be solved as soon as possible.

In addition to studying behavioral disorders, research is devoted to modeling various psychopathologies and neurodegenerative diseases (Zhu et al., 2019; Zhvania et al., 2021; Zwierzyńska, Pietrzak; 2024). Parkinson's disease and Alzheimer's disease, schizophrenia, and cognitive impairment in aging are most often modeled (Zurkovsky et al., 2013; Zugno et al., 2014, 2017; Zurawek et al., 2018; Zhvania et al., 2021; Zuo et al., 2023). A large layer of developments is associated with the use of rodents as models of various behavioral and cognitive disorders. The knockout model of the gamma-aminobutyric acid transporter gene of subtype 1 (GAT1) (ko) (*gat1^{-/-}*) in mice shows impaired memory, attention, coordination of movements and increased impulsivity (Yang et al., 2013). Major reviews provide a comprehensive analysis of the possibility of using animals in modeling ADHD-like disorders (Lee, Yoon, 2023; Kim et al., 2024).

In addition to the study of behavioral disorders themselves, a considerable amount of research is devoted to the animal model development of various psychopathologies. A large stratum of research is related to the use of rodents as animal models of behavioral and cognitive disorders, including attention deficit hyperactivity disorder. It should be taken into account that for rodents, these disorders occur only in a simulation situation, and not under conditions of natural behavior. Most often, animal model of single disorder is reconstructed, which does not allow analyzing the comorbidity of the complex disorders. This kind of model does not allow direct extrapolation of the obtained data for the humans. Consequently, more and more research is devoted to modeling phenotype of the behavioral, cognitive, and neurochemical correlates of human psychopathologies in a pet dog model (Bunford et al., 2019; Chen et al., 2023). In both humans and dogs, a high level of arousal is associated with a violation of top-down cognitive control, which mediates the occurrence of anxiety (Chen et al., 2023).

The purpose and article's methodology

The purpose of this review is to summarize information related to the causes and consequences of behavior disorders in domestic dogs (*Canis familiaris* L.), as well as their physiological and neurochemical mechanisms. Almost 130 articles submitted to Pubmed, Crossref, and Google Scholar databases have been analyzed. The selection of articles was carried out for sources published between 2000 and 2024. Full-text scientific articles published in English were selected. The keywords for the selection were determined on the basis of the most commonly used scientific terms in the developments known to the authors of this article: impulsivity, anxiety, aggression, cognitive learning, behavioral disorders, companion dog, cortisol, oxytocin, vasopressin, etc. During the initial selection, 221 sources were selected. After excluding articles with an unavailable full-text version

that did not meet the objectives of the analysis, 130 articles were selected. The inclusion of the article in the analysis was carried out because of the expertise of at least two authors of the article. As a main result of the analysis, possible methods are presented to investigate the physiological correlates of behavioral disorders in dogs.

The dog-human relationship as a predictor of behavioral disorders

The uniqueness of the domestic dog lies in the adaptation of its psychological processes (because of domestication) primarily for the establishment of strong and effective communication with humans (Topál et al., 2009; Bunford et al., 2019; Dreschel, 2010). This is a fundamental difference between dogs and wolves as their closest relatives. First, wolves' behavior focuses on in-group interactions between conspecifics (Marshall-Pescini et al., 2015), whereas dogs focus on interactions with their owners. At the same time, when analyzing the behavior of dogs, it is necessary to distinguish between problematic behavior associated with the manifestation of anxiety or aggression, and undesirable behavior. Undesirable behavior is the natural behavior of a dog that is unpleasant to the owner (Boyd et al., 2018; Kimura et al., 2022; Miller et al., 2022).

The unique behavior of domestic dogs, their acquisition of social interaction skills and adaptation to humans (e.g., staring, gesturing, and certain behaviors), is to some extent regulated by the endocrine system, in particular glucocorticoids and oxytocin (Thielke & Udell, 2017; Kikusui et al., 2019). In a number of studies, reliable evidence for a specific attachment style between humans and dogs, based primarily on social interaction and life experience, is the change in oxytocin concentrations in bodily fluids (Nagasawa et al., 2015; Thielke & Udell, 2017; Wirobski et al., 2021). Wirobski et al. (2021) showed a positive correlation of oxytocin concentration in the urine of domestic dogs after physical contact with the owner, but none in domesticated wolves.

A study by Nagasawa et al. (2015) found an increase in oxytocin concentration in owners' urine after staring at a dog. This, in turn, correlates to an increase in the concentration of oxytocin in the dog's urine (Nagasawa et al., 2015). In addition, even for socialized wolves, interaction with humans through the exchange of stares is not shown to decrease performance on cognitive tests (Miklósi et al., 2003; Bentosela et al., 2016). This proves the existence of a positive feedback relationship between species and may be one of the mechanisms of coevolution between humans and dogs. It is also assumed that this mechanism works as a way of forming social attachment (Miklósi et al., 2003; Nagasawa et al., 2015; Bentosela et al., 2016), separation anxiety (Tilke, Udell, 2017) and regulation of social behavior (Keys et al., 2017; Banford et al., 2019).

Due to the presence of high emotional attachment between humans and animals, as well as complex social interaction, it is likely that the probability of behavior disorders (not only ADHD behavior) in a dog is related to the characteristics of the psychological profile of the owner. According to the work of Gobbo E, Zupan M. (2020), aggressive

behavior toward humans correlated with low sociability of the animal, and high levels of neuroticism of their owners. Human neuroticism, as an analogue of insecurity in dogs, correlated with anxiety and restlessness (Salonen et al., 2022). Fearfulness, as a personality trait, on the other hand, has been closely correlated with sensitivity to noise (Tiira et al., 2016; Salonen et al., 2022).

The occurrence of separation anxiety is also determined by the relationship between the owner and the dog. An avoidant attachment style, in which the owner does not provide the dog with an appropriate level of attention to its basic needs, leads to an increase in the animal's neuroticism and the emergence of separation anxiety. Hence, the key factor, according to the authors, is not the owner's neuroticism, but the avoidant attachment style (Konok et al., 2015). In addition, avoidant attachment style may be the cause of the dog's aggressive behavior already towards the owner (Gobbo, Zupan, 2020). The importance of separation as a stressor is evidenced by a smaller increase in a dog's heart rate during contact with a dangerous stranger in the presence of the owner compared to separation and loneliness (Gácsi et al., 2013).

Dogs of emotionally unstable owners are characterized by a high frequency of manifestations of signs of separation anxiety, fear of a stranger. The main reason for this is the lack of socialization of dogs. Owners with an increased level of anxiety and neuroticism limit the socialization of the dog, reducing the possibility of obtaining new information and contributing to an increase in the frequency of aggressive behavior (including towards the owner himself). Another factor of the owner's influence on behavioral problems of dogs, is the use of aversive or confrontational training methods associated with, among other things, negative reinforcement (Dodman et al., 2018). As a result, the dog has a low level of socialization, a weak connection with the owner is formed, which leads to a lack of understanding of commands, incorrect behavior from the point of view of the owner and an increase in stress levels. If the owner does not specify the requirements and does not allow the dog to adapt to the situation, this leads to increased stress in the dog and aggravation of undesirable behavior (Miller et al., 2022).

Based on Ainsworth's classification system, Solomon J. et al. (2019) identified four main patterns of dog-owner attachment.

- Secure: finding and initiating contact, striving to get closer to the owner, maintaining contact for at least 10 seconds. The dog actively interacts with the owner after separation.
- Avoidant: the dog's lack of desire for contact and interaction, refusal to invite owner to play, lack of search for the owner when parting for at least 30 seconds.
- Ambivalent: the mismatch of the actions of the dog and the owner to maintain contact, the owner's misunderstanding of the dog's current motivation; physical contact is accompanied by significant efforts on the part of the dog.
- Disorganized: violation of the search for contact and interaction, avoidance or resistance to the interaction of the dog and the owner when initiating human contact.

An increase in owner attentiveness to the pet led to a decrease in the likelihood of aggressive or hyperactive behavior (Solomon et al., 2019). In turn, in the classic strange situation test, less aggressive dogs showed greater attention and attachment to their owner compared to dogs that avoided such contact and exhibited aggressive behavior (Riggio et al., 2020). In addition, a modified strange situation test revealed that dogs with a secure attachment type sought to initiate contact with their owner while solving the test; whereas, dogs with an avoidant attachment type did not attempt to initiate contact (Riggio et al., 2020). Therefore, the owner-dog relationship is identified in many studies with the parent-child position (Konok et al., 2015; Dodman et al., 2018; Solomon et al., 2019; Riggio et al., 2020 et al.)

Dysfunctional relationships between dogs and owners, which are usually detected already at the stage of occurrence of behavioral problems (primarily anxiety and aggression), will have negative consequences for both sides. In particular, in dysfunctional dyads, owners are more likely to report injuries of various origins to their dogs. Therefore, timely provision of medical care and a safe lifestyle by the owner of the dog are considered as a sign of a functional dyad (Canejo-Teixeira et al., 2019).

Non-medicinal causes of behavioral disorders in dogs living in families

Because of the special role of companion animals in modern life, the stress factor takes on a special role in assessing the prediction of behavioral problems. In addition to the classical and most obvious markers of well-being, which include health status, longevity, growth traits, occupational manifestations, etc. (Sonntag, Overall, 2014), behavioral markers play an important role, primarily the presence of fears, anxiety, and impulsive behavior. Any behavioral markers can be classified as unwanted for the owner (but normal for the animals), and are a sign of true behavior disorders (Sonntag, Overall, 2014). The manifestations of such disorders can range from mild to disabling, leading to euthanasia or owner abandonment of the animal (Masson, Gaultier, 2018).

The simultaneous accounting of fear and aggression in dogs is due to a similar neurochemical and physiological nature with different behavioral manifestations (Hydbring-Sandberg et al., 2004; Gobbo, Zupan Šemrov, 2021; Mikkola et al., 2021). Fear is regarded as one of the most common reasons for aggressive behavior in dogs, even though owners may not interpret aggression as fear (Tiira, Lohi, 2014; Tiira et al., 2016). Furthermore, it is for fear that fear has been shown to have the strongest comorbidity with aggressive behaviors, lack of early socialization, and aging (Tiira et al., 2016; Mikkola et al., 2021).

As a basic emotion that determines an organism's survival, fear can become a pathological character trait when present for a long time (Tiira et al., 2016; Hakanen et al., 2020). Fear associated with various stimuli has been shown to be closely related to neuroticism (also called indecision) in dogs (Salonen et al., 2022). Moreover, the manifestation and degree of indecision in dogs is directly influenced by his or her

interaction style with the owner (Dodman et al., 2018). Another factor influencing the owner's behavioral problems of dogs is the use of aversive or confrontational training methods, including those associated with negative reinforcement (Dodman et al., 2018). Most often in this situation, the authors noted aggression toward the owner and strangers, compulsive barking, separation anxiety, and urination and defecation in the house.

The initial stage of socialization has a significant impact on the development of the voluntary attention system in dogs. A common behavioral problem is social fear - fear of strangers or dogs (Puurunen et al., 2020). The basis for social fear, according to the authors, is insufficient socialization at an early age; in addition, a significant correlation with small body size and castration has been shown. Non-social fear is characteristic of dogs deprived of sufficient socialization in puppyhood, socialization with kin, and adequate training (Hakanen et al., 2020).

In addition, signs of ADHD behavior were more pronounced in male dogs, young dogs, and medium-sized dogs; lack of training and prolonged exposure to loneliness were also risk factors (Sulkama et al., 2021). ADHD behavior in dogs was significantly influenced by training (trained dogs were less likely to exhibit behavioral disorders due to developed self-control skills) and age (as older animals generally experience a decrease in motor activity) (Vas et al., 2007; Sontag et al., 2010).

Similar data are presented in Foraita M, et al (2021), where early quality socialization, good housing conditions, human contact, training and the presence of stress are noted as key factors in the development of attention. Solvable tasks and mild stress have a positive effect on attention functions, while insurmountable difficulties and severe stress have a negative effect. However, the effect of prior training was not a reduction in the number of erroneous responses, but a shortening of reaction time, which, according to the authors, was a reflection of response confidence and focus on human interaction (Bunford et al., 2019).

The causes of behavioral disorders in dogs

In the current literature, there is an evidence that 72-85% of dogs living in families have some kind of behavioral disorder (Salonen et al., 2020; Powell et al., 2021). These behaviors may be normal but undesirable to the host, or they may actually represent a behavioral pathology. Drastically negative impact on both dog and owner quality of life lead to the importance of investigating and correcting such behaviors in pets (Masson, Gaultier, 2018; Bleuer-Elsner et al., 2019 Fux et al., 2021; Mikkola et al., 2021). Those problems include aggressive and disruptive behavior, impulsivity, hyperactivity, separation anxiety, excessive barking, etc. (Lit et al., 2010; Mikkola et al., 2021). Many studies repeatedly cite behavior disorders as a reason for refusing to further keep of an animal, placing dogs in a shelter, and/or euthanizing it (Vas et al., 2007; Masson, Gaultier, 2018; Bunford et al., 2019; Salonen et al., 2020; Fux et al., 2021; Mikkola et al., 2021; Powell et al., 2021; etc.). As a result, there is an increase in the number of stray dogs due to the rejection of maladjusted pets (having an increased level of anxiety and aggression).

According to Dinwoodie I. R. et al. (2019), 85% of dogs (data based on the analysis from at least 17 countries) have some kind of behavioral problem, with 44% of these disorders being related to fear and/or anxiety. The second most common problem (30%) is aggressive behavior (Dinwoodie et al., 2019). The incidence of ADHD behavior in domestic dogs is also quite high, ranging from 12% to 34%, according to various data (Fux et al., 2021; Salonen et al., 2021). According to Salonen et al. (2021), on average, 20% of dogs have clear attention deficits and 15% have hyperactivity/impulsivity. According to K. Tiira et al (2016), general fearfulness is characteristic for 26.2% of dogs, noise sensitivity for 39.2%, and separation anxiety for 17.2%. Similar data are presented in the study of Dinwoodie I. R. et al. (2019).

The literature suggests common physiological mechanisms of human and canine ADHD. Similar to humans, ADHD in dogs is the result of dysfunctional interaction between the frontal cortex and striatum (Winstanley et al., 2006; Genro et al., 2010; Sontag et al., 2010), as well as disruption in interactions between mesocortical and mesolimbic regions (Sonuga-Barke, 2003; Oades et al., 2005). These interactions are mediated by dopaminergic, serotonergic (Oades, 2008) and noradrenergic systems (Oades et al., 2005). Therefore, it has been suggested that functional disorders of the aforementioned mediator systems play a major role in the development of the disease (Oades et al., 2005; Russell, 2007; van der Kooij, Glennon, 2007; Sontag et al., 2010).

In a study by Chen et al. (2023) a violation of the formation of the brain connectome in anxious dogs has been shown, which leads to a decrease in the level of motor control, deterioration of learning ability and adaptability.

A key aspect is the possible similarity of the molecular and neurobiological mechanisms of this disorder in both dogs and humans (Puurunen et al., 2016). For dogs, horses, and chimpanzees, a tandem repeat polymorphism of the DRD4 gene in exon 3 of the dopamine receptor D4 gene, which is thought to be associated with ADHD, has been identified similar to humans (Hejjas et al., 2007). Specifically, German Shepherds and Siberian Huskies that exhibit ADHD phenotype (especially impulsivity and lack of attention) have been shown to be characterized by short alleles of the dopamine receptor D4 (DRD4) exon 3 and tyrosine hydroxylase intron 4 repeat polymorphisms (Wan et al., 2013). This fact is the basis for the use of drugs that affect the function of the dopamine transporter in ADHD (Fernandez et al., 2021).

One possible approach to uncovering the biological pathways of ADHD is to use animal models, such as dogs, that spontaneously exhibit ADHD-like behaviors such as hyperactivity, impulsivity, and inattention (Lit et al., 2010; Wright et al., 2012; Puurunen et al., 2016). These behavioral disorders are phenotypically similar to a number of psychopathologies in humans, which may be an indication of homology of biological mechanisms of such disorders in dogs and humans. (Lit et al., 2010). In addition, behavior consistent with psychopathological disorders in dogs is spontaneous in dogs, whereas in standard laboratory animals it is usually induced (Salonen et al., 2022). Consequently,

the domestic dog is a suitable model for investigating the mechanisms underlying mental disorders in humans (Lit et al., 2010; Salonen et al., 2022).

Vitamin D deficiency may also be a factor provoking behavioral disorders. This is due to its ability to regulate brain development in early ontogenesis, the formation of synaptic plasticity, neuroprotection, and the dopaminergic neuronal system (Bivona et al., 2019; Gáll, Székely, 2021). In addition, vitamin D deficiency is associated with impaired regulation of dopamine and serotonin neurotransmission (Gáll, Székely, 2021). Early vitamin D deficiency is a contributing factor to impulsivity and decreased inhibitory control (Turner et al., 2013).

The disruption of the sleep-wake cycle that leads to disruptions in serotonergic, dopaminergic, and noradrenergic systems (Mogavero et al., 2018) and synaptic homeostasis (Frank, 2020) is another important factor in behavioral disorders in dogs, particularly in ADHD behavior and violent aggression attacks.

Chronic pain is a separate and important factor (Mills et al., 2020), and new behavioral problems may arise, reinforce or exacerbate existing problems. Aggressive behavior and sensitivity to noise are the most common due to chronic pain (Lopes Fagundes et al., 2018; Mills et al., 2020), which is associated with higher levels of anxiety in the animal (Mills et al., 2020).

The Covid-19 pandemic contributed to the exacerbation of behavioral disorders in dogs. For owners, keeping an animal in the house in forced isolation seemed to reduce stress (Bowen et al., 2020; Grajfoner et al., 2021). However, the unfavorable social environment, limited walks and lack of access to veterinary care have led to a sharp increase in tension, aggression and fear in animal behavior, exacerbating existing problems and creating new ones (Bowen et al., 2020; Parente et al., 2021).

However, it is important to keep in mind that it is not uncommon to underestimate the severity of behavioral problems and their causes, or to misinterpret them, due to lack of knowledge about the possibility of such situations and the signs of behavioral disorders (Mikkola et al., 2021; Powell et al., 2021). Competent analysis and interpretation of the causes and consequences of behavioral problems in dogs will allow the owner to recognize problems, identify contributing factors and take corrective actions timely.

Using owner questionnaires to identify behavioral problems in dogs

The questionnaires for dog behavior assessment by their owners can be adapted versions of similar methods for assessing ADHD in children. Undoubted advantages of using specialized and adapted questionnaires are the possibility of obtaining quick results - also with large groups of animals under study - as well as good owner awareness of the behavioral features of the dog and a positive attitude towards this kind of testing (Vas et al., 2007). The validity of behavioral testing of dogs and owner interviews is determined in several ways: the repeatability of the result after a certain period of time, the comparison of the result obtained with a known benchmark, and the ability to compare the result of

the questionnaire and the behavioral tasks (Tiira, Lohi, 2014). In particular, the owner's responses to the questionnaire regarding fear of noise, a persistent response of the dog that changes with age, correlated significantly with behavioral parameters in the animal's response to the appearance of a stranger and interaction with him (Tiira, Lohi, 2014).

In Segurson S. A. et al (2005), based on a questionnaire aimed at identifying reasons for abandoning and placing a dog in a shelter, revealed a curious effect of the ability to make test results public on their validity. The key questions in the analysis were the presence of aggression or fear of a stranger. The prospect of publicly releasing the test results – including for further dog placement – significantly reduced the likelihood of detecting signs of aggressive behavior or fear of a stranger or other dog, as well as impaired social adjustment and separation from the owner.

Vas J. et al (2007) presented a 13-item questionnaire based on a similar one for children to assess ADHD-like behavior in domestic dogs. The questionnaire allows analyzing the development of attention-holding skills, impulsivity and motor activity in attention, impulsivity and motor activity in domestic dogs.

In a large series of studies (over 13000 dog) (Tiira, Lohi, 2014; Puurunen et al., 2016, 2020, Tiira et al., 2016; Hakanen et al., 2020; Junttila et al., 2021; Mikkola et al., 2021; Salonen et al., 2020, 2021, 2022) a survey test was developed and validated to analyze a set of behavioral problems. These include ADHD behavior (inattention/impulsivity, aggression, anxiety, social and non-social anxiety, noise sensitivity, separation anxiety and compulsive behavior. In addition, a separate section of the questionnaire is devoted to an analysis of the dog's early socialization and current circumstances.

That series of studies described a high comorbidity of behavioral disorders. In a study by Salonen et al (2021), based on an analysis of questionnaires administered to Finnish dog owners regarding the frequency of some signs of ADHD behavior (as well as aggression, anxiety, noise sensitivity, separation anxiety and several others), it was found that in 32% of cases the probability of behavioral disturbances correlated with high sensitivity to noise. The highest comorbidity was shown between hyperactivity/inattention, separation anxiety, fear and aggression behaviors and separation compulsion, and between fear and aggression. High comorbidity has been shown for fearfulness and aggressive behavior: aggressive dogs were more than three times more likely to be fearful than non-aggressive dogs (Salonen et al., 2020). Sulkama et al (2021) reported similar results: high levels of hyperactivity/impulsivity were accompanied by high levels of aggressive fearfulness and inattention.

In general, according to the authors, fear and sensitivity to noise are the most important concomitant disorder in dogs exhibiting behavior. In particular, when separation anxiety was detected, signs of ADHD behavior were 4.1 times more frequent, inattention was 3.4 times more frequent, and fear was 2.8 times more frequent than in dogs without separation anxiety. The gender of the animal also appeared to be an influencing factor. Aggression and hyperactivity/impulsivity were more frequently detected for males, while

fearfulness was predominant for females. The likelihood of aggressive behavior increased with age - older dogs were more aggressive than younger dogs (which may be related to the presence of chronic pain) (Mikkola et al., 2021).

In terms of breed differences, the most pronounced traits on the hyperactivity/impulsivity index were shown for the Cairn Terrier, Jack Russell Terrier, German Shepherd, and Staffordshire Terrier, while the least pronounced were shown for the Chinese Crested Dog, the Hardy Collie, and the Chihuahua (Sulkama et al., 2021).

A number of personality traits such as neuroticism for example can be a precursor to behavioral and psychopathological problems in dogs. Salonen M. et al (2022) correlated seven personality traits with ten undesirable behaviours, based on the analysis of questionnaire data from 1,360 dog owners. It is noteworthy that a trait similar to neuroticism in humans was positively correlated with the majority of undesirable behaviors extracted.

The use of the described questionnaires for owners of dogs exhibiting ADHD symptoms has the significant disadvantage of subjectivity of the information obtained, as well as the owner's initial misjudgment of the animal's behavior. This implies a distortion of the actual results (Bleuer-Elsner et al., 2019; Fux et al., 2021); consequently, such questionnaires are often not applicable in clinical practice. In a study by Lit L. et al. (2010), when evaluating the validity of a modified test aimed at assessing ADHD in humans, validity was found only for the inattention and hyperactivity/impulsivity scales.

Instrumental and behavioral tests

Impulsivity as a typical trait closely related to human and animal ADHD (Sulkama et al, 2021) manifests as the ability to act without first assessing the situation (Oades, 2008), and the inability to suppress ineffective behavior (Junttila et al, 2021). Two main manifestations are suggested for impulsivity: impulsive action (inability to suppress unproductive, unwanted action) and impulsive choice. The former is more common in male dogs and the latter in females (Winstanley et al., 2006; Wright et al., 2011; Weafer, de Wit, 2014; Junttila et al., 2021). In humans, excessive motor activity and inability to concentrate for a long time are considered key manifestations of impulsivity, whereas in dogs – inattention, impulsivity and aggression (Vas et al., 2007; Bleuer-Elsner et al., 2019; Bunford et al., 2019).

Impulsivity is based on deficits in inhibitory control and inhibition of behaviors. It has been argued that in dogs, impulsivity is inherited and is a predictor of behavioral problems, including aggression (Mongillo et al., 2019; Junttila et al., 2021). In addition, so-called cognitive impulsivity in dogs, which is associated with the choice of immediate or delayed rewards, does not change as they mature (Riemer et al., 2014). Because behavioral inhibition deficits are a key risk factors for psychiatric disorders of various genesis (Bunford et al., 2019), an assessment of inhibitory control must come to the forefront when assessing the nature of behavior problem. Inhibitory control is a cognitive skill that has been extensively studied in humans and other animals. It is defined as the

ability to inhibit immediate, ineffective behavior in favor of more beneficial behavior. In contrast, a lack of inhibitory control - impulsivity - is often seen as a tendency to act prematurely, without forethought or consideration of consequences (Junttila et al., 2021).

The literature considers three interrelated phenomena as behavioral manifestations of inhibitory control: suppression of the primary reaction to an event, halting the current action and lengthening the decision-making time, and interference tolerance as a lack of reactions to external stimuli (Bunford et al., 2019). Animals with good inhibitory control exhibit high interference tolerance, whereas those with poor control are easily distracted from the task by external stimuli and extraneous actions (Müller et al., 2016).

For animal's behavior tests in laboratory, impulsivity can be measured using computerized tests aimed at assessing behavioral paradigms. Such testing can be based on both an assessment of the likelihood of premature response, the difficulty of inhibiting unwanted actions, and the lack of consideration of the possibility of multiple correct response options (Dalley, Roiser, 2012). In addition, a good method of assessing inhibitory control in dogs is the cylinder test, in which the dog must bypass a transparent barrier (cylinder) rather than reaching across it to receive a reward (Junttila et al., 2021). Inhibitory control is better represented in females, hence, they perform target tests more efficiently; in addition, females are more attuned to interacting with humans during complex tasks (Junttila et al., 2021). This is especially important in view of the opinion that dogs do not transfer the existing experience of a complex task to similar ones, but rather perceive them as new situations (Müller et al., 2016).

When evaluating ways analyze indicators of behavior disorders, we were able to find several studies in which the probability of impulsive choice is assessed using delayed discounting tasks. This test trial is regarded as the most valuable for measuring the probability of impulsive choice (Winstanley et al., 2006) and involves choosing between receiving a small reward after a short time interval and a more substantial reward after a longer time interval. These studies have unequivocally found that for both humans and animals in behavioral disorders there is a choice of immediate minor reinforcement and rarely a choice of major delayed rewards (Winstanley et al., 2006; Dalley, Roiser, 2012; Sjöberg et al., 2021). The probability of choosing immediate reinforcement is an indicator of impulsivity (Sjöberg et al., 2021). It has also been shown that for animals no effect of the inter-stimulus interval on the choice of options in the delayed reward test has been shown (Sjöberg et al., 2021), whereas for humans a significant effect of the length of the inter-stimulus interval on the probability of choice has been shown (Sjöberg et al., 2021). The results of The Dog Impulsivity Assessment Scale (DIAS) owner test and behavioral tests related to delayed or immediate reward choice were closely correlated with each other, allowing these research methods to be used together (Riemer et al., 2014).

In dogs, an increase in the number of erroneous reactions in the Go/No-Go test is regarded as a correlate of hyperactivity and/or impulsivity (Bunford et al., 2019). At the same time, sufficient cognitive inhibition has not been shown for dogs as a delayed

reward ability (Bunford et al., 2019). A method for assessing behavioral stability is the stability of solving tasks involving behavioral inhibition; however, these test trials have been developed and applied only to children. For animals, the authors (Tiira, Lohi, 2014) have not found similar studies.

A common and rather significant disadvantage of survey and behavioral analysis methods in dogs is the lack of validity, repeatability and objectivity of these techniques, as well as the great influence of the testing environment and the promising publicity of the results. Specifically, owners compared to abandoned dogs; and based on the Canine Behavioral Assessment and Research Questionnaire (C-BARQ) scale results rated behavioral problems in dogs living at home more loyally, behavior disorders were present in both cases. Consequently, abandoned dog owners tended to provide more accurate information (Powell et al., 2021). This may be due to both an underestimation of the complexity of the situation and a reluctance to publicly voice problems.

At the same time, it is the behavioral tests that allow obtaining objective results of behavior in the natural environment due to the absence of exogenous interferences (Gobbo, Zupan, Šemrov, 2021). A common disadvantage of behavioral tests is the possibility to record and analyze short fragments of activity in strictly defined, standardized situations (Magula et al., 2019).

A series of papers (Bleuer-Elsner et al., 2019; Fux et al., 2021) have proposed a method for the automatic tracking and video recording of a dog's voluntary movements in consultation with a veterinarian or zoopsychologist. The hypothesis of the study is the presence of specific motor patterns in dogs with ADHD behavior, which can be recorded and analyzed by applying specialized algorithms based on machine learning. This cycle of work proposes 12 main indicators of motor activity, of which the key ones are high movement speed, large coverage of space and constant changes in the direction of movement. Notably, these indicators showed no correlation with the gender, weight, breed, or castration of the animal (Bleuer-Elsner et al., 2019). According to the authors, the differences in movement patterns between healthy dogs and dogs with ADHD behavior averaged 81% (Fux et al., 2021).

A dog's movement patterns are seen as a reflection of its behavioral traits (Bleuer-Elsner et al., 2019; Fux et al., 2021), whereas sonic behaviors (barking, growling, howling) are seen as markers of emotional states (Fragó et al., 2014; Pongrácz, 2017; Kim et al., 2018; Jégh-Czinege et al., 2020). The integrated assessment of movements and vocalizations allows objective results of behavior in the natural environment due to the absence of exogenous disturbances (Gobbo, Zupan Šemrov, 2021).

Based on the literature, this confirms the identified correlation of ADHD behavior with increased intensity of motor activity, lack of response to stop cues, and low sensory homeostasis threshold (Bleuer-Elsner et al., 2019). The high frequency of change of direction was also associated with inattentiveness of the animal and an increased response to mild stimuli.

Application of biochemical and physiological parameters

Comprehensive analysis of behavioral, physiological and biochemical indicators will allow a more correct assessment of animal behavior, the causes of adverse reactions, as well as to predict further developments. Due to the need to address this problem, we analyzed the literature regarding the use of a number of objective methods for assessing behavioral and physiological markers. Both methods used for animals and methods for humans, which with proper adaptation could be applicable for animals or become a promising method, were analyzed. The analysis of physiological and biochemical parameters is necessary to obtain a complete picture of the reaction to undesirable behavior in real time.

Biochemical indicators of behavioral disorders

A study by Puurunen J. et al. (2016) proposed the study of metabolites contained in blood plasma by liquid chromatography and mass spectrometry as an objective method for studying ADHD behavior in German shepherds. This revealed a negative correlation of ADHD behavior with the plasma concentration of phospholipids and the tryptophan metabolite, 3-indolepropionic acid; a positive correlation, however, was found for another tryptophan metabolite, kynurenic acid. More intense ADHD-like behavior was associated with decreased plasma phospholipid levels but increased fatty acid content. In total, the authors suggest 27 tryptophan and phospholipid metabolites as possible markers of ADHD-like behavior that correlate with attention deficits and/or impulsivity (Puurunen et al., 2016). Lower cholesterol and bilirubin concentrations, as well as low levels of omega-3 fatty acids, may also influence the increase in aggressive behaviors (Re et al., 2007).

Impulsivity in domestic dogs was assessed by owner surveys, the Impulsivity Assessment Scale (DIAS), a delayed reward test, and urine dopamine and serotonin concentrations (Wright et al., 2011, 2012). High impulsivity scores on the behavioral and questionnaire tests correlated with low serotonin concentration and low serotonin/dopamine ratios. Low levels and poor regulation of serotonin and dopamine are associated with disruptive and/or aggressive behaviors exhibited by ADHD in dogs (Fux et al., 2021).

High levels of anxiety correlated with an increase in cortisol and serotonin concentrations in saliva, whereas aggressive behavior correlated with a decrease. This, according to the authors, can be explained by the fact that an increase in cortisol levels reflects emotional arousal, while a decrease in serotonin reflects a fear response (Gobbo, Zupan Šemrov, 2021). Similar data were shown in the work of M. León et al. (2012), where the analysis of serotonin concentration in serum, blood plasma and platelets also revealed an inverse correlation between the activity of the serotonergic system and the level of aggression in dogs (serotonin concentration was significantly lower in aggressive dogs).

An indirect method of measuring fear of noise exposure is an increase in cortisol in the hair (Siniscalchi et al., 2013, Roth et al., 2016). Social contact with humans correlated with decreased cortisol concentrations in the hair, reflecting reduced stress levels (Roth et al., 2016). Consequently, cortisol levels in the hair reflect a dog's chronic state of emotional reactivity or temperament (Siniscalchi et al., 2013). In addition, the rate of change in cortisol concentration in saliva correlated with a dog's attachment to its owner: dogs with high levels of attachment had a higher rate of change in this index than disorganized dogs (Schöberl et al., 2014).

Attempts to correct aggression by applying intranasal oxytocin modulated not so much behavioral disorders (where no significant difference was shown compared to placebo) (Hernádi et al., 2015), but rather an increase in social interaction with humans (Romero et al., 2014; Hernádi et al., 2015). In addition, the effect of oxytocin was influenced by the relationship with humans and the dog's individual level of aggression (Hernádi et al., 2015).

Similar data were obtained when attempting to correct aggressive behavior in shelter dogs by consuming olive oil containing 5% cannabidiol. Pure olive oil was used as a control to assess the severity of the placebo effect. As a result, although there was a decrease in aggression toward humans in dogs that took cannabidiol, there were no significant differences compared to the control group. Also cannabidiol had no significant effect on the manifestation of stress (Corsetti. Et al., 2021).

Increased oxytocin concentrations in saliva and plasma after human contact (MacLean et al., 2017). this effect in saliva appears with a significant delay (at least 10 minutes) compared to plasma, and persisted longer. In addition, saliva intake does not lead to increased stress levels and pain effects, and is not contaminated by interferences similar to plasma. In addition, saliva contains oxytocin in the free state, whereas plasma contains it in the bound state, which is more difficult to detect with the test systems used in these studies.

Physiological indicators of behavioral disorders

The importance of considering autonomic regulation indices when assessing behavioral disorders in animals is also related to the available data on the correlation of cardiac cycle indices and the ability to regulate activity (Staton et al., 2009; Wickramasuriya, Faghih, 2019; Adelhofer et al., 2020; Al et al., 2020). Cardiac cycle metrics and central regulation are linked by intercorrelated relationships, and are a source of information about attention (Cuevas, Bell, 2011). From this perspective, accounting for the physiological correlates of the psychoemotional state of animals as well as the activity performed allows for a more accurate assessment of the degree of adaptation to the current situation (Luque-Casado et al., 2016; Fan et al., 2020).

The most sensitive indicator is heart rate variability (HRV) (Maros et al., 2008; Gácsi, et al., 2013; Solhjoo et al., 2019), as it is the central mechanism of cardiovascular

regulation (Hjortskov et al., 2004). This occurs due to reflection in HRV indices of the upward modulation of cerebral function with changes in baroreceptor activity (Duschek et al., 2009). This is associated with increased perfusion of brain tissues with blood, which suggests the presence of unified mechanisms of synchronization of cardiac and CNS activity (Park et al., 2015). Hence, HRV is one of the reliable noninvasive methods of measuring the mammalian organism response, including to stressogenic influences (Amaya et al., 2020).

High HRV values are indicators of adequate adaptation to the new environment and effective CNS functioning, whereas low values are the signs of inadequate adaptation (Nagendra et al., 2015). As a result, a quantitative assessment of adaptability is possible based on HRV values (Thayer et al., 2009; Gianaros et al., 2015; MacNeil et al., 2017; Mulcahy et al., 2019). The high-frequency component of heart rate variability (HF) is considered to be the most sensitive marker for assessing stress levels (MacNeil et al., 2017) as well as heart rate control by the parasympathetic part of the vagus nerve (Mulcahy et al., 2019). A decrease in HF values is observed with an increase in task difficulty (Hjortskov et al., 2004; Duschek et al., 2009; Luque-Casado et al., 2016), and an increase with a decrease in erroneous reactions (Gianaros et al., 2015). For heart rate and high-frequency component of HRV, the opposite dynamics has been shown with increasing difficulty of the load, the increase in HR is accompanied by a decrease in HF (Yu et al., 2009).

An inverse correlation between measures of voluntary attention and HF has been shown (Duschek et al., 2009; Luque-Casado et al., 2016): individuals with high baseline HF values perform better on tasks involving the attention and inhibitory control system (Mulcahy et al., 2019). Consequently, HRV HF can be used as an early marker of impairment (Forte et al., 2019; Spangler, McGinley, 2020)

To explain this relationship, the literature suggests a model of neurovisceral integration linking a particular set of neural structures - primarily the prefrontal cortex, limbic system, and brainstem - to heart rate variability and cognitive function (Thayer et al., 2009; Yu et al., 2009; Zhang et al., 2010; Gianaros et al., 2015; Mulcahy et al., 2019). The ability to self-control in emotionally colored activities correlates with the balance of autonomic processes on measures of cardiac regulation, suggesting a common neuroanatomical basis for both processes (Tonacci et al., 2019).

There are several works concerning the analysis of overexcitation of the autonomic nervous system and reflection of this condition in HRV parameters in domestic dogs. At the same time, all the works we analyzed were related to the correction of the state of stress or undesirable behavior. The study by Wormald D. et al. (2017) based on HRV parameters confirms the view of the peculiarities of the physiology of the cardiovascular system in dogs with behavioral disorders, namely the influence of anxiety on the indicators of standard deviation of R-R-intervals, the increase in the spectrum of the low-frequency component of the heart rhythm LF and HF.

A study by M. Amaya et al (2020) proposed a method to reduce stress in shelter dogs by sensory enrichment of the environment. Of the options offered, musical stimulation

was the most effective. This exposure led to the activation of the sympathetic and parasympathetic parts of the ANS, which was reflected in higher HRV indices. An increase in HRV was also shown when receiving positive reinforcement (the dog's preferred toy) (Maros et al., 2008). In contrast, aggressive behavior and inadequate adaptation were accompanied by a decrease in HRV and deterioration of autonomic regulation (Craig et al., 2017). Similar studies have shown a direct correlation between a decrease in behavioral signs of anxiety, cortisol concentration in saliva, the LF/HF ratio and the duration of the RR interval values in dogs with improved conditions (Bergamasco et al., 2010; Palestrini et al., 2015; Bowman et al., 2017). According to the authors, this is also evidence of the positive impact of human communication on the well-being of dogs (Maros et al., 2008; Bergamasco et al., 2010; Palestrini et al., 2015; Bowman et al., 2017; Craig et al., 2017; Amaya et al., 2020).

A study by Gobbo E. and Zupan Šemrov M. (2021) showed a correlation of neuroendocrine regulation, HRV and aggressive behavior in dogs. Notably, this study used infrared thermography of the body surface to assess ANS activation, which allows us to analyze the influence of the animal's emotional states on vascular activity and heat output without behavioral restrictions. Aggressive behavior showed a direct correlation with an increase in muzzle temperature, and reflected specifically vascular responses (and not neuroendocrine responses) (Gobbo, Zupan Šemrov, 2021).

Since mydriasis is an indirect sign of stress and hyperactivity in humans (Sonntag & Overall, 2014; Hall & Chilcott, 2018; Hamrakova et al., 2020), the pupil's response to a light stimulus can be used as one of the markers of anxiety in animals. The linear change in pupil diameter before and after exposure to light and its percentage constriction, rate of constriction and dilation (average and maximum) were proposed as sensitive parameters. These differences are determined by reduced activation of the parasympathetic system and dominance of the sympathetic part of the autonomic nervous system. Accordingly, with proper adaptation, this method can also be applied to assess the correlation of behavioral disorders and imbalances in autonomic regulation in animals. An example of its use can be the swinging flashlight test (Hall, Chilcott, 2018).

Behavioral disorders and the gut microbiota

A separate big question is the correlation of the features of the gut microbiota and manifestations of ADHD disorders (brain-gut axis). Such a correlation may be related to impaired metabolism of neurotransmitters produced by gut bacteria (Wan et al., 2020; Sukmajaya et al., 2021). According to a literature review by Shirvani-Rad S. et al. (2022), children and adults diagnosed with ADHD were found to have increased enterococci, bifidobacteria, and odoribacteria, resulting in an imbalance of dopamine in the CNS. A study by Wan L. et al (2020) states that children with ADHD may have an abnormality of the gut flora in the form of a decrease in *Faecalibacterium*; a reduction in this group of bacteria can cause allergic reactions by altering the brain-gut axis. In turn, the allergic

reaction affects the release of neurotransmitters and induces manifestations of ADHD. This is due to the ability of *Faecalibacterium* to regulate the level of inflammatory cytokines, the increase of which plays a role in the pathogenesis of ADHD.

Although the question of the correlation between ADHD behavior and the gut microbiota has been considered in great detail for children, no similar studies for dogs have been found in the open literature. We analyzed the study (Kirchhoff et al., 2019) on the relationship between aggressive behavior and intestinal microbiota in fighting dogs using the example of a small population of pit bulls participating in dogfights (21 dogs). It was found that aggressive dogs had a higher prevalence of bacteria of nine (or twelve) clades of the genus *Lactobacillus*, and a lower prevalence of bacteria of some clades of the genus *Fusobacterium* in the fecal microbiota. The authors conclude that gut microbiome data could potentially be used in the future not only to diagnose canine aggression, but also to predict it. It should be noted that these results echo the data obtained by Kubinyi et al. (2020), which showed a decrease in the number of *Fusobacterium* in older dogs.

The similar correlation of disorders have been found in ADHD diagnosed humans and ADHD behavior in dogs, where it was related to alterations in tryptophan and lipid metabolism (Puruunen et al., 2016; Bleuer-Elsner et al., 2019). Works devoted to the analysis of this issue in dogs are currently sparse. In particular, the association of behavioral problems in dogs with impaired tryptophan metabolism and, consequently, the effect of the gut microbiome on the serotonergic system has been shown (O'Mahony et al., 2015).

In a study by D. Puurunen et al. (2016) showed differences in tryptophan metabolites, among which lower plasma levels of IPA and IAA correlated with a clear severity of ADHD behavior in dogs. Because *Enterobacteriaceae* of the genus *Clostridium* produces these tryptophan metabolites, the authors suggest negative correlations between ADHD behavior and the representation of these bacteria in the gut microbiota if the diets of the animals studied were similar (Puurunen et al., 2016).

This is also supported by data on the possibility of correcting aggression in dogs by introducing tryptophan supplements into the diet (DeNapoli et al., 2000). In dogs suffering from idiopathic epilepsy, a significant decrease in the representation of several bacterial phylotypes producing GABA as well as short-chain fatty acids has been found (García-Belenguer et al., 2021). In addition, cognitive deterioration - namely short-term memory - in aging dogs has been shown to be related to changes in gut microflora (Kubinyi et al., 2020); good test performance was correlated with a low proportion of actinobacteria. However, a study by Muñana KR. et al. (2020) showed no significant differences in the relative or absolute abundance of *Lactobacillus* species, the main microorganisms associated with CNS protection against neurological disorders, in dogs with idiopathic epilepsy compared to healthy animals.

At the same time, since 3-indolepropionic acid can be produced from tryptophan in the mammalian gut by *Clostridium* bacteria, this allows its use as a marker of the gut-brain axis and allows extrapolation of animal data to works on the influence of gut microbiota

on ADHD in humans (Puurunen et al., 2016). This correlation is built by a decrease in available tryptophan, which leads to an overall decrease in serotonin levels as well as the ratio of serotonin to dopamine concentration (Puurunen et al., 2016).

Conclusion

This review analyzed the most common behavior disorders in dogs, their possible causes, and the comorbidity of such disorders. Among the leading behavioral disorders in the analyzed literature, fear and aggression, ADHD behavior and impulsivity were indicated. These results were obtained mainly using owner questionnaires and assessment of behavioral patterns of the animals. Despite the safety and non-invasiveness of such approaches, their accuracy remains relatively low due to possible misinterpretation of information and high individual variability. In addition, the questionnaires and checklists have a high level of subjectivity, because they depend on the characteristics of the perception of the dog's behavior by the owner and the expert.

The introduction of biochemical research methods, in particular, analysis of the concentration of cortisol in wool, saliva and blood plasma, oxytocin, vasopressin and prolactin, will help to increase the accuracy of the study of the causes and mechanisms of problematic behavior of dogs.

It should be noted that the proportion of works related to the use of biochemical and physiological diagnostic methods was significantly lower. This is probably due to the higher cost of such studies, their invasiveness, as well as the need to observe special conditions of material sampling. However, their combined use with questionnaires and behavioral methods will allow to reveal objective reasons of behavioral disorders in dogs, and to predict further development of the situation.

A multifactorial approach to the study of behavior can contribute to a general understanding of the dog's condition; identify signs of distress – physiological, emotional, behavioral, social. Therefore, the optimal approach to identifying problematic dog behavior should take into account medical and life history, analysis of behavioral tests and questionnaires, physiological indicators of the condition, assessment of postures, movements and minor signs of increased anxiety.

There is a lack of similar studies in the population of domestic dogs residing in the Russian Federation. Screening questionnaires covering a wide range of Russian owners have not been found at present. Therefore, conducting such a comprehensive study would allow obtaining a comprehensive picture of the presence, prevalence and causes of behavioral disorders in Russian domestic dogs, taking into account the public and social realities of the country.

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Self-Regulation and Decision-Making in Students with Diverse Meaning-Transmission Styles

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Absrtact

Introduction. In the modern educational space, characterized by dynamism, information saturation and multitasking, the study of the process of meaning transmission, self-regulation of behavior and decision-making by students come to the forefront in the context of their academic and professional success. The aim of our research is to study the peculiarities of self-regulation of behavior and decision-making in students with different styles and strategies of meaning- transmission in the process of solving educational and professional tasks. **Methods.** The study involved 72 students, including 64 girls, 8 boys, average age 21.1 years. Natural experiment, questionnaire and survey were used as research methods. Research methods: Questionnaire "Strategies of meaning-transmission" (Suroedova, 2011); Questionnaire "Style of self-regulation of behavior" by V. I. Morosanova (Morosanova, 2004); Melbourne Decision Making Questionnaire (Kornilova, 2013). **Results.** We identified the styles of meaning-transmission: neutral, emotional, declarative, philosophical. The study found that there are significant differences in self-organization of activity and decision-making styles in students with different styles and strategies of meaning-making. Students with an active strategy of meaning-transmission are distinguished by developed skills of goal setting, planning and controlling the process of activity, they tend to collect information from different sources and consider alternative ways of solving problems, choosing the most effective. Respondents with the emotional style of meaning-transmission are distinguished by a high level of development of goal- setting and activity programming, evaluation of intermediate and final results of problem-solving, they show flexibility in choosing ways and means of solving a problem situation. **Discussion.** The results of our study can contribute to the

development of psychological and pedagogical technologies aimed at improving the effectiveness of learning and assimilation of professional knowledge, taking into account the students' abilities to make meaning.

Keywords

meaning transfer, styles of meaning transfer, translation of meanings, self-regulation of behaviour, decision-making, educational and professional tasks

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Introduction

Communication and communication are the prerequisites for human interaction. In the process of communication, people receive information and knowledge, express their thoughts and ideas, understand the inner experiences and needs of other people (Mifsud, 2019; Yakupov, 2016). Through communication, communication and meaning-transmission in the joint activity of people, different variants of problem solving are discussed, advantages and disadvantages of strategies for solving the problem are analysed, the most appropriate ways and means of achieving the results of joint activity are selected (Poole, 2008; Orlov, 2018; Suroedova, 2022; Suroedova, Lomova, 2018; Suroedova, Lomova, 2018; Shutenko, 2011).

Meaning-transfer in the educational process

Higher professional education is aimed not only at transferring fundamental knowledge to the student, but also at the formation of practical skills and competences that are in demand in educational and professional activities. As foreign studies show, university graduates feel uncertain about the level of their professional qualification (Jones et al., 2017; Mohammed et al., 2021). In order to increase the level of development of professional competences and confidence in the abilities of students in the educational process, interactive teaching methods are often used, "immersing" students in various professional situations that they may encounter in the future (Moeller et al., 2012; Korotaeva, Andryunina, 2021; Kudakov et al., 2021; Popey-Ool, Shishov, 2021; Morosanova, Bondarenko, Fomina, 2022), including reflexive technologies (Prokhorova, Belova, 2009) and technologies of semantic dialogue (Sharapa, Agasyan, 2019). In practical classes, when discussing non-standard situations arising in professional activities, students

need to show self-organisation and self-regulation of their behaviour, decision-making skills. During the discussion of a problem situation in student groups, "the formation of a common attitude of participants to reality and at the same time the generation of this reality" (Belousova, 2004, p. 26) takes place, which, in turn, leads to the formation of "a common psychological situation as a part of the combined parts of the image of the world and the life world of participants" (Belousova, 2004, p. 23). When jointly solving educational and professional tasks, participants of the educational process have a need to share "open" meanings and psychological qualities of the studied object or situation (Polas, 2023; Belousova, Pischik, 2011). At this point, it is possible to observe the process of meaning-transfer as a system-forming mechanism of formation of common systemic new-formations (individual and group) in the process of joint thinking activity. Pronenko E. A., Bunyaeva M. V. point out that meaning transfer plays an important role in the process of problem solving and decision making. Meaning-transference refers to the transfer and understanding of the meaning of information, ideas, and goals between people (Pronenko, Bunyaeva, 2019). Meaning-transference helps students to see the connection between learning theory and its practical application, promotes deeper understanding and learning of the material, development of critical thinking skills, flexibility and the ability to work in a team (Maknuunah et al., 2021).

Translation of meanings between participants of joint activity is possible by verbal and non-verbal (emotional) means (Belousova, 2004). Such qualities of speech activity as argumentation, logical and coherent presentation of one's thoughts, hypotheses, simplicity and clarity of statements play a leading role in the translation of meanings (Gridina, 2018; Serova, 2021; Stepykin, 2021; Suroedova, 2011). But an important aspect of meaning transmission is understanding not only the verbal content, but also adequate interpretation of the emotional component of a speech utterance, "reading" non-verbal manifestations. Nonverbal communication is a means of self-expression of the student, his ability to reflect emotions and feelings, to express personal meaning (Abakumova, Godunov & Grishina, 2021). It is worth noting that emotional experiences accompany the process of problem solving and decision making, they influence these processes and their result (Belousova, 2020). The ability to convey and understand emotional information allows taking into account and processing emotional evaluations in decision making (Suroedova, Belousova, 2022).

The role of meaning-making in self-regulation of activity and decision-making

The study of the role of meaning transfer in self-regulation of activity and decision-making in the process of joint solution of educational and professional tasks is becoming an increasingly demanded problem in psychology and pedagogy. In the process of joint problem solving, students face various educational and professional problems and uncertainty, and then the system of personal meanings becomes an integral regulator of life activity (Abakumova, Godunov & Grishina, 2021). Through the exchange of meanings

and understanding of the goals and meanings of the task, students can independently manage their learning activities, plan, control and evaluate their actions (Moeller et al., 2012). Meaning transfer in a combined psychological situation allows students to better understand what to do and what path to choose to solve the problem, to understand what meanings and values are embedded in the task, which, in turn, has a stimulating effect on the formation of intrinsic motivation and the effectiveness of learning activities. As studies show, when solving professional tasks, subjects form individual ways of meaning transmission by verbal and non-verbal means of communication - strategies of meaning transmission (Suroedova, 2011).

Styles of meaning transmission

In the process of decision-making by students in joint problem solving, the formation of "group thinking style" (Belousova, 2020) takes place, in the formation of which meaning-transfer plays a leading role. Communication and communication between the subjects of education allow to present and discuss different variants of the solution, analyse and evaluate their advantages and disadvantages (Abakumova, Kagermazova, 2008). Through communicating and understanding the meaning of ideas, opinions and ways of solving a problem, students can jointly make informed decisions, taking into account the different points of view and experience of each participant. Subjects in joint interaction demonstrate different styles of meaning-transfer. Under the styles of meaning transmission we understand the individual form of meaning transmission in subject-subject interaction in various situations: educational and professional activities, training and education, in the ways of joint decision-making and implementation, in the resolution of interpersonal and business contradictions.

The study of the process of meaning transfer in joint problem solving is an urgent problem, because it allows us to reveal the hidden phenomena of thought processes of subjects of joint activity and to identify the most effective ways and strategies of interaction (Belousova & Belousova, 2020). No less important is the problem of studying the personal characteristics of subjects of joint activity with different styles and strategies of meaning-transmission. The skill of effective meaning transfer helps students to be successful in collective projects, negotiations and teamwork in solving professional tasks.

Thus, the study of the role of meaning transfer in self-regulation of activity and decision-making in the process of joint solution of educational and professional tasks is important for modern education. It contributes to the development of key skills and competences necessary for students to work successfully in the future and ensures the effectiveness and quality of learning.

Purpose and hypothesis of the study

The aim of the research is to study the peculiarities of self-regulation of behaviour and decision-making in students with different styles and strategies of meaning-transfer in the process of solving educational and professional tasks.

The object of the study – students with different styles and strategies of meaning-transmission, the subject – features of self-regulation of behaviour and decision-making by students with different styles and strategies of meaning-transmission in the process of solving educational and professional tasks.

The hypothesis was the assumption that there are differences in self-regulation of behaviour and decision-making among students with different styles and strategies of meaning-transmission in the process of solving educational and professional tasks.

Methods

Sample

Bachelor's and Master's degree students of DSTU studying in the direction of "Psychology" took part in the study. A total of 72 respondents aged 20-25 took part in the study, among them 64 girls and 8 boys.

Natural experiment

In this study we used the results of an experiment using video recording of students solving educational and professional tasks (cases) to identify the styles of meaning transfer. Students were presented with a problematic pedagogical situation. The main character of the case was a 2nd grade student (a 7-year-old boy) who demonstrated aggressive and deviant behaviour towards teachers and students, and also had difficulties in writing. In the course of solving the educational and professional task, students had to identify the causes of the child's behaviour and propose ways to correct and prevent deviant behaviour of the schoolchild.

The styles of meaningfulness of the researched were determined by experts according to the following criteria:

- sensitivity / insensitivity to estimates, hypothesis evaluation;
- recursive actions, returning to previously discussed ideas and hypotheses;
- Sensitivity / insensitivity to contradictions;
- inconsistency / consistency of statements / logicity;
- complexity/simplicity of statements;
- operating with scientific concepts,
- an appeal to psychological theories;
- criticality;
- a tendency to generalise, to draw conclusions;
- Managing the discussion process;
- frequency of hypotheses, ideas.

In the course of content analysis and frequency analysis, we have identified the following styles of meaning transmission: **emotional, declarative, philosophical, neutral.**

Methods

- Questionnaire "Strategies of Meaning Transmission" (Suroedova, 2011). This technique allows us to identify verbal and non-verbal activity of respondents, as well as strategies of meaning transmission: passive, balanced, active, emotional-dominant and cognitive-dominant strategies.
- Self-regulation behaviour style questionnaire (Morosanova, 2004).
- Melbourne Decision Making Questionnaire (MDMQ) (Kornilova, 2013).

Processing of results

Methods of mathematical statistics: frequency analysis, descriptive statistics, method of pairwise comparisons Mann-Whitney U-criterion. Mathematical analysis was performed using IBM SPSS Statistics 20.

Results

Styles and strategies of meaning transmission

In the course of the research we have established the styles and strategies of meaning transfer in students in the process of group solution of educational and professional tasks. In the course of the experiment we identified four styles of meaning- transmission, on the basis of which we distinguished 4 groups:

- Group 1 (n = 17) – students with a neutral style of meaning-making;
- Group 2 (n = 12) – students with an emotional style of meaning-making;
- 3 (n = 19) - students with a declarative style of meaning-making;
- Group 4 (n = 24) – students with philosophical style of meaning-making.

Respondents with emotional style are characterised by sensitivity to evaluations, emotional evaluation of hypotheses, situation, object of discussion; recursive actions, frequent returns to previously discussed ideas and hypotheses; sensitivity to contradictions.

Students with declarative style take the role of managing the discussion process (often authoritarian management); high frequency of hypotheses, ideas; show a tendency to make generalisations, conclusions.

Students with philosophical style of meaning-transmission are characterised by complexity of statements; criticality; operation with scientific concepts, reference to psychological theories.

The neutral style of meaning transmission is characterised by the presence of all indicators, but their expression is much weaker than in other styles.

Based on the survey of students to identify meaning-transfer strategies, we found that 5 meaning-transfer strategies are represented in the sample, the results of the survey allowed us to categorise the researched into the following groups:

- Group 5 (n = 3) – students with a passive meaning-transfer strategy;
- Group 6 (n = 10) – students with cognitive-dominant meaning-transfer strategy;
- Group 7 (n = 14) – students with emotionally dominant strategy of meaning-transfer;
- Group 8 (n = 27) – students with balanced meaning-transfer strategy;
- Group 9 (n = 18) – students with an active meaning-transfer strategy.

Features of self-regulation of behaviour in students with different styles and strategies of meaning-transmission in the process of solving educational and professional tasks

The comparative analysis of the results of the study of self-regulation of behaviour between the groups of students with different styles and strategies of meaning-transfer allowed to reveal significant differences. The results of the study of peculiarities of self-regulation of behaviour between the groups of subjects are presented in Tables 1 and 2.

Table 1

Features of self-regulation of behaviour in students with different styles of meaning-transmission in the process of solving educational and professional tasks

Groups	Programming		Modelling		Evaluation of results	
	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ
1-2					56.0 / .050	1 / 6.3 / 1.62
						2 / 7.1 / 1.52
2-3			70.0 / .046	2 / 6.3 / 1.43 3 / 5.1 / 1.55	48.0 / .004	2 / 7.1 / 1.52 3 / 5.5 / 2.21
2-4	84.0 / .037	2 / 7.1 / 1.62 4 / 5.9 / 1.41	74.0 / .017	2 / 6.3 / 1.43 4 / 4.83 / 1.81		

Note. Group 1 - students with neutral style of meaning-transmission; Group 2 - students with emotional style of meaning-transmission; Group 3 - students with declarative style of meaning-transmission; Group 4 - students with philosophical style of meaning-transmission.

Students with the leading emotional style of meaning-transmission differ from students with neutral and declarative styles of meaning-transmission by a greater expression of manifestation of evaluation of results in the process of problem solving. Differences on the "Modelling" scale were revealed in students with emotional style of meaning-transmission and students with declarative and philosophical styles. Students with the emotional style of meaning-transfer differ from students with the philosophical style by the greater expression of indicators on the "Modelling" scale (tab. 2).

Table 2

Features of self-regulation of behaviour in students with different strategies of meaning-transfer in the process of solving educational and professional tasks

Groups	Planning		Programming		Modelling		General level	
	U/p	Group / \tilde{x} / σ	U/p	Group / \tilde{x} / σ	U/p	Group / \tilde{x} / σ	U/p	Group / \tilde{x} / σ
5-6	0.0 / .030	5 / 3.1 / 0.1 6 / 6.4 / 1.95						
5-7	0.0 / .026	5 / 3.1 / 0.1 7 / 6.5 / 1.22	2.0 / .047	5 / 6.4 / 0.4 7 / 6.71 / 1.20			0.0 / .024	5 / 22.8 /1.1 7 / 31.5 / 5.43
5-8	0.0 /.018	5 / 3.1 / 0.1 8 / 6.5 / 1.75						
5-9							0.0/ .019	5 / 22.8 /1.1 9 / 33.5 / 6.09
7-9					70.0 /.03	7 / 5.0 / 1.66 9 / 6.4 / 1.61		
8-9					138.0 /.009	8 / 4.7 / 1.93 9 / 6.4 / 1.61		

Note. Group 5 – students with passive strategy of meaning transfer; Group 6 – students with cognitive-dominant strategy of meaning transfer; Group 7 – students with emotional-dominant strategy of meaning transfer; Group 8 – students with balanced strategy of meaning transfer; Group 9 – students with active strategy of meaning transfer.

The results of mathematical statistics revealed significant differences in self-regulation of behaviour in the process of discussing a problematic pedagogical situation between groups of students with different meaning-transfer strategies. Students with passive strategy of meaning-transfer differ from students with other strategies of meaning-transfer by lower expression of indicators on the following scales of the methodology: "Planning", "Programming" and "General level of self-regulation". Students with active strategy of meaning transfer differ from students with emotionally dominant and balanced strategy by greater expression of indicators on the scale "Modelling".

Features of decision-making in students with different styles and strategies of meaning-transmission in the process of solving educational and professional tasks

The results of mathematical analysis showed the presence of significant differences in the features of self-regulation of behaviour and decision-making styles in students with different styles and strategies of meaning-transfer (Tables 3, 4).

Table 3
Peculiarities of decision-making in students with different styles of meaning-transmission in the process of solving educational and professional tasks

Groups	Procrastination		hyper-vigilance		Avoidance	
	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ
1-2	56.00 / .050	1 / 10.3 / 2.36 2 / 9.3 / 1.96				
1-4			118.0 / .038	1 / 11.1 / 2.15 4 / 9.4 / 2.41		
2-3					70.0 / .046	2 / 9.8 / 2.03 3 / 11.5 / 2.11

Note. Group 1 – students with neutral style of meaning-transmission; Group 2 – students with emotional style of meaning-transmission; Group 3 – students with declarative style of meaning-transmission; Group 4 – students with philosophical style of meaning-transmission.

The results of mathematical statistics allowed to establish: students with neutral style of meaning-transmission differ from students with emotional style by greater expression of data on the scale "Procrastination"; differences on the scale "Supervigilance" are revealed between groups of students with neutral and philosophical strategies of meaning-transmission; differences on the scale "Avoidance" are revealed between groups of students with declarative and emotional style of communication.

Table 4
Peculiarities of decision-making in students with different strategies of meaning- transfer in the process of solving educational and professional tasks

Groups	Vigilance		Procrastination	
	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ
5-6	0.00 / .03	5 / 11.0 / 1.00 6 / 14.2 / 1.81		
5-7	0.00 / .021	5 / 11.0 / 1.00 7 / 14.8 / 2.17		
5-8	0.00 / .018	5 / 11.0 / 1.00 8 / 15.4 / 1.87		
5-9	0.00 / .019	5 / 11.0 / 1.00 9 / 16.6 / 1.28		
6-7			32.0 / .024	6 / 9.4 / 1.95 7 / 11.0 / 2.35
6-9	26.0 / .002	6 / 14.2 / 1.81 9 / 16.6 / 1.28		

GENERAL PSYCHOLOGY, PERSONALITY PSYCHOLOGY, PHILOSOPHY AND PSYCHOLOGY

Groups	Vigilance		Procrastination	
	U/p	Group / \bar{x} / σ	U/p	Group / \bar{x} / σ
7-8			102.0 / .011	7 / 11.0 / 2.35 8 / 9.5 / 1.84
7-9	66.0 / .002	7 / 14.8 / 2.17 9 / 16.6 / 1.28	74.0 / .046	7 / 11.0 / 2.35 9 / 9.5 / 2.38
8-9	152.0 / .021	8 / 15.4 / 1.87 9 / 16.6 / 1.28		

Note. Group 5 – students with passive strategy of meaning transfer; Group 6 – students with cognitive-dominant strategy of meaning transfer; Group 7 – students with emotional-dominant strategy of meaning transfer; Group 8 – students with balanced strategy of meaning transfer; Group 9 – students with active strategy of meaning transfer.

The study revealed differences in decision-making styles among groups of students using different meaning-transfer strategies. It was found that students with a passive meaning-transfer strategy demonstrate a lower tendency to use the "Vigilance" decision-making style compared to other groups of study participants. Students with emotionally dominant strategy differ from groups of students with cognitive-dominant, balanced and active meaning-transfer strategies with higher procrastination rates. Students using the active strategy of meaning-transmission are characterised by a more pronounced tendency to "Vigilance" in the framework of decision-making compared to representatives of other groups.

Discussion

Students with emotional style of meaning-transmission have more needs to think over the ways of their actions and behaviour in order to achieve the planned goals than other groups of students, the action programmes they develop are detailed and detailed. In the majority of respondents with the emotional style of meaning- transmission the programmes are developed independently and flexibly change in new circumstances and are characterised by greater stability in the situation of interference. In case of inconsistency of the obtained results with the goals, the respondents correct the programme of actions until an acceptable result is obtained. Besides, this group of students to a greater extent is characterised by the ability to identify significant conditions for achieving goals both in the current situation and in the promising future, which is manifested in the conformity of action programmes to activity plans and the conformity of the obtained results to the accepted goals. Students with the emotional style of meaning-transfer are characterised by a developed and adequate self-assessment, a formed and stable system of subjective criteria for evaluating the results of solving problem situations and tasks. This group of students is able to adequately assess the fact of discrepancy between the obtained results and the purpose of activity, as well as the reasons that led to it, they flexibly adapt to changing conditions.

In decision-making, students with neutral style of meaning-transmission differ from respondents with emotional style by deliberately postponing the planned things, despite the fact that it will entail certain problems and complications. Besides, the respondents with neutral style of sense-transmission have the coping "Supervigilance" much more expressed than others and acts as a factor of decision- making which does not include intellectual orientation of search of a way out of a dilemma. Supervigilance provides impulsive decision-making, which promises the possibility of avoiding the problem, and in extreme situations is realised as "panic" in choosing between alternatives.

The results of Simonton et al. (2023) showed that emotions elicit stronger correlations with self-efficacy and Schweder et al. (2020) showed that learning and problem-solving goals are related to positive emotions and self-efficacy in adolescent girls and boys. The relationship between achievement emotions and mindfulness in activity mediated by self-regulation is evidenced by the research of Howell et al. (2011). Research by Seo et al (2007) found that individuals who experienced more intense feelings achieved higher decision-making performance. Moreover, people who were more able to identify and distinguish their current feelings achieved higher decision-making outcomes due to their increased ability to control possible biases caused by these feelings. These findings indirectly support the results of our study that people with an emotional sense-transfer style are more effective in decision making.

For students with a declarative style is inherent to a greater extent coping "Avoidance", which does not require decisive actions, significant tension and responsibility for actions and their consequences when making decisions, but on the contrary - distances from the conflict situation and gives the opportunity to postpone the solution of the problem.

Students with a low level of verbal and non-verbal activity (passive strategy of meaning-transfer) are characterised by a reduced need for planning activities, their goals are subject to frequent changes and are put forward situationally, usually not independently and are rarely achieved. In addition, they are characterised by inability and unwillingness to think through the sequence of their actions. Such people prefer to act impulsively, they cannot independently form a programme of actions, often face inadequacy of the obtained results to the goals of activity and do not make changes in the programme of actions, act by trial and error. It can be said that subjects with a passive strategy of meaning-transmission have no need for conscious planning and programming of their behaviour, they are more dependent on the situation and the opinion of people around them. Such subjects have a reduced ability to compensate for unfavourable personality traits in order to achieve their goals.

Students with an active strategy of meaning-transfer are characterised by a developed ability to identify the most effective ways and strategies of solving tasks to achieve goals. They are distinguished by the ability to goal-setting and problem-setting taking into account the present situation and future perspective, control the process of problem solving and goal achievement in accordance with the action plan. The findings are supported by the results of Jeitziner et al. (2024), where it is shown that non-verbal behaviour acts as a facilitator for students' use of regulatory strategies of planning and monitoring behaviour when solving tasks in online learning and has links with high cognitive ratings of the quality of collaborative group interaction. The authors also observe that there is a greater need for verbal discussion than non-verbal communication in cases of collaborative regulation and control of the task-solving process.

Students with active strategy of meaning-transfer differ from students of other groups by more frequent use of productive coping "Vigilance", which is manifested in decision-making in the context of rationality as readiness to think about goals and alternatives of decisions, focus on collecting information and maximising the coverage of the field of alternatives. This coping is least of all manifested in students with a passive strategy of meaning-transfer. Postponement of decision-making, search for ways out of difficult situations, fulfilment of academic tasks is most often manifested in students with emotionally dominant strategy of meaning-transmission. The studies of Polas et al (2023) prove the importance of effective communication for decision making by employees of enterprises. These results are consistent with our data: students with an active strategy of meaning transfer, which is considered effective (Suroedova, 2011), more often show the ability to make the most effective decisions in joint thinking activity.

Conclusion

In the process of solving educational and professional tasks, four styles of meaning-transmission can be distinguished. The emotional style is characterised by evaluation and sensitivity to the evaluations of others, return to previously discussed ideas and hypotheses,

and sensitivity to contradictions. Declarative style is used by leaders who take on the role of managing the discussion process, initiate hypotheses and ideas, systematise and generalise the results of problem solving. The philosophical style is characterised by complexity, vagueness and ornate statements, operating with scientific concepts; criticality towards hypotheses, tasks and goals. The neutral style of meaning transmission is characterised by the presence of all indicators, but their expression is much weaker than in other styles.

The most effective in self-regulation of activity in problem solving are students with the emotional style of meaning-transfer. They are distinguished by the formed need to achieve the goal, the ability to develop a programme of actions taking into account various factors, flexibly adjust them in new circumstances, show stability in situations of interference; show the ability to adequately assess the fact of discrepancy between the results obtained and the goal of activity, as well as the reasons that led to it.

In decision-making and self-regulation of activity when solving educational and professional tasks, students with an active strategy of meaning-transfer are the most effective. They are characterised by the ability to set goals and plan the course of goal achievement, taking into account various conditions and factors. In the process of problem solving they tend to consider various alternatives taking into account the collected information.

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Is there a Connection Between Genetic Predictors and Psychological Characteristics With the Effectiveness of Psychotherapy?

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Abstract

Introduction. The scientific review presents the results of the analysis of modern literature devoted to the study of the relationship of genetic, epigenetic and psychological factors with the effectiveness of psychotherapy. **Theoretical justification.** Statistical data indicate that in the Russian Federation, taking into account the socio-political transformations of recent times, the population's need for psychological and psychotherapeutic assistance is increasing every year. Despite this, it is still not included in the health insurance. This is largely influenced by the lack of sufficient evidence base confirming the effectiveness of various psychological and psychotherapeutic approaches. The creation of such a system is possible based on the fundamental biological mechanisms underlying mental processes. These include, among others, genetic and epigenetic predictors. The article discusses the basic concepts of genetics and epigenetics related to psychological characteristics and the psychotherapeutic process. Models of correlation and interaction between genes and the environment are described. The results of the analysis of scientific literature devoted to the study of the influence of the carrier of "plasticity alleles", as well as genes of neurotransmitter systems on the effectiveness of psychotherapy are presented. The factors of the social environment that have a significant impact on neurobiological development are described. The relationship of the severity of DNA methylation processes with traumatic experiences on the one hand and with the effects of psychotherapeutic assistance on the other is described. The features of the relationship of methylation

profiles with the psychotherapeutic effect are described. The analysis of the relationship of genetic predictors and psychological characteristics with the use of methods of cognitive behavioral therapy, therapy of PTSD, BPD, panic disorders, depression. **Discussion.** The analysis of modern scientific literature on the topic allows us to conclude that the DNA methylation index can be used as a predictor of effectiveness and an indicator of the response to psychotherapy. In the future, knowledge of the relationship between genetic predictors and psychological characteristics with the effectiveness of psychotherapy can be used to develop personalized programs aimed at providing psychological assistance.

Keywords

effectiveness of psychotherapy, epigenetics, DNA methylation, distress, cognitive behavioral psychotherapy, genes, neuroplasticity

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Introduction

Since the middle of the twentieth century, with the active development of genetics, researchers have begun to note the great role of heredity in the genesis of mental disorders. The question of the extent of the influence of genotype and environment on psychological characteristics and human behavior is still open. At the same time, recent discoveries in the field of neuroscience indicate the opposite effect of behavior on gene expression. The epigenetic approach allows us to take a different look at mental disorders and the available methods of their correction, such as medication, psychotherapy, and psychological correction. Epigenetic studies can play a key role in determining biomarkers associated with human vulnerability to psychopathologies, which can help improve the accuracy of diagnosis and expand opportunities for timely prevention of mental maladaptation and study the mechanisms of psychotherapy (Kumsta, 2019).

Psychotherapy is an interpersonal process that aims to change feelings, behaviors, attitudes, and cognitions that are problematic for the person seeking help (Strupp and

Binder, 1984). One of the goals of psychotherapy is the restoration of human social functioning, that is, the ability to maintain stable and productive interpersonal relationships that promote physical and emotional development. The most important change occurs with a person's ability to change their social environment (Fonagy et al., 2015).

To date, more than 400 types and methods of psychotherapy have been described, which relate to the main areas: psychodynamic, cognitive-behavioral, existential-humanistic (Roth and Fonagy, 2005). Recent studies indicate the effectiveness of therapy regardless of the direction, since common factors such as therapeutic alliance play the greatest role. The authors of the book "The Great Discussion about Psychotherapy. Evidence of what makes psychotherapy effective" Wampold and Imel give an example of a study of the effectiveness of group psychotherapy, in which an improvement in the psychoemotional state of members of the group receiving psychotherapeutic help was proved compared with the control group that did not receive such help, and with the placebo group (Wampold and Imel, 2015). The authors note that psychotherapy has fewer side effects than many conventional medical interventions and is more effective in terms of financial costs (if you take into account financial investments in the development and research of the effectiveness of medications). In the most common mental disorders, psychotherapy is comparable in effectiveness to drug treatment and has fewer adverse reactions. In addition, the psychotherapeutic process also has a preventive effect: the frequency of relapses is lower after its completion. There is no such effect in drug treatment (Wampold and Imel, 2015).

Considering the interdisciplinary problem of the relationship between genetics and psychotherapy, it is necessary to study the main modern concepts and discoveries of genetic neuroscience.

Some questions still remain open. For example, the question of which genes and their combinations affect susceptibility to stressful experiences, the genesis and manifestation of mental disorders (Gelernter, 2015). This scientific review is devoted to the search for answers to this and other designated questions.

Theoretical justification

Basic provisions of epigenetics

The human genome contains about 26 thousand genes encoding proteins, so the relationship between genotype and phenotype is incredibly complex. One gene can be associated with several phenotypes (the principle of multifinality), while one specific phenotype can be caused by mutations in several genes (the principle of equifinality). Consequently, one particular mutation can manifest itself differently in different people, which can be explained by a different profile of genetic variations and the influence of various environmental factors (Cicchetti and Rogosch, 1996).

The term "epigenetics" was first used by C. Waddington in the 1950s to refer to the mechanisms by which a genotype leads to a specific phenotype during embryonic development (Jamniczky et al., 2010). Currently, it is believed that an epigenetic trait is a stable and inherited phenotype resulting from chromosomal changes without any changes in the nucleotide sequence (Berger et al., 2009). Thus, epigenetics refers to all the mechanisms that regulate the genome by regulating gene expression - modifications that are not related to changing the DNA sequence.

Epigenetic changes have three key features:

4. they depend on the environment (Zhang, Meaney, 2010);
5. they are hereditary, that is, they can be transmitted to at least the first three generations of descendants (Daxinger, Whitelaw, 2012);
6. dynamic throughout life and potentially reversible (Szyf et al., 2008).

There are several mechanisms of epigenetic regulation. The most studied are: 1) DNA methylation, 2) histone modification, 3) chromatin conformation, 4) microRNA regulation (Graff et al., 2011).

DNA methylation is a process of activation and suppression of gene activity, which plays an important role in cell differentiation and provides a mechanism by which the genome can express multiple phenotypes in a multicellular organism. It can also serve as a form of biological adaptation to an ever-changing environment, especially in the early years of life (Szyf, 2012).

Histones are proteins that pack and organize DNA, and are also involved in the regulation of chromatin condensation.

MicroRNAs are widely activated in neurons and are associated with the processes of neurogenesis and neuroplasticity. They may play a role in the pathogenesis of depression (Dwivedi, 2014).

The "diathesis-stress" model

There are different models of the origin of mental disorders. According to the "diathesis-stress" model (Monroe, Simons, 1991; Patten, 2013), psychopathology arises as a result of the interaction of premorbid genetic vulnerability or organic predisposition (diathesis) and environmental aggression (stress).

In recent years, another assumption has been discussed, according to which, instead of diathesis, people have different susceptibility to environmental influences; they may not only be more vulnerable to the negative effects of an unfavorable environment, but also sensitive to beneficial influences (Belsky et al., 2007), that is, the effect of a particular polymorphism will be reflected in the phenomenon of plasticity. Thus, the transformation of the environment into a resource environment at the individual (for example, by encouraging prosocial behavior and psychotherapeutic interventions) or sociocultural level (a favorable environment for the population) can have positive results. Therefore,

the understanding of the role of prevention, diagnosis and treatment of mental disorders and maladaptations will change.

Currently, two ways of linking genes with the environment have been described (Caspi and Moffitt, 2006; Kendler, 2011):

7. Gene-environment correlation (rGE);
8. Gene-environment interaction (GxE).

Correlations between genes and the environment are divided into three types (Kendler and Eaves, 1986):

- passive, where children not only inherit genes, but also share with their parents the environment in which they grow and develop. For example, they inherit an athletic physique and family sports habits (Plomin et al., 1997);
- reactive or provocative – refers to the tendency of certain genetically determined temperamental behavior to cause certain types of reactions in people around them. For example, a child with a "difficult" temperament is more likely to provoke negative parental behavior;
- active or selective – defined as the active generation of certain environments based on genetically determined behavioral tendencies. This refers to the relationship between a person's genetic characteristics and the niches in the environment that a person chooses or creates. For example, an intellectually inquisitive child will tend to find an intellectually rich environment, while a child with a behavioral disorder will look for peers with similar behavior and related interests (Plomin et al., 1997).

The gene-environment interaction explains why people react differently to environmental factors (for example, why some people are more prone to depression after exposure to negative life events; why some people with genetic risk are less prone to depression if they were influenced by a favorable environment). So in the study of Heils et al. (1996) it was shown that the risk of depression increases due to the interaction between the genotypes of the 5-HTTLPR gene and the number of stressful life events experienced (Heils et al., 1996): individuals with one or two copies of the short allele of the 5-HTTL promoter polymorphism have more pronounced depressive symptoms and suicidal tendencies due to stressful life events, compared with carriers of the homozygous variant of the long allele (Caspi et al., 2003).

Correlation and interaction models are not mutually exclusive. Genetic polymorphism may be associated with certain traits that cause changes in the environment and interact with the environment to determine the phenotype. An example of such an indirect model is the detection of the correlation of a short polymorphic allele in the promoter region of the serotonin transporter gene (5HTTLPR) with neuroticism (Greenberg et al., 2000; Sen et al., 2004), which, in turn, is associated with a tendency to negatively interpret life events and with higher rates of depression (John and Gross, 2004).

Thus, it can be concluded that psychosocial interventions (environmental effects) are reflected in biological changes; therefore, psychotherapy is a type of treatment/support

that involves learning from the environment determined by therapeutic relationships and can lead to certain changes in behavior, well-being, quality of life, etc., which are also reflected in biological shifts.

The study of the effect of carrying "plasticity alleles" on the effectiveness of psychotherapy has contradictory results. Thus, Bryant et al. (2010) demonstrated that respondents diagnosed with post-traumatic stress disorder with a short 5HTTPLR allele reacted worse to cognitive behavioral therapy (CBT) compared with patients with a homozygous variant of the long allele. In another study, it was found that in patients with post-stroke depression with a short 5HTTPLR allele, psychosocial rehabilitation had a significant effect that was not obvious for patients with homozygous carriers with a long allele (Kohen et al., 2011). Eley et al. (2012) showed that children with anxiety disorder who have two short alleles in the genotype (SS) show more pronounced success in cognitive behavioral therapy than children with a long allele (SL/LL). In a study by Bockting et al. (2013) the relationship between the serotonin 5HTTLPR transporter gene and the response to cognitive behavioral therapy in patients with recurrent depression has not been identified.

The relationship between the genotype of the 5HTTLPR gene and the effectiveness of cognitive behavioral therapy could not be replicated in childhood anxiety disorder. The authors reported that children homozygous for the short allele showed more positive treatment results, but with minor effects that did not reach the level of statistical regularity (Lester et al., 2016).

It is important to note that in recent years, research in this area has shifted from low-productivity studies of genetic associations in which one or more genetic loci (candidate genes) are simultaneously genotyped to high-performance full-genome associative studies that include thousands of gene variants (GWAS) (CONVERGE consortium, 2015; Hou et al., 2016; Power et al., 2017).

The study of the complex relationships between genes and the environment has led to the development of epigenetic models that go beyond the classical paradigm of vulnerability to stress. Let's turn to a more detailed consideration of them.

Research on the relationship between social and (epi)genetic factors

Several social environmental factors, such as parental care in infancy and distress, can have a significant impact on neurobiological development by altering epigenetic programming, causing long-term consequences for mental health. It is known that the quality of parental care can determine the activation of certain genes in offspring associated with the development of certain areas of the brain, such as the hippocampus, which are involved in the regulation of stress response (Meaney, 2001). Thus, chronic and unpredictable separation from the mother causes depressive behavior in offspring in adulthood, changing the DNA methylation profile, which is passed on to the next generation with subsequent changes in gene expression (Franklin et al., 2010). For

example, a study of rat development has shown that abuse at an early age leads to persistent changes in the methylation profile of the BDNF gene and, consequently, in its expression in the prefrontal cortex, which in turn is observed in subsequent offspring (Fumagalli et al., 2004, Roth et al., 2009). Prenatal stress in rats and social stress in mice reduced BDNF levels in the hippocampus and prefrontal cortex (Luoni et al., 2014). As for humans, patients with depression had decreased levels of BDNF in serum and plasma, as well as in the hippocampus, during pathoanatomic studies (Lee and Kim, 2010). Thus, BDNF can be associated with adaptation to environmental conditions.

Other studies have shown that exposure to an acute stressor activates several effects, including enhanced danger memory, adaptive immunity, and metabolic changes that prepare the body to deal with the threat (Rubin et al., 2014). On the other hand, more intense and/or longer periods of stress have negative consequences, including memory impairment, cardiovascular disease, and metabolic syndrome (McEwen, 2007).

Transcriptomic studies in animal models have shown that both acute and chronic stressors cause behavioral changes in high anxiety, changes in hippocampal function and gene expression, although these effects vary depending on the type of stressor. For example, the transcription profile of the hippocampus in response to acute stress differs depending on whether the animal was previously subjected to chronic stress, even if a recovery period followed (Verhagen et al., 2010). Thus, each stressful situation that arises can change the initial set level, which also depends on the stage of development at which the stressor is affected.

In humans, prenatal exposure to depressed/anxious maternal mood was associated with increased methylation of the GR (NR3C1) gene in the fetus, which, in turn, led to an increased salivary cortisol response to stress in the child 3 months after birth (Oberlander et al., 2008). In addition, in patients with a high risk of suicide and a history of sexual violence, researchers observed an increase in methylation of exon 1F NR3C1 and a decrease in its expression in the hippocampus (McGowan et al., 2009). This suggests that the intergenerational transmission of vulnerability to psychopathology in adulthood may be mediated by early epigenetic modifications (due to an unfavorable environment) associated with the regulation of stress response.

Let us turn to the study of the relationship between genetic and epigenetic factors with the effectiveness of psychotherapy.

Genetic and epigenetic correlates of psychotherapy effectiveness

Patients diagnosed with borderline personality disorder (BPD) were treated with dialectical behavioral therapy for 4 weeks. The Beck Depression Questionnaire II, the Beck Hopelessness Scale (BHS) were used to assess negativity and pessimism about the future, the Barratt impulsivity Scale (BIS-10), the trauma questionnaire (CTQ). DNA extraction was performed from blood leukocytes. Before and after the psychotherapeutic intervention, the percentage of CpG methylation of exons I and IV of the brain neurotrophic factor

(BDNF) gene protein was measured. The study showed that, compared with the control group, the level of methylation (directly proportional to the number of traumatic events in childhood) in both areas of BDNF was significantly higher in people diagnosed with PRL. In addition, a positive association was found between BDNF methylation status and levels of depression, hopelessness, and impulsivity. In patients with PRL, BDNF methylation increased significantly after psychotherapeutic intervention, especially in those who demonstrated pharmacoresistance. In patients who noted the effectiveness of drug treatment, a decrease in the severity of the DNA methylation process was recorded. Changes in methylation status were largely associated with changes in symptoms of depression, hopelessness, and impulsivity (Perroud et al., 2013).

In another study, patients with post-traumatic stress disorder underwent psychotherapy for 12 weeks. At the end of the course of psychotherapy and after 3 months of follow-up, the level of methylation of DNA isolated from blood lymphocytes was measured before treatment. Methylation of the NR3C1 gene predicted a response to treatment, but did not change significantly over time. Patients who had higher methylation levels before treatment responded better to the intervention. Methylation of the FKBP51 gene is not a predictor of treatment success, although it tends to decrease in patients who have experienced the effectiveness of drug treatment (Yehuda et al., 2013).

After undergoing cognitive behavioral therapy for 6 weeks, patients with panic disorder had lower DNA methylation, compared with the control group, in the monoamine oxidase A (MAOA) gene. An increase in methylation of MAOA correlates with a decrease in the intensity of symptoms of agoraphobia (Ziegler et al., 2016).

After undergoing cognitive behavioral therapy for 12 weeks, children with anxiety disorder showed a decrease in the level of methylation of CpG IV FKBP5. The analysis showed that a change in the methylation of CpG4 FKBP5 DNA was largely associated with a "good" response to treatment (Roberts et al., 2015).

An increased level of GLUT1 methylation, compared with conditionally healthy people, was found in patients with depression. In addition, patients with depression in remission after treatment (6 weeks of inpatient treatment, cognitive behavioral therapy and taking antidepressants) had significantly lower levels of GLUT1 methylation compared to patients without remission (Kahl et al., 2016).

In total, some disorders (for example, borderline personality disorder and panic disorder) exhibit characteristic patterns of gene methylation associated with neurotransmission or neuroplasticity functions. Preliminary data indicate that these methylation profiles may mitigate the effect of psychotherapy or vary depending on the patient's response to it. In this regard, epigenetic changes, for example, the level of methylation, can be used as predictors and indicators of response to psychotherapy (Jiménez J. P. et al. 2018).

Thus, the study of epigenetic mechanisms that may underlie psychotherapeutic changes is a promising area of research. At the same time, scientists emphasize the need

to control mixed environmental factors and whether methylation variations are caused by a simple passage of time (Jiménez J. P. et al. 2018). Also, studies on the relationship between epigenetics and psychotherapy did not exceed 12 weeks in duration, which may not be enough to cause persistent changes in personality functioning (Lindfors et al., 2015).

Discussion

Children inherit not only genes from their parents, but also significant environmental influences encoded in them. Given that there is some evidence of the transmission of epigenetic modifications in people who have been subjected to traumatic situations, it can be assumed that epigenetic changes caused by psychotherapy can also potentially be transmitted to offspring. In addition, the fact that epigenetic changes are reversible may serve as an argument in favor of the use of psychotherapy (Yehuda et al., 2016).

The transfer of knowledge from one generation to another is another mechanism for the transfer of information necessary for survival, in parallel with the transfer of genetic material (Fonagy and Allison, 2014), where epigenetic modifications play an important role.

Summarizing the above, we can conclude that the origin of mental illness is related to the interaction of the environment and the genome, and that this interaction also depends on epigenetic mechanisms. On the other hand, we also know that the effectiveness of psychotherapy largely depends on a number of factors related to both interpersonal processes and biological changes in the central nervous system. Also, differentiating genetic polymorphisms of variability, one can assume the presence of susceptibility to positive environmental stimuli, which may be useful as an indicator of response and prognosis for psychotherapy.

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Emotion Dysregulation and its Neurophysiological Basis in People with Autism Spectrum Disorders

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Abstract

Introduction. Emotion dysregulation is a characteristic of autism spectrum disorders (ASDs). This study aims to systematize and analyze data on the specificity of emotion dysregulation in children and adults with autism spectrum disorders (ASDs) and their neurophysiological correlates. **Emotion regulation in ASDs.** Typical manifestations of emotion dysregulation in different age groups with ASDs, the relationship between efficient and inefficient regulatory mechanisms and concomitant disorders, external and internal problems, and key symptoms of autism are described. The emotion regulation system in ASDs shows a developmental delay. **Neurobiological mechanisms of disorders in the emotional sphere and social interactions in ASDs.** Data on the neurobiological mechanisms of emotion dysregulation in ASDs show a number of structural, functional, and molecular characteristics in the brain regions associated with the processing of social information, as well as an imbalance of excitation and inhibition processes, which obviously decreases stress resistance. Due to the increase in avoidance behavior and reduction in social experience, low stress resistance to social stimuli creates secondary obstacles to the formation of effective self-regulation strategies. **Neurobiological mechanisms of emotion dysregulation in ASDs.** There is a single neurophysiological basis for disturbances in the processing of emotional and social signals and in emotion dysregulation in ASDs.

Keywords

autism spectrum disorders, emotion dysregulation, ontogenesis, neurobiology, social interactions, stress resistance

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Introduction

Autism spectrum disorders (ASDs) are widespread dysontogenetic disorders that persist throughout life. In the modern world, the prevalence of ASDs continues to grow. Thus, according to a meta-analysis from 2023, the prevalence of ASDs as a whole was 0.72 % of the population, Asperger's syndrome – 0.13 %, atypical autism and pervasive developmental disorders – 0.18 % (Talantseva et al., 2023). Considerable investment is needed to facilitate and support people with ASDs, and their families are suffering from social instability (Bonis, 2016; Lievore et al., 2023).

ASDs are characterized by the presence of a wide range of mental development and behavioral defects, the main of which are impairments in communication and social interaction, self-regulation, sensory processes, reduction in motivation, psychological and behavioral stereotypes, and poor behavior (Posar & Visconti, 2023).

Several models have been proposed to explain the mechanisms of development of ASDs and attempts have been made to find the key factors causing a wide range of their symptoms. The theoretical importance of this issue is primarily related to the possibility of using autism spectrum disorders as a model to better understand the functioning of the healthy brain. The practical importance is to expand the possibility of helping people with ASDs based on understanding the mechanisms that form the disorders.

The severity of the deficit, especially in the field of social interaction, attracts research attention to this aspect of ASDs. The specificity of the emotional sphere is of particular interest, as its normal functioning is an integral part of social competence. One of the main characteristics of the emotional sphere in ASDs is emotion dysregulation.

Effective social interaction includes the development of a mature system of emotion regulation, including social expression and the ability to control internal states. Emotions

that first arise in response to a situation undergo changes that lead to the optimization of response at the behavioral level and its functional support. Emotions can change intensity, character, and direction (reorienting towards another situation or another aspect of the situation) (Gross & John, 2003). Efficient individual emotion regulation styles predict psychological well-being (Da Costa Dutra et al., 2023). Emotion dysregulation is defined as a lack of control and modulation of the valence, intensity, and expression of emotions (Davico et al., 2022); emotion dysregulation is a factor in many mental disorders (Igra et al., 2023).

Efforts to rehabilitate people with ASDs require the development of emotion regulation skills that increase stress resistance, enable them to enter social interaction situations efficiently (unlike avoiding potentially stressful conditions), gain social experience, and be subjected to correctional influences (Shaffer et al., 2023).

This study aims to systematize modern data on emotion dysregulation in the structure and dynamics of ASDs and to examine the neurophysiological correlates of emotion regulation.

Emotion regulation in ASDs

The immaturity of the emotion regulation system, the reduction in efficient strategies for self-regulation and regulating emotions in others, and the increase in inefficient strategies can be observed at all age stages of the development of children and adults with ASDs (Bradley et al., 2023). Children with ASDs show a decrease in positive emotional expression since childhood when they interact with adults, resulting in negative emotional reactions in parents and reducing their activity in interaction with children, reducing the possibility of developing emotional regulation of children with the help of adults (Jahromi et al., 2013; Sung et al., 2024). In pre-school age, children with ASDs tend to use primitive self-regulatory methods such as emotional outbursts and avoidance of situations that cause unwanted tension (Davico et al., 2022; Taylor et al., 2022). The degree of emotional deregulation already at this age is linked to various distress symptoms, such as sleep disorders (Favole et al., 2023), and also shows strong correlations with social functioning and behavioral disorders (Berkovits et al., 2017). Self-soothing through stereotypical behavior and self-stimulation is common in children and adults with ASDs, especially in situations of social stress; stereotypic behavior that leads to self-harm is generally associated with an increase in other forms of emotion dysfunction (Martnez-González et al., 2022; Lampi et al., 2020). At the same time, neurotypical children can already use attention switching, re-evaluation, rethinking in pre-school; stereotypic behavior, self-stimulation, and self-harm are observed in them very rarely.

In early school age and adolescence, low-functioning autistic children continue to use immature self-regulation strategies, while high-functioning autistic children gradually develop more mature cognitive strategies. However, even high-functioning autistic adolescents and adults have inefficient regulation strategies, including rumination

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(obsessive negative experiences); suppression of thoughts that cause unpleasant emotions, with their subsequent uncontrollable "intrusion", impulsive discharge, catastrophizing, self-blame, dissociation in the context of a decrease in effective strategies (Bruggink et al., 2016; Ilen et al., 2023; Martínez-González et al., 2022; Mazefsky et al., 2014). Adults with ASDs also maintain primitive regulation strategies; mature self-regulation strategies, such as cognitive reappraisal, can not only be reduced, but also less efficient when used (Zaharia et al., 2021).

The research findings also show that the use of emotion regulation strategies is linked to mental health problems in ASDs; greater external (behavior, interpersonal relationships) and internal (well-being, emotional states, and self-esteem) problems are associated with a decline in mature efficient emotion regulation strategies or an increase in emotion dysregulation (Cai et al., 2019; Conner et al., 2020; Bruggink et al., 2016; Mazefsky et al., 2014; Samson et al., 2014).

At the same time, it is reported that an inefficient strategy of thought suppression, combined with a high cognitive reappraisal in a group of adolescents and young adults with ASDs, is associated with relative psychological well-being; this association is not typical in neurotypical development (Pouw et al., 2013a).

A reduction in depression symptoms was observed in boys with ASDs who use avoidance strategies in stressful situations (Pouw et al., 2013b). The reduction of depression symptoms has also been demonstrated with the increase in avoidance strategies, such as in adolescents with ASDs (Cracco et al., 2017). Another characteristic difference between high-functioning autistic adolescents and their neurotypical peers is the maintenance of levels of depression with an increase in efficient emotion regulation strategies and the lack of conviction that emotional experience contributes to solving the problem. The authors believe that attempts to solve problems are less likely to yield results and the accumulation of positive experiences in this group. (Rieffe et al., 2011). Studies of the neurotypical population usually show a direct link between depression and avoidance strategies. Perhaps the inability to cope with stressful situations makes the avoidance strategy adaptive in ASDs under some conditions (at least in the short and medium term). Overall, these results may suggest specific prognostic implications for the severity of various emotional regulation strategies in ASDs.

A mixed group of adolescents with mental disabilities reported a regression to less adaptive strategies for regulating emotions between the ages of 12 and 15, which may be related to physiological changes at this age (Cracco et al., 2017); this requires careful comparison among the age groups.

Emotion regulation indicators are associated with important developmental characteristics in the context of basic ASDs. In a sample of children aged 3 to 12 years, a positive relationship was found between efficient emotion regulation and the age of verbal development, which further emphasizes the role of speech in the development of self-regulation (Nader-Grosbois & Mazzone, 2014). Samson et al. (2014) report a link between

emotion dysregulation and all the main symptoms of autism, including deficiency in social functioning, communication, sensory disorders and, above all, stereotypic behavior; this enables us to consider the phenomenon of dysregulation as a cross-sectional phenomenon in the structure of autism spectrum disorders (Samson et al., 2014). The contribution of almost all autism symptoms to emotion dysregulation, which modulates the development of anxious states, is noted (Swain et al., 2015). Stereotypic and restricted behavior is closely related to rumination, one of the major forms of emotion dysregulation, and some authors consider it to be a cognitive form of stereotyping (Ibrahim et al., 2019). According to other data, ruminative thinking in adult autists is associated with depression, a comorbid disorder similar to a neurotypical population (Williams et al., 2021). The link between high levels of rumination and subsequent external and internal problems in children with ASDs was also shown (Bos et al., 2018). A considerable interest is the mediation by ruminating the relationship between autism symptoms and depression (Keenan et al., 2018). Since symptoms of depression and anxiety are associated with ASDs (Smith & White, 2020), these data draw more attention to the problem of increased rumination in high-functioning ASDs.

There is a question about the characteristics of emotion dysregulation that combine ASDs with other disorders, and specific ones. There is evidence that there are generalized mechanisms of disorders (impairments in excitation processes, affective lability, dysfunction of the prefrontal cortex and amygdala) and more specific aspects (changes in the processing of sensory information, features of cognitive processes, disturbances of social motivation and processing of social information) (Mazefsky et al., 2013).

Neurobiological mechanisms of disorders in the emotional sphere and social interactions in ASDs

A considerable amount of data has been collected on the neurophysiological substrate of ASDs. One of the main research areas is the identification of the specific functions and interactions of brain structures associated with the processing of social information.

The main results were abnormal activity of the prefrontal cortex, the cingulate cortex, the superior temporal sulcus, the amygdala and, less often, the basal ganglia (striatum, caudate nucleus, putamen) and deteriorating interactions between these regions. The activation of these areas and the nature of their connection are related to the lack of recognition of emotional facial expressions (Samaey et al., 2020; Swartz et al., 2013) and the impairment of decision making and self-consciousness in social situations (Chiu et al., 2008; Schulte-Ruether et al., 2011). An atypical modulation of the amygdala on the cerebral cortex is considered a key possible disorder (Sato et al., 2011).

In ASD subjects and their healthy siblings, activity in the superior temporal sulcus, orbitofrontal cortex, and anterior cingulate cortex was reduced compared to control groups when presented with faces with positive emotions (Spencer et al., 2011). Similar

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changes in brain activity during the processing of facial images, but not during the processing of stimuli of another kind, were also shown for children with ASDs and their healthy parents (Dawson et al., 2005). Changes in hippocampal and amygdala volume, and the structure of white brain matter are related to the characteristics of emotion regulation in children at high risk for autism (Ding et al., 2024). These data are of interest to identifying an endophenotype in autism, since changes in activation of certain regions of the brain can be markers of hereditary predisposition to ASDs. The problem of the interaction of factors in the development of ASDs is also raised: How is the development trajectory formed in the presence of multiple interactions in the neurosubstrate?

Experimental models of social interaction in ASDs often involve the presentation of the eye region that generates strong emotional reactions. It has been shown that when instructed to fixate different face regions, patients with ASDs were more likely to lose fixation stability to the eye region. They also showed relatively higher activation of the amygdala when fixated the eye region and relatively lower activation when fixated the mouth region (Kliemann et al., 2010). Another study showed that amygdala activation was modulated when children with ASDs, but not in neurotypical children, fixated the eye region. The specific effect of this stimulus on the activation of the amygdala may indicate that the dysfunctional neuronal dynamics in ASDs can lead to increased negative emotions in response to contact with the eyes and, consequently, to its avoidance (Kliemann et al., 2012). Compared to neurotypical and mentally disabled children with autism, the frontal cortex was more active in response to lateral gaze than in response to direct gaze. This may reflect the decline in social motivation that normally occurs in response to direct gaze (Lauttia et al., 2019).

After describing the mirror neuron system – nerve cells that are excited when another person performs specific actions or display emotions – it was suggested that disturbances in its function contribute to difficulties in social interaction in ASDs. A number of studies confirm abnormal activation in the frontal and parietal lobe regions where the mirror neurons are located when participants with ASDs observed the movements of other people (see review: (Chan & Han, 2020). When the task of voluntary imitating the emotional expressions of the subjects was performed, participants with ASDs, compared to control groups, had lower activations of the caudate nucleus and putamen (Dapretto et al., 2006), indicating the role of subcortical structures in disturbances of imitation processes and their effect on the function of the cortex.

Not all studies confirm the general disfunction of the mirror neuron system in autism. For example, when automatic imitation of facial expressions is recorded under the control of attention to facial stimuli, participants with ASDs have shown results similar to neurotypical participants. However, only they are characterized by no direct relationship between empathy self-assessment and imitation success. The authors conclude that in ASDs, the simple level of motor imitation is not associated with complex cognitive social abilities such as emotion understanding and empathy. (Schulte-Rüther et al., 2013).

In recent years, it has become increasingly popular to study not only areas of the brain that are responsible for immediate responses to stimuli, but also neural systems that are involved in the extra-situational processing of social information and the implementation of self-perception processes. Therefore, ASDs is associated with a number of impairments in the default mode network functions (Harikumar et al. 2021; Padmanabhan et al., 2018).

Another area of ASDs research is related to the study of the functioning of neurotransmitters and hormonal systems. The concentration of impairments in brain regions associated with the behavioral reward system leads to the hypothesis that the dysfunction of the behavioral reward system plays a role in the social behavioral deficit in ASDs (Spence et al., 2011; Vaan de et al., 2020; Dichter, 2012). Dopaminergic deficiency in individuals with ASDs have been noted in a number of studies (see review: (Greene et al., 2019)). Dysfunctions of dopaminergic structures are associated with early developmental disorders of the brainstem (Dadalko & Travers, 2018). Based on the hypothesis of activation by oxytocin and vasopressin of the reinforcement system of social behavior in neurotypical development, Insel & Fernald (2014) suggested that ASDs interferes with the modulation of dopaminergic neurons in the neural attachment system, resulting in a decrease in social motivation. Therefore, social stimuli do not lead to the experience of pleasure. Social motivation is essential to social learning, and its impairments cause great difficulties (Fareri et al., 2008). The deficit in the reinforcement system in ASDs is also considered in the context of a wider range of motivation components, including responses to non-social rewards and a limited range of motivations (Clements et al., 2018).

The search for causes of reduced stress resistance in ASDs has attracted attention to other neurotransmitter systems (Sato et al., 2023). For example, using facial expression recognition tasks, it was shown that acute tryptophan depletion (which leads to a reduction in serotonin synthesis) in participants with ASDs leads to an excessive reduction in response to emotional facial expressions in socio-emotional brain areas (Daly et al., 2012).

Dysfunctions of the hypothalamus-pituitary-adrenal axis and excessive or insufficient cortisol increases in response to new and stressful stimuli are also observed (Spratt et al., 2012). According to other data, children and adults with autism respond to cortisol similar to neurotypical peers, but their levels of cortisol are associated with several symptoms of autism and related disorders, including stereotypic behaviors (Vaan de et al., 2020) and cognitive decline (Ogawa et al., 2017). There is evidence of an increase in cortisol levels in stressful situations with age. This may indicate the existence of secondary disorders that develop in children with ASDs (Schupp et al., 2013).

The characteristics of excitation that arise in response to various types of stimuli are studied by cortical activation indicators, galvanic skin reactions, heart rate, pupillary reactions and startle responses. Several studies have shown an increase and decrease in excitation in response to similar emotional and social stimuli compared to neurotypical individuals, as well as correlations between its changes and individual autism symptoms

and adaptation problems (Anderson et al., 2013; Baker et al., 2018; Dijkhuis et al., 2019; Verneti et al., 2020).

We should note that the data from different studies are often contradictory, which may be associated not only with differences in methodological approaches, but also with the heterogeneity of ASDs and its association with other mental disorders.

Neurobiological mechanisms of emotion dysregulation in ASDs

The neurophysiological substrate of emotion regulation is assumed to be the interacting cortical structures (areas of the prefrontal and frontal cortex, the posterior parietal cortex, and the insular lobe) and the limbic system structures (mainly the amygdala and striatum) (Sato et al., 2023).

The experimental approach to studying emotion regulation usually includes instructions on how to control emotion that arises in response to a stimulus. A study showed that neurotypical children show a significant reduction in activation in the amygdala and insular cortex when they voluntarily reduce their affective reactions to emotogenic images, according to the instructions. At the same time, children with ASDs did not demonstrate similar regulations. In addition, neurotypical participants in the study showed a higher functional connectivity of the amygdala and prefrontal ventrolateral cortex than participants with ASDs, as well as a lower functional connectivity of the amygdala with the orbitalfrontal cortex (Pitskel et al., 2011). Using instructions to increase positive and negative emotions while viewing face images, less activation was seen in the nucleus accumbens, amygdala, and dorsolateral prefrontal cortex of participants with high-functioning ASD than in neurotypical controls (Taylor et al., 2018). When an emotional response was actively modulated according to instructions in social situations, adults with ASDs showed compensatory activation in the dorsolateral prefrontal cortex, but the activation of the nucleus accumbens was reduced, and the compensatory mechanism did not lead to typical modulation of the emotional processing areas (Latinus et al., 2019).

Another type of task proposed includes the presentation of negative stimuli. Under these conditions, participants in the experiment should regulate (improve) their emotional states. In a study in which instructions were given to recognize words that trigger unpleasant emotions, participants with ASDs showed differences in the function of the anterior cingulate cortex, the anterior insular lobe, and dorsolateral prefrontal cortex – areas responsible for regulating emotions in a healthy population (Mazefsky et al., 2020).

Modeling stress situations in young children with autism allowed to describe a delay in the physiological maturation of their emotion regulation system. With the Still-Face Paradigm procedure (Giusti et al., 2018), the emotional reactions of children to a reduction in communication indicators after playing with their mothers were measured.

Children with ASDs, like neurotypical children, showed negative emotions in response to emotionless expressions of their mothers, looked at them longer, but their self-regulation was easier – for example, they sucked the thumb or repeated the same actions, while neurotypical children were able to change attention, etc. Mothers of children with ASDs smile more before and after stress on their children, look at them longer; this may reflect their greater efforts to regulate the child's emotions. It is also noted that in the presence of mothers, only children with ASDs show a reduction in the production of cortisol – i.e., external control leads to a reduction in stress levels; normally, children of the same age can regulate emotions independently (Ostfeld-Etzion et al., 2015). The later maturity of self-regulation indicates the need for longer-term social support. This can further complicate the development of emotional control as positive feedback decreases.

In a number of studies, the conceptual link between emotional regulation disorders and autism symptoms is primarily considered to be caused by autism symptoms that interfere with the acquisition of social experience and the effective co-regulation of emotions with parents (Mills et al., 2022); other authors believe that most of them are disturbances in the functioning of the nervous system that lead to emotional dysregulation, which, in turn, results in the emergence of autism symptoms in different configurations as phenotypic manifestations (Dell'Osso et al., 2023). It is also suggested that there is a general impairment of executive functions that mediates the relationship between ASD symptoms and emotional dysregulation (Costescu et al., 2023). These approaches are not fundamentally contradictory to each other. It can be assumed that a weakened regulatory function based on neuronal substrate impairment interacts with autism symptoms in accordance with the vicious circle principle of mutual influence.

Conclusion

Therefore, disturbances in emotional regulation can be considered as a transdiagnostic factor of ASDs, which has specific characteristics, including the following: (a) decreasing efficient strategies and increasing inefficient ones, (b) large number of immature strategies in older children, adolescents, and adults, (c) stereotyping, including cognitive components, (d) severity of the regulatory strategy associated with avoiding stressful situations, mainly social ones, combined with a reduction in the processing of extra-situational social information, (e) imbalance of components, and (f) differences in the efficiency of specific regulatory mechanisms, compared to neurotypical individuals.

According to most authors, emotion regulation disturbances are associated with the severity of other major symptoms of autism, depression, anxiety, and social maladaptation. Signs of emotion dysregulation are observed in all age groups. Children and adolescents with ASDs have a longer training period of independently implemented and efficient strategies of emotional regulation than their neurotypical peers.

Obviously, both primary physiological mechanisms and secondary disorders that develop in the social environment due to a slower accumulation of social experience and a decrease in the effectiveness of joint emotional regulation with parents contribute

significantly to the development of emotional dysregulation in ASDs. It can be assumed that there is a single neurophysiological basis that combines deficits and/or distortions in the processing of emotional and social signals and emotion regulation disorders. Individual function disorders obviously form a complex system, which, in combination with a specific perception of environmental factors, may clearly form complex trajectories of the development of self-regulatory processes.

The imbalance in excitation and inhibition processes, which leads to a reduction in stress resistance, can be considered as an inferential mechanism complicating emotional regulation in ASD. Another integrated mechanism may be a reduction in general and social motivation caused by dysfunctions in dopaminergic and oxytocin systems.

It is necessary to emphasize the importance of correctional work with secondary factors of emotion dysregulation in ASD. Several cautions in the direct formation of efficient strategies for emotional regulation are associated with a lack of resources to overcome stressful situations in individuals with autism. A significant decrease in avoidance strategies can lead to maladaptation.

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Eye-tracking for non-symbolic numerosity estimation: A systematic literature review

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Abstract

Introduction. The processing of quantitative information is one of the basic processes that ensures successful interaction with the environment. In one form or another, this ability is found in a large number of biological species. In humans, the specifics of processing quantitative information in different formats are analysed in experimental and correlational studies using various methods and approaches, including eye tracking. Eye tracking makes it possible to follow the mechanisms of the formation of the mental representation of quantity and to evaluate the connection of the non-symbolic "sense of number" with the systems of representation of other visual parameters, such as the size of objects. **Methods.** This paper presents a systematic review of eye tracking studies of non-symbolic numerosity estimation published from 2008 to 2023. A search of Scopus, Web of Science and PubMed databases identified 13 studies. **Results and Discussion.** The research questions, the characteristics of the tasks and stimulus materials used, the characteristics of the sample and the results obtained have been systematised. This review highlights the mechanisms of operation of the numerosity representation system and the characteristics of conducting eye-tracking studies to investigate them.

Keywords

Nonsymbolic number sense, nonsymbolic numerosity representation, eye tracking, saccades, visual fixations

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Introduction

The ability to perceive and process nonsymbolic numerosity plays a key role in the adaptation of the organism to the environment (Nieder, 2018). This ability emerged quite long ago during evolution, as numerosity sensitivity has been documented to some extent not only in humans and primates, but also in more evolutionarily ancient species such as amphibians or fish (Agrillo & Bisazza, 2018; Brannon, 2005). Researchers use a variety of terminology to describe the ability to perceive quantitative information: some prefer the term "Number Sense" (Agrillo & Bisazza, 2018; Burr & Ross, 2008; Dehaene, 2001), while others prefer "approximate number sense" (Halberda et al., 2008a), "intuitive number sense" (Feigenson et al., 2013), or "Nonsymbolic Number Sense" (Decarli et al., 2023). Despite some differences in terminology, most researchers agree that number sense involves the ability to compare sets of objects and select the set that contains a larger/fewer number (nonsymbolic comparison), to notice whether there have been changes in the number of objects (nonsymbolic detection of changes), and to establish quantitative similarities or differences by comparing two or more sets of objects (Berch, 2005; Gebuis & Van Der Smagt, 2011; Halberda et al., 2008a; Park et al., 2016; Sasanguie et al., 2014).

Research on the ability to process numerosity has developed into the 'number sense' theory, according to which the ability to process nonsymbolic quantitative information is provided by a separate nonsymbolic quantity representation system (Arrighi et al., 2014; Burr et al., 2018; Odic & Starr, 2018). This system is activated whenever a person is 'confronted' with quantitative information. In this case, 'numerosity' is described as a primary attribute of the perceived objects, along with other properties that can be processed in the early stages of perception: size, colour, shape (DeWind et al., 2019; Harvey & Dumoulin, 2017; Park et al., 2016).

Using various tasks (e.g. non-symbolic comparison tasks), researchers have found that one of the main features of the system of non-symbolic representation of quantity is its imprecision, its approximation (which is reflected in one of the widely used terms -

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Approximate Number Sense). What is meant by this? First of all, no matter what tasks are used, accuracy never reaches 100%. For example, when comparing two sets of objects, a person will always make some mistakes, provided they compare them quickly and do not use counting.

It should be noted that there is also an accurate system for estimating nonsymbolic quantities, called subitising (Revkin et al., 2008). Subitising is the ability to quickly and accurately estimate the number of objects within 1-4 (1-3) (Anobile et al., 2019; Burr et al., 2010). More often, researchers consider subitising as a separate system (Feigenson et al., 2004; Revkin et al., 2008). In addition, they also distinguish a separate texture judgment system, the quantity representation system, when the number of objects is so large that the boundaries of individual objects are barely distinguishable (Anobile et al., 2014).

Returning to the system of non-symbolic representation of numerosity, it has been shown that representation errors obey certain regularities. In particular, the number of errors increases with response time as the size of the sets being compared gets closer, i.e. as the distance between them decreases and the numerosity ratio increases (Dehaene, 2003; Lyons et al., 2015). This means, for example, that a person is more likely to make an error when comparing 7 and 9 objects than when comparing 5 and 11 objects. This pattern has been called the 'numerical distance effect' or 'numerical proportion effect' (Dehaene, 2003; Dietrich et al., 2015; Lyons et al., 2015). Another pattern found when examining patterns of error making in nonsymbolic numerosity estimation or comparison is that the probability of error increases as numerosity increases (when numerical proportion remains intact). This pattern is called the 'size effect' (e.g. (Dehaene, 2001)).

The presence of these features is explained by the 'mental number line' model (Dehaene et al., 1993). This model assumes that perceived numerosities (numbers or sets of objects) are conventionally arranged along a line that runs from left to right (in cultures with corresponding writing patterns). Each perceived quantity corresponds to a specific population of neurons whose activation can be represented by a 'Gaussian' curve (Nuerk et al., 2011; Toomarian & Hubbard, 2018). When the numbers on this number line are far apart, the 'Gaussian' curves do not overlap, so each quantity corresponds to a separate representation. However, if the numbers are close together, the curves may overlap significantly, leading to an error in identifying the quantities and their relative locations on the mental number line.

In addition, the mental number line model may partly explain the relationship between the perception of quantity and the perception of space. For example, many studies have found the so-called SNARC (spatial-numerical association of response code) effect, one manifestation of which is that large numbers are associated with the right side of the visual field and small numbers with the left side (Chen & Verguts, 2010; Fischer et al., 2003; Nemeš et al., 2018).

The relationship between number and spatial perception is also supported by many neurophysiological studies. Number operations have been found to be associated with

activation of posterior parietal areas that are also associated with spatial perception and attention (e.g. (Göbel et al., 2001; Göbel et al., 2006; Hubbard et al., 2005). Furthermore, it has been shown that there is a developmental change in the extent to which parietal areas are involved in quantitative information processing (Ansari et al., 2005). It has been shown that children show greater activation of the frontal zone, whereas adults show greater activation of the parietal zones.

Common neurophysiological correlates for the estimation of number and space gave rise to a discussion about the existence of a single system for estimating number, magnitude, space and time - the General Magnitude System (Lourenco & Longo, 2011). This general system became one of the main provisions of the Theory of Magnitude, which questioned the existence of a separate system for estimating discrete quantities (Walsh, 2003).

But if there is no separate system for numerosity estimation, and there is no special 'sensitivity' to quantity, then how can a person, for example, compare two sets of objects (which is possible, no one can argue with that)? To explain this, the theory of 'sensory integration' has been proposed (Gebuis et al., 2016). According to this theory, the estimation of the number of discrete objects is based on the estimation of several non-numerical visual parameters, such as the size of the shapes, their cumulative area, their density of arrangement and their surface area. Each visual parameter has its own 'weight' in the estimation of quantity (Clayton et al., 2015; Gilmore et al., 2016). In support of this theory, it has been found that changes in the activation of brain areas involved in quantity estimation are associated with changes in visual parameters rather than changes in their quantity (e.g. (Gebuis & Reynvoet, 2012).

It was also shown that the accuracy of the nonsymbolic comparison depended on the relationship between quantitative and visual parameters. When visual and quantitative parameters were positively correlated (e.g., a set containing a larger number of objects had a larger occupied area), i.e., congruent, accuracy was higher than in incongruent conditions (Clayton et al., 2015; Smets et al., 2016; Szűcs et al., 2013). This difference in accuracy between congruent tasks has been termed the congruency effect. It reflects the extent to which quantity estimates depend on visual parameter estimates. Furthermore, it has been shown that when sets are incongruent with respect to multiple visual parameters, comparison accuracy is critically reduced and does not exceed the random guessing threshold (Szűcs et al., 2013).

Viarouge et al. (2019) suggest that the congruency effect reflects the suppression of irrelevant cues, rather than the dependence of quantity estimation on visual parameter estimation. From this perspective, when comparing numerosities, participants can process both non-numerical visual parameters and quantitative features, but the former are processed faster.

The nonsymbolic number representation system may be the basis for the development of symbolic numerical skills (De Smedt et al., 2013). Symbolic and non-symbolic representations have been shown to share similar features, such as the Numerical Distance Effect (NDE) (Halberda et al., 2008a; Holloway & Ansari, 2009). Another and more important argument comes from research on the relationship between non-symbolic number sense and mathematical achievement. A large number of studies have shown that the accuracy of non-symbolic number sense correlates with mathematical achievement measured at the same time or even several years later (Chen & Li, 2014; Libertus et al., 2012; Schneider et al., 2017).

However, some studies have found no significant relationship between non-symbolic number sense and symbolic math skills (Fuhs & McNeil, 2013; Gilmore et al., 2013). Some researchers believe that symbolic and non-symbolic number representation systems are two separate systems (Lyons et al., 2015; Sasanguie et al., 2017). For example, it has been shown that at the individual level there is no significant correlation between the effects of numerical proportion in number comparison and non-symbolic comparison tasks (Lyons et al., 2015).

In general, despite the growing number of studies on non-symbolic numerosity, there are several open questions. First of all, the mechanisms that enable the processing of non-symbolic quantitative information are still unclear. Is this system separate and independent from the estimation of non-numerical visual parameters? Can humans estimate quantities without relying on the estimation of continuous visual features? (e.g., de Hevia et al., 2017; Harvey & Dumoulin, 2017; Wilkey et al., 2017).

The second controversial debate concerns the extent to which non-symbolic number sense is related to symbolic numeracy. Can the accuracy of non-symbolic number sense predict mathematical achievement? Could the non-symbolic number representation system be a system that has been used during evolution to develop symbolic number skills? Researchers have attempted to answer these questions using a variety of approaches, both experimental (Park et al., 2016) and correlational (Halberda et al., 2008b). Neurophysiological and neuroimaging methods such as EEG (e.g. (Gebuis & Reynvoet, 2012)), fMRI (Mock et al., 2018), transcranial magnetic stimulation (Sasanguie et al., 2013) or eye tracking (e.g. (Price et al., 2017)) are also commonly used.

Each of these methods has its advantages and limitations. This review aims to analyse research on non-symbolic number sense using eye tracking.

Possibilities of using eye tracking to study numerosity processing

Eye tracking is an increasingly popular method for investigating the perception and processing of information, including quantitative information, both with and without the use of symbols (Hurst & Cordes, 2016; Irwin & Thomas, 2007; Lilienthal & Schindler, 2019;

Merkley & Ansari, 2010; Odic & Halberda, 2015; Price et al., 2017). Eye tracking provides direct access to internal processes by tracking the focus of attention with high spatial and temporal resolution.

Variables collected by recording eye movements include saccadic movements (movements of the eye that represent a change in the focus of attention) and fixations (maintaining perception in an area of interest and hence sustained concentration of attention). These indicators generally fall into two categories. The first category includes the location and duration of the first fixation and indicates bottom-up, stimulus-driven processes related to visual-perceptual processes and involuntary attention.

The second category reflects top-down processes related to voluntary control, attitude, and motivation, and involves more intensive and prolonged cognitive processing (Calvo & Meseguer, 2002; Mock et al., 2016). These include the total number of fixations, the total duration of fixations, and the frequency and direction of saccadic movements. Thus, based on the analysis of different types of oculomotor indicators, it is possible to say which processes - ascending or descending - are involved in the processing of quantitative information.

Characteristics of oculomotor responses can indicate which of the two visual systems, dorsal or ventral, is activated at a given time (Pannasch et al., 2008; Velichkovsky et al., 2005). Studies of visual perception have shown that morphological visual information can follow two pathways: dorsal and ventral (Mishkin et al., 1983). The ventral stream sends information from occipital regions to inferior temporal regions. Here, foveal information is processed at a relatively slow rate. The dorsal stream sends the signal faster, but with less spatial resolution, to posterior parietal regions.

The functional division is based on the processing of information in these streams in two modes: in the ventral stream, the subject stream, which answers the question 'what', and in the dorsal stream, the spatial stream, which answers the question 'where'. For example, comparing numbers has been shown to be a task that activates the dorsal pathway in the right parietal regions. However, the task of deciding whether a number is odd or even activates the ventral pathway (Klein & Knops, 2023). Thus, analysing oculomotor performance during different number operations can provide important information about the mental processes behind these operations.

A systematic review of eye tracking research in mathematics education has already been conducted (Strohmaier et al., 2020). It reviewed the main findings of research from 1921 to 2018, but its main focus was specifically on mathematics learning; this study did not include detailed findings of research on nonsymbolic representations of quantity, as not all number sense research is related to research on math skills.

Aims of the systematic review

Our systematic review includes eye tracking studies of a non-symbolic quantity representation system. The aims of this review are:

1. To highlight and describe the main research questions, instruments (tests, tasks) and results of research on the non-symbolic representation system using eye tracking;
2. To analyse the main ways of interpreting indicators of oculomotor reactions from the point of view of the characteristics of the non-symbolic representation system;
3. To identify the main mechanisms for processing nonsymbolic quantitative information based on the results of eye tracking studies.

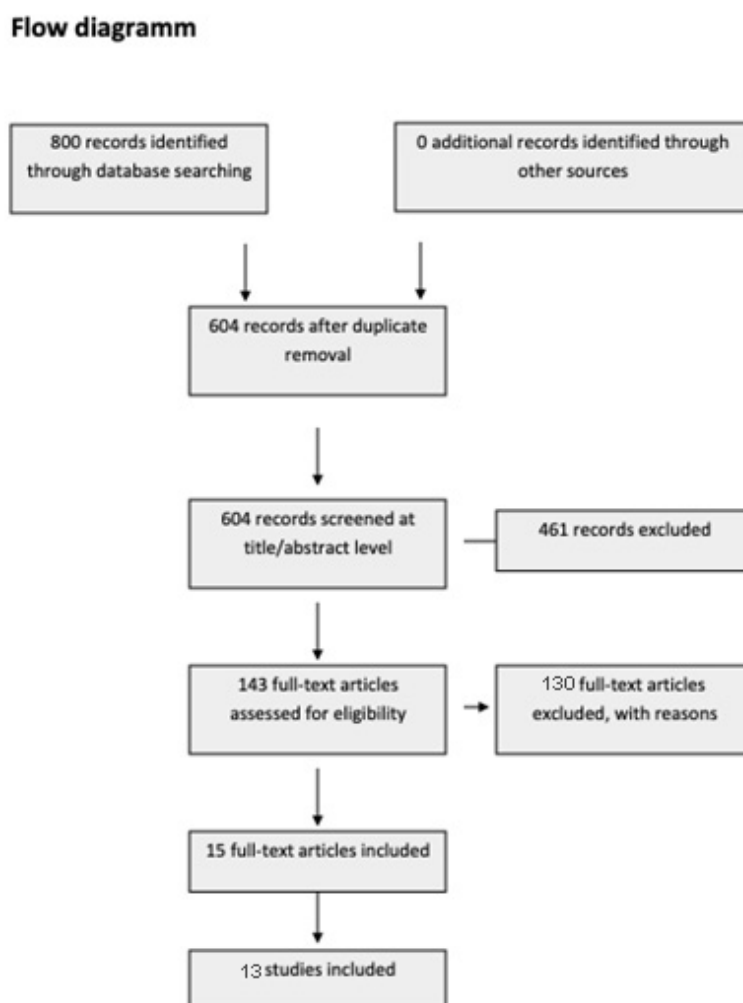
Methods

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews guidelines (Page et al., 2021). To identify the studies that met our criteria we implemented the following search strategy. The first step was the database search, for which we used the search string: ("approximate number sense*" OR "sense of magnitude*" OR "nonsymbolic comparison*" OR "symbolic representation*" OR "numerical representation*" OR "symbol grounding*" OR "number processing*" OR "representation of number magnitude*" OR "estimation biases*" OR "non-symbolic number comparison*" OR "non-symbolic representation*" OR "nonsymbolic representation*" OR "numerosity*" OR "numerosity processing*" OR "intuitive number sense*" OR "sense of number*") AND ("eye-movements*" OR "eye-tracking*" OR "saccade-terminated*" OR "eye-fixation behaviour*" OR "foveal*" OR "fixation*" OR "saccade*"), referring to titles and abstracts. Duplicates were automatically discarded. Articles were not limited by publication date. This resulted in a total of 604 studies.

Step two involved screening titles and abstracts for the inclusion: (a) the study was published in a journal article, a book chapter, or in conference proceedings; (b) the study was published in English; (c) the study involved eye-tracking; (d) the study used eye-tracking data to analyze non-symbolic numerosity estimation tasks. After this screening, 15 studies remained. We searched citation databases: Web of Science (n=59), Scopus (n=458), PubMed (n=87). Initial searches were conducted on October 06, 2023.

Citations were imported into CADIMA tool for systematic reviews (Kohl et al., 2018) for automated duplicate removal by title and screening. Titles and abstracts were screened by two reviewers (Sofia Mironets, Ilona Denisova) independently (Kappa value: 1). The two researchers agreed 92% of the time and discrepancies were resolved through discussions with the first author. CADIMA flowchart depicting the results of the selection process is shown in Fig. 1. The papers were assessed by two reviewers (SM, ID) independently; the consensus was reached in a group discussion.

Figure 1
CADIMA flowchart for study identification and selection



Results

Data collection

We reviewed 13 eye-tracking studies published between 2008 and 2023. The following information was extracted from the studies: (1) author, (2) title, (3) task type, (4) stimulus type, (5) stimulus presentation time, (6) sample characteristics, (7) oculomotor responses,

(8) equipment, (9) recording condition. Brief summaries of the 13 studies are outlined in chronological order in Table 1 for an overview (Appendix). All in all, there was a considerable overlap between the main variables in all empirical experiments as regards the examined samples, research procedure and equipment.

Main research questions

The 13 selected publications can be roughly categorized according to the research questions and aims. The most numerous group of publications focuses on studying the mechanisms of the system of nonsymbolic representation and its interactions with the system of processing space, time, depth, and other magnitudes. Six publications fall into this category (Bulf et al., 2016; Castaldi et al., 2020; Cheyette & Piantadosi, 2019; Lindskog et al., 2021; Odic and Halberda, 2015; Schütz, 2012).

Some of these papers are focused directly on the assessment of eyes movements, reflecting the distribution of attention resources when assessing the numerosity without the use of symbols. For example, Castaldi et al., 2020 investigates whether humans can choose the most numerous array of items with fast saccadic eye movements and how oculomotor movements differ depending on the number of objects being evaluated.

Other studies considered processing of numerosity, space and magnitudes in the framework of different theories which were mentioned in the introduction (e.g. theory of sensory integration or the ANS theory). Particularly, Odic and Halberda (2015) in the framework of the ANS theory considered the question if the patterns of eye-movement were different with the same stimulus regarding different tasks: comparison of numerosities and comparison of areas (magnitudes).

The second large category of selected papers included three papers, which focused on study of associations between symbolic and nonsymbolic numerosity representations (Guan et al., 2020; Peake et al., 2020; Price et al., 2017). It should be noted that in two papers (Peake et al., 2020; Price et al., 2017) it was considered the mechanisms of functioning of both symbolic and nonsymbolic representation and overlap between them. Hence, to some extent these papers may be also included in the first category. For example, Peake et al. (2020) considered how participants distributed their perceptual attention and focused on the stimuli in the process of symbolic and nonsymbolic comparison.

The next category included two papers, aimed to estimate differences in accuracy and eye-movement patterns between individuals with different disorders in comparison to typical developing individuals (Abreu-Mendoza et al., 2015; Van Herwegen et al., 2019). Particularly, Van Herwegen et al. (2019) considered eye-movement patterns during non-symbolic comparison for individuals with Down syndrome and Williams syndrome in comparison with individuals without such disorders.

Finally, two articles do not fall into any of the above categories. One study examines the process of approximate quantification, i.e. the rapid and approximate estimation of the number of objects by assigning numbers to sets of objects (Gandini et al., 2008).

This study identified different quantification strategies and investigated the patterns of oculomotor responses depending on the strategy. Another independent study aimed to investigate the contribution of genetic and environmental factors to some measures of non-symbolic number sense. In this case, eye tracking was only used to obtain one characteristic of the performance of the non-symbolic number representation system, namely gaze duration (Viktorsson et al., 2023).

In summary, a review of the main research questions revealed that eye-tracking research has been used to better understand the mechanisms of the functioning of the non-symbolic quantity representation system and its relationship to other numerosity or magnitude estimation systems, through analyses of oculomotor responses and allocation of attentional resources.

Task

Nonsymbolic comparison task

Nine of the thirteen selected papers used the classic nonsymbolic comparison task (NSCT), which can be subdivided into a Numerosity Comparison Task (NCT) and a Magnitude Comparison Task (MCT).

The Numerosity Comparison Task (sometimes called Number/Quantity Comparison Task) asks participants to estimate which of two arrays contains more objects. This task occurred in the 8 selected studies (Castaldi et al., 2020; Cheyette & Piantadosi, 2019; Guan et al., 2021; Lindskog et al., 2021; Odic & Halberda, 2015; Peake et al., 2020; Price et al., 2017; Van Herwegen et al., 2019). The most common stimuli were simple geometric shapes: dots and blobs (angular size ranged from 0.18 to 1.26°). Abreu-Mendoza et al. (2015) compared coloured cartoon images of food and animals.

In a Magnitude Comparison Task (also called Area Comparison Task), participants are asked to determine which of two arrays occupies the larger surface area (Odic & Halberda, 2015). Abreu-Mendoza et al. (2015) modified the task to match the stimulus material, asking participants to determine which of two cartoon images had more food.

Stimuli design

Stimuli in the non-symbolic comparison test can be either arrays with objects of the same colour (black, green, white) (Cheyette & Piantadosi, 2019; Guan et al., 2021; Price et al., 2017) or with objects of different colours (classically yellow and blue (Lindskog et al., 2021; Odic & Halberda, 2015); black and white (Castaldi et al., 2020); red and blue (Van Herwegen et al., 2019)).

In all but one study (Cheyette & Piantadosi, 2019), the arrays for comparison were presented simultaneously on the screen in a separate format, with each array on the left or right side of the screen. In Cheyette & Piantadosi (2019), the arrays to be compared were presented sequentially, with no interstimulus interval.

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The number of objects in the comparison arrays varied across studies. In general, the arrays contained between 4 and 90 objects. The most common values were between 5 and 16 objects (in each array). The number of stimuli used in each study is shown in Table 1.

Most studies controlled for the ratio of the number of objects in the arrays, defined as the lower number of objects divided by the higher number of objects. Only three papers included arrays with a low ratio of less than 0.5 (Abreu-Mendoza & Arias-Trejo, 2015; Castaldi et al., 2020; Peake et al., 2020). The most common ratio between arrays for comparison was 0.5 (found in eight studies), while ratios greater than 0.5 (0.6-0.91) were used in four studies (Castaldi et al., 2020).

Some papers assessed the effect of congruency by controlling the size ratio, total surface area, total cumulative area and density of objects in the array (e.g. (Lindskog et al., 2021). Dots could either have a predetermined size or vary in size depending on the above factors.

Presentation time

The duration of the array presentation depends on the research question and the oculometric parameters to be analysed. For example, Castaldi et al (2020) investigated fast saccadic movements and presented stimuli for 200 ms. In one of their experiments, Cheyette & Piantadosi (2019) manipulated the presentation duration of two arrays for comparison: dot sets could be presented for the same duration (100:100 ms, 1000:1000 ms) or for different durations (0:1000 ms, 1000:100 ms) to assess the role of the foveation accumulation effect.

Other studies have used presentation durations in the range of 1000 to 2000 ms, which is considered sufficient to produce several reliably recorded fixations.

Array estimation (enumeration) task

Two studies (Cheyette & Piantadosi, 2019; Gandini et al., 2008) used the Array Estimation/ Enumeration Task to estimate the number of points in an array.

Stimuli design

The selected papers used monochrome stimuli (black in (Gandini et al., 2008); blue in (Cheyette & Piantadosi, 2019). The size of the dots varied (Gandini et al., 2008 - 18px; Cheyette & Piantadosi, 2019 - 10px), as did the size of the sets to be compared. In the study by Gandini et al. (2008), target arrays consisted of 15, 20 or 25 dots, and control arrays could contain between 4 and 79 dots. The Cheyette & Piantadosi (2019) study contained between 10 and 90 dots.

Gandini et al. (2008) used a more complex experimental design in which participants were presented with black dots in cells of white grids. Thus, in contrast to the other two studies, the stimuli were ordered by fitting into the cells. In addition, the dots could be arranged both chaotically within the grids and in predetermined 'canonical' patterns.

Presentation time

The choice of stimulus presentation duration was related to the research questions. Cheyette & Piantadosi (2019) varied stimulus presentation durations (100, 333, 1000, 3000 ms) to assess the relevance of the number of fixations and foveations on the accuracy of object numerosity estimation. The stimuli in Gandini et al. (2008) remained on the screen for 6 s, during which time participants had to estimate numerosity using one of two strategies: perceptual estimation or anchor estimation. In the latter, participants were asked to count the dots in one of the clusters aloud and to estimate the number of remaining dots according to the experience gained in the first count.

Passive viewing tests

Two studies investigating non-symbolic number sense in infants used a passive viewing paradigm (Bulf et al., 2016; Viktorsson et al., 2023). In this paradigm, no action is required; the participant simply observes changes in the presented arrays of objects. Depending on the type of task, participants may be presented with two arrays of objects, one with a constant number of objects and the second with a changing number of objects (visual detection task). In this case, the average duration of gaze on the side with the changing number of dots was estimated. In the other type of task, arrays of objects or geometric shapes were used as 'cues' and presented before the target stimulus to determine the extent to which quantity or physical size could be a feature that determines the direction of attention (paired visual preference paradigm).

Stimuli design

Viktorsson et al (2022) showed infants a series of pictures with two dot arrays. The array on one side of the screen was numerically constant, while the array on the other side varied in the number of dots at a ratio of 1:1 and 1:2 or 1:1 and 1:4 to the constant array. The constant set consisted of 10 or 6 dots and the alternating set could contain from 6 to 24 dots.

In the study by Bulf et al. (2016), the arrays contained 2-9 dots. The task contained both congruent and incongruent trials. Congruency was determined by matching the side of the screen on which the 'cue' (a larger array or physically sized figure) and the target stimulus were displayed. Time to fixation on the target was assessed in the task.

Presentation time

The on-screen duration of the arrays was 500 ms in Viktorsson et al. (2022) and 300 ms in Bulf et al. (2016). The interstimulus interval was 300 ms (Viktorsson et al., 2023) and 400 ms (Bulf et al., 2016).

Sample

In the majority of studies, the sample consisted of healthy adults, most often students. Group sizes ranged from small (9-15 participants) (Castaldi et al., 2020; Gandini et al., 2008; Odic & Halberda, 2015) to medium (27-58 participants) (Cheyette & Piantadosi, 2019; Guan et al., 2021; Lindskog et al., 2021; Peake et al., 2020; Price et al., 2017).

The studies that examined differences between clinical and non-clinical samples also had small sample sizes and included participants of different ages (children, adolescents, adults). Group sizes ranged from 16 to 24 participants (Abreu-Mendoza & Arias-Trejo, 2015; Van Herwegen et al., 2019).

The largest sample size was reported in a study of young children. In the study by Viktorsson et al. (2022), the sample consisted of 514 twins (age 5 months). The sample in Bulf et al. (2016) consisted of 36 infants (age 8-9 months).

Discussion

In this section, we review the main findings from eye tracking studies of non-symbolic number sense according to the main research questions.

Mechanisms of the system of non-symbolic representation of quantity and its relation to the systems of estimation of continuous quantities

Results from eye-tracking studies of infants' perception of quantity suggest that the processing of quantity information is an automatic, bottom-up and, at least in part, biologically determined process (Bulf et al., 2016). Six-month-old infants already showed sensitivity to quantity: they looked longer at arrays with more objects, and no relationship was found between mean gaze duration and accuracy (Viktorsson et al., 2023).

It has also been found that even in infancy there is a link between the representation of quantity and space, with larger quantities being associated with the right side of space and smaller quantities with the left. As in adults, this association appears to be automatic in infants: numerical information elicits spontaneous shifts of visual attention to specific regions of space in a magnitude-dependent manner (Bulf et al., 2016). This suggests that the link between numerical order and left-right orientation emerges early in life, before the acquisition of symbolic knowledge. The involvement of spatial attention mechanisms in determining the number of objects may suggest that estimating quantity involves estimating the spatial location of objects.

The existence of a special sensitivity to quantity and the fact that the processing of quantitative information takes place at an automatic level also follows from estimates of the direction and duration of the first fixation. Saccadic movements have been shown to be controlled by feature salience: the most salient object (in this case, an array containing a larger number of objects) is more likely to be selected first (Lindskog et al., 2021; Peake et

al., 2020). In addition, the duration of the first fixation is also longer for an array containing a larger number of objects (Peake et al., 2020).

The importance of quantitative features is further supported by the fact that the duration of the first fixation was longer for arrays with more complex quantitative proportions (Peake et al., 2020). The probability that the longest fixation was on a larger array also increased with increasing proportion, which is more consistent with the hypothesis of automatic processing of quantitative features.

At the same time, a study showed that the direction of attention is determined by the physical size of objects rather than their number. Specifically, gaze was directed to an array containing a larger number of objects only in congruent tasks (Lindskog et al., 2021). In contrast, in non-congruent tasks, initial gaze was more likely to be directed to an array containing fewer objects but with a larger cumulative area. This may suggest that the physical dimensions of objects are processed more automatically than quantitative parameters. It should be noted, however, that this does not rule out the existence of a separate process for estimating quantity.

The existence of a separate process for processing quantitative information was confirmed in a study by Odic & Halberda (2015), who demonstrated differences in oculomotor movements in the numerosity and area comparison tasks using the same arrays. For example, participants made faster saccades and switches between regions of interest when performing NCT vs. ACT. In addition, the number of saccades also increased in the condition with more complex numerosity ratios between the arrays being compared (Odic & Halberda, 2015). This increase may indicate a focal information processing stage, which is necessary to obtain a more detailed view of the perceived arrays. The encoding of information about the surface of the arrays was more dependent on distributed attention, as reflected in longer and less frequent saccades, less frequent switching, and a higher percentage of fixations in the centre of the screen. This suggests the existence of a distinct quantity estimation process that adapts to different contexts and is robust to changes in cumulative area or other visual parameters.

The importance of the number of switches for improving non-symbolic comparison accuracy is presented in the 'foveal accumulation' model (Cheyette & Piantadosi, 2019). According to this model, quantity estimation accuracy 'accumulates' as a series of visual fixations are made. The authors showed that estimation accuracy increases as the number of objects entering the visual field increases, with a smaller contribution from the peripheral dots. The proposed model suggests that numerosity estimation is closely related to the mechanisms that control eye movements and attention.

However, it should be noted that Lindskog et al. (2021) and Castaldi et al. (2020) presented arrays for comparison simultaneously, whereas in Cheyette & Piantadosi (2019) the arrays were presented sequentially. This format of stimulus presentation involves working memory and may lead to adjustments in the visual strategies used to estimate quantity. Sequential presentation allows the size of each array to be estimated separately,

while in the simultaneous format the estimate is driven by the most salient feature of the objects, which could be their size or area. Thus, the proposed model of sequential foveation accumulation may contribute to the understanding of how the processes of quantity estimation and attentional allocation are related.

Eye tracking studies have also shown differences between the three systems of quantity representation (sabitising, non-symbolic number sense, and texture (density) estimation). In particular, a study by Castaldi et al. (2020) showed that saccade duration was shorter when comparing two arrays containing an 'average' number of objects (12 to 35) than when comparing a small number (up to 4) or a very large number (more than 100).

In conclusion, eye-tracking studies have shown that there is a specific mechanism for numerosity estimation that is separate from the estimation of other visual parameters. Furthermore, the link between numerosity estimation and the spatial distribution of attention has been demonstrated.

Relationship between symbolic and non-symbolic quantity representation systems

Investigating the relationship between symbolic and non-symbolic systems of quantity representation may contribute to ideas about the formation and development of mathematical ability. To assess the extent to which symbolic and non-symbolic representations of quantity share a common mechanism, differences in eye movement patterns in symbolic and non-symbolic comparison tasks were assessed (Peake et al., 2020; Price et al., 2017). As in previous studies, the first fixation was shown to occur at larger magnitudes, confirming that quantity estimation is driven by bottom-up attention, regardless of format (non-symbolic or symbolic). It is suggested that some aspects of the visual-perceptual processes underlying magnitude comparison are common to all formats and are related to the speed, but not the accuracy, of decisions.

However, specific visual-perceptual processing differed when comparing arrays of objects and numbers. Longer fixations were found when comparing arrays of objects than when comparing numbers. Furthermore, the effect of numerical proportion was more pronounced for both duration and number of fixations in the non-symbolic comparison (Guan et al., 2021; Price et al., 2017). However, in the study by Peak et al. (2020), the increased proportion effect for the non-symbolic comparison task (compared to numerical comparison) was only confirmed for reaction time, but not for the duration of the first fixation.

Differences between symbolic and non-symbolic quantity representation mechanisms were also evident in how maths anxiety altered the numerical proportion effect for both types of representation (Guan et al., 2021). In a non-symbolic comparison task, participants with high levels of math anxiety showed a larger proportion effect, as manifested by an increase in fixation duration when comparing arrays with a higher numerical proportion. Furthermore, this effect was enhanced in the presence of interfering

information. For the two-digit comparison task, participants with higher levels of anxiety showed an increase in fixation duration in the presence of interfering information, but the numerical proportion effect did not vary significantly with level of maths anxiety.

Thus, studies on the relationship between non-symbolic and symbolic representation of quantity using eye tracking have shown the existence of specific mechanisms for each type of representation. First of all, these differences are manifested in the expression of the numerical proportion effect for two indicators of oculomotor responses: the duration of the first fixation and the number of fixations. For both types of quantitative representation, the duration of the first fixation was longer in the higher numerical proportion conditions than in the lower numerical proportion conditions. However, the differences were significantly greater for the non-symbolic comparison task.

The effect of different disorders on the representation of quantity

Studies of the oculomotor response in children with different types of disabilities have attempted to understand the nature of difficulties in mathematics acquisition in these children. Previous studies have suggested that impaired mathematics ability in children with Williams syndrome and Down syndrome is caused by atypical viewing patterns (Van Herwegen et al., 2019, 2020). However, the study by Van Herwegen et al. (2019) did not support this hypothesis. A comparison of several indicators of oculomotor responses (mean fixation rate, mean fixation duration, time to first fixation or duration of first gaze) during a non-symbolic comparison task showed no significant differences between the groups with disorders and controls.

A similar result was found in a study comparing number and area in children with Down syndrome compared to typically developing children (Abreu-Mendoza & Arias-Trejo, 2015). The researchers calculated the difference in fixation duration between a target stimulus (e.g., an array with more objects) and a distractor (an array with fewer objects). A positive value of this index indicates a preference for the target over the distractor, while a negative value indicates the opposite. In addition, this index also indicates the duration of information processing when comparing quantities and areas.

In general, children with Down syndrome showed the same pattern of task performance as control children of comparable mental age. First, children with Down syndrome were more successful at comparing areas than at comparing quantities, i.e. the difference in gaze duration between the larger and smaller stimuli was greater for the area comparison task. Second, children with Down syndrome also showed a significant numerical proportion effect - a reduction in the difference in first look duration as the numerical proportion between the quantities being compared increased. Importantly, the numerical proportion effect was not significantly different between children with Down syndrome and the control group.

For example, studies have shown the preservation of non-symbolic comparison processes in children with Down syndrome and Williams syndrome, and the similarity

of oculomotor responses to non-symbolic comparison in children with disabilities and typically developing children. This may suggest that the basis of the difficulties in mastering mathematics in children with disorders does not lie in disorders of the system of non-symbolic representation of quantity.

Approximate quantification mechanisms

One study has been devoted to investigating the mechanisms of approximate quantification, which we will focus on in more detail. Gandini et al (2008) identified 5 main quantification strategies and examined the patterns of oculomotor responses depending on the strategy. The main strategies are the anchoring strategy, the benchmark strategy, the decomposition strategy, the approximate counting strategy and the exact counting strategy. An anchoring strategy involves, for example, a participant counting a number of dots and then visually estimating the remaining number of dots by comparing it to a subset that has already been counted. The benchmark strategy involves participants comparing the stimulus with a representation held in long-term memory and then adjusting their response based on the estimated difference. The accuracy of quantity estimation differed according to the strategy used. Participants were less accurate but faster when using the benchmark strategy than when using the fixation strategy.

It should be noted that the choice of strategy depends on the stimulus configuration (random or non-random configuration), the number of objects to judge and the age of the participants. For example, the approximate strategy was used more often when estimating the number of dots in the random configuration and when increasing the number of dots in the estimated array. For younger participants the most popular strategies were approximate counting and benchmarking, and for older participants the most popular strategies were approximate counting and exact counting.

Oculomotor performance was used as a more precise measure of cognitive processes within each strategy. It was shown that the mean number of fixations and saccade amplitude differed depending on the strategy used and the time interval from stimulus presentation (in the first 500 ms of comparison and from 500 to 1000 ms). Saccade amplitudes were larger between 500 and 100 ms of task performance than in the first interval up to 500 ms for the benchmark strategy, but not for the anchoring strategy. Thus, when participants used the benchmark strategy, they made small amplitude saccades first, followed by larger saccades. In contrast, when participants used the anchoring strategy, they made larger amplitude saccades in the first interval than in the second interval.

In conclusion, the results of the study show that eye movements during approximate quantity estimation (number of fixations, saccade amplitudes) are sensitive to stimulus features (in particular their number and spatial position) and also depend on the strategy and the age of the participants. This study is the first to directly demonstrate that people use a wide range of approximate quantity estimation strategies in addition to basing their

estimates on the visual properties of stimuli.

Conclusion

The recording of eye movements is becoming increasingly popular in the study of the perception and processing of quantitative information. Eye tracking provides insight into the mechanisms of perceptual and behavioural processes involved in the processing of quantitative information. This systematic review examined eye-tracking studies of non-symbolic quantity representation processes published in the last 15 years (from 2008 to 2023). Thirteen studies met the selection criteria and were grouped according to the main research questions. Most studies focused on investigating the mechanisms of non-symbolic numerosity representation and assessing the relationship between numerosity estimation and the estimation of non-numerical visual parameters.

Researchers have used different metrics for oculomotor responses, which sometimes makes it difficult to compare results. One of the most commonly used measures is the location of the first gaze. Most studies have shown that participants tend to direct their initial gaze to a set containing a larger number of objects or a figure with a larger area. This supports the hypothesis that quantity processing is a bottom-up process and that quantity is a visual feature that is processed at the level of precognition.

Number sense studies have also looked at indicators such as fixation duration and number of saccades. It has been shown that the number of saccades increases and the duration of fixations decreases with increasing cognitive load associated with increasing numerical proportion between the compared object arrays. This may be due to the involvement of the focal attention system with increasing cognitive load.

The results suggest that there is a separate process for processing quantity information, independent of the evaluation of other visual parameters. Eye-tracking studies have shown specific features of oculomotor responses in quantity comparison tasks, depending on both stimulus characteristics (e.g. number, numerical proportion, congruence) and respondent characteristics.

In general, it can be said that the processing of quantitative information can occur directly at the moment the information enters the visual system. In the first stage, there is an initial 'coarse' processing of quantitative information based more on low-frequency information, resulting in a kind of topographically organised map of perceived objects. In the second stage, this initial information is refined by processing high-frequency information (e.g. (Fornaciai & Park, 2021).

However, it must be recognised that eye-tracking studies have focused less on the stages of processing quantitative information and forming a representation of quantity. Most studies have been limited to comparing different indicators of eye movements for different types of tasks and stimuli. An exception is the work of Gandini et al. (2008), who investigated the temporal dynamics of eye movement characteristics in quantity estimation tasks. It is possible that a more detailed study of the temporal changes

in indicators such as the number and duration of fixations, amplitude and number of saccades during the performance of quantity comparison tasks will provide a more detailed picture of how the internal representation of quantity is formed.

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PSYCHOPHYSIOLOGY

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Conflict of Interest Information

The authors have no conflicts of interest to declare.

Appendix A

Table 1

A brief summary of the studies

Authors

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Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
<p>is more ind it: ed depth biases ceived erosity/ nsity</p>	<p>Determine direction and number comparison</p>	<p>Black and white dots on a grey background; the dots moved at a speed of 10 deg/s and had a limited presentation duration of 200 ms. 7 experimental tasks with different stimulus speed and brightness conditions</p>	<p>0-600 ms</p>	<p>12 (4 male; 8 female); aged 20-31 years</p>	<p>smooth pursuit eye movements, eye velocity; the eye velocity in the orthogonal direction</p>	<p>EyeLink; 1000 Hz</p>	<p>Monitor distance 47 cm</p>

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Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Bulf et al., 2016	Small on the left, large on the right: visual attention onto space in preverbal infants	Number comparison. Area comparison	The visual target appeared either to the left or to the right of the screen immediately after the appearance of a centred image of either small or large size. Both tasks consisted of a small number of objects (e.g. 2 dots) or a large number of objects (e.g. 9 dots); the 60 trials were divided into three blocks. Each block consisted of 16 experimental trials and 4 control trials. In total, there were 48 experimental trials.	100- 2000 ms	36 infants	Three areas of interest: accuracy, target stimulus fixation time	an ASL6 remote eye-tracking system; 120 Hz	Car seat; monitor distance 60 cm

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presentation time	Sample characteristics (n)	Oculomotor indicators	Equipment, model (type)	Recording conditions
Price et al., 2017	Eye-movement patterns during nonsymbolic and symbolic numerical magnitude comparison and their relation to math calculation skills	Number comparison	Two sets of dots were presented simultaneously on either side of the central fixation point. The black dot sets ranged from 6 to 15 dots on a white background. For analysis, a total of 72 trials were divided into 36 small ratio trials (ratio < 0.7) and 36 large ratio trials (ratio > 0.7), for a total of 14 different ratios.	1000 ms	56 (36 female); average age 19.4 years	Number of fixations; duration of fixation; spatial distribution of fixations; proportion of first fixations at higher numerosity; number of fixations at correct and incorrect numerosity (symbolic; non-symbolic).	Eyelink; 1000 Hz	Frontal chin support; monitor distance 58 cm

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Van Her- egen et al., 2019	Eye Movement Patterns and Approximate Number Sense Task Performance in Williams Syndrome and Down Syndrome: A Developmental Perspective	Number comparison	Congruent / incongruent (see similar task in Van Herwegen et al., 2018)	1500 ms	Two clinical groups: 24 (18 women); 25 (11 women); two control groups: 24 (12 women); 24 (17 women)	Time before start of viewing; mean fixation duration; mean proportion of viewing; duration of first fixation, total number of fixations; averaged over the left and right edges of the screen; differences in eye movements between groups.	Tobii T120 screen- based eye tracker; 120 Hz	Monitor distance 60 cm

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Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Peake et al., 2020	First fixation duration as a bottom-up measure during symbolic and non-symbolic numerical comparisons	Symbolic and non-symbolic number comparison	Stimulus set size ranged from 1 to 9 in the symbolic task and from 4 to 15 in the non-symbolic task. Each task consisted of 72 trials	-	32 participants, evenly distributed by gender; average age 20 years	Duration of first fixation	Eyelink II eye tracker (SR Research, Kanata, Ontario, Canada); 500 Hz	Monitor distance 60 cm

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Castaldi et al., 2020	Fast saccadic eye-movements in humans suggest that numerosity perception is automatic and direct	Number comparison	Arrays of white and black dots on a medium grey background, bounded by a circle. Number of dots: 1-4 dots - Subitising range: 12, 17, 24, 35 dots - Estimating range: 158, 195, 240 and 296 dots - Texture density range: 96 trials	200 ms	Experiment 1: 14 (6 male); Experiment 2: 11 (5 male)	Saccades; saccade direction; corrective saccade; reaction time (ms, min/max); correct response	an infrared eye tracker (EyeLink; 1000 Hz)	-

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Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Linds- kog et al., 2021	Attentional bias induced by stimulus control (ABC) impairs measures of the approximate number system	Number comparison	90 images containing two spatially separated arrays of black dots on a white background. Half of the images contained 7 and 8 dots in the two arrays, while the other half contained 14 and 16 dots. One third of the images were congruent, incongruent and neutral, with no systematic difference in dot size between the two arrays.	1000 ms	40 (23 female); average age 24 years	Three areas of interest: fixation time; first fixation to area	Tobii T120 (Stock- holm, Sweden); 60 Hz	Partici- pants were instruc- ted to remain as still as possible throug- hout the proce- dure

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Viktor- sson et al., 2022	Infants' sense of approximate numerosity: Heritability and link to other concurrent traits	Quantity change detection	The videos consisted of a series of images, with two sets of dots appearing on the left and right sides of the screen. On one side of the screen the set of dots was numerically constant, while on the other side the set of dots alternated in number (10 and 20 or 6 and 24 dots). Each condition consisted of four stimulus videos.	500 ms	514 same- sex twins in infancy	Average viewing time on the side changing numerically (in relation to the whole screen), expressed as a percentage	Tobii T 120; 60 Hz	Child sitting on parent's lap; monitor distance 65 cm

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Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Abreu- Mendo- za et al., 2015	Numerical and area comparison abilities in Down syndrome	Cartoon pictures area comparison Number comparison	The visual stimuli were six coloured cartoon pictures of larger and smaller food items. For the number comparison task, the visual stimuli were six coloured cartoon images of animals.	2500 ms	clinical group: 16 (7 females) and two control groups of 16 each	Two regions of interest: one for the target and one for the distractor. The difference in gaze duration (Schafer & Plunkett, 1998), which is the difference between a single sustained look at the target and a single sustained look at the distractor.	A portable eye- tracker (Tobii X2- 30); 30 Hz	Monitor distance 60 cm

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Gandi- ni et al., 2008	Older and younger adults' strategies in approximate quantification	Number estimation (naming without counting)	144 configurations of black dots presented as a visible square grid on a white background. Two thirds of these were experimental stimuli (including 15, 20 or 25 dots). The set of 144 gratings was divided into three series of 48 trials each	6000 ms	15 (7 female); mean age 26.8 and 15 (9 female); mean age 69.8	Mean number of fixations and mean saccade amplitudes; strategy	iView Remote Eyetra- cking Device (Senso- Motoric Instru- ments); 50 Hz	Not to make sudden move- ments of the head or body, but no device restric- ted their move- ments; monitor distance 60 cm

PSYCHOPHYSIOLOGY

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presentation time	Sample characteristics (n)	Oculomotor indicators	Equipment, model (type)	Recording conditions
Odic & Halberda, 2015	Eye movements reveal distinct encoding patterns for number and cumulative surface area in random dot arrays	Number comparison	The stimulus images used in the two tasks were identical and consisted of multiple blue and yellow dots	2000 ms	12 adults	The onset of the first saccade; the proportion of time spent looking at each region of interest; the location and duration of the first, last and longest fixation; and the number of switches between regions of interest. Pupil size	Tobii TX300; 300 Hz	-
Guan et al., 2020	Non-symbolic representation is modulated by math anxiety and cognitive inhibition while symbolic representation not	Number comparison	A total of 40 trials, two sets of 20 trials each: a set of dots with a larger number and a larger area had to be compared with a set of dots with a smaller number and a smaller area; a set of dots with a larger number but a smaller area was compared with a set of dots with a smaller number but a larger area.	more than 2000 ms before response	19 students with HMA (74% female) and 16 LMA (88% female)	Area of interest: number of fixations and duration of fixations	Eyelink; 1000 Hz (SR Research, Mississauga, Ontario, Canada)	Frontal chin support

Authors	Title	Task type	Type of stimulus. Colour, shape, presentation format, quantity, number of presentations	Stimulus presen- tation time	Sample charac- teristics (n)	Oculomotor indicators	Equip- ment, model (type)	Recor- ding condi- tions
Cheyete & Piantadosi, 2019	A primarily serial, foveal accumulator underlies approximate numerical estimation	Number estimation (harming without counting). Number comparison	An array of blue dots (10 to 90) on a white background, which were masked by noise after a short time in two experiments. Experiment 1 consisted of 64 trials consisting of 4 blocks of 16 trials each. The 4 different temporal conditions were: 100; 333; 1000 and 3000 ms. Experiment 2: two dot flashes, one after the other of the same stimuli, 4 conditions of 16 trials each (as in Experiment 1), 4 conditions (100; 100 ms), (100; 1000 ms), (1000; 100 ms) and (1000; 1000 ms).	100 - 3000 ms	27 adults (15 female); mean age 21.4 years	Fixing positions	Tobii T60XL; 60 Hz	Frontal chin support, monitor distance 66,4 cm

Eye Tracking as a Tool for Medical Diagnosis

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Abstract

Introduction. The transition to personalized, predictive and preventive medicine, high-tech healthcare and health-preserving technologies is one of the priorities of scientific and technological development in the next decade. The possibility of using eye tracking for medical diagnostics meets this priority. **Eye tracking as a tool for medical diagnostics.** Using eye tracking, disease detection is based on the main types of eye movements: fixations, saccades and nystagmus. However, protocols that allow a comprehensive assessment of the patient's condition have not been fully validated. The purpose of the current review is an attempt to consider studies in the Scopus, Web of Science, and RSCI databases regarding the utilizing of eye tracking as an addition to the diseases and disorders diagnosis, and to outline possible trajectories for the development of this method in the field of medicine. The article provides examples of the use of eye tracking in dementia, mild cognitive impairment, Alzheimer's disease, schizophrenia, schizotypal and delusional disorder, mood disorder, attention deficit syndrome, the consequences of a stroke, and head injuries. **Results and discussion.** Eye tracking is characterized by objectivity, brief and stress-free observation of a patient, the ability to simplify the tasks presented with high diagnostic accuracy, finding a simulated disorder, supplementing existing tests, searching for latent signs, higher sensitivity compared to some neuropsychological tests, the ability to dynamically switch between tasks. As a prospect for developing diagnostic protocols based on eye tracking, it is possible to: use existing paradigms for conducting eye tracking studies, combine new paradigms with existing neuropsychological tests and methods, inherit the basic principles of examining

the patient's condition, and build data analysis models. Validation on a wider sample and clarification of the list of stimuli are necessary.

Keywords

eye tracking, high-tech healthcare, diagnostics, psychiatric disorders, neurological disorders, machine learning, eye movements

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Introduction

The competitiveness of national economies is determined by conditions where the high rate of acquisition of new knowledge and creation of science-intensive products on their own technological basis is a key factor. One of the priorities of scientific and technological development in the next decade should be considered the transition to personalized, predictive and preventive medicine, high-tech healthcare and health-preserving technologies. The response to major challenges should be creation of science-intensive technologies and products that meet the national interests of the Russian Federation and are necessary for a significant improvement in the quality of life of the population.

The transition to "digital healthcare" is likely to be the defining characteristics for the industry. Digital technological innovations, robotics, the Internet of Things, artificial intelligence, and a number of other factors have led to an increase in the use of various digital devices by healthcare professionals, as well as hospital and clinic workers. As a result of digitalization, the industry is also expected to experience institutional shifts: new types of biomedical companies will emerge that will lobby for the transformation of legal norms and rules, the transformation of the institutional landscape regarding the rights, uses, and commercialization of digital technologies in the healthcare system (Doan, Krestyaninova, & Plotnikov, 2023; Zabolotnaya, Gatilova, & Zabolotny, 2020; Bondarenko, & Guzenko, 2021; Rieke et al., 2020; Guo et al., 2020).

Eye tracking as a tool for medical diagnostics

The use of eye tracking in medical practice is another promising area of development that is consistent with current trends in healthcare development and the blurring of disciplinary and industry boundaries in scientific research and development. Firmly entrenched in the field of experimental psychology and originating from the study of the physiology of the visual system, eye tracking is a method of recording a person's gaze, allowing one to calculate indicators of macro- and micro-movements of the eyes. Eye movements reflect a person's thought processes, determining the goal-directed behavior. Recording eye movements allows one to accurately determine which objects attract the observer's gaze, in what order and how often. The development of eye movement recording and processing technology makes it possible to use eye tracking in various fields of activity: neuromarketing, sports, education, psychodiagnostics, etc. This is confirmed by the successful use of eye tracking to study psychological processes and human states, as well as the active patenting of methods for recording oculomotor reactions as part of a comprehensive personality assessment in various fields of activity (Ognev & Likhacheva, 2015). This method improves diagnostics and accelerates the detection of diseases, which ensures faster treatment.

In clinical practice, eye movement monitoring has been conducted for a long time. Precise clinical measurements were carried out as early as the middle of the 20th century. In the works of A. R. Luria, A. Karpov and A. L. Yarbus, two forms of gaze apraxia were first identified, namely occipito-parietal, in which the higher visual functions themselves are primarily affected, and frontal, in which the planning and organization of eye movements is impaired (Karpov, Luria, & Yarbus, 1968; Luria, Karpov & Yarbus, 1966; Karpov, 1975).

The importance of these pioneering works was noted in their review last year by Marim Puchalska et al. (Pachalska, Buczaj, Kopowski, Pecyna, Maksym, Buczaj, & Rasmus, 2023). It is noted that, although historically eye tracking has been used more in the field of psychology of cognitive processes, eye tracking has the potential to study movement disorders and measure cognitive processes in neurodegeneration. The methods of the mid-20th century made it possible to conduct individual studies, but could not be widely used due to the labor-intensive nature of data recording and processing. Modern technologies are easy to use, reliable, safe, accurate, and can be used in large-scale clinical studies. A detailed description of modern methods of recording eye movements in the field of psychology is given in the review by V. A. Barabanshchikov and A. V. Zhegallo (Barabanshchikov, & Zhegallo, 2014).

Currently, in medical practice, it is possible to conduct large-scale studies of eye movements in a variety of cognitive-emotional disorders. It is possible to detect diseases by monitoring the main types of eye movements, namely fixations, saccades, tremor, and nystagmus. To generate saccades, commands come to the superior colliculus, then to the nuclei of the oculomotor nerves, which directly innervate the eye muscles. Eye movement commands are generated by neural networks of the parietal eye fields

(PEF), the frontal eye field (FEF), the supplementary eye field (SEF), and the dorsolateral prefrontal cortex (DLPFC). Voluntary pro-saccades are mainly under the control of the FEF, while reflexive saccades are generated through PEF neurons. Some saccadic tasks, such as antisaccades, add cognitive layers to the oculomotor pattern and more directly engage the DLPFC and PEF.

Smooth pursuit and fixation of the eyes is initially processed by extrastriatal cortical regions including V5 and the medial superior temporal visual area, connecting to the posterior parietal cortex, FEF, and SEF, and then projecting downward to the pontine nuclei and cerebellum (Russell, Greaves, Convery, Bocchetta, Warren, Kaski, & Rohrer, 2021).

The following tests are used to assess oculomotor activity at the behavioral level:

1. Fixation stability measurement test

Aimed at assessing the ability to maintain gaze on a stationary target, the ability to follow a smoothly moving target, and the ability to maintain fixation stability while reading. Dependent variables: number of blinks, number and amplitude of saccades, average fixation duration, frequency of microsaccades, stability between fixations and within fixations.

2. Saccade assessment tests

This category includes several tests based on saccadic eye movements:

- Prosaccade Test: Measures the ability to quickly and accurately move the eyes to a suddenly appearing target.
- Antisaccade Test: Assesses the ability to suppress a reflexive shift of gaze to a new target and instead move the gaze in the opposite direction.
- Predictive Saccade Test: Assesses the ability to anticipate and move the eyes to where a target will appear based on learned patterns.
- Remembered Saccade Test: Tests the ability to move the eyes to a target location after a delay, requiring remembering the target's location.

Dependent variables: latency, amplitude, direction, peak velocity, accuracy, and corrective saccades.

3. Smooth tracking tests

Includes various methods to assess how well the eyes can follow moving objects:

- Constant Velocity Test: uses a target moving back and forth in a straight line at a constant speed.
- Sinusoidal Test: the target moves in a smooth, wave-like pattern, changing speed.
- Jump-Move Test: the target moves suddenly (a jump) and then continues moving at a constant speed, useful for assessing pursuit onset.
- Dependent Variables: Velocity Ratio, Root Mean Square Error (RMSE), Log Signal-to-Noise Ratio, Number and Type of Saccades (catch-up, retreat, anticipatory saccades), and Pursuit Onset/Acceleration/Velocity.

4. Reading and developing professional skills

Determining the impact of work experience on visual text processing skill: with increasing professional skills in analyzing text information, more optimized eye movement strategies are observed, allowing for efficient task performance with minimal effort (Skuratova et al., 2022). Dependent variables: number of fixations, scan path length, saccade amplitude and velocity.

5. Assessment of medical experience

The qualitative perception of visual images also depends on current professional experience (Figure 1). This is due to learning to recognize low-information low-frequency images presented by the periphery of the visual field to control gaze translation (Skuratova, Shelepin, & Yarovaya, 2021).

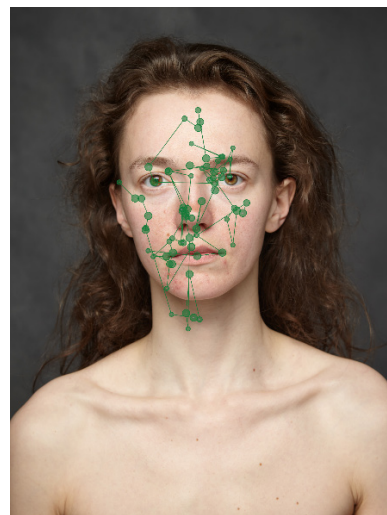
Figure 1

Trajectories of eye movements and fixation points when doctors perceive a patient's face depending on their experience up to one year (a), up to 7 years (b), up to 10 years (c), up to 21 years (d) (Skuratova, Shelepin, & Yarovaya, 2021).

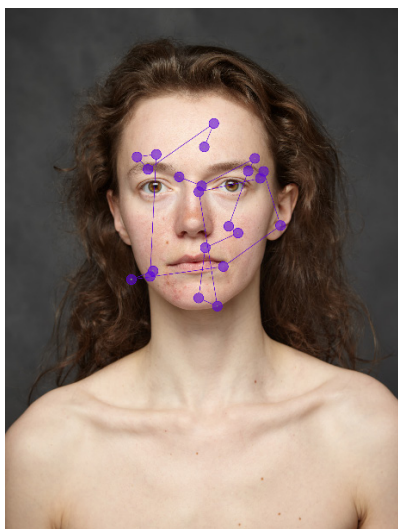
(a)



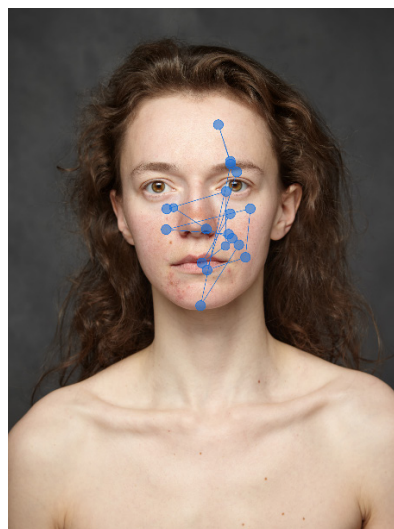
(b)



(c)



(d)



6. Nystagmus

Despite the importance of this clinical indicator, nystagmus is not considered in the current review, as it requires a separate detailed discussion: neurologists qualitatively (visually) assess its condition.

Although eye tracking has obvious potential as a method of medical diagnostics, the use of eye tracking in medical practice and psychodiagnostics currently remains limited: protocols that allow for a comprehensive assessment of a patient's condition have not yet been fully validated.

The purpose of the forthcoming review is an attempt to demonstrate the experience of using eye tracking as an addition to the diagnosis of diseases and disorders, to outline possible trajectories of development of this method in the field of medicine. The article provides examples of the use of eye tracking in various neurological, mental disorders, the review is structured according to the ICD-10 classification.

Results and Discussion

1. Chapter V Mental and behavioral disorders

1.1 Organic, including symptomatic, mental disorders (F00–F09)

The block associated with dementia includes mental disorders with obvious etiologic factors: brain diseases, brain injury or stroke, leading to cerebral dysfunction. Dementia is

a syndrome caused by brain damage, in which such higher cortical functions as memory, thinking, orientation, understanding, counting, learning ability, speech and judgment are impaired. This syndrome is observed in Alzheimer's disease, cerebrovascular diseases and other conditions that primarily or secondarily affect the brain (according to: International Classification of Diseases, 10th revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>).

The category of mild cognitive impairment includes mixed conditions causally related to brain disorders caused by a primary brain disease, a systemic disease secondarily affecting the brain, exposure to exogenous toxic substances or hormones, endocrine disorders or other somatic diseases; dementia is excluded. Alzheimer's disease is a primary degenerative cerebral disease of unknown etiology, manifested by specific neurochemical, neuromorphological, and psychopathological signs (according to: International Classification of Diseases, 10th Revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>).

Increased microsaccades associated with saccadic intrusions, initially moving the eye away from the visual target and then returning in a corrective manner, are more common in brainstem and cerebellar diseases, and cortical disorders such as Alzheimer's disease (Nakamagoe et al., 2019). Patients with frontotemporal dementia have difficulty maintaining fixation for long periods, which may be explained by a problem with saccade inhibition, especially given the correlation with the orbitofrontal cortex. The smooth pursuit eye movement system is also vulnerable to cerebral dysfunction, with morphological abnormalities found in the visual cortex of patients with idiopathic dementia (Hutton, Nagel, & Loewenson, 1984).

1.1.1 Unspecified dementia (F03)

The following stimuli were used to assess cognitive functions in dementia: scene exploration with social and non-social context, missing elements and social scenes; semantic processing through sentences with matching and mismatching meanings; recognition of image pairs (control: n = 432, dementia: n = 30). Next, a deep learning algorithm was applied to classify and interpret cognitive activity and dementia status based on raw eye tracking parameters (x,y coordinate of gaze, mean pupil size). The obtained results indicate that unsupervised learning methods can complement cognitive assessment for rapid and stress-free monitoring of patients at different stages of the disease, although more research is needed (Mengoudi et al., 2020).

In the study by Russell, Greaves, Convery, Nicholas, Warren, Kaski, & Rohrer (2021), a prosaccade task was initially presented to assess basic oculomotor functions and hence the participant's ability to perform emotion recognition tasks (frontotemporal dementia patients: n = 18, controls: n = 22). Two tasks were designed to assess recognition of simple and complex emotions. Pictures of people with different emotions were shown in the corners of the screen, with the emotion label in the center. Although no statistically

significant differences were found on the prosaccade task, the control group spent significantly more time looking at the target image after the label was presented than the dementia group. The controls also spent significantly less time looking at similar and distracting images after the label was presented. The authors note that further research in a larger control group is needed to better understand the reproducibility and reliability of the task (Russell, Greaves, Convery, Nicholas, Warren, Kaski, & Rohrer, 2021).

The study (Córdoba et al., 2023) presents a diagnostic biomarker for Alzheimer's disease (AD) and the behavioral variant of frontotemporal dementia (moderate AD: $n = 38$, dementia: $n = 24$, controls: $n = 39$). Differences were found in saccade, fixation, and smooth pursuit paradigms. Accuracy and area under the curve (AUC) exceed 95%.

1.1.2 Mild cognitive impairment (Mild cognitive disorder F06.7), Alzheimer's disease (G30)

To study these pathological conditions, memory (coding) tasks with tracking a moving coin and separately tracking a falling drop of water (without instructions), deductive reasoning, viewing a landscape photograph, visual working memory (memorization and reproduction), attention and counting, and visuospatial function were proposed. The percentage of fixation duration on each area of interest, x,y coordinates of gaze were taken as dependent variables for the machine learning classifier. The resulting model distinguished cognitive functions in the control group, AD, and mild cognitive impairment subjects, with memory and deductive reasoning tasks being the most indicative (mild cognitive impairment patients: $n = 52$, Alzheimer's disease patients: $n = 70$, controls: $n = 52$). Meanwhile, some tasks can be omitted for further simplification while maintaining good test performance (Tadokoro et al., 2021).

A study (Polden, & Crawford, 2021) examined a visual distraction task. Inhibition of recent distraction (IRD) refers to the suppression of saccadic eye movements toward a target that is located at the location of a previous distractor. Two studies compared IRD in a large cross-cultural sample consisting of young ($n=75$), older European participants ($n = 119$), older South Asian participants ($n=83$), participants with Alzheimer's dementia ($n = 65$), and participants with mild cognitive impairment ($n=91$). Significantly longer saccadic reaction times on target-distractor trials compared to target-target trials were evident across all groups, countries, and ages. Importantly, IRD was also preserved in participants with Alzheimer's disease and mild cognitive impairment, demonstrating that IRD is robust across cultures, age groups, and clinical populations.

To investigate visual attention during a test of spatial orientation and navigation ability in Alzheimer's disease, subjects were asked to find a way to a specific location in a VR simulation by navigating the environment with a joystick ($n = 15$, AD: $n = 7$, controls: $n = 8$). Differences in the percentage of fixations on visual cues were found, reflecting the difficulty of AD patients in selecting relevant information for wayfinding compared to controls, paying attention to irrelevant information. The authors note the need for further research, expanding the sample (Davis & Sikorskii, 2020).

1.2 Schizophrenia, schizotypal and delusional disorders (F20–F29)

Schizophrenia is characterized by distortions of thinking, perception, and affect, often in the presence of normal consciousness and intelligence (although cognitive decline may occur over time) (International Classification of Diseases, 10th Revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>). Patients with schizophrenia often have impaired smooth eye movements during visual target tracking. However, this effect may be the result of pharmacological interventions rather than a reflection of the oculomotor control peculiarities in this disorder. The visual tracking task is relatively difficult, which may be due to dysfunction in areas of the visual motor system (middle temporal area and medial superior temporal area) (Lencer et al., 2005). At the cortical level, self-movement signal processing occurs in the dorsal visual pathway (Bremmer et al., 2000). Disturbances have also been observed in the ventral intraparietal area, which may also contribute to eye movement dysfunction (Ales et al., 2021).

1.2.1 Schizophrenia (F20)

In schizophrenia, eye tracking may be used as a method for detecting malingering in psychiatric practice. Thus, a control group ($n = 43$) was asked to simulate eye movement patterns demonstrated by a group of patients with schizophrenia ($n = 40$) in three tasks: smooth pursuit, prosaccade (which served as a baseline measure), and anti-saccade. The dependent variables studied were mean saccade latency, standard deviation of latency, amplitude, peak velocity, number of successful trials, and percentage of errors. Data analysis showed that the eye movements of the participants instructed to simulate (a) were only partially different from the eye movements of the control group and (b) did not closely resemble the eye movements of patients with schizophrenia reported in previously published articles. Together, these results suggest that eye movement testing may indeed help detect malingered schizophrenia (Ales et al., 2021).

In another study, the dependent variables were the number of fixations (NEF), mean scan length (MESL) in the retention task; cognitive search score (CSS), which reflects the frequency of focusing on the regions of interest of the figure for subsequent figure recognition in the comparison task; and responsive search score (RSS), which reflects the frequency of fixations on each part of the figure in response to questions in the comparison task. The RSS of patients with schizophrenia ($n = 145$) was significantly lower than that of patients with depression ($n = 116$) or controls ($n = 124$), while no statistically significant differences were found in RSS between patients with depression and controls. The discriminant function showed a sensitivity of 89.0% and a specificity of 86.7% (Kojima et al., 2001).

The aim of the study (Li et al., 2024) is to compare an ecologically valid measure (Cambridge Prospective Memory Test, CAMPRMPT) and a laboratory-based measure (eye-tracking paradigm) in assessing prospective memory (PM) in individuals with schizophrenia spectrum disorders (SSD). PM performance was assessed using total fixation time and total number of fixations on distractor words. A picture was presented in the center of the screen, four different tokens were presented, and the subjects were asked to determine whether one of the words matched the object in the previously shown picture. Patients with SSD ($n = 32$) demonstrated fewer total fixations on distractor words and lower PM accuracy compared to controls ($n = 32$). The laboratory-based eye-tracking paradigm has advantages over ecologically valid measures in detecting signal detection errors, making it a more sensitive tool for identifying PM deficits in patients with SSD.

1.3 Mood [affective] disorders (F30–F39)

In mild, moderate, or severe depressive episodes, patients experience low mood, decreased energy, and decreased activity. The ability to enjoy, joy, be interested, and concentrate is reduced, and there is marked fatigue. The mood disorder block includes disorders in which the main disturbance is a change in emotions and mood toward depression (with or without anxiety) or toward elation (hypomania) (according to: International Classification of Diseases, 10th Revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>).

The psychopathology of depression is associated with changes in the prefrontal and orbitofrontal cortex. Patients have preserved visual perception, but there are changes in sensorimotor integration processes (Fabisch et al., 2009). Deficits in prosaccades may be related to functional changes affecting cortical structures such as the frontal eye fields (FEF) and the superior colliculus (Schall, 2004). Disruption of deep areas of the FEF may also cause deficits in the visual pursuit system (Rosano et al., 2002). Non-melancholic depressed patients are characterized by an increase in peak saccade velocity. The cerebellum and basal ganglia are brain structures directly involved in the execution of a memory-guided saccade (Dreher & Grafman, 2002). All of these structures interact with other regions such as the dorsolateral prefrontal cortex (DLPFC) (Pierrot-Deseilligny, & Burke, 2005). The DLPFC appears to be involved in the inhibition of saccades generated by the superior colliculus (Kaufman, Pratt, Levine, & Black, 2010). The eye movement inhibition deficits observed in major depression may be related to previously described deficits in (ventrolateral) prefrontal cortex activation and impulsivity in patients with major depression (Carvalho et al, 2015).

1.3.1 Major depressive disorder (F32.2 Severe depressive episode without psychotic symptoms), Bipolar affective disorder (F31)

The study (Wang, Lyu, Tian, Lang, Wang, St Clair, & Zhao, 2022) consisted of the following stages: free viewing task, fixation stability task, and smooth pursuit task (control group: n = 104, patients with major depressive disorder: n = 48, patients with bipolar disorder: n = 57; the corresponding diagnosis was made by psychiatrists based on DSM-IV). In affective disorder, a smaller saccade amplitude was found in the free viewing task, a higher number of fixations and saccades in the fixation stability and smooth pursuit task, shorter fixation duration, longer saccade duration in the fixation stability and smooth pursuit tasks. The authors conclude that patients with major depression, bipolar depression, and bipolar mania have similar eye movement dysfunction in free viewing, fixation stability, and smooth pursuit tasks.

A meta-analysis (patients with depression: n = 474, controls: n = 693) (Huang et al., 2023) showed that:

1. for positive emotional stimuli, the duration of fixation was significantly lower; for negative stimuli, the duration of fixation was higher.
2. the number of fixations on positive emotional stimuli is also lower, the number of fixations on negative emotional stimuli, on the contrary, is higher;
3. age influences the duration of fixation of positive emotional stimuli. In the case of negative emotional stimuli, the duration of fixation was influenced by age and the type of negative emotional picture (sad, dysphoric, threat, anger).

The study (Rantanen et al., 2021) (unipolar depression: n = 16, controls: n = 16) used a free viewing task of visually matching interpersonally aggressive and neutral pictures presented in pairs. When participants were able to anticipate the stimulus valence, depression showed an earlier attentional bias towards interpersonally aggressive pictures. The results demonstrate both an early attentional bias towards interpersonal aggression that may be present in depression and a later attentional bias towards aggression avoidance. The early information processing bias associated with depression may have maladaptive effects on how depressed individuals perceive and function in social interactions and may therefore maintain depressive mood.

The study (Barsznica et al., 2021) describes oculomotor functions in elderly patients with depression and suicidal behavior (SB) based on the prosaccade and antisaccade task. Patients with SB showed a lower number of corrected antisaccade errors and a longer time to correct them than patients without SB. These preliminary results indicate higher cognitive inflexibility in suicidal patients compared to those who are not prone to suicide. Such inflexibility may explain the difficulties of elderly people with depression in finding a

solution to the problem of suicidal thoughts in order to adequately respond to a stressful environment.

1.4 Disorders of psychological development (F80–F89) + Behavioural and emotional disorders with onset usually occurring in childhood and adolescence (F90–F98)

A group of childhood disorders with early onset, characterized by disorganized activity, lack of persistence and a tendency to jump from one task to another, social relationships may be impaired, and cognitive functions are insufficient (according to: International Classification of Diseases, 10th revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>). Childhood autism here is a type of pervasive developmental disorder, which is determined by the presence of: a) abnormalities and delays in development, manifested in a child under three years of age; b) psychopathological changes in all three areas: equivalent social interactions, communication functions and behavior, which is limited, stereotyped and monotonous; c) possible nonspecific problems.

Individuals with ASD demonstrate reduced saccadic eye movement accuracy, the magnitude of which varies across studies. Increased variability suggests deficits in cerebellar variability-reducing functions, resulting in a reduced ability to make compensatory adjustments to ensure consistent and accurate saccade execution. Reduced peak saccade velocity and increased saccade duration may be due to reduced excitatory pontine brainstem burst cell activity and/or increased inhibitory omnipause cell activity, altering saccadic eye movement performance. Reduced ability to consistently modulate saccadic eye movement amplitude may negatively impact early social learning, thereby affecting social and cognitive development (Oldham, Meehan III, & Howell, 2021). On the other hand, in ASD, the mechanisms underlying the ability to direct gaze to a specific stimulus (social or non-social) and hence capture attention are also atypical. They arise from dysfunctions in several brain regions, including the amygdala, frontal eye fields (FEF), temporal parietal junction, insula, and dorsal lateral prefrontal cortex. Attempts are currently being made to elucidate the cortical mechanism of face perception in ASD, however, the eye movement research literature in ASD shows a lack of consistency in the approaches to data collection, analysis, and subsequent interpretation (Papagiannopoulou et al., 2014).

ADHD involves structural/functional abnormalities of the basal ganglia-thalamocortical circuit projecting to the frontal cortex; frontostriatal network. Problems with interpreting abnormal saccades include that saccade performance changes dramatically with age, and involvement of the frontal eye field (FEF) for saccade control has only been demonstrated in lesion studies in adults. Hypofunction of ventral striatum dopaminergic neurons causes motor inhibition failure and may be involved in dysfunction

of the limbic region of the prefrontal cortex, i.e., orbitofrontal cortex, anterior cingulate cortex, especially when the ascending output of the basal ganglia is hypofunctioned. These mechanisms may explain the higher distractibility observed in older patients with ADHD (Goto et al., 2010).

1.4.1 Attention deficit disorder (ADHD) (Disturbance of activity and attention F90.0.)

The study by A. Lev et al. (Lev, Braw, Elbaum, Wagner & Rassovsky, 2022) aimed to evaluate the possibility of integrating eye tracking with MOXO-dCPT, a test related to the assessment of cognitive functions in patients with suspected or confirmed ADHD (patients with ADHD: $n = 35$, controls: $n = 35$). MOXO-dCPT consists of eight blocks, each block consisting of tasks in which a grid of stimuli (target or non-target) is displayed in the center of the screen. Based on the results of MOXO-dCPT, four performance indices are calculated: attention, timeliness, impulsivity, and hyperactivity. The study also used an 18-item questionnaire for self-report of ADHD symptoms in adults, detailed in DSM-5 (American Psychiatric Association, 2013). The authors considered the duration of gaze to regions of interest: the task stimulus (in the center of the screen), the periphery (the area around the task stimulus), and the area behind the screen. Using gaze direction measurements, it was found that patients with ADHD spent more time looking at irrelevant areas both on and off the screen than control participants. Consistent with the distractibility characteristic of ADHD, difficulty in suppressing spontaneous eye movements toward the MOXO-dCPT distractors appears to be the cause of the group differences. From a clinical perspective, the scale combining eye movement measures and conventional indices has shown the ability to discriminate ADHD, but further studies are needed to confirm the results and address the limitations of the study.

Children with autism spectrum disorder (ASD) have sensory-perceptual processing deficits that impair their ability to pay attention and perceive social stimuli in everyday life. While everyday social episodes consist of subtle dynamic changes in social information, any failure to attend to or process subtle human nonverbal cues such as facial expressions, postures, and gestures can lead to inappropriate social interactions. A study (Tsang & Chu, 2018) collected eye-tracking data while three participants watched a video of a social scenario using a single-case comparison design: a child with autism spectrum disorder (ASD), a child with comorbid attention-deficit hyperactivity disorder (ADHD), and a neurotypical control. The duration of the first fixation (at 500 ms of the target ROI) was longer in the neurotypical child (150 ms) than in children with ASD and ASD-ADHD (both 110 ms). The total fixation duration (per 500 ms target EoI) was shorter for the child with ASD-ADHD (120 ms) than for the neurotypical child (170 ms) and the child with ASD (180 ms). The total number of fixation bursts (per 500 ms target EoI) was

highest for the child with ASD (4.62), second highest for the neurotypical child (4.09), and shortest for the child with ASD-ADHD (3.19). The scan path plot captures visual scanning of multiple AOIs in a social scene.

The aim of the study (Sweere et al., 2022) was to examine distractibility, quantified by recording and analyzing task-irrelevant eye movements, in children with and without ADHD and in children with and without neurological disorders ($n = 141$). Participants with ADHD and participants with neurological disorders spent less time fixating on target stimuli compared to their non-ADHD peers or their peers without neurological disorders. Participants with and without ADHD had similar press latencies. Participants with neurological disorders had longer press latencies compared to their typically developing peers. Target fixation duration showed a significant association with parent-reported attention problems. The authors conclude that eye tracking during a distraction task provides potentially valid clinical information that can facilitate the assessment of dysfunctional attention processes. Further research into the validity and reliability of this paradigm is recommended.

The aim of the work (Oliveira, Franco, Revers, Silva, Portolese, Brentani, & Nunes, 2021) was to study the Visual attention model (VAM) for the diagnosis of ASD and ADHD (ADHD patients: $n = 30$, ASD patients: $n = 76$). Three videos with human movements and three videos with geometric shapes were combined into nine videos displayed sequentially, with a total duration of 54 s. The order and position of frames with human and shape movements varied throughout the video. A fixation map was used to train the model. The result was a model for the diagnosis of ASD and ADHD based on the use of video as a stimulus with an average accuracy of 90%, recall of 69%, and specificity of 93%.

A study (Kong et al., 2022) analyzed the gaze patterns of 1.5–3-year-old children ($n = 95$) and 3–5-year-old children ($n = 74$) with and without ASD while viewing video clips and still images. The percentage of fixation time in children with ASD was significantly reduced compared to that in normal children in almost all ROIs, except for a moving toy (helicopter). Support vector machine analysis showed that the classifier could differentiate ASD from normal in toddlers with 80% accuracy and differentiate ASD from normal in preschoolers with 71% accuracy.

The study (Vacas et al., 2021) aimed to compare visual attention patterns to social and non-social images in children with ASD and matched controls ($n=36$), assessing the role of emotion in the face stimuli and the type of competing object. A paired preference task was designed pairing happy, angry, and neutral faces with two types of objects (related or unrelated to their autism-related CIs). Three indices were considered as dependent variables: prioritization (attentional orientation), preference, and duration (sustained attention). Results showed that both groups had similar visual patterns to faces (prioritization, greater attention, and longer attendance to faces paired with objects

unrelated to their CIs); however, the ASD group attended to faces significantly less than the controls. Children with ASD showed an emotional bias (late orienting to angry faces and typical preference for happy faces). Finally, objects related to their concomitant restricted interests attracted attention in both groups, which significantly reduced social attention in children with ASD. Atypical social attention is present in children with ASD regardless of the competing nonsocial object.

2. Chapter IX Diseases of the circulatory system

Stroke is an acute disturbance of blood circulation in the brain, accompanied by tissue death and dysfunction of the nervous system. The consequences of stroke include conditions specified as such, as residual effects, or as conditions that exist for a year or more from the onset of the causative condition (according to: International Classification of Diseases, 10th revision (ICD-10). URL: <http://mkb-10.com/index.php?pid=4048>).

Pupillary dilation is controlled by both the sympathetic and parasympathetic nervous systems in response not only to changes in light but also to cognitive processes including attention, memory, language, decision making, and emotional processing. Receiving, processing, and recognizing emotional information from the human face involves a complex network of peripheral and central systems. In addition to the visual cortex and cortical association areas that are typically involved in visual processing, other brain regions such as the fusiform face area in the ventral temporal lobes are also involved in the decoding of emotional information when imaging the human face. Other structures such as the inferior occipital gyrus, superior temporal sulcus, and amygdala are also involved in decoding emotional information. The distributed nature of these brain circuits makes them particularly vulnerable to both focal and diffuse damage, such as that resulting from cerebrovascular and traumatic events, as evidenced by the high incidence of impairments in emotion discrimination following brain injury (Maza, Moliner, Ferri & Llorens, 2020).

The absence of pathological rightward bias during free scene viewing may depend on the integrity of the second branch of the right superior longitudinal fasciculus (SLF II), a white matter tract connecting cortical areas critical for visual attention, and damage to which is closely associated with the occurrence of neglect (Kaufmann et al., 2020).

2.1 Stroke (Sequelae of cerebrovascular disease I69)

Spatial neglect is associated with the inability to observe and respond to the contralateral hemispace and is a negative predictor of functional outcomes after stroke (Ales et al., 2021). The aim of the study was to test the sensitivity of eye movement measurement during Free Visual Exploration (FVE) (stroke patients: n = 78, controls: n = 40). Twelve

images of nature or urban public spaces and 12 mirrored versions (reflected along the vertical axis) were presented on the screen. The instruction was to freely explore the images. The direction of first fixation (left or right) and average gaze duration were examined. Patients with neglect demonstrated a rightward bias in free visual exploration. FVE correctly detected neglect in 85% of patients with an AUC value of 0.922 in the ROC analysis. Traditional paper-based neuropsychological tests, considered alone or in combination, showed heterogeneous results and were significantly less likely to detect neglect (21.74%–68.75%). Eye tracking was more sensitive in detecting neglect in everyday behavior than neuropsychological tests (Kaufmann et al., 2020).

The study (Maza, Moliner, Ferri & Llorens, 2020) examined accuracy, response distribution, visual behavior and pupil dilation in stroke survivors when recognizing emotional facial expressions (ischemic stroke: $n = 18$, hemorrhagic stroke: $n = 22$, controls: $n = 65$). The authors' results confirmed the deterioration of performance after stroke and showed a decrease in attention to the eyes. The dependence of visual behavior on performance, although not determinative, may indicate that altered visual behavior may be a factor negatively affecting the recognition of emotions from facial expressions.

Gaze-evoked nystagmus (GEN) is a central feature of acute vestibular syndrome (AVS); however, distinguishing pathological from physiological GEN is challenging. In controls with GEN, the centripetal drift time constant was >18 s. Eye tracking detected pathological GEN (time constant ≤ 18 s) in 33% of patients with vestibular strokes. The results were equivalent to specialist examination. Automated GEN quantification was specific and accurately identified patients in the emergency department with stroke-induced AVS (Mantokoudis, Korda, Zee, Zamaro, Sauter, Wagner, & Caversaccio, 2021).

3. Chapter VI Diseases of the nervous system

Multiple sclerosis is an autoimmune disease caused by a malfunction of the body's immune system. Parkinson's disease includes movement disorders resulting from the death of neurons in the substantia nigra of the brain.

In multiple sclerosis, inflammatory demyelinating lesions in different brain regions result in a wide range of oculomotor abnormalities, most commonly static and dynamic eye movements (Serra, Chisari & Matta, 2018) combined with dysmetric saccadic behavior (Serra, Derwenskus, Downey & Leigh, 2003). Fixation (Mallery et al., 2018), smooth pursuit (Lizak et al., 2016), and vestibulo-ocular responses (Huygen et al., 1990) are also frequently impaired. Most of these abnormalities are exacerbated by the presence of internuclear ophthalmoplegia (INO). INO is a neuro-ophthalmic disorder occurring in approximately one in three patients with multiple sclerosis (Jozefowicz-Korczynska, Łukomski & Pajor, 2008) and characterized by impaired adduction of conjugate lateral eye movements. The presence of INO is often decisive for confirming

the diagnosis of multiple sclerosis, especially if it is bilateral (Bolanos, Lozano & Cantu, 2004), but its subclinical manifestations are difficult to detect without quantitative approaches (Matsumoto et al., 2011).

The frontal, supplementary and parietal eye fields, prefrontal and posterior parietal cortex project to brainstem structures that control saccades via the superior colliculus, thalamus and basal ganglia. Within this brainstem-parietotemporal and basal ganglia-frontal neural network, there is a two-way interaction between voluntary eye movements and attentional switches, with the former exerting bottom-up control over the latter and the latter exerting top-down influence on the former. In addition, fixation saccades and microsaccades play an important role in information selection during free visual scanning and search, with the speed increasing depending on the size of the scanned scene and the level of information content. Abnormal visual scanning is not uncommon in Parkinson's disease, and the deficit increases with the complexity of visual images (Matsumoto et al., 2011). Saccade abnormalities caused by cortical and subcortical neurodegenerative changes are also observed in PD (Rascol et al., 1989). Increased saccade latency, impaired saccade programming and execution, error rates, and reduced saccade amplitude are typical in patients with idiopathic non-demented Parkinson's disease (Beylegil et al., 2022).

3.1 Demyelinating diseases of the central nervous system (G35–G37) + Extrapyramidal and movement disorders (G20–G26)

3.1.1 Multiple sclerosis (G35) and Parkinson's disease (G20)

The SONDA (Standardized Oculomotor and Neurological Disorder Assessment) test is based on the analysis of eye tracking recorded during a short and intuitive continuous tracking task. The visual stimulus is represented by a Gaussian spot of increased luminance moving along a random walk trajectory on a uniform gray background (~140 cd/m²). There were two stimulus presentation conditions: in the smooth tracking condition, the stimulus moved continuously along the random walk path, and in the saccadic tracking condition, an additional positional shift to a random location on the screen was added to the trajectory, which occurred every 2 s. Using the SONDA approach presented in the study by Grillini et al. (2020) found preserved smooth pursuit responses and two abnormal features in the saccadic pursuit condition in MS, but this finding is limited by the sample size (PD patients: n = 9, MS patients: n = 12, controls: n = 50). Slower saccades are to be expected in advanced PD. One of the characteristic oculomotor abnormalities in PD is the impairment of self-generated saccades with relative preservation of visually guided saccades, which worsens as the disease progresses. Most errors are made when

PD patients have to switch between instructions (e.g., switching between pro- and antisaccades) (Grillini, Renken, Vrijling, Heutink, & Cornelissen, 2020).

In a study (Brien, Riek, Yep, Huang, Coe, & Areshenkoff, 2023), patients with Parkinson's disease (n = 121: 45 cognitively intact/45 MCI/20 dementia/11 others) and controls (n = 106) were given a pro/antisaccade task. Using saccade, pupil, and blink parameters, the classifier achieved 83% sensitivity and 78% specificity. Confidence scores predicted motor and cognitive performance in PD. The resulting model can be used as an additional screening tool in the clinic.

Eye movements and horizontal and vertical angular position vectors of the right and left eyes were also measured using high-resolution video-oculography in a cohort of patients with Parkinson's disease who viewed a blank scene and images of a real scene. The latter was associated with the task of finding an object among other objects in an expected and unexpected location. The group of people with Parkinson's disease took longer to find the object. The final response time was comparable in both patients with Parkinson's disease and controls (patients with Parkinson's disease: n = 13, controls: n = 7). Fixation duration was comparable in the two groups, but tended to be shorter for stimuli located in atypical locations. Participants with Parkinson's disease made more fixational saccades with significantly larger amplitude and fewer non-fixational saccades with significantly smaller amplitude while viewing the blank scene. However, the total scan area of the blank scene was not affected by Parkinson's disease. Participants with Parkinson's disease made fewer non-fixational saccades during visual search for a target object, with amplitudes comparable to healthy controls. Fixational saccades during visual search were greater in Parkinson's disease, especially when the target was placed in an unexpected location, but the frequency did not change (Beylergil, Kilbane, Shaikh, & Ghasia, 2022).

4. Chapter XIX Injury, poisoning and certain other consequences of external causes

4.1 Injuries to the head

Concussion is the result of a biomechanical impact to the head that disrupts normal brain function (McCrory et al., 2009). The integrity of multiple brain regions (occipital lobe, parietal lobe, frontal eye field, brainstem, and connecting pathways) is necessary for the preservation of vision and vestibulo-ocular reflexes (Ciuffreda et al., 2007). Because concussion is likely a diffusely distributed injury, visual impairment may be common (Zahid et al., 2020).

4.1.1. Concussion (S06.0)

The aim of the study (Oldham, Meehan III, & Howell, 2021) was to (1) examine the association between patient-reported symptoms and concussion-related eye tracking impairments and (2) compare gait quality between (a) adolescents with concussion who have normal eye tracking, (b) adolescents with concussion who have impaired eye tracking, and (c) controls (concussion: $n = 30$, controls: $n = 30$). BOX (pupil dehiscence index) assessment was performed, the Post-Concussion Symptom Scale (PCSS) was administered, and gait speed was measured with triaxial inertial measurement units. The concussion and eye tracking impairment group had higher overall symptom severity and worse symptom severity across the 5 PCSS symptom profiles. In the eye-tracking study, participants watched a short video that moved across a screen. The concussion group with abnormal eye tracking had worse overall symptom severity and higher scores on each of the 5 symptom profiles than the normal eye-tracking and healthy control groups. Additionally, the abnormal eye-tracking group walked at a slower speed when performing one and two tasks, although the difference was not statistically significant. The authors conclude that eye tracking is a clinically useful tool for identifying visual and motor impairment after concussion, and suggest that further research is needed to determine whether eye tracking can help clinicians monitor people at risk for prolonged recovery from concussion.

The authors (Zahid et al., 2020) evaluated an automated eye tracking algorithm as a biomarker of concussion, defined by its symptoms and clinical signs of convergence insufficiency and accommodative dysfunction, in a pediatric population (children with concussion: $n = 56$, controls: $n = 83$). Metrics comparing the speed and coupling of eye movements over time were derived and compared with the correlation between acute concussion assessment (ACE) scores, convergence, and accommodative dysfunction. Twelve eye tracking metrics differed significantly between children with and without concussion. The model for classifying concussion as diagnosable by its symptoms assessed using ACE achieved an area under the curve (AUC) = 0.854 (sensitivity 71.9%, specificity 84.4%, cross-validated AUC = 0.789). An eye tracking model designed to detect near point of convergence (NPC) disability achieved a specificity of 95.8% and a sensitivity of 57.1% with an AUC of 0.810. Eye tracking correlated with concussion symptoms and identified convergence and accommodation impairments associated with concussion in a pediatric population. It demonstrated utility as a rapid, objective, and noninvasive method for diagnosing concussion.

Conclusion

Eye movements are probably the best way to assess the state of the brain mechanisms that determine the purposeful activity of a person. Based on the measurement of eye

movement characteristics, the effectiveness of this activity can be measured. The analysis showed that the advantages of eye tracking over other methods include: objectivity, expressed in independence from the interpretation of a complex cognitive state by a diagnostician, brief and stress-free observation of patients, the ability to simplify the tasks presented with high diagnostic accuracy, finding a simulated disorder, supplementing existing tests, searching for latent features (especially characteristic of machine learning-based models), higher sensitivity compared to some neuropsychological tests, the ability to dynamically switch between tasks. The general features of the design of research in the field of medical diagnostics include:

- Using existing paradigms for conducting eye tracking studies;
- Combining new paradigms with existing neuropsychological tests and methods;
- Inheriting the basic principles of examining a patient's condition;
- Building data analysis models;
- Building models of purposeful human behavior.

Eye tracking as a possible method of medical diagnostics has a high potential for complementing and refining other research methods. As a further direction for the development of this method, it is necessary to validate the protocols on an extended sample, assess the sufficiency of the stimulus material for the expected oculomotor reaction, and consider the possibility of combining with already accepted diagnostic methods to obtain additional information.

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Student's Adaptation to Distance Learning (on Example of Armenian and Russian Students): Psychoemotional Features

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Abstract

Introduction. The article substantiates an individually and socially significant problem that is relevant to different educational systems and countries: the recent forced transition to distance learning. Distance learning is a set of educational services, which is provided through a special information and educational environment. The current study aims to investigate the attitude of ethnic Armenians and Russians to distance learning during that affected psychoemotional condition of personality. **Methods.** The study investigated the experience from distance learning in students from Russia and Armenia (N=185, M age = 21.98, SD age=5.73). The study was conducted using State-Trait Anxiety Inventory (S-Anxiety scale) and authors' questionnaire to assess distance learning experience. **Results.** The majority of Armenian and Russian students mentioned advantages of distance learning, such as they found it convenient, were satisfied and had adequate home conditions for learning. However, some disadvantages were mentioned including the difficulty of the objective assessment of their knowledge in distance learning context. Statistical analysis allowed to observe relationship between the anxiety level and students' experience with distance learning, i.e., the adaptation level and the satisfaction value. Additionally, the association between adaptation level and the country of residence was found along with the determinants of distance learning effectivity. **Discussion.** The study revealed the main trends in students' perception of distance learning on the territory of Armenia and Russia. We showed the association between psychoemotional features and assessment of distance learning.

Keywords

distance learning, psychoemotional condition, state anxiety, adaptation, ethnic Armenians, ethnic Russians

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Introduction

The education of the individual is the most important universal problem in the modern world. Especially in the 21st century, this has become the most significant condition, since this is the age of informatization and computerization of all spheres of life. In the recent decade, there has been a considerable interest in the distance learning among researchers (e.g., Harting & Erthal, 2005; Moore, Dickson-Deane, & Galyen, 2011; Valentine, Gellman-Danley & Fetzner, 1999). These works reflected on the essence and content of distance education.

Recently, most educational structures across the world have switched to a distance learning format in connection with the epidemic of the coronavirus, the Covid-19 pandemic. The cardinal transformation of the format of education was a forced experiment for a significant number of universities, developing the higher education system in the direction of digitalization. The key problem, in our opinion, was the fact that distance learning has not become a general cultural practice. The transition to distance learning was performed in an extremely limited period of time, excessively harsh, without initial training, without training programs for subjects of educational activity. Today, it is unequivocally difficult to evaluate the forced, determined by the necessity of modern conditions, distance learning.

Due to this cardinal transformation of education affecting many countries worldwide, there has been an outbreak in research on distance learning (e.g., Armstrong-Mensah, Ramsey-White, Yankey & Self-Brown, 2020; Berberyan, 2021; Danchikov, Prodanova, Kovalenko & Bondarenko, 2021; Demetriou, Keramioti & Hadjicharalambous, 2021; Gevorgyan, Berberyan & Berberyan, 2022). Despite this interest, to our knowledge, there have been no studies assessing distance learning experience in both Russian and Armenian students. In the current paper, we aim to investigate this transfer on example of Armenian and Russian

students, namely, psychoemotional features and adaptation to distance learning. In the rest of introduction, we will discuss the main theoretical approaches regarding distance learning and the core conceptual approaches regarding adaptation.

The Concept and Essence of Distance Learning

In psychology, the term "distance education" has the following meaning: distance education (from the Latin word *distantia* - distance) is an international term that acts as a purposeful and methodically organized guide for the educational and cognitive activities of students who live at a distance from an educational institution and, as a result, do not come into contact with the teachers of this institution. Based on this, the definition of distance education is considered as a predominantly independent education (self-education) but differs from self-education in that it includes some kind of feedback from the teacher. Next, we turn to the analysis of common ideas about the concept of "distance learning" in 4 components: 1) as an equivalent of distance education; 2) as a form of education; 3) as a method of obtaining education; 4) as a form and method of teaching.

There has been an ongoing discussion considering the relation between two terms: distance learning and distance education as synonyms (King, Young, Drivere-Richmond & Schrader, 2001). Gospodarik (2001) mentions that "distance learning is an educational system based on computer telecommunications using the latest pedagogical and information technologies, such as mail, the Internet, platforms for creating video meetings, etc., which is receiving education services away from an educational institution." According to Mogilev (2014), distance learning is a method of learning, a practice that "connects a teacher, a student and sources located in different areas, using special new technologies that provide interaction."

Andreev and Soldatkin (2013) view distance learning as a synthetic, integral humanistic form of education, using both traditional methods and the latest information technologies." They believe that it is better to use the term "distance learning" rather than "distance education", because education is not classified by distance to the student, but what is its purpose, its level, field of knowledge, industry, etc. According to Moiseeva et al. (2020), distance learning is a new specific form of learning that involves the use of special approaches, methods and means of teaching, contact between the teacher and students with each other. It can be noted that these formulations do not reflect the versatility of distance learning, the fact that students can be in the nearby territory is not taken into account, along with the possible contact between students (Ovsyannikov & Gustyr, 2001).

Distance learning was formed in the middle of the 20th century, when computers and telecommunications technologies were developing, at the moment it meets the requirements, and its main value is not knowledge and skills, but the information provided (Traxler, 2018). Thus, distance learning is defined as a complex of educational services, which is provided to a wide segment of the population, using a professional information and educational environment based on the methods of exchanging educational information, being at any distance. The distance learning has a range of advantages

including detailed teaching methods that are time-tested and used for large groups of students, no restrictions on the number of students in certain courses, the possibility for students to choose a schedule of educational activities that is convenient for themselves, which is the individualization of education and the possibility for students to choose a teacher who is an expert in a particular academic discipline (Sadeghi, 2019).

In addition, in the distance learning system there is considerable experience in dealing with methodological and educational materials, tasks for self-fulfillment, descriptions of tasks in a test form. Currently, distance learning, based on the latest information achievements, is gaining more and more popularity, based on the situation of the pandemic. The goals of distance learning are actually the same as those of face-to-face learning and have the same content. However, it is characterized by other forms of studying the material, forms of contact between the teacher and students, and the interaction of students with each other is also different. A demonstration of the successful implementation of a distance form of education, according to researchers, is e-learning, based on e-learning using the Internet and multimedia practiced in South Korea, the USA, France, Japan and other countries (Jiang & Xie, 2021).

So, what is distance learning in the emerging conditions? In our opinion, with this form of education, the subjects of educational activity organize the transmission and perception of educational information through a virtual environment, which is determined by the strategy of educational activity, using special technologies for the development of academic disciplines, as well as electronic and Internet communication techniques. In terms of content, under the traditional system of distance learning, the thesis: "knowledge – ability – skills – comprehension – understanding – implementation" is transformed into a complex of didactic components of the learning and virtual model of education. This mechanism goes into the following scheme: "creative awareness of the problem – reproduction by a person using his own experience – building a hypothesis and presenting a plan – solving the problem in new ways – application – introduction to the personal system" (Bederkhanova, 2003).

Psychological Adaptation and Adaptability of the Student's Personality

Psychological adaptation is a multi-level and diverse phenomenon that affects both the personal characteristics of a person and aspects of his life, i.e., his mental health and social environment, with the inclusion of all areas of activity, primarily educational and professional, in which he is included. Psychological adaptation of a personality is a bidirectional process of interaction, in which changes occur both in the mental activity of the individual and in relationships with society: in the transformation of norms, rules, values, all spheres of a person's spiritual life. With psychological adaptation, harmonization occurs in the interaction of the individual and the environment. Changes arise in the individual and in the social environment, the nature and level of which is justified by almost all life circumstances. Psychological adaptation is the process of bringing the psychological work of the individual into line with the social and socio-psychological requirements of the environment, the conditions and content of the work of a person (Ball, 1989).

Theoretical and methodological issues of socio-psychological adaptation of the personality are presented in the works of such researchers as A.A. Ball, L.I. Bozhovich, V.A. Petrovsky, J. Piaget, Z. Freud, E. Erickson and others. The most relevant is the conceptual approach of E. Erickson, who put forward the position of the existence of mutual continuous adaptation of the individual and society (Hoare, 2002). The state of psychological comfort of the individual and adaptability appears in the adapted, ordinary environment of life and work of the individual, in the process of successful resolution of adaptation problems and contradictions. Failure to comply with this state of comfort and the process of personality destabilization leads to the actualization of the needs that encourage the personality to functional interaction with the environment in order to restore the harmonization of relations.

Psychological adaptation has the ability to act as one of the ways of the formation and self-development of the individual (Rean, 1995). Representatives of the humanistic direction of psychology consider the issues of adaptation from the perspective of the optimal interaction of the individual and the environment. A. Maslow notes that the process of adaptation is dynamic, consisting in the interaction of the individual and the environment, and the main criterion for the adaptation of the individual is the degree of its integration with the environment (Maslow, 1968). In order to emphasize the result of adaptation, such a concept as the "adaptation" of an individual or group is often used. Adaptability can be defined as such a state of the person, which allows him to feel free and uninhibited in the socio-cultural environment, to be included in the main activity, to feel changes in the usual socio-cultural environment, to deepen into intrapersonal spiritual problems, to enrich his own world through more perfect forms and ways of sociocultural interaction.

Adaptation of students implies, basically, adaptation to the lifestyle of students, to indicators of typical forms of educational activity, including educational activities, various forms of communication. Based on the results of the personality adaptation potential, a certain state of the student's personality is achieved during the period of adaptation itself - adaptability. We understand the educational adaptation of students as a part of professional adaptation, as a result of which the student acquires educational knowledge and skills for successful learning and the acquisition of professional competence, as well as the main parameters of the student's social and personal characteristics are brought into dynamic balance in accordance with the conditions of the university environment (Santrosyan, 1973). Particular attention should be paid to the adaptation of first-year students, since the subsequent experience will depend on the degree of success in completing the initial stage of adaptation to the university (Voronaya, Pronenko, 2022; Voronaya, Pronenko, 2023).

The **methodological basis** of our study is the conceptual positions on distance learning in science (A.A. Andreev, Yu.P. Gospodarik, V.P. Kolmogorov, E.S. Polat, V.P. Tikhomirov and others, as well as theoretical and methodological issues of socio-psychological adaptation of the personality (A.A. Ball, L.I. Bozhovich, V.A. Petrovsky, J. Piaget, Z. Freud, E. Erickson, etc.).

Based on the thorough theoretical analysis and methodological basis, the following **hypotheses** were formulated:

1. There is a relationship between satisfaction and adaptation with distance learning and the state anxiety level.
2. The effectiveness of distance learning depends on both teacher's work and student's work.
3. The adaptation to distance learning and, thus, the preferred form of education depend on the country of residence.

Method

Participants

The study was conducted with 194 students from various universities of Armenia and Russia. At the moment of questionnaire, all the participants were studying in distant form of education. Prior to their participation, all participants gave written informed consent. Data from four participants was removed due to implausible answers (e.g., age consisting of three digits), from two – due to repetitive answers. Additionally, because our analyses concerned ethnic characteristics, we excluded 3 participants from included only participants from Armenia and Russia due to small sample size in other groups. The final sample consisted of 185 participants (153 female) with age range from 17-48 years old (mean age = 21.98, SD = 5.73; see Table 1 for descriptive statistics).

Table 1
Descriptive statistics

Participants	Number
Sex	
Female	153
Male	32
Age range	
17-25	150
25-48	35
Country of residence	
Armenia	86
Russia	99
Educational level	
Bachelor	160
Master	23
Doctoral	2
Total number of participants	185

Materials

The research was conducted in an online form (using google docs) and anonymously. The following questionnaires were administrated:

1. STAI (State-Trait Anxiety Inventory, S-Anxiety scale; Spielberger, 2010). This questionnaire was used to assess state anxiety level and consists of 20 items scored on a Likert scale from 1 (not at all) to 4 (very much so). These statements include, for example, "I am relaxed" or "I am presently worrying over possible misfortunes".
2. Author's questionnaire to assess students' experience with distance learning. The questionnaire consisted of 27 multiple choice questions. The questions aimed assessing students' satisfaction of distance learning, motivation level, experiences and difficulties that they encountered. It included questions like: "How did you adapt to the new conditions of distance learning?", "Is it convenient for you to study remotely?", "Are you satisfied with the distance learning process?", "How do you evaluate the work of the teaching staff in the framework of distance learning?", "Would you like to continue studying at a university remotely in the future?" and others.

Statistical Analysis

All statistical analysis described in this paper was performed in R (R Development Core team, 2021). To explore the relationship between continuous variable (state anxiety level) and its predictors (adaptation and satisfaction) we fitted linear models (*lm* function). To explore the relationship between categorical variables (evaluation of effectiveness of distance learning and evaluation of teacher's and student's work; adaptation to distance learning and preferred form of education per country of residence) Pearson chi-squared test was calculated (*chisq.test* function).

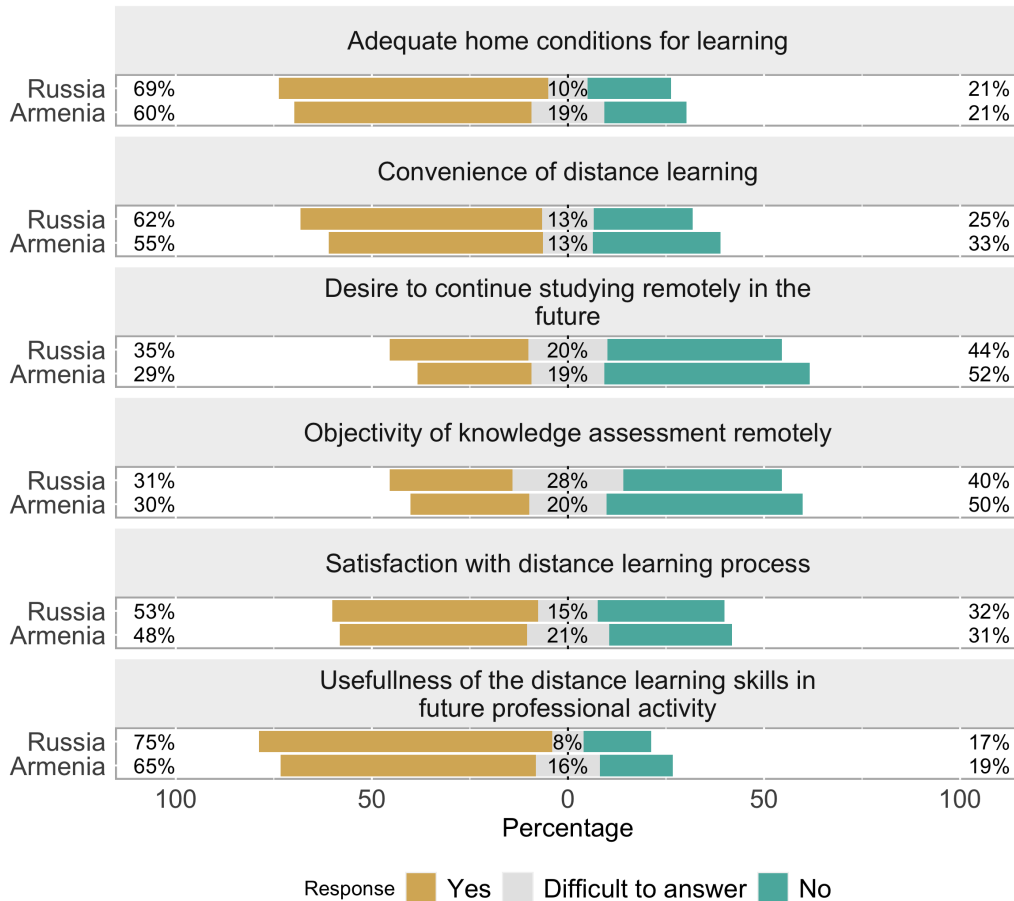
Results

Assessment of Overall Experience in Distance Learning

The results on several items of author's questionnaire were combined and displayed in Figure 1. These items describe students' overall experience with distance learning depending on the country of residence (Armenia and Russia). Overall, both ethnic Armenians and Russians tend to have positive experiences related to distance learning. This includes, for example, high satisfaction with distance learning (53% of Russian participants and 48 % of Armenian participants). Additionally, most participants had adequate conditions at home to be able to follow distance learning (69% of Russian participants and 60 % of Armenian participants). Despite those positive experiences, majority of participants indicated no desire to continue studying at the university remotely (44% of Russian participants and 52% of Armenian participants). Another important question is that students did not feel

that the distance format allowed teachers to objectively assess their knowledge (40% of Russian participants and 50% of Armenian participants).

Figure 1
The overall experience in distance learning



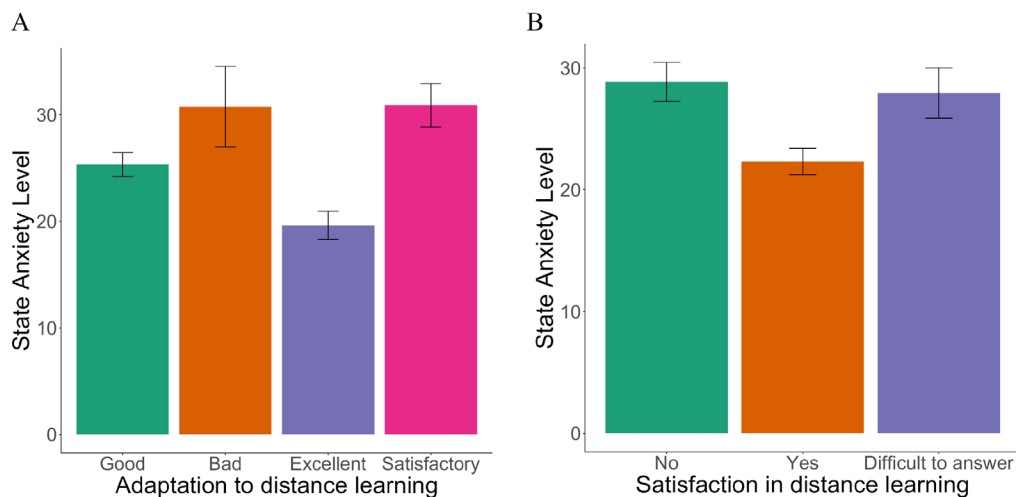
Is There a Relationship Between Assessment of Distance Learning and the State Anxiety Level?

The state anxiety level assessed by the State-Trait Anxiety Inventory for adults (Spielberger, 2010) was compared to the adaptation level assessed by the author's questionnaire. Mean values along with standard errors (Morey, 2008) were visually inspected (Figure 2A). Additionally, mean state anxiety was inspected along with the satisfaction assessment from distance learning (Figure 2B).

To statistically assess whether there is a relation between the state anxiety level and adaptation and satisfaction from distance learning, we fitted linear models. For most levels

of adaptation as a predictor of state anxiety level, we observed statistically significant predictions (see reference "Excellent" and "Good", Table 2). Thus, people with excellent adaptation were characterized by low state anxiety level (on average 19.66). The anxiety level was significantly higher for participants with good adaptation by 5.81 and with bad and satisfactory adaptation by 11.11, consequently. Moreover, for bad compared to good adaptation there was a slight nonsignificant difference and compared to satisfactory adaptation there was no difference (0).

Figure 2
 The mean values and standard errors



Note. A. The mean values and standard errors of state anxiety level for different types of adaptation to distance learning. B. The mean values of state anxiety level and standard errors for different types of satisfaction from distance learning.

Table 2
 The LM results for state anxiety as dependent variable and adaptation as a predictor

Formula	State anxiety ~ Adaptation to distance learning		
Reference: Excellent	Estimate	t value	p-value
Intercept	19.61	12.87	<0.001***
Bad	11.15	3.27	<0.01**
Good	5.73	2.91	<0.01**
Satisfactory	11.29	4.99	<0.001***

EDUCATIONAL PSYCHOLOGY

Formula	State anxiety ~ Adaptation to distance learning		
Reference: Excellent	Estimate	t value	p-value
Reference: Bad			
Intercept	30.77	10.10	<0.001***
Good	-5.42	-1.64	0.10
Satisfactory	0.13	0.04	0.97
Reference: Good			
Intercept	25.35	20.25	<0.001***
Satisfactory	5.56	2.66	<0.01**

For most levels of satisfaction from distance learning as a predictor of state anxiety level, we observed statistically significant predictions (see Table 3 for overview of all comparisons). Participants satisfied from distance learning were on average less anxious (mean = 22.48) than the ones that were not satisfied (mean = 28.86) and that were hesitating to answer (mean = 27.94). There was no significant difference in state anxiety level between participants satisfied from distance learning and the ones that were hesitating.

Table 3
The LM results for state anxiety as dependent variable and satisfaction as a predictor

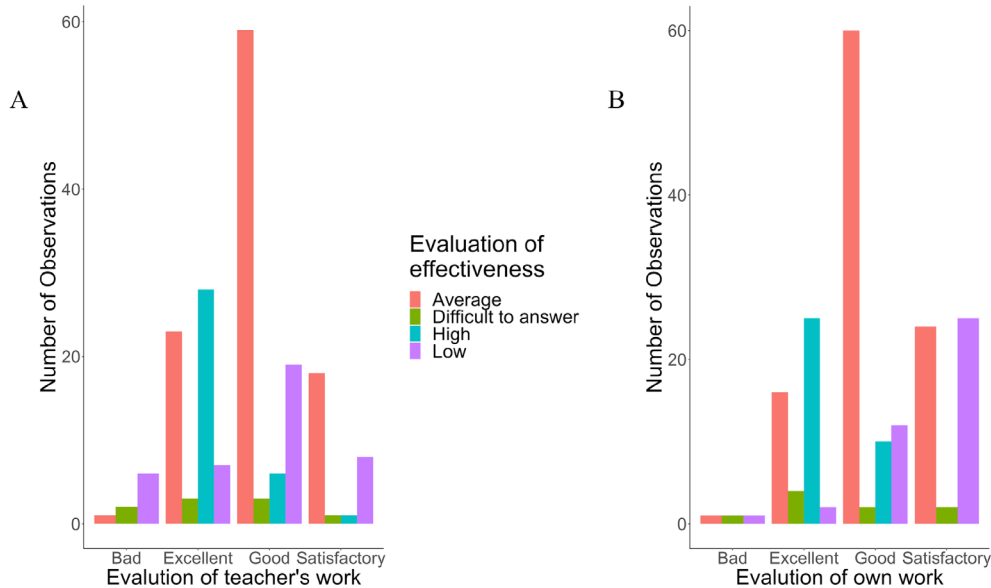
Formula	State anxiety ~ Satisfaction from distance learning		
Reference: Yes	Estimate	t value	p-value
Intercept	22.32	18.96	<0.001***
Difficult to answer	5.62	2.44	<0.05*
No	6.54	3.46	<0.001***
Reference: No			
Intercept	28.86	19.53	<0.001***
Difficult to answer	-0.92	-0.37	0.71

What Are the Determinants of Evaluation of Effectiveness of Distance Learning?

We compared the evaluation of effectiveness of distance learning to a) evaluation of teacher's work and b) evaluation of students' own work both assessed by the author's questionnaire. Mean values along with standard errors (Morey, 2008) were visually inspected (Figure 3). To evaluate these relationships statistically we calculated Pearson chi-squared test. We found that there is a relationship between the evaluation of effectiveness of distance learning and the evaluation of teacher's work (X-squared = 62.89, df = 9, p-value <0.001). Next, to assess the strength of this relationship, we calculated Cramer's V that resulted in a moderate association value (V = 0.33).

Pearson chi-squared test also showed that there is a relationship between the evaluation of effectiveness of distance learning and the evaluation of own work (X-squared = 84.34, df = 9, p-value <0.001). Additionally, Cramer's V resulted in a moderate association value (V = 0.39). Overall, this shows two import factors that influence the effectivity of distance learning: teacher's work and student's own work.

Figure 3
The mean values and standard errors



Note. A. The mean values and standard errors of evaluation of effectiveness linked to evaluation of teacher's work. B. The mean values and standard errors of evaluation of effectiveness linked to evaluation of students' own work.

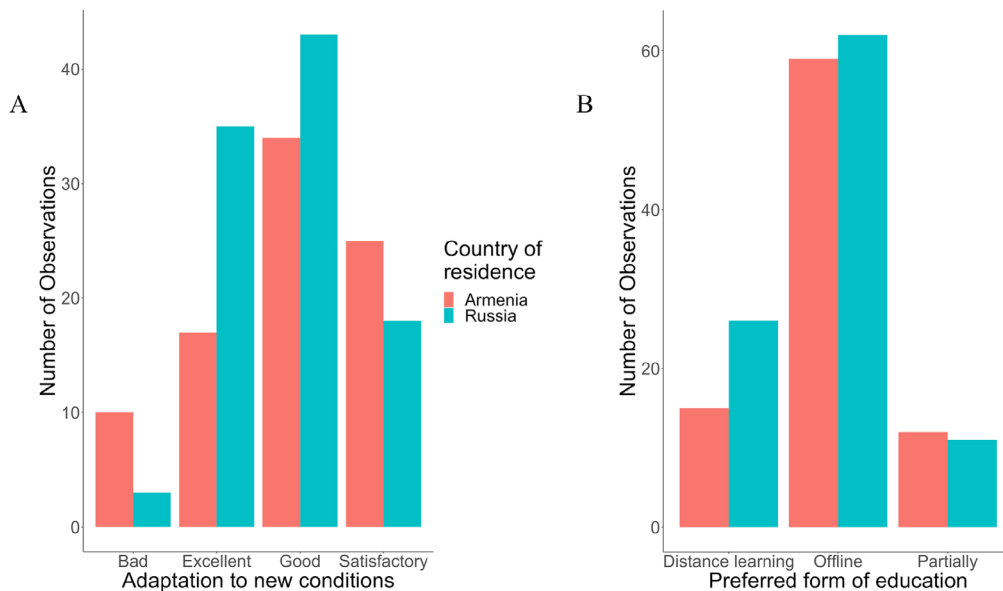
Does Adaptation to Distance Learning and Its Preference Depend on the Country of Residence?

To evaluate an influence of country to the adaptation to distance learning, we first visually inspected them (Figure 4 A). To evaluate these relationships statistically we calculated Pearson chi-squared test. We found that there is a relationship between the adaptation to distance learning and the country of residence (X-squared = 12.93, df = 6, p-value <0.05). Next, to assess the strength of this relationship, we calculated Cramer's V that resulted in a moderate association value (V = 0.25).

To evaluate an influence of country on the preferred form of education, we also visually inspected them (Figure 4 B). Pearson chi-squared test showed no relationship between the preferred form of education and the country of residence (X-squared = 2.62, df = 4, p-value > 0.05).

To summarize, this shows that the adaptation to distance learning was determined by country of residence, namely, Russians had on average higher adaptation to new conditions of distance learning during pandemic than Armenians. Additionally, there was no difference in preferred form of education, namely, most participants in most groups preferred offline (in-person) form of education.

Figure 4
The mean values and standard errors



Note. A. The mean values and standard errors of adaptation to new conditions per country.
 B. The mean values and standard errors of preferred form of education per country.

Discussion

The current paper aimed to investigate the transition to distance learning that occurred due to recent Covid-19 pandemic on an example of Armenian and Russian students. We discussed the definition of distance learning and the core theoretical approaches that clarify its specific goals, advantages and disadvantages. Analyzing various research sources, despite some disagreements, we notice the unanimity of researchers across the main features of distance education. First of all, this concerns flexibility, i.e., students' ability to study anytime, anywhere and at any time rhythm (Oliveira, Penedo, & Pereira, 2018). Another two important features are asynchrony, i.e., when teaching takes place according to a schedule or schedule agreed upon by students and teacher, regardless of time and economic efficiency. Thus, the evidence suggests that distance learning requires less financial costs than traditional forms of education (Rumble, 1987).

Moreover, not only student's role is discussed in the literature but also teacher's perspective (Offir, Barth, Lev, & Shteinbok, 2003; Sikwibele & Mungoo, 2009). This includes the role of the teacher, who is responsible for the functions of coordinating the learning process, correcting the course being taught, advising the course for individual learning, managing learning projects, etc. Additionally, the education process is modernized and includes the need for teachers to use special technologies and teaching aids: distance learning technology acts as a set of methods, forms and means of interaction with the student in the process of independent study, but under the control of the student's assimilation of a certain amount of knowledge (Sherry, 1995; Williams, McIntosh, & Russell, 2021).

To better understand overall experience with distance learning in ethnic Armenians and Russians we investigated this with our questionnaire. We found overall positive experiences concerning distance learning including high satisfaction, adequate home conditions, convenience of distance learning and usefulness of the distance learning skills in future professional activity. Our findings add to body of literature on analysis of transition to distance learning during Covid-19 (Armstrong-Mensah et al., 2020; Churiyah, Sholikhah, Filianti, & Sakdiyyah, 2020; Danchikov et al., 2021; Poluekhtova, Vikhrova, & Vartanova, 2020). While the mentioned studies investigated this transfer in various groups, to our knowledge, this is the first study to investigate this transfer on both Armenian and Russian students.

Despite those positive experiences, majority of participants in both groups did not want to continue study remotely and were doubting the possibility of objective evaluation of their knowledge by teachers in the context of distance learning. This clearly shows that distance learning for the student has both positive and negative sides (for review, see Oliveira, Penedo, & Pereira, 2018). Since there is no direct contact in distance learning, it becomes necessary to pay special attention to the psychological characteristics of the organization of training, which to a greater extent affect the effectiveness and quality of educational activities. Additionally, in distance learning, there is an excessive need in discipline of students.

Based on our theoretical analysis, we formulated three hypothetical assumptions that were tested using visual inspection complemented with statistical analysis. To this end, we assessed whether there is a relationship between adaptation and satisfaction with distance learning and the state anxiety level. Our results showed statistically significant differences in the levels of adaptation and the state anxiety value, namely, participants with higher adaptation were characterized with lower state anxiety value. Additionally, we found statistically significant differences in the levels of satisfaction and the state anxiety value, namely, participants that were satisfied with distance learning were characterized with lower state anxiety value. Overall, this shows an important source of state anxiety that is a low adaptation to emerging conditions of distance learning due to Covid-19 pandemic. This is consistent with the previous findings that showed high anxiety level to be related to challenges of distance learning (Demetriou et al., 2021; Savitsky, Findling, Erel, & Hendel, 2020; Unger & Meiran, 2020).

Next, we investigated the components of effectivity of distance learning, i.e., evaluation of teachers' work and students' work. Consistent with our hypothesis, both had an equal influence on evaluation of effectiveness of distance learning. The third hypothetical assumption regarding an influence of residence country on adaptation to distance learning and the preferred form of education was partially confirmed. Thus, we found a relationship between the adaptation to distance learning and the country of residence with higher adaptation level in Russian students. Due to the fact that the adaptation level was linked earlier in this paper to the anxiety level, we could link this lower adaptation level in Armenians to their high anxiety value. In the previous work, the higher anxiety level found in Armenians than in Russians was interpreted as a result of an unexamined trauma of the Armenian Genocide (Berberyan & Berberyan, 2016).

However, we found no relationship between preferred form of education and the country of residence while most participants in both groups gave their preference to in-person education, when possible. We explain this finding due to the fact that educational system of Armenia is very close in value-semantic characteristics to the educational system of Russia, which has absorbed Orthodox values, which for centuries have been its spiritual and moral foundations. During the development of the educational system until the beginning of the twentieth century, the Christian worldview, which is based on Christian values, enriched the axiological content of education.

Conclusion

To summarize, conducting a comprehensive analysis of the essence of distance learning and education clearly shows the multidimensionality and difficulty of this phenomenon, that this problem has not been sufficiently studied in the Russian and Armenian spheres of education, but is very relevant today's reality. Moreover, distance learning methods, based on modern technological advances, covering a large area, have a huge role in vocational education at various levels.

While the majority of our participants, both in Armenian and Russian groups, were satisfied with distance learning and found it convenient, they expressed some disadvantages of it, namely, the difficulty of the objective assessment of their knowledge in distance learning context. Additionally, we found a relationship between the anxiety level and students' experience with distance learning. While we found differences in the adaptation level depending on the country of residence, no differences were found in the preferred form of education.

Limitations

While our study provided important insights on perception of distance learning in Armenian and Russian students, it would be of interest to conduct a similar survey with teachers. This would enrich understanding of distance learning satisfaction and would allow to compare the evaluations of students' work from perspective of both students and teachers. Thus, further research with the comparable sample of Armenian and Russian teachers is needed.

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Conflict of Interest Information

The authors have no conflicts of interest to declare.

Does Implicit Response Competition Cause Aftereffects?

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Abstract

Introduction. Information is often ambiguous. Several theories suggest that the resolution of ambiguity involves an implicit selection of solution options, the result of which manifests itself in long-term negative and/or positive after-effects. However, in experimental studies, these effects are often mixed, leading to interpretations of the results. This study aims to identify and distinguish these effects. **Methods.** In this study a within-subject design was used. A total of 56 volunteers (21 males, 35 females; mean age: 25, SD = 5.8) took part in the study. In the first stage, the participants completed unambiguous and ambiguous fragmented word combinations. In the second stage, the participants completed fragmented nouns, some of which appeared in the first stage and some were alternatives not selected in the first stage of completion. **Results.** In the first stage of the experiment, ambiguous stimuli were completed slower and with more errors (ambiguity disadvantage effect). In the second stage, presentation of the same nouns resulted in the positive priming effect for both ambiguous and non-ambiguous stimuli. Positive and negative after-effects of resolving implicit competition have not been identified. **Discussion.** The results obtained can be explained by the fact that the implicit response competition has no long-term aftereffects. Another explanation is that the second stage uses tasks that do not require semantic processing and that the word is retrieved by a low-level letter processing before aftereffects of a previous choice appear.

Conclusion. Experimental data may support theories that consider only the short-term aftereffects of implicit competition. However, additional verification of the results is required using a task involving the semantic level of information processing.

Keywords

response selection, implicit response competition, ambiguity disadvantage effect, word-fragment completion task, priming

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Introduction

In life, we often encounter information that can be interpreted differently or problems that can have multiple possible solutions. The choice can be made unconsciously at different stages of solving the problem – from the choice of a representation to the choice of an action. A relevant question is whether a previously made choice can be retained for some time and affect the subsequent processing of information, or whether the choice is made again every time? If the choice is still maintained, what are the mechanisms to support its stability? This study **aims** to test the hypothesis of the long-term negative and positive after-effects of implicit choice and to distinguish their mechanisms.

It has been demonstrated with different stimulus material, that the implicit competition between answers in a problem provokes a selection process, which manifests itself in a slowdown in response time and/or an increase in the errors rate – we will call “selection cost”. This cost effect in a choice situation has been demonstrated both with homonyms (so-called ambiguity disadvantage effect) (Rodd, Gaskell, & Marslen-Wilson, 2002), which involve the selection of semantic representations (Simpson & Burgess, 1985; Simpson & Krueger, 1991; Maciejewski & Klepousniotou, 2020), and with orthographic neighbors (Coltheart, Davelaar, Jonasson, & Besner, 1977; Alekseeva & Slyusar, 2017), which involve the selection of lexemes (Pollatsek, Perea, & Binder, 1999, see Experiments 2–3; Snodgrass

& Mintzer, 1993, see Experiment 5), as well as the word fragment completion task with two alternative completion options (Heyman, Van Akeren, Hutchison & Storms, 2016) and in the presence of a context word that suggests a relevant choice (Kireev et al., 2022; Chernigovskaya et al., 2020).

The selection mechanisms are fundamental and manifest at different stages of information processing. Consequently, the question is whether a decision in favor of one of the alternatives results in long-term after-effects, i.e. changes in the processing of the selected and not selected options.

Two groups of theories can be distinguished that approach this issue differently.

The first group of theories does not assume any long-term effects specific to the choice situation, and the choice is actually remade each time (see the local inhibition mechanism) (McClelland & Rumelhart, 1981), the reordered access model (Duffy, Morris & Rayner, 1988), and the parallel independent activation model (Dixon & Twilley, 1999). These models assume a positive priming effect from increasing the accessibility of the selected representation, but this effect is not specific to the choice situation.

In the second group, four theories can be distinguished that assume different long-term effects.

Anderson, Bjork & Bjork (1994) proposed a retrieval-induced forgetting (RIF) theory, which emphasizes that the need to selectively retrieve one of the competing representations from memory leads to active suppression of the unselected (alternative) representation (Anderson, 2003; Anderson & Bell, 2001; Shivde & Anderson, 2001). The implicit competition induced by retrieval practice leads to the suppression effect (long-term negative aftereffect), which is consistently observed for explicit memory tests. However, an alternative interpretation of some of the effects obtained in studies in terms of a blocking mechanism is also discussed (Anderson et al., 1994; Raaijmakers & Jakab, 2013; Bäuml & Kliegl, 2017). It is assumed that what occurs is not the suppression of competing options, but the enhancement of selected options, which leads to interference at the retrieval stage – selected options gain an access advantage, blocking the retrieval of irrelevant ones. For example, an argument in favor of such an interpretation can be the absence of the suppression effect in the word fragment completion task (Butler, Williams, Zacks & Maki, 2001), which is an implicit memory test and should be insensitive to interference (Schacter, 1987). However, in another study, the effect was obtained under conditions when the memory test addressed the same lexical representations that were suppressed during retrieval practice (Bajo, Gomez-Ariza, Fernandez & Marful, 2006). It is currently considered that both mechanisms of suppression and blocking can be involved (Rupprecht & Bäuml, 2016).

The Structure Building Theory was proposed by M. A. Gernsbacher to describe the processes of language comprehension (lexical/semantic access, comprehension of metaphors, anaphors, etc.) (Gernsbacher, 1990; Gernsbacher, 1997, Gernsbacher, Keysar, Robertson & Werner, 2001). According to this approach, a central selection mechanism is

involved in ensuring choice, which implies the engagement of two different independent mechanisms – enhancement of the selected representation, as well as suppression of the alternative, non-selected meaning, which in theory is interpreted as a directed reduction in activation also extending to lower levels of processing (Gernsbacher, Robertson & Werner, 2001). Experiments have shown difficulties in retrieving the previously rejected meaning of a homonym (Gernsbacher et al., 2001), but it could appear due to the activation of a previously selected meaning and the need for its conscious rejection in order to select an alternative option or the activation of a blocking mechanism (see Gorfein, 2001).

The approach proposed by D. Gorfein for situations related to resolving ambiguity (activation-selection model) assumes that resolving competition results in an additional enhancement of the selected representation and the author recognizes the suppression mechanism as unnecessary (Gorfein, 2001; Gorfein, Brown & DeBiasi, 2007).

V. M. Allakhverdov (Allakhverdov, 1993; Allakhverdov, 2000; Allakhverdov et al., 2019) proposed a theory of the unconscious negative choice, which suggests two mechanisms of long-term aftereffects of competition resolution and their joint contribution to maintaining the choice. In this framework, it is assumed that when faced with ambiguity, a cognitive mechanism is activated that allows only one meaning to enter consciousness (a positive choice). At the same time, awareness of all other possible meanings (and even their elements) becomes difficult. The unselected option is activated, but is marked as inappropriate for the situation and is stably kept away from awareness. When encounter a similar situation again, a person will strive to repeat not only the previously made positive choice (aftereffect of a positive choice), but also the previously made negative choice (aftereffects of a negative choice). V. M. Allakhverdov's predictions have found their empirical confirmation on the material of ambiguous figures (Filippova, 2011; Filippova & Moroshkina, 2015; Filippova & Allakhverdov, 2020; Filippova, Chernov & Gorbunov, 2023), homonyms (Mamina, 2013; Mamina, Dedova, 2013) and anagrams with two alternative solutions (Lapteva, Valueva, Belova, 2018).

Consequently, in a situation where a task requires an implicit choice between competing answer options, the choice in favor of one of the alternatives may result in long-term aftereffects - the effect of a positive choice (positive priming effect), as well as enhancing the alternative selected as a result of competition, and the effect of a negative choice (negative priming effect), i.e. the difficulty of retrieving the rejected alternative. In most studies, however, these effects may be mixed. Distinguishing between the two aftereffects is a methodological challenge, because the target stimulus for capturing the negative aftereffect is usually either the same multi-alternative stimulus or a related stimulus for which a choice has already been made. This, in turn, can provoke a mechanism for enhancing the processing of a previously chosen alternative due to the previous processing of a similar or the same stimulus. In our previous experiments on the completion of fragmented word combinations (Kireev et al., 2022, Chernigovskaya et al., 2020), we also failed to distinguish between the expected aftereffects of positive and negative choices.

Overview of the study

The purpose of the present study was therefore to identify and distinguish between the positive and negative long-term effects of the implicit choice of solutions. To create the conditions for a choice at the first stage, the word fragment completion task was used, in which a letter was omitted in the same words in such a way that only one option for completion (unambiguous completion) or two options (orthographic neighboring words) (ambiguous completion) could be made. In order to induce an unconscious choice and, at the same time, to prevent awareness of both options to complete the stimulus, the words were presented with a contextual adjective, in which a letter was also omitted, which prevented automatic processing, but allowed the word to be completed to a single meaningful option. Thus, it was assumed that when completing ambiguous fragmented words, there is a competition of representations and, accordingly, a choice of one of them is necessary ("selection for awareness"). According to this hypothesis, we additionally control, whether the participants recognized the ambiguity of the stimuli and such trials were not included in the analysis. Since we expected the facilitation in retrieval of the chosen options / difficulty in accessing the rejected ones, the aftereffects of implicit choice were studied using a cognitive task traditionally employed to investigate implicit memory (Roediger, Weldon, Stadler & Riegler, 1992) – repeated completion of word fragments without a contextual adjective. To distinguish between the effects of positive and negative aftereffects, in the second stage, the word fragments always had only one option for completion, and either a word was presented that corresponded in meaning to the word presented in the first stage (the same word), or was an alternative to the word chosen in the first stage (a neighboring word). We assumed that the repetition of the word itself would provoke the classical priming effect (Tulving, Schacter & Stark, 1982). We expected that this priming effect would be enhanced by competition resolution (see, e.g., Gorfein, 2001; Gorfein et al., 2007) and, therefore, would be more pronounced for situations where ambiguous fragments were presented as a prime task. A negative aftereffect was also expected for the completion of an unambiguous word in the second stage (see Allakhverdov, 2000), which represented an alternative to the option chosen at the first stage. The presentation of words with only one unambiguous option of completion in the second stage should have allowed us to distinguish between the two types of aftereffects.

The following hypotheses were put forward: 1. When completing ambiguous fragments, selection mechanisms will be involved, providing an unconscious choice of one of the representation options, which will manifest in an increase of error rate and response time when completing ambiguous fragments compared to unambiguous ones (ambiguity disadvantage effect). 2. A positive priming effect will be observed, which manifests itself in faster response times and smaller number of completion errors when repeating the meaning of the previously completed word compared to a change in the meaning. 3. The resolution of the ambiguity of the fragment during its initial perception

should lead, on the one hand, to a faster recognition of the repeatedly presented meanings (a positive aftereffect) and smaller number of errors, and on the other, to a slower recognition of the previously non-selected meanings (a negative aftereffect) and larger number of errors compared to the condition in which initially presented stimulus was unambiguous.

Methods

Design

To verify the hypotheses put forward, a two-factor experimental design (2x2) was developed with within-subject varying of independent variables. The first independent variable was the ambiguity/unambiguity of the completion of the fragmented nouns in the first stage; the second independent variable was repetition of the noun from the first stage to the second stage / change to its neighbor. All conditions were counter-balanced. In total eight experimental lists were created. As dependent variables in both stages, the response time was measured (from stimulus onset until pressing the space bar to pronounce the word combination), as well as its accuracy.

Participants

A total of 56 volunteers (21 males, 35 females; mean age: 25 years, SD = 5.8) participated in the study. All participants were native Russian speakers. Advertising on social networks was a means of recruitment. The study was approved by the St. Petersburg Psychological Society Ethics Committee (Protocol No. 31 of 04/18/2024).

Stimulus material

As stimulus material, word combinations containing contextual adjectives and nouns, each with one omitted letter, were used. The stimulus material was compiled as follows: on the basis of previous studies (Kireev et al., 2022; Chernigovskaya et al., 2020) we selected 36 pairs of four- and five-letter neighboring words, differing from each other only by one letter (for example, baron-baton ('baron' – 'bread'), vino-kino ('wine' – 'cinema')). The frequency of selected words is 4.9 to 99.4 ipm (Savchuk et al., 2024), and the difference between the frequency of paired neighboring nouns do not exceed 47.9 ipm. The letter omission was at the beginning, middle or end of the word, and at the same time allowing either a single completion option (as, for example, for a fragmented word "k_tel" (kotel - 'pot'), where only the letter "o" can be placed in the place of omission), or a two-alternative completion (for example, a fragmented word "ko_el" can be completed both to the word

“kotel” (‘pot’) and to the word “kozel” (‘goat’) of the same noun. The number of words with a different letter omission place was balanced between unambiguous and ambiguous conditions. For each of the 72 nouns using the Rusvectōrēs service (Kutuzov & Kuzmenko, 2017), a contextual adjective was selected, suggesting a meaningful option for completing only one of neighboring words (for example, the adjective “rich” was selected to the noun “baron”, and the adjective “wheat” was selected to the noun “bread”). It is the contextual adjective, unique for each noun, that indicates which variant of completing the noun is correct in the condition of ambiguous completion. Omissions in adjectives always allow the only option for completing; 30 nouns-fillers were also selected, corresponding to targeted words by frequency and number of letters and accompanied by contextual adjectives. Omissions in fillers allow the only option for completing both the adjective and the noun. The fillers were added to reduce the probability that participants will predict the presence of words with ambiguous completion and search them specifically.

At the second stage, the same 72 target nouns and 30 fillers were used. Compared to the first stage, a different letter was always omitted in the words (for example, for the noun “baron”, fragmented words “_aron”/ “ba_on” were compiled at the first stage, and at the second stage “b_ron” was compiled). Therefore, fragmented words in the second stage were used without contextual adjectives and always allowed only one completion option, which differed from the completion in the first stage.

Equipment

The experiment was carried out using the Psychopy and Pavlovia software (Peirce et al., 2019). The study was conducted online, under the supervision of an experimenter, the experimenter asked participants to share their screens and observed them via video communication using Zoom / Telegram / Skype / Microsoft Teams applications.

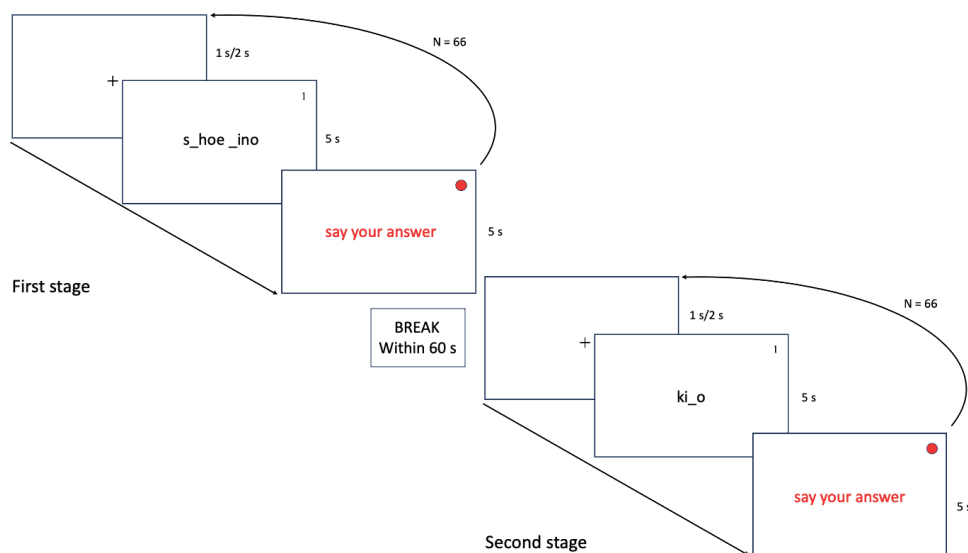
Procedure

Before the experiment started, the experimenter and the participant called each other using a platform to make calls that had screen-sharing function, so that the participant could start a screen demonstration during the experiment. Then the experimenter sent a link to the experiment. The experiment consisted of two stages. The experimental procedure is shown in Figure 1.

In the first stage, the participants performed the task of completing fragmented word combinations composed of contextual adjectives and nouns, each with one omitted letter. The participants were informed that the experiment was devoted to studying the processing of fragmented information; they were not informed of the presence of ambiguity of completion options. Before starting the first stage, the instructions were presented as well as five training combinations, and after the end of the training, the participant could ask the experimenter questions. Then 66 word combinations for completion were presented to the participant in a random order, 36 of which were target

words (in 18 of them, nouns have only one completion option, in 18 – two completion options) and 30 were fillers (always have only one completion option). Word combinations were presented in the center of the screen written in black Times New Roman font on a white background. First, a fixation cross appeared on the screen for 1 or 2 seconds, then a fragmented word combination appeared for 6 seconds, and the participant's task was to complete the fragmented word combination as quickly and accurately as possible into meaningful phrase and then say his answer loud. When the participant was ready to answer, he pressed the space bar – at that moment the phrase disappeared, the microphone was turned on, and the participant pronounced the phrase.

Figure 1
Experimental procedure



After the first stage, the participant could either proceed immediately to the second stage, or take a short break (within a few minutes).

The procedure and instructions for the second stage were identical to those of the first stage, except that in the second stage only fragmented nouns were presented, which participants had to complete as quickly and accurately as possible (see Fig. 1). 66 words were presented to the participant in a random order for completion, 36 of which were target words (18 words were the same as in the first stage, 18 words were changed to their neighboring words) and 30 were fillers.

After the experiment, the participant answered questions from the post-experimental interview, where, among other things, he was shown a list of stimuli from the first stage (in the fragmented form in which they were presented) and asked to mark all the word combinations in which the participant realized several possible options for completion. The trials with these word combinations were later excluded from the analysis.

Results

Data preprocessing

The analysis included only trials in which in the first and second stages it was possible to decipher the participants' oral answers in the audio recordings and in which the participants did not realize the ambiguity in stimuli (95% (1745) of trials). Additionally, the analysis included only nouns for which, after exclusion of the trials with realized ambiguity and trials with errors, there remained at least three presentations in each of the experimental conditions. Thus, the analysis of the results included 33 pairs of neighboring words out of 36, in which each of the nouns was correctly completed by the participants in more than 50 % of cases (both in unambiguous and ambiguous conditions of presentation).

Next, the "error type" variable was encoded. The errors made by the participants were distributed by type as follows: omission errors (no response) – 35 trials, substitution errors (completion of the target noun to its neighboring word) – 61 trials, and all other errors – 37 trials. If the participant correctly recognized the word combination, but did not press the spacebar to pronounce it (2 % of the total number of trials with the correct answer (40 trials)), the response time was recorded as 6 seconds (the maximum time of stimulus presentations).

Results of the first stage

To test the hypothesis of the ambiguity disadvantage effect, an analysis of the proportion of correct responses aggregated by stimuli was conducted during the first stage of completing word combinations, depending on the type of stimulus (unambiguous/ambiguous) using Student's t-test for paired samples. Significant differences were found: Participants gave less correct answers when completing ambiguous stimuli ($M = 0.88$, $SD = 0.12$), compared with unambiguous ones ($M = 0.96$, $SD = 0.08$), ($t = 4.46$, $df = 65$, $p < 0.001$, $d = 0.549$), see Fig. 2.

The analysis of stimulus completion time in the first stage included only correctly completed stimuli. Using the paired samples t-test, we compared the mean completion time of unambiguous and ambiguous stimuli (see Fig. 3). Significant differences were found: Ambiguous stimuli took longer to complete ($M = 2.19$ sec., $SD = 0.66$) than unambiguous ones ($M = 2.03$ sec., $SD = 0.47$), ($df = 65$, $t = 2.432$, $p < 0.05$, $d = 0.299$).

Figure 2

Comparison of the proportion of correct answers when completing stimuli in the first stage

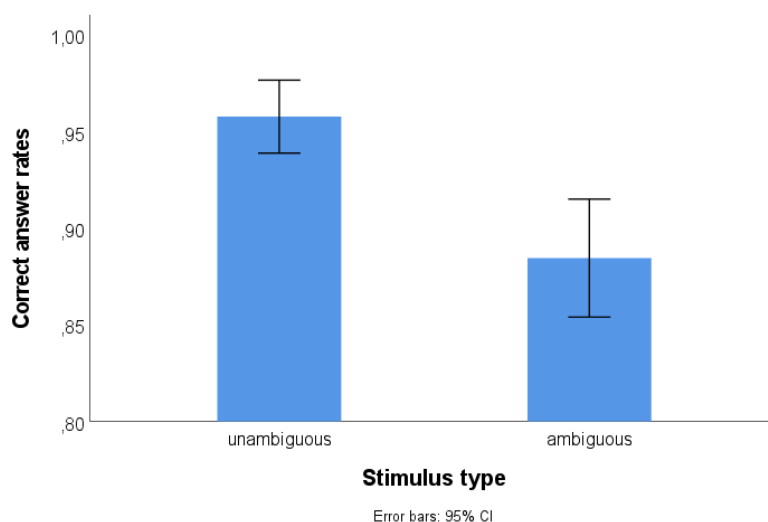
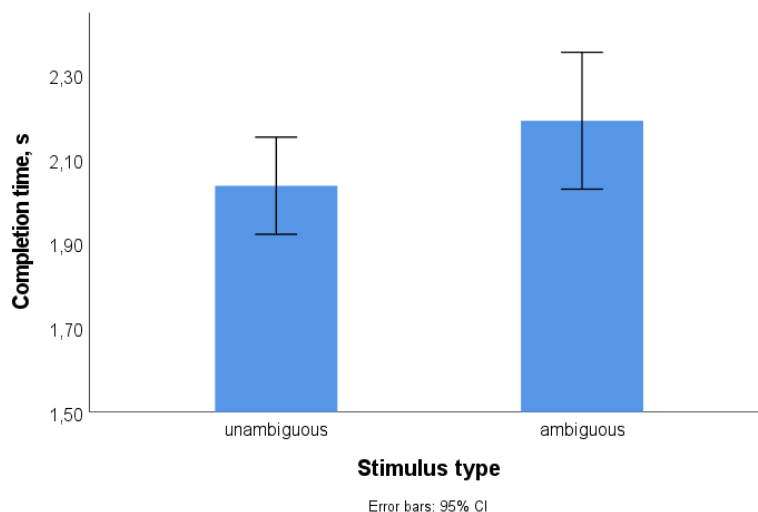


Figure 3

Comparison of completion time for unambiguous and ambiguous stimuli in the first stage



Thus, we discovered the ambiguity disadvantage effect, i.e., the ambiguous stimuli were completed by participants more slowly and with more errors. This confirms that our stimulus material actually models the situation of answers competition and allows us to proceed with the analysis of data from the second stage.

Results of the second stage

To test the hypotheses about priming effects, the influence of the stimulus type in the first stage (unambiguous or ambiguous) and the factor of change in the noun at the second stage (same or "alternative") on the completion of nouns was analyzed. We expected to reveal a positive priming effect – a decrease in the number of errors and a reduction in response times in the condition where the noun was the same as in the first stage for all stimuli – both ambiguous and unambiguous. We also assumed that, for ambiguous stimuli, repeating a noun at the second stage may result in a smaller number of erroneous completions and faster response times (hypothesis of aftereffects of a positive choice), and change in the noun to an alternative, on the contrary, may lead to an increase in the number of erroneous completions and longer response times (aftereffects of a negative choice), compared to unambiguous stimuli. The analysis included only trials from the second stage that corresponded to correctly completed stimuli in the first stage. Due to the small amount of errors (participants almost always completed the nouns correctly; among 1612 trials only 60 (3.7 %) erroneous completions), we decided not to analyze the correctness of completions in the second stage.

To analyze the impact of a stimulus type factor and a factor of change in the noun on the time taken to complete nouns in the second stage, we ran a linear mixed-effects regression model (see table 1). A dependent variable was the time taken to complete the noun in the second stage; fixed factors were the type of stimulus in the first stage and a change in the noun in the second stage; the participant factor was added as a random factor.

Table 1
The influence of a stimulus factor and a factor of change in the noun on completion time (results of the mixed-effects regression model)

Predictor	β	SE	z	[2.5%	97.5%]	p
Intercept	1.043	0.045	23.316	0.956	1.131	< 0.001
Change in the noun	0.189	0.040	4.676	0.110	0.268	< 0.001

Predictor	β	SE	z	[2.5%	97.5%]	p
Ambiguity of the stimulus	0.003	0.042	0.065	-0.079	0.084	0.948
Change in the noun x Ambiguity of the stimulus	-0.035	0.059	-0.597	-0.152	0.081	0.550
Log-Likelihood	-1421.57					

Note. Intercept is an unambiguous stimulus in the first stage, repeating a noun in the second stage.

A significant influence of the factor of change in the noun ($\beta = 0.189$, $SE = 0.040$, $Z = 4.676$, $p < 0.001$) was observed. When the noun was the same in the second stage as in the first stage it resulted in faster response times compared to the condition of presenting an alternative noun. The influence of other factors was not found.

Discussion

The purpose of this study was to test the assumption about the presence of negative and positive long-term aftereffects of making an implicit choice and to distinguish between their effects on the material of word fragment completion with a contextual adjective in the first stage and without an adjective in the second stage.

On the basis of available data, indicating that the presence of competition between different solution options leads to slower response times in different cognitive tasks (Heymen et al., 2006; Chernigovskaya et al., 2020; Kireev et al., 2022), we assumed that the presence of implicit competition in the task of completing ambiguous word fragments leads to the need for choice, which would manifest in slower response times and an increase in error rates.

The results of the first stage confirmed the hypothesis of the involvement of selection mechanisms under the condition of the existence of alternatives. Indeed, the time taken to correctly complete word combinations containing two-alternative fragments to meaningful phrases was significantly longer than the time taken to complete unambiguous ones. Also, participants gave, on average, fewer correct answers when completing ambiguous stimuli than when completing unambiguous ones. The obtained results indicate the presence of the ambiguity disadvantage effect when performing this

task and are consistent with the results obtained using homonyms (Piercey & Joordens, 2000; Maciejewski & Klepousniotou, 2020; Rodd et al., 2002), using neighboring words when completing fragmented stimuli with two possible completion options (Heymen et al., 2006), and also replicate the effect we previously obtained using the same task (Chernigovskaya et al., 2020; Kireev et al., 2022). There are some differences between our design and that used by other authors. First, we recorded in our experiment, based on the post-experimental interview data, whether the participants were aware of both possible completion options and excluded those trials in which the ambiguity of the stimuli was realized. This gives us reason to assume that the resolution of competition was more likely to occur unconsciously. However, since we only retrospectively determined whether participants noticed the ambiguity, it is impossible to entirely rule out the interpretation that the slowdown is observed due to conscious competition and the selection of the appropriate option. Secondly, we also provided a contextual adjective that indicated what choice was relevant. To ensure that the choice was not completely determined by the context, the letter was omitted from the adjective. However, the ambiguity disadvantage effect in the completion of ambiguous fragments was evident even in the presence of a contextual adjective.

In our second hypothesis, we assumed that there would be a classical priming effect (Tulving et al., 1982) from word repetition on the word fragment completion task. We found a positive priming effect that manifested itself in faster response time when completing the repeatedly presented words. We should note that in the second stage, although the word itself has been repeated, the omitted letters differ from the ones omitted in the first stage. Since the long-term perceptual priming effect is traditionally most strongly manifested under conditions of identical form repetition, the result obtained cannot be explained exclusively by perceptual priming, sensitive to changes in the surface characteristics of the stimulus between the training and testing stages (Roediger & Blaxton, 1987). Consequently, we assume that the priming effect that occurred is associated with lexical processing. We should also note that the positive priming effect we obtained was observed despite the fact that the priming effect during the repeated reading of words is usually significantly less pronounced if the word was presented in context during the first reading (Levy & Kirsner, 1989; MacLeod, 1989; Smith, 1991).

However, the main assumption of our study was that as a result of resolving implicit competition, a result of the positive choice would be observed – i.e. an increase in the positive priming effect for ambiguous fragments compared to unambiguous fragments, and negative aftereffects of choice would also be observed, i.e. the negative priming effect would be more pronounced for rejected alternatives under the ambiguous condition compared to unambiguous options. Our data did not confirm this hypothesis. The magnitude of the priming effect did not depend on which fragment was completed in the first stage - ambiguous or unambiguous. Our results contradict the models of M. Anderson, M. A. Gernsbacher, D. Gorfein, and V. M. Allakhverdov discussed above, which suggested a long-term positive and/or negative aftereffects of choice in a situation of

implicit competition, as well as the spread of suppression to lower levels, as predicted by the model of M. A. Gernsbacher. The results are consistent with models in which the selection is made each time, depending on the task, and/or the selection is very short-lived, supported only by local inhibition mechanisms (McClelland & Rumelhart, 1981; Duffy et al., 1988; Dixon & Twilley, 1999). It is also worth noting that, in general, the effects of inhibition from neighboring words in the priming paradigm are studied for very short-term intervals (up to 600 ms) (see, e.g., Massol, Molinaro & Carreiras, 2015). In our experiment, we did not find long-term effects. This can indicate that the selection takes place very quickly and that maintaining the chosen option is not necessary in such tasks. It is possible that, since the task of identifying the word from a fragment in the unambiguous condition relies mainly on bottom-up perceptual processing (from letters to words), the word is retrieved automatically. Consequently, this level of processing is sufficient to make the appropriate choice in the second stage, and the higher-level processing required to cause the aftereffects is not engaged.

It is also possible that, although we vary the unambiguity/ambiguity of completion by omitting a letter, thus provoking competition between neighboring words in the ambiguous condition, competition between neighboring words could also arise in the unambiguous condition. Under both the unambiguous and ambiguous conditions, other neighboring words could be activated at the first stage due to the coincidence of letters that were not varied in our experiment (i.e., *ba_on/_aron* could provoke the activation of not only the lexical units "baron/baton", but also "baran", "barin", etc.). Their number, frequency, and the position of matching letters between the word presented and the neighboring word could affect access to the word (Slyusar, Alekseeva, 2017). For example, the influence of the number and frequency of neighboring words on the short-term priming effect was shown in the lexical decision task. Priming from the repetition of words is more pronounced for words with a smaller number of neighbors than for words with a larger number of neighbors (Perea & Rosa, 2000), which indicates the emergence of competition already at the early stages of lexical processing. However, in this study, the prime word was always presented without omitted letters. The number of other orthographic neighbors that could be activated despite the omission of a letter was not controlled in our experiment and, accordingly, competition could have arisen both in the unambiguous condition and in the ambiguous one, provoking an increase in the positive priming effect from word repetition, analogous to the predictions of D. Gorfein's model for ambiguous words (Gorfein, 2001). It is also possible that we did not find any aftereffects due to the fact that a sufficient level of competition between the response options was not achieved in the first stage. Thus, studies of retrieval-induced forgetting suggest that suppression effects depend on the strength of competition in the retrieval practice stage (Anderson, 2003) and are most pronounced for explicit memory tests (e.g., free recall). Our results are consistent with those data in which retrieval-induced forgetting has not been demonstrated in such an implicit memory test as word fragment completion (Butler et al., 2001) and are inconsistent with the results of the experiment by

Bajo et al., where the effect was demonstrated (Bajo et al., 2006). However, the procedure of this experiment was significantly different from ours: firstly, participants in the study performed a memory task in the first stage, and secondly, they then underwent a retrieval practice, which should have increased the competition of lexical representations. Although we demonstrated the presence of implicit competition in the first stage, it may not have been strong enough to produce the desired effect and has therefore not been manifested in implicit memory tests such as word fragment completion task.

Future research directions could focus on testing the suggested explanations, particularly the inclusion of semantic processing in the second stage of the study.

Conclusion

The aim of this study was to test the hypothesis that an unconscious choice made once between the solution options can persist and influence further processing of information related to the choice made by enhancing the processing of the selected option and inhibiting the retrieval of the rejected one. In our study, the ambiguity disadvantage effect was demonstrated on the performance of word fragment completion task with two completion options. The effect was observed in the presence of contextual adjectives and control over the awareness of the choice alternatives. However, neither positive nor negative long-term effects of resolving competition on the task of identifying a word from a fragment in the second stage, involving low-level processing mechanisms, were found.

Overall, the results tend to support models that do not imply long-term selection effects. However, future research should test the hypothesis that aftereffects will emerge in tasks requiring semantic processing.

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Conflict of Interest Information

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Overcoming Difficult Life Situations in Alcohol-Dependent Men and Women: The Potential of Psychocorrectional Group Sessions

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Abstract

Introduction. The article is devoted to the analysis of strategies for overcoming difficult life situations of men and women with alcohol addiction. Due to the current need to revise the concepts of rehabilitation measures and psychological impact on persons belonging to the addictive category of the population, we have developed and implemented a program of group sessions with patients and evaluated its effectiveness.

Methods. The study was conducted among 120 respondents in the Lugansk Republican Narcological Dispensary: 60 patients with I-II stages of chronic alcohol addiction (30 men and 30 women), as well as 60 employees of the medical institution without alcoholism in the anamnesis (30 men and 30 women). The method of psychological testing and psychodiagnostic tools were used: Test "Overcoming Difficult Life Situations"; "Coping Behavior Questionnaire"; "Stress Susceptibility Questionnaire"; "Level of Subjective Control Questionnaire"; Michigan Alcohol Screening Test. The group psychocorrectional sessions were aimed at increasing the level of expression of adaptive strategies for overcoming difficult life situations in men and women with alcohol addiction, along with the reduction of dysfunctional and maladaptive behavioral strategies; increasing the level of internality of the locus of personality control, as well as reducing the severity of stress and actualization of resources for its overcoming. **Results.** Addictive men prefer to engage in confrontation with others with a clear sense of self-pity. Women are oriented towards obtaining effective and emotional support and delegating personal responsibility. Psychocorrectional group sessions contribute to the manifestation of active and goal-oriented strategies of effective resolution of difficulties. The increase of self-control,

acceptance of responsibility, as well as the decrease in susceptibility to stress with the increase in internality of the personality are resources for the formation of constructive behavior of alcohol-addicted patients. **Discussion.** The externality of the addicts control locus and low stress resistance indicate a variant of the destructive manifestation of personal resources. The formation of a cognitive and practical basis for functional strategies is possible through a comprehensive rehabilitation process.

Keywords

difficult life situation, alcohol addiction, strategies for overcoming difficult life situations, coping, dysfunctional behavior, psychocorrection, training impact.

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Introduction

The realities of modern society expose people to the need to overcome difficult life situations, without losing their own effectiveness. The success of the interaction of the individual with the surrounding world lies in the assessment and relief of stress, its timely reduction. In this regard, the predominance of constructive and functional strategies in the behavioral repertoire of the individual has special significance for their personality, which is also one of the factors of integrity, stability and adaptability of the personality (Abdurakhmanov, 2019). The integral indicator of a difficult life situation is a disruption of the adaptation mechanism, an increase in the intensity of psychological stress (Evtushenko, Karnaukhov, 2018).

The impact of a difficult life situation on an individual manifests itself in obstacles to its full functioning. Under conditions of a difficult life situation, a person needs changes and restructuring (Nartova-Bochaver, 1997). Restructuring requires an increase in social activity when choosing resources and strategies to overcome a difficult life situation (Parfenova, 2009).

The focus of attention of researchers in the field of psychology of coping behavior has for the most part been concentrated on the study of general and age-related features of the behavior repertoire of an individual without pronounced pathologies and deviations (Heim, 1988; Lazarus, 1998; Nartova-Bochaver, 1997; Kryukova, 2007; Kossova, 2005; Covered, 2006). Separately, the behavior and cognitive assessment of patients with chronic alcoholism in the context of encountering with difficulties was studied (Biggs, Brough & Drummond, 2019; Kelly, Humphreys & Ferri, 2020; Spivakovskaya, Lutsenko, 2021; Tsapenko, 2021).

Constructive behavior and the acquisition of knowledge, skills, and skills for coping with difficulties not only serves as a factor of personality protection from destructive phenomena, but also as a factor that contributes to the recovery, actualization of the adaptive potential, the formation of life experience without addiction and the development of the ability to resist the influence of the external environment for persons exposed to narcological diseases (Fadeeva, Lanovaya, 2024).

The realities are characterized by a greater normalization of the lifestyle, including latent or irregular drinking regardless of gender. There is a unification of condemnation of female alcoholism in society, which leads to its universality as a disease (Mandel, 2018; Stepanova, Salimova, 2020; Shaidukova, 2005).

In addition, the data on the need to revise the concept of treatment and rehabilitation of addictive patients are mainly due to the low rehabilitation potential of patients, the severity of anosognosia (Yalton, 2017), along with the lack of stability of external and internal motivation, the weakness of the "I-concept" and the lack of environmental and internal resources to cope with difficulties (Shaidukova, 2005). The task arises of forming and subsequent implementation of a group training impact program that contributes to the corrective and auxiliary effect in terms of constructive and socially acceptable behavior in the addictive category of the population (Bordonosenko, 2023a).

Thus, the goal of the study is to research the strategies for overcoming difficult life situations among men and women with alcohol addiction, to develop a training program for accompanying addicts and to evaluate its effectiveness.

The main goals of the developed correctional measures can be highlighted as follows: formation of cognitive and practical foundations of skills for the use of effective and problem-oriented strategies in men and women with alcohol dependence, as well as reduction of dysfunctional and maladaptive behavior; increasing the level of internality of the personality control locus as well as reducing the degree of stress and actualization of resources for its overcoming (Bordonosenko, 2023b).

Methods

Sample

An experimental study of 120 respondents (resp.) was conducted on the basis of the Lugansk Republican Narcological Dispensary, where some author's studies were previously conducted (Bordonosenko, 2023a). A group of alcohol-dependent respondents (group 1) with stage I-II disease (60 reps.) was formed, of which 30 men (average age 44.6 years) and 30 women (average age 45.1 years).

After the initial presentation of psychological tests (Overcoming Difficult Life Situations (ODLS) test; questionnaire "Methods of controlling behavior" Lazarus R., Folkman S. (Kryukova, Kufiyak, 2007); questionnaire determining the tendency to develop stress

(according to T. Nemchin and S. Taylor); questionnaire "Level of subjective control" (LSC) Bazhin EF, Golyukina EA, Etkind LM; Michigan alcohol screening test), an experimental group was formed for further participation in the cycle of sessions developed within the framework of this study. The experimental group included 10 men (average age 46.2 years) and 10 women (average age 47.4 years) with I and II stages of chronic alcohol addiction. A control group was also formed to search for indicators of program effectiveness: 10 men (average age 45.9 years) and 10 women (average age 46.2 years) with stage I and II disease.

In addition, respondents without a history of alcohol dependence (Group 2) were studied, consisting of 30 men (average age 43.3 years) and 30 women (average age 38.3 years). Respondents in Group 2 are medical staff of the Lugansk Republican Clinical Psychoneurological Hospital.

Techniques

The psychodiagnostic toolkit includes:

1. Test "Overcoming Difficult Life Situations" in the adaptation of Vodopyanova N. E. (Vodopyanova, 2009);
2. Questionnaire "Methods of coping behavior" Lazarus R., Folkman S. (Krukova, Kufiak, 2007);
3. Questionnaire determining the tendency to develop stress (by Nemchin T. A. and Taylor S.) (Raigorodsky, 2001);
4. Questionnaire "Level of Subjective Control";
5. Michigan Alcoholism Screening Test (MAST).

Data processing

Statistical data processing was carried out using the Statistica program 13.3. The non-parametric U-criterion of Mann-Whitney was used to identify differences in the results of non-addicted and addicted respondents, as well as differences due to gender, differences between the control and experimental groups. The Spearman rank correlation method was used to identify features of choosing strategies to overcome difficult life situations in men and women with alcohol addiction. The Wilcoxon T-criterion was used to evaluate the effectiveness of the developed training program in the experimental group.

Results

Description of training impact

The training impact involved 8 group meetings in a mixed composition. The selection of participants in the group was carried out in compliance with the ethical regulations and voluntary consent of patients, as well as taking into account the severity of the level of their maladaptive behavior strategies in combination with stress exhaustion and predominant externality of personality.

The program was developed based on the elements of cognitive-behavioral therapy aimed at creating a cognitive and practical basis for functional skills and working with beliefs (Beerse, Van Lith, & Stanwood, 2020); gestalt approach was integrated into the therapy to build the foundations for recognizing, monitoring and verbalizing one's own state; elements of an existential approach were integrated to confront the boundaries of the self and explore the images of the self-concept; body-oriented therapy techniques combined with art techniques were integrated to ensure the relaxation component of the sessions (Kelly, Humphreys & Ferri, 2020).

The program of psychocorrectional sessions is presented in Appendix.

Screening test for alcoholism

According to the Michigan Alcoholism Screening Test, no alcohol dependence was detected among respondents in Group 2. The suspicion of the syndrome of heavy alcohol use in this group for 10% of men (3 respondents) and 3.3% of women (1 respondent) is an intermediate stage of abusive drinking behavior and cannot be correlated with the established diagnosis. The subjects in Group 2 do not have a history of diagnosed alcohol dependence. In Group 1, alcohol addiction was found in 100% of the subjects (60 respondents), during the period of diagnostics, the respondents were patients of narcological departments.

Overcoming difficult life situations

The application of the test "Overcoming Difficult Life Situations" in the adaptation of N.E. Vodopyanova reflects the tendency towards increased irritability, conflict behavior, and aggressive tendencies in men with chronic alcoholism (SD = 14.2). At the same time, the behavioral repertoire is characterized by a tendency towards frequent unjustified and exaggerated self-pity (SD = 10.3). The tendency to delegate responsibility to the reference group is observed in women with addiction when coping with difficulties, along with

the expectation of emotional support and interest in improving their well-being (SD = 23.4). However, negative experiences do not find their constructive resolution and lead to valuing alcohol as a means to cope with stress (SD = 24). The respondents with addiction tend to have a similar cognitive appraisal of difficulties, forming distinct negative images of possible consequences, along with a decrease in goal-oriented and problem-oriented behavior.

Training sessions can reduce maladaptive manifestations of self-pity (Temp. = 0 in men and Temp. = 5 in women). The activity-oriented component of overcoming difficulties, control over the situation becomes more pronounced in men (Temp. = 3) and women (Temp.= 10) with alcohol addiction after attending training sessions (Uemp = 98), which may indicate an increase in the ability to analyze the situation, plan and execute the necessary actions to resolve the problem.

Coping strategies

In the experimental group, the questionnaire "Ways of Adaptive Behavior" by Lazarus R. and Folkman S. indicates a marked predominance of confrontation combined with avoidance of difficulties among men (70% of respondents) with low self-control (90% of respondents), indicating impulsiveness and loss of purposefulness of behavior. Attending the training sessions reduces excessive tension of maladaptive coping strategies. Before attending the training, women had a pronounced need for social support (80% of respondents), low levels of responsibility (90% of respondents) and problem-solving planning (100% of respondents).

The impact of training sessions increases the tendency to choose constructive behavior strategies. It can be concluded that the training impact contributes to a positive dynamics and change in behavior towards greater adaptability. Moderate use of confrontation in difficult life situations indicates the formation of skills of constructive defense of one's own position, which is confirmed statistically: Temp.= 9 in men and Temp.= 3 in women. The results indicate a change in favor of a more independent and active resolution of difficulties (Temp.= 1 in men and Temp.= 0 in women).

The given sessions increase acceptance of responsibility, establish a causal link between personal contribution to the resolution of a situation, as well as the consequences of such intervention (Temp.= 0 in men and Temp.= 6 in women) and reduce the likelihood of accumulation of unresolved situations (Temp.= 3,5 in men and Temp.= 6 in women). Maladaptive manifestations are preserved in patients not involved in psychocorrection.

Tendency to develop stress

Indicators according to the scales of the questionnaire determining the tendency to develop stress (according to T. A. Nemchin and S. Taylor) in men and women with alcohol dependence before and after the training are presented in Figure 1.

Before attending the group sessions, the pronounced stress state and low stress resistance indicate insufficient stability of the alcohol-addict respondents and the development of negative consequences in the absence of appropriate measures (see Figure 1). The intensity of stress in addicted men and women may be intensified through ineffective responses to difficult life situations, thereby encouraging them to repeat alcohol consumption. Training sessions contribute to increasing patients' stress resilience. Training impact acts as a measure that prevents the development of a stressful state, and also promotes the mastery of skills of self-regulation of behavior, relaxation techniques, and reassessment of the situation (Temp.= 6.5 in men and Temp. = 0 in women). A high tendency to develop stress is characteristic of the respondents of the control group, who did not attend the sessions (Uemp = 125.5).

Figure 1

Correlation of stress resistance levels of men and women in the experimental group before and after training impact according to the questionnaire determining the tendency to develop stress (according to T.A. Nemchin and S. Taylor)



Level of subjective control

Let us consider at the results obtained by the LSC questionnaire (Bazhin E.F., Golinkina E.A., Etkind L.M.). In the absence of appropriate corrective measures, the personality of alcohol-addict men and women is characterized by a clear predominance of externality in all the studied spheres. Significant events, regardless of their scale and emotional charge, are perceived as the result of the influence of uncontrollable circumstances from the outside (100% of respondents). Building the foundation for the manifestation of internality of the personality of alcohol-addicted people will contribute to the increase in self-efficacy and the sense of control over situations, the ability to take actions to transform them. Despite the previously identified importance of receiving social support, women with alcohol addiction are not inclined to show initiative and responsibility both in the family (70% of respondents) and in interpersonal communication (100% respondents), expecting active actions from their environment. Passive position and delegation of responsibility on others is also noted in addicts, regardless of gender, in relation to health, revealing passive position in treatment and manifestations of alcoholic anosognosia (100% of men and 100% of women).

Group sessions promote responsibility in the area of emotionally positive events in 50% of men (5 respondents) and 30% of women (3 respondents), which is confirmed statistically: $Temp. = 6$ for men and $Temp. = 5.5$ for women. Respondents who attended the training sessions show a greater degree of general subjective control ($U_{emp} = 90$) and internality in the area of achievements rather than those in the control group ($U_{emp} = 101$). The training effect contributes to an increase in responsibility in situations related to family interaction in 40% of men (4 respondents) and 50% of women (5 respondents), but significant indicators were identified only in women ($Temp. = 2$), which is likely to be due to their greater orientation to interaction with other people, getting attention and empathy. However, externality in the area of health at this stage is not subject to correction, which is presumably due to the chronic course of addiction and the progression of the disease, along with manifestations of anosognosia and unstable internal motivation for sobriety.

Discussion

The study allows us to conclude about the distinct manifestation of maladaptive and non-constructive strategies among men and women with alcohol addiction. For patients with this narcological disease, the phenomenon of alcohol degradation is characteristic, which, most likely, has an effect on the absence of intersexual differences in preferred strategies for coping with difficult life situations (Bratus', 1988). For respondents with

alcohol addiction, it is characteristic to manifest hostility in combination with high levels of aggression and confrontation with reduced self-control, as well as avoiding responsibility and the need for effective resolution of the situation (Folomkin, Veprencova, 2021). Psychoactive drugs act as a leading component in coping with difficult life situations (Beerse, Van Lith & Stanwood, 2020). The social support process also has a pseudo-adaptive character: when the basic strategy of "search for social support" develops, the patient is oriented towards the local alcoholic environment, and not towards the prosocial supportive behavior (Belokolodov, Malkova, 2016).

Given that alcohol consumption has a destructive effect on the nervous system and higher nervous activity, the uncoped psychoemotional stress in maladaptive behavior also reduces the resistance to the influence of stress situations (Saunders, Degenhardt, Reed & Poznyak, 2019). Alcohol addicts, are more characterised by a high propensity to develop stress, a general depletion of internal personality resources (Castillo-Carniglia, Keyes, Hasin & Cerdá, 2019). Taking into account the data on the pathogenesis of alcohol dependence, it is noted that in addictive women this maladaptive mechanism proceeds rapidly and intensively, which is due to the high progression of the disease and more severe clinical manifestations in general (Bohan, Ankudinova, Mandel, 2013).

It is important to note the pronounced lack of resources for coping with difficulties that connect the personal characteristics of the addict and the social situation: deformed and negative "self-concept" in combination with a lack of manifestations of empathy and affiliation, externality of the locus of control, predominantly in all areas of social relations (Milayeva, 2023; Stepanova, Salimova, 2020). The mentioned characteristics are evaluated as destructive psychological factors that enhance the individual needs of addicts for alcoholic beverages (Goncharova, 2022). A distinctive feature of this model is the absence of factors that ensure the preservation and stability of the psychological well-being of patients, which can additionally enhance maladaptation (Yaltonsky, 2017). In the context of the model presented above, addiction acts as a maladaptive, stress-coping behavior. The studies of Castillo-Carniglia et al. (2019) also indicate a direct connection between the effectiveness of overcoming difficulties and a decrease in the frequency of relapses.

The addict's behavior largely depends on how the current or potential situation is perceived and assessed, the level of development of basic coping resources is also important: self-confidence, competence, degree of recognition of the presence of addiction, self-control (Barman, 2019; Khantzian, 2021). In the situation of inclusion of alcohol addicts in the process of mastering the cognitive and practical foundations of adaptive strategies, the progressive process of the disease can become controllable and correctable (Belokolodov, Malkova, 2016; Rachok, 2001).

Considering the need to form a stable inner motivation, to overcome the contradictory behavior of patients, as well as to develop adaptive and functional strategies, during the comprehensive rehabilitation process, both individual and mixed group classes can be conducted (Breuninger et al., 2020). Preference is often given to personality-oriented therapy, and the implementation of the sobriety program is also monitored (Kuhlemeier et al., 2021).

Conclusion

According to the obtained results, alcohol addicted men and women are prone to pronounced aggression and confrontation in combination with low self-control and responsibility, along with avoidance of active and proactive problem solving. In addition to these maladaptive manifestations, addicts are characterized by a pronounced orientation towards receiving social support and sympathy from their environment, orientation towards a local alcoholic social environment and evaluation of alcohol as a means of relieving psychological and emotional stress.

The developed training program demonstrates its effectiveness in the aspect of increasing the expression of active and targeted strategies for overcoming, aimed at effective problem solving, both in alcohol addicted men and in women. Increasing tendencies towards self-control, acceptance of responsibility in combination with control over the stressful situation with an increase in the internality of the individual, as well as decreasing tendency to stress development act as important intrapersonal resources, contributing to the formation of constructive behavior of alcohol-dependent patients.

The data of the conducted research may be useful not only in the situation of narcological treatment against the background of a given diagnosis, but also act as a basis for the preparation of psychoprophylactic programmes and educational events among the adolescence and youth.

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Appendix

Group Session Program for Men and Women with alcohol addiction

Goal. To increase the level of expression of adaptive coping strategies in difficult life situations in men and women with alcohol addiction, along with a reduction in dysfunctional and maladaptive behavioral strategies; to increase the level of internality of the locus of control of the personality, as well as to reduce the severity of stress and actualisation of resources to overcome it.

Objectives: to provide general psychological education to men and women with alcohol addiction attending training sessions; to teach the skills of recognizing, monitoring, and verbalizing their own emotional state and identifying the causes of its occurrence; teach adaptive behavior skills; teach skills for dealing with aggressive behavior, expressed in confrontation and anger; develop the ability of self-regulation and strengthen the ability to differentiate personal experiences; teach skills of taking responsibility and reducing the expression of the avoidance strategy; activate positive personal resources and increase internality as a personality characteristic; investigate and integrate the "Self-concept" images of the group members, increase their level of reflection and build internal psychological supports, positive personal resources for overcoming difficult life situations; form the cognitive basis of confident behavior, open expression of feelings; form the cognitive basis of understanding psychological barriers in interpersonal communication and practical work on forming, consolidating the skills of their overcoming; consolidate skills of open expression of both positive and negative feelings of the participants of the training based on the actualization of their personal experience; activate positive intra-individual resources of the training participants, self-reflection and positive reassessment of the main aspects of the personality.

Group inclusion criteria: Alcohol-addicted men and women who show a high level of expression of maladaptive coping strategies in difficult life situations: aggression, confrontation, avoidance, seeking social support and psychoactive drugs (alcohol), along with low stress resistance and a predominance of externality of the locus of control.

Form of conducting sessions: group work of a mixed group (10 men with alcohol addiction and 10 women with alcohol addiction).

Methods and techniques used: cognitive behavioral therapy: formation of the cognitive basis of functional skills using thematic information blocks; methods of existential therapy: Methods of clarification and elaboration, methods of "life path (continuum)," methods of confrontation with existential boundaries "I" (collisions with boundaries of proximity),

methods of deepening freedom of choice and responsibility: awareness of maladaptive defenses and methods of evading responsibility, motivation letter to the future; elements of body-oriented therapy; gestalt approach in therapy: techniques "Here and Now," "Building Living Chains," "Integrating Awareness," "I Like It/I Don't Like It"; art-therapeutic techniques: Metaphorical self-portrait, "Map of my soul».

Total work time, frequency of meetings: 8 psychocorrectional meetings, 3 times a week.

Duration of the correctional session: 8 sessions of 90 minutes each.

Expected result: Reduction of the severity of maladaptive strategies for overcoming difficult life situations, as well as an increase in indicators related to functional and adaptive behavior: acceptance of responsibility, planning for solving the problem, positive reassessment of the situation.

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Author Contributions

Svetlana S. Kuzenko – formulation of the research concept, development of the research methodology; preparation of a plan and scientific editing of the text of the article; preparation of appendices of the article and description of the program of psychocorrection group classes; translation and preparation of the article in English.

Anastasia S. Bordonosenko – review of studies on the article problem, statistical processing of empirical data in the Statistica 13.3 program, interpretation of study results, formulation of conclusions, development and approbation of the group training session program, formation of methodological recommendations.

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Conflict of Interest Information

The authors have no conflicts of interest to declare.

Cyber Socialization Engagement and Psychological Well-Being of University Students

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Abstract

Introduction. The article is devoted to the problem of psychological well-being of university students under the conditions of cyber socialization and digitalization of the educational environment. The cyber socialization engagement was considered an ambivalent phenomenon. Psychological well-being was understood in a broad sense, encompassing indicators of life and study satisfaction, participation in studies, organizational identity with university faculty, and the expression of Dark Tetrad personality traits. The purpose of the study was to determine the impact of the students' cyber socialization engagement on their psychological well-being. **Methods.** The sample included 315 students from Russian universities. The measures used were "The Cyber Socialization Engagement Questionnaire", "The Organizational and Suborganizational Identity Questionnaire", "The Satisfaction with Life Scale", "The Short Dark Tetrad Scale", and the questionnaires "Utrecht Work Engagement Scale" and "The Brief Index of Affective Job Satisfaction" modified for the students' learning context. **Results.** Destructive cyber socialization engagement was found to decrease overall satisfaction with life, learning engagement, learning satisfaction, and identification with faculty, and to increase the expression of the Dark Tetrad traits such as psychopathy and sadism. Constructive cyber socialization engagement increases life satisfaction, learning engagement, learning satisfaction, and organizational identity, and decreases the expression of Dark Tetrad traits such as psychopathy and sadism. **Discussion.** A new and specific ambivalence of the influence of engagement on cyber socialization was revealed: constructive engagement,

along with an overall positive influence, increases the expression of Machiavellianism, and destructive engagement decreases the expression of narcissism. It is shown for the first time that overall cyber socialization engagement can have a significant ambivalent effect on the psychological well-being of university students. **Conclusion.** The obtained results substantiate the necessity of predicting such influence within the framework of work on ensuring psychological safety of the educational environment, creating conditions for successful personal, social, and professional development of university students in the conditions of intensive digitalization of education.

Keywords

Cyber socialization engagement, constructive engagement, destructive engagement, university students, psychological well-being, life satisfaction, learning satisfaction, learning engagement, organizational identity, Dark Tetrad of personality

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Introduction

University students are a part of young people, interesting in many ways. First, they form the dominant part of the future intellectual and spiritual elite of society, which determines the strategic directions and achievements of its subsequent development. Secondly, despite their young age, they are already in a certain sense an established, self-actualized part of the youth, who have achieved a high enough social status and therefore deserve a parity dialogue and interaction with representatives of older generations. Third, already at the stage of studying at university, these young people are highly socially active and often demonstrate high achievements in various fields of activity: science, technology, sports, technological among social innovations, and others. In addition, due to their normative inclusion in educational processes and educational space, university students are a fairly accessible category of respondents (compared, for example, with many categories of working professionals) to conduct heterogeneous scientific research. This list can be continued, but the reasons why heterogeneous psychological research carried out on samples of university students is very widely represented, including with regard to heterogeneous aspects of well-being: physical, mental and social health, success of personal and professional development, psychological safety of the individual, identification of risk factors for deviant behavior, etc., become clear from the arguments already given.

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We will limit ourselves to the direction of such studies related to psychological well-being, which we will understand in a broad sense, encompassing heterogeneous psychological manifestations of success (normativity, etc.) of mental, personal, and social development. Note that in the literature there is a point of view according to which the concepts of subjective and psychological well-being are distinguished: for example, Anglim et al. (2020) in a meta-analysis discuss in detail the differences between these concepts and provide many examples of studies of subjective and psychological well-being, performed, among others, on samples of university students. From our point of view, subjective well-being is a special case of psychological well-being, and row-by-row opposition violates the existing generic species relations between these concepts.

Thus, we will consider the psychological well-being of university students in a broad sense, including, among other things, indicators of traditionally distinguished subjective well-being (such as subjective life satisfaction). Many other authors use a similar broad understanding (see, e.g., Denisova et al., 2022). At the same time, we specify the subject of the study, considering the modern conditions of education, conditioned by the processes of informatization and associated, on the one hand, with the formation of a digital educational environment, and on the other hand, with a qualitative change in the socialization of younger generations, manifested in the expansion of cyber socialization.

In theoretical and methodological terms, cyber socialization is a construct with the help of which researchers try to explain not so much technical-technological but sociopsychological processes of information society formation. The topic of cyber socialization has become increasingly popular among researchers in recent years, including in relation to university students (Shitova & Maslakov, 2020). At the same time, along with the concept of cyber socialization, many other concepts are used for similar purposes, such as *digital socialization* (Podbolotova et al., 2021), *virtual socialization* (O'Connell et al., 2022, p. 159), *web-based socialization* (Haase et al., 2021), *Internet socialization* (Honnekeri et al., 2017), *computer-mediated socialization* (Asghar et al., 2021). Some authors believe that such concepts are semantic equivalents: for example, it is noted that "Internet socialization", "cyber socialization", and "digital socialization" are synonyms (Podbolotova et al., 2021). However, despite their proximity, each of these concepts has its own specificity. In other words, the disadvantage of such equivalents is their excessive specificity. Thus, *computer-mediated socialization* emphasizes the role of computers, but misses the role of gadgets (e.g., smartphones); *virtual socialization* rightly captures the virtual nature of such interactions, but misses their inextricable intertwining with the real world (e.g., paying for transportation by credit card, a student gets access to a nonvirtual service); *digital socialization* ignores the fact that for socialization in cyberspace, the technological nature of information signals (digital or analog) does not really matter; types such as *web-based socialization*, *social media socialization*, etc. limit the scope of cyber socialization to specific types of cyber technologies; *online socialization* ignores the fact that some cyber socialization processes can take place offline, etc. The term "cyber socialization" is devoid of such shortcomings: due to its obvious conventionality

(provided by the semantic prefix «cyber»), it is the most general, covering various aspects of socialization in cyberspace. At the same time, the prefix "cyber" is used in the formation of other concepts that are a wide range of virtually universally recognized, such as cybersecurity, cyberspace, cybertechnology, and others.

Thus, we will consider cyber socialization as the broadest generic concept that includes many more specific manifestations.

With this in mind, we note, first of all, that there are a large number of theoretical works that develop certain aspects of cyber socialization (e.g., Pleshakov, 2023; Soldatova & Voyskunsky, 2021). Taking into account such studies, we will rely on our own concept of cyber socialization, which substantiated the construct of "cyber socialization engagement" that has received operationalization (Lenkov et al., 2019) and empirical validation in a number of previous studies (Lenkov & Rubtsova, 2019, 2022; Rubtsova & Lenkov, 2020).

Similar to the general concept of cyber socialization, cyber socialization engagement also appears in the academic literature under many different names. With this in mind, with respect to empirical studies of cyber socialization engagement, it can be noted that many such works use primary measurement tools with untested psychometric properties such as questionnaires, single questions, etc. Other works that operate with the concept of cyber socialization (or do not operate, but in essence consider this very phenomenon), in their empirical part actually go to individual aspects, private manifestations, local indicators of cyber socialization, such as the time of Internet use, frequency of social network use, purposes and forms of ICT use, etc.

There is also a large number of works whose authors do not claim a global context for the study of cyber socialization of university students but clearly identify a specific facet of it that is under study. Many works focus on students' use of social networks and the impact of such use on academic performance and engagement in learning and related interactions (Ashraf et al., 2021; Gulzar et al., 2021; Masrom et al., 2021; Shi et al., 2020). Some such studies do not look at social networks in general, but at specific varieties of networks or communication technologies (messengers, etc.). For example, Hoi (2021) provides a review of studies on the impact of students' use of Facebook on their academic performance and engagement; Nyembe and Howard (2021) looked at the impact of WhatsApp use on students' academic performance and social interaction; Dzulkarnain et al. (2021) showed that participation in a specific online video project improves learning outcomes and is positively correlated with student engagement in a university STEM course; etc.

However, the results of such studies are often contradictory. For example, Nyembe and Howard (2021) empirically found that using WhatsApp messenger increased students' academic performance and social interaction, while Alkhalaf et al. (2018) found no such effect on academic performance; moreover, time spent using WhatsApp was found to be directly proportional to addiction symptoms. Or, for example, on the one hand, a number of studies have found positive effects of social networks: for example, Rasheed et al. (2020) found that knowledge sharing meaningfully mediated the effect of social networks

use on student engagement in academic contexts. On the other hand, Koranteng et al. (2019) reported that the use of social networking sites did not predict knowledge sharing or student engagement in academic contexts. Liebherr et al. (2020) in their review showed that there is conflicting evidence on the impact of smartphone use on academic performance and cognitive functions, particularly of university students. As noted by Whelan et al. (2020), several studies show that university students are more prone to problematic social media use than others. There are also works that show the negative impact of cyberbullying and cyberstalking on students, leading to serious psychological problems (Harding et al., 2019; Metin-Orta & Demirtepe-Saygl, 2023).

Much work has also focused on the impact of the COVID-19 pandemic on university students: in particular, on their social and psychological well-being, as well as on changing characteristics of cyber socialization engagement, such as the transition of university learning processes to an online format (Hudimova et al., 2021). For example, it has been reported that university students find both positive aspects and negative aspects in the transition to online learning (Mishra et al., 2020); with such a transition leading university students to a "lack of socialization" consisting of a reduction in live (face-to-face) interactions, student participation in study groups outside the classroom, etc. (Easa & Bazzi, 2021). (Easa & Bazzi, 2021).

Thus, despite extensive research into the influence of certain aspects of cyber socialization (the use of specific cyber technologies, specific forms of behavior in cyberspace, etc.) on the psychological well-being of university students, the influence of general (nonspecific) cyber socialization engagement on such well-being has not been studied sufficiently, including its ambivalent nature, manifested in the presence of two types of such engagement, constructive and destructive.

The purpose of the study was to identify the possible impact of Cyber socialization engagement on the psychological and social well-being of university students. This objective involved answering the following research questions:

Does Cyber socialization engagement affect university students' psychological well-being as examined through the constructs of life satisfaction and the Dark Tetrad of personality?

Does Cyber socialization engagement affect university students' social well-being as examined through the constructs of learning engagement, learning satisfaction, and organizational identity?

Is there a joint influence of constructive and destructive factors of Cyber socialization engagement on the psychological and social well-being of university students?

Methods

Concepts that develop and operationalize the concepts of cyber socialization engagement, life satisfaction, the Dark Tetrad of personality, learning engagement, learning satisfaction, and organizational identity were used as methodological foundations for the study.

Cyber socialization engagement was understood in accordance with the author's concept of cyber socialization, within which the psychological structure of cyber socialization engagement includes two subsystems, constructive engagement and destructive engagement, each of which contains three components related, respectively, to constructive or destructive motivation for cyber socialization, personal position in relation to cyber socialization, and competence in the field of cyber socialization. The "The cyber socialization engagement questionnaire" was used for measurement, containing scales of constructive and destructive Cyber socialization engagement, respectively (Lenkov et al., 2019).

Life satisfaction was considered according to the concept of Diener et al. (1985). In the context of the study, we understood life satisfaction as general, nonspecific life satisfaction and considered it, on the one hand, as one of the components of psychological well-being and, on the other hand, as a certain, rather autonomous predictor of the latter. The 5-item "The Satisfaction with Life Scale (SWLS)" in the Russian-language adaptation was used for measurement (Elshansky et al., 2015).

The Dark Tetrad of personality was considered according to the concept of Paulhus et al. (2021), according to which this tetrad includes such personality traits as Machiavellianism, narcissism, psychopathy (not clinical) and sadism (domestic, everyday). The 28-item questionnaire "The Short Dark Tetrad Scale [SD4]" in its Russian-language adaptation (Kornienko et al., 2022) was used for measurement.

Engagement in learning within the framework of the study was considered by analogy with the concept of work engagement by Schaufeli and Bakker (2004). The nine-item "Utrecht Work Engagement Scale [UWES-9]", modified by the authors of the article, was used for measurement in the Russian version presented by the authors of the scale (Schaufeli & Bakker, 2004). The modification consisted of replacing the term "work" with the term "learning" in all questions (e.g., "My learning inspire me").

The study examined *job satisfaction* in a similar way to Thompson and Phua's (2012) concept of affective job satisfaction. The authors' modified 7-item questionnaire "The Brief Index of Affective Job Satisfaction", including 4 meaningful and 3 masking items, in the Russian-language adaptation (Lovakov, 2018, p. 123) was used for measurement. The modification consisted in replacing the term "job" with the term "learning" in all questions (e.g., "I am completely satisfied with my learning").

Organizational identity was considered and measured according to the concept operationalized in the 6-item "Organizational and Sub-Organizational Identity Questionnaire" (Sidorenkov et al., 2019), which allows it to be flexibly adjusted for application to different types of organizations. Accordingly, within the framework of the research, organizational identity was understood as the result of the student's identification processes with the university faculty where he or she is studying.

In all questionnaires used, responses were rated on a 5-item Likert scale (from 1 "Strongly disagree" to 5 "Strongly Agree").

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The study sample consisted of 315 Russian university students aged 17 to 35 years ($M = 21.70$, $SD = 3.130$). In addition to age, the controlled factors were: sex, type of educational organization, level, and subject area of education received. Accordingly, the sample included: 218 females and 97 males; 172 bachelor students and 143 master students; 107 technical students and 208 humanities students, 212 students of state universities, and 103 students of nonstate universities.

Data analysis was performed using the SPSS package. Such statistical methods as analysis of variance (one-way and two-way ANOVA), hypothesis testing methods (Mann-Whitney, Games-Howell tests, etc.), reliability of scales (Cronbach's alpha) (IBM, 2022), including methods for determining the effect size (eta-square and partial eta-square) within ANOVA and nonparametric tests (Fritz et al., 2012) were used.

Results

The scales used in the study sample showed high or satisfactory reliability, with the exception of the Machiavellianism scale, which had a reliability of only about 0.5 (Table 1). Nevertheless, for completeness of coverage of the Dark Tetrad traits, we used this scale in the further study.

The descriptive statistics (Table 1) shows that a number of scales are characterized by significant deviations from the normal distribution. For this reason, we used the nonparametric Mann-Whitney test for generality in pairwise comparisons of the groups, applying the eta-square method specific to it to determine the effect size.

Table 1
Descriptive statistics and reliability of scales (N = 315)

Scales	Indicators of descriptive statistics				NOI	Alpha
	M	SD	Skewness	Kurtosis		
Satisfaction with life	16,62	4,285	-0,290	-0,456	5	0,818
Machiavellianism	21,85	3,797	-0,271	0,432	7	0,463
Narcissism	20,72	4,905	-0,123	-0,292	7	0,697
Psychopathy	16,37	5,582	0,484	-0,073	7	0,791
Sadism	15,02	5,297	0,632	-0,286	7	0,766

Scales	Indicators of descriptive statistics				NOI	Alpha
	M	SD	Skewness	Kurtosis		
Learning engagement	26,75	7,065	0,055	-0,505	9	0,915
Satisfaction with learning	12,53	3,375	-0,347	-0,077	4	0,854
Organizational identity	20,01	4,641	-0,312	0,381	6	0,828
Constructive Cyber socialization engagement	55,18	10,044	-0,271	-0,318	21	0,799
Destructive Cyber socialization engagement	4,89	3,454	0,928	1,100	6	0,705

Source: Compiled by the authors. Note: NOI is the number of points, and Alpha is Cronbach's alpha. The standard error is equal to: 0.137 for skewness and 0.274 for kurtosis.

The following statistically significant effects were identified (see Table 2), presented in descending order of effect size:

- for the factor of sex: men, compared to women, have a higher expression of sadism, constructive Cyber socialization engagement and Machiavellianism, but lower life satisfaction at the trend level ($p < 0.1$);
- for the factor of education level: master's students, compared to undergraduate students, have higher expression of Machiavellianism, but lower expression of narcissism, psychopathy, learning engagement, satisfaction with learning and organizational identity;
- for the subject area factor: technical students, compared to humanities students, have a lower expression of narcissism, psychopathy, learning engagement, and constructive cyber socialization, but a higher expression of Machiavellianism at the trend level ($p < 0.1$);
- for the factor of type of educational organization: students of state universities, compared to students of nonstate universities, have higher expression of

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Machiavellianism, but a lower expression of narcissism, learning engagement, satisfaction with learning, organizational identity; as well as psychopathy at the level of tendencies ($p < 0.1$).

Table 2
Comparisons between groups of mean values

Scales	Mean values for groups		Mann-Whitney test		
	Group 1	Group 2	Z	p	η^2
Factor: sex. Groups: 1 - female (n = 218), 2 - male (n = 97)					
Satisfaction with life	16,92	15,95	-1,934	0,053	0,012
Machiavellianism	21,48	22,69	-2,512	0,012	0,020
Sadism	14,21	16,85	-3,979	0,000	0,050
Constructive engagement	54,18	57,42	-2,853	0,004	0,026
Factor: level of education. Groups: 1 - bachelor's degree (n = 172), 2 - Master's degree (n = 143)					
Machiavellianism	21,26	22,56	-2,980	0,003	0,028
Narcissism	21,36	19,94	-2,341	0,019	0,017
Psychopathy	17,33	15,87	-2,165	0,030	0,015
Learning engagement	27,55	25,79	-2,257	0,024	0,016
Satisfaction with learning	12,81	12,20	-2,212	0,027	0,016
Organizational identity	20,46	19,46	-1,986	0,047	0,013
Factor: subject area. Groups: 1 - technical (n = 107), 2 - humanitarian (n = 208)					
Machiavellianism	22,47	21,53	-1,710	0,087	0,009
Narcissism	19,37	21,41	-3,531	0,000	0,040
Psychopathy	15,44	17,30	-2,698	0,007	0,023
Learning engagement	25,59	27,35	-2,324	0,020	0,017
Constructive engagement	56,52	54,49	-2,008	0,045	0,013

Scales	Mean values for groups		Mann-Whitney test		
	Group 1	Group 2	Z	p	η^2
Factor: type of university. Groups: 1 - state (n = 212), 2 - non-state (n = 103)					
Narcissism	19,37	21,41	-4,177	0,000	0,055
Psychopathy	15,44	17,30	-1,698	0,090	0,009
Learning engagement	25,59	27,35	-2,968	0,003	0,028
Satisfaction with learning	12,14	13,44	-3,437	0,001	0,038
Organizational identity	19,78	20,51	-3,136	0,002	0,031

Source: Compiled by the authors. Note: Only results for which the significance of the differences is $p < 0.1$ are shown. Values of $p < 0.05$ are shown in bold.

The factor of age statistically significantly increases Machiavellianism, engagement in learning, satisfaction with learning and organizational identity (Table 3).

Table 3
 One-factor analysis of variance (ANOVA) for the age factor

Dependent variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Satisfaction with life	0,778	0,460	0,007	1	20,77	1-2	0,059
				2	21,96	1-3	0,007
Machiavellianism	5,249	0,006	0,033	3	22,68	2-3	0,360
Narcissism	1,475	0,230	0,009				
Psychopathy	0,157	0,855	0,001				
Sadism	0,845	0,431	0,005	1	24,90	1-2	0,092
				2	26,96	1-3	0,011
				3	28,14	2-3	0,427
Learning engagement	4,335	0,014	0,027				

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Dependent variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Satisfaction with learning	4,756	0,009	0,030	1	11,91	1-2	0,623
				2	12,36	1-3	0,010
				3	13,48	2-3	0,030
Organizational identity	10,750	0,000	0,064	1	17,99	4,8	0,000
				2	20,45	5,5	0,000
				3	21,08	6,2	0,608

Source: Compiled by the authors. Note: F is Fisher's statistic, η^2 is eta-squared. Age groups: 1 - younger than 21 years (n = 63), 2 - 21 to 23 years (n = 191), 3 - older than 23 years (n = 61). The results of multiple comparisons using the Games-Howell test are shown only for cases where ANOVA revealed a significant effect (p < 0.05). Values of p < 0.05 are shown in bold.

Destructive Cyber socialization engagement decreased life satisfaction, narcissism, learning engagement, learning satisfaction, and organizational identity, but increased the expression of psychopathy and sadism (Table 4).

Table 4

One-factor analysis of variance (ANOVA) for the factor of destructive Cyber socialization engagement

Variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Satisfaction with life	10,073	0,000	0,061	1	17,92	1-2	0,076
				2	16,72	1-3	0,000
				3	15,10	2-3	0,018
Machiavellianism	0,678	0,508	0,004	1	21,30	1-2	0,949
Narcissism	3,898	0,021	0,024	2	21,11	1-3	0,035
				3	19,48	2-3	0,049
				1	14,38	1-2	0,004
Psychopathy	18,200	0,000	0,104	2	16,56	1-3	0,000
				3	19,21	2-3	0,002
				1	14,38	1-2	0,004

Variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Sadism	18,934	0,000	0,108	1	13,25	1-2	0,168
				2	14,48	1-3	0,000
				3	17,73	2-3	0,000
Learning engagement	11,762	0,000	0,070	1	28,81	1-2	0,211
				2	27,19	1-3	0,000
				3	23,91	2-3	0,001
Satisfaction with learning	5,313	0,005	0,033	1	13,40	1-2	0,093
				2	12,44	1-3	0,004
				3	11,78	2-3	0,305
Organizational identity	5,742	0,004	0,036	1	21,17	4,8	0,129
				2	19,99	5,5	0,004
				3	18,83	6,2	0,176

Source: Compiled by the authors. Note: F is Fisher's statistic, η^2 is eta-squared. Groups by level of destructive engagement in cyber socialization: 1 - low (n = 89), 2 - medium (n = 140), 3 - high (n = 86). The results of multiple comparisons using the Games-Howell test are shown only for cases where ANOVA revealed a significant effect (p < 0.05). Values of p < 0.05 are shown in bold.

In turn, constructive Cyber socialization engagement increases Machiavellianism, learning engagement, learning satisfaction, and organizational identity (Table 5).

Table 5

One-factor analysis of variance (ANOVA) for the factor of constructive Cyber socialization engagement

Variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Satisfaction with life	1,029	0,359	0,007				
Machiavellianism	5,249	0,006	0,033	1	20,77	1-2	0,059
				2	21,96	1-3	0,007
				3	22,68	2-3	0,360
Narcissism	1,475	0,230	0,009				
Psychopathy	0,157	0,855	0,001				

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Variable	ANOVA			Mean values for groups		Post hoc test	
	F	p	η^2	Group	M	groups	p
Sadism	0,845	0,431	0,005				
Learning engagement	4,335	0,014	0,027	1	24,90	1-2	0,092
				2	26,96	1-3	0,011
				3	28,14	2-3	0,427
Satisfaction with learning	4,756	0,009	0,030	1	11,91	1-2	0,623
				2	12,36	1-3	0,010
				3	13,48	2-3	0,030
Organizational identity	10,750	0,000	0,064	1	17,99	4,8	0,000
				2	20,45	5,5	0,000
				3	21,08	6,2	0,608

Source: Compiled by the authors. Notes: F is Fisher's statistic, η^2 is eta-squared. Groups by level of constructive Cyber socialization engagement: 1 - low (n = 77), 2 - medium (n = 159), 3 - high (n = 79). The results of multiple comparisons using the Games-Howell test are shown only for cases where ANOVA revealed a significant effect (p < 0.05). Values of p < 0.05 are shown in bold.

As shown by two-factor analysis of variance (two-way ANOVA), the interaction between the factors of constructive and destructive Cyber socialization engagement is not significant for all the dependent variables considered: life satisfaction, Dark Tetrad traits, engagement in learning, learning satisfaction, and organizational identity (p from 0.969 to 0.185, η_p^2 ranges from 0.002 to 0.020).

Discussion

The revealed absence of significant interfactor interaction between the indicators of constructive and destructive Cyber socialization engagement confirms the validity of our approach to considering these constructs as relatively autonomous, not additively summarized into an indicator of some general, total Cyber socialization engagement.

Some of our results are qualitatively consistent with the results of Rogowska et al. (2021) obtained in a cross-cultural study on a sample of 285 Russian university students: here, as in our study, life satisfaction was higher for women than for men, and the level of education (bachelor's or master's degree) was insignificant.

The ambivalence of the impact of cyber socialization on university students was confirmed by Shitova & Maslakov (2020): on the one hand, many students are interested in educational information in cyberspace and actively use online resources for learning; on the other hand, some students have symptoms of information stress.

The negative impact of general destructive Cyber socialization engagement on students' psychological well-being scores found in our study is qualitatively consistent with the results of many previous studies that have found a similar impact of individual, private manifestations of such engagement, such as cyberaddictions, engagement in cyberbullying, social media overload, problematic Internet use, etc. (Arpaci et al., 2020; Su et al., 2020; Tahoona, 2020; Tahoona, 2020). (Arpaci et al., 2020; Su et al., 2020; Tahoona, 2020). On the other hand, the alternative positive impact of constructive engagement is also qualitatively consistent with previous studies, where similar effects were found for private manifestations of such engagement, such as participation in specially designed forms of online learning, constructive online interactions between students in sharing knowledge and solving learning tasks, etc. (Arpaci et al., 2020; Su et al., 2020; Tahoona, 2020). (Hoi, 2021; Nyembe & Howard, 2021).

However, empirical evidence of the ambivalent effect of overall cyber socialization engagement on university students' psychological well-being is apparently obtained for the first time in this study.

An interesting result is also the revealed "ambivalence within ambivalence": constructive engagement with its generally positive influence increases Machiavellianism, and destructive engagement with its generally negative influence decreases, however, the expression of narcissism. However, a detailed discussion of these results requires a deep dive into the problems of the Dark Tetrad traits' identification and is therefore beyond the scope of this article.

Conclusion

The results of the conducted study clarify the role of cyber socialization engagement in shaping the psychological well-being of student youth.

It is found that the impact of overall Cyber socialization engagement is generally ambivalent:

- constructive engagement has an overall positive effect, increasing measures of psychological well-being such as engagement in learning, satisfaction with learning, and organizational identity, although it increases the expression of the Dark Tetrad trait of Machiavellianism;
- destructive engagement has an overall negative impact, decreasing life satisfaction, learning engagement and learning satisfaction, organizational identity, and increasing the expression of Dark Tetrad traits such as psychopathy and sadism, although decreasing the expression of narcissism.

At the same time, the effects of constructive and destructive engagement were statistically independent, which confirms the appropriateness of the theoretical model of Cyber socialization engagement used.

The practical significance of the study lies in the fact that its results make it possible to outline expedient work to ensure psychological safety of the educational environment and psychological support of university students, aimed at ensuring their psychological well-being by adjusting the ratio of constructive and destructive Cyber socialization engagement.

Prospects for further research within the framework of the stated problem are connected, first of all, with the expansion of the range of studied indicators of psychological well-being, as well as with clarifying studies in connection with such ambiguous results as an increase in Machiavellianism under the influence of constructive Cyber socialization engagement and a decrease in narcissism under the influence of destructive Cyber socialization engagement.

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Sergey L. Lenkov – disclosure of the idea of the article using the author's methodology "Cyber socialization engagement", meta-analysis of scientific domestic and foreign articles similar to the topic of the article, statistical processing of data, interpretation of results.

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Family of a child with autism spectrum disorders: analysis of inclusive potential

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Abstract

Introduction. Working with the family of a disabled child in the context of its support combines special education, education, family psychology, and sociology. This paper is based on the analysis of measurable parameters of parental effectiveness in families raising children with autism spectrum disorders as a result of testing the mechanisms for assessing and studying inclusive potential. **Methods.** The study included 160 families raising children with autism spectrum disorders. The parameters of family functionality were groups of competencies, and the indication was measuring the degree of parental inclusiveness expertise. The study used the Self-Assessment of Parental Inclusiveness and the Expert Assessment of Inclusive Potential questionnaires developed by the authors. The results of the analysis were indicators of expert accordance and non-accordance in the form of overestimation or underestimation of subjective assessments. **Results.** Structured data on subjective expert assessments of family functionality were obtained in the context of five basic groups of competencies, including information-related, communicative, value- and meaning-related, personal, and educational competencies. Subjective attitudes towards information and communication support received from various services and departments were revealed. The problem of a unified family approach to the issue of encouraging and stimulating children was addressed. Data on the level of psychological and emotional comfort, attitudes towards the prospects for development and the specificity of attitudes towards the child and his defect were presented. The shortcomings and problems in the development of inclusive family competence are a

lack of parental awareness of the special educational needs of children and the necessary special conditions, a lack of conflict-free communication skills, a lack of family education resources and parents' personal resources. Analyzing adaptability, educational resources, personal maturity, ecological compatibility in relationships, availability and quality of channels for receiving assistance help determine priority areas and the nature of targeted psychological and educational support for families raising children with autism spectrum disorders. **Discussion.** The proposed framework for the quantitative and qualitative analysis and evaluation of parental competency enables us to reconsider the nature of interaction with families raising children with autism spectrum disorders and to change the system of their psychological and educational support.

Keywords

children with autism spectrum disorders, family inclusive potential, self-assessment of parental inclusiveness, parental competency, family functionality

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Introduction

In modern studies, the concept of "inclusive potential" is closely linked to the population of individuals with disabilities (IWDs) as a particular set of their own resources. The social environment strongly determines the system of relationships within the family, education and the broad sociocultural space. In general, the family inclusion potential is defined as its role in carrying out the tasks of education and social integration with respect to its own child. This definition and the potential for the rehabilitation of children with disabilities are considered as the basis of the paradigm of parental effectiveness for the formation of a culture of inclusion of all subjects of civil society.

Families raising children with ASD

Families raising children with autism spectrum disorders (ASDs) represent a very large group with high social activity (Tkacheva, 2023). This situation must be taken into account

as an effective tool for identifying and preventing the deep socio-psychological and socio-environmental maladaptation of high-functioning autistic children. The subjective space of families where primary socialization of children with ASDs takes place has been little studied from the point of view of creativity and inclusion (Semenova, Bozhkova, & Koneva, 2022). A comprehensive scientific study of the competency of parents, which is the potential for inclusion, is required.

Inclusive potential

In terms of terminology and substance, the concept of "inclusive potential" should be interpreted as a complex of opportunities and resources of different environments, including social ones, in combination with the established system of important relationships and the level of the potential for personal adaptation and rehabilitation of individuals with disabilities (Afonkina, 2016). In contrast to individual potential, the inclusive potential of a family that raises a child with a disability is built on intra-family resources and the abilities of all family members, their functional effectiveness and competency (Starobina, 2018). It is the level of development of certain competencies that determines the potential of the family in terms of effective active participation in the processes of education, upbringing, comprehensive development, socialization, and integration of children into various types of social activity.

Inclusive competency

The inclusive competency of parents should be considered as their general ability and readiness to perform rational and effective functional tasks and provide conditions conducive to the complete development and well-being of their children, other family members and the family as a single system of life (Smogorzewska & Osterhaus, 2023). The assessment of the inclusive potential of a family consists of aggregated indicators for individual abilities of family members. The choice of competency groups incorporated in inclusive potential assessment mechanism allows a systematic assessment of the capabilities and resources of the family from the point of view of educational and sociocultural processes. The inclusive competency of family members is revealed through the understanding and acceptance of certain functions, rational possession of knowledge and skills in the field of constructive interaction with a child with disabilities and its effective inclusion in various types of social activities (Chemirilova, Kirilova, Gavrilova, & Akieva, 2021).

Information-related competencies

A family is a relatively open social system with emotional, informational, and activity links with other members of the community (Churkina, 2023). This demonstrates the importance of considering information-related competencies (ICs) as an important component of the overall inclusive potential of the family. The following indicators should

be considered as indicators of the level of development of this group of competencies : (a) demonstration of knowledge in the fields of special education and psychology affecting the processes of education, upbringing, development and socialization of children with disabilities; (b) knowledge of the age characteristics of children in the normal and deviant development; (c) knowledge of the abilities of searching, receiving, and transmitting information to a communication partner; and (d) awareness of information on the current state of individuals belonging to important social groups, situations, events, and processes that are of objective or subjective importance in the life of a person and society (Tkacheva, 2023).

Communicative competencies

Among the most important components of the inclusive potential is a group of communication competencies (CCs), which form the basis for constructive, comfortable and productive relationships with others. These competencies determine the readiness and ability to establish and maintain contacts, build interactions and relationships with different groups of citizens, predict, prevent or effectively resolve conflict situations (Zotova, 2020). Particular importance is placed on the ability of parents to create constructive interactions with their children, taking into account their age-related, psychological, individual and typological characteristics (Kurdyumova, 2020). The nature of social interaction between the family and various social institutions in resolving urgent educational and general developmental tasks is also important (Chugaeva, 2017). Social interaction must be understood as a specific type of activity represented by following functional components: socially oriented, performing, and effective ones (Krushnaya & Pinkus, 2016).

Parents' attitudes towards the effectiveness of psychological and educational support for children with disabilities, especially ASDs, are quite sceptical, and experts' attitudes towards parents' competence and claims are unclear. Consequently, parents and teachers treat each other as part of the problem, not as a means of solving the problem (Mckenzie, Vassallo, & Dallos, 2020).

Educational competencies

The educational competence group (EC) provides parents with the ability and willingness to solve independently various problems related to the education, spiritual and moral development of children. The structure of educational competence should include rationality of educational strategies, guidance, development and implementation of educational potential, degree of involvement of the immediate environment in education, and adaptability of educational resources (Gerasimovich, 2018). In relation to the adaptability of educational resources, it is worthwhile to address the problem of theoretical awareness and practical training of parents in the area of motivating and stimulating strategies that strengthen desired behavior and stop negative behavioral

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reactions. Most parents of children with ASDs believe that these skills are lacking (Iadarola, Levato & Harrison, 2018).

The rational design of the object-developing environment at home, combined with appropriate tools, substantially optimizes the process of child development, its adaptation to the objective and social reality of the surrounding world. Changing the comfortable and developing environment, their modelling in the context of family education, must fully take into account the individual characteristics of the child's activity, his interests and potential for emotional response (Yaremchuk, 2019). In this case, it is necessary to consider some characteristics that determine the quality and rationality of environmental conditions, including spatial (location selection, fullness and structure of premises, design and object organization), (b) temporal (fullness of events, taking into account the child's perception, inclusion in processes, satiation with activity); (c) emotional (moderate emotional loads, use of attractive stimuli, naturalness and moderation of adults' expressive displays), and (d) meaning-related (variability of meaning levels – sensory interests, performance of activities, constructive and productive activities, emotional response).

In view of the adaptability of educational resources, it is worthwhile mentioning the problem of theoretical awareness and practical training of parents in the field of motivation and stimulating strategies to strengthen desirable behaviors and stop negative behavior reactions. Most parents raising children with ASDs believe that these skills are lacking (Galkiene & Blinkevičienė, 2019). Limited knowledge and insufficient abilities in supporting, encouraging and punishing children, effective motivation and stimulation of positive behavior are also noted (Kizilkaya & Sari, 2021).

Value- and meaning-related competencies

Parents' value- and meaning-related competencies (VMCs) determine their willingness and ability (a) to accept their own child and others as an unconditional value, regardless of specific developmental characteristics, undesirable behaviors, and inappropriate appearances, (b) to maintain a friendly environment and a favorable climate in the family and in the immediate environment of the child, and (c) to systematically participate (possibly with a long-term perspective) in the development and realization of the potential of their child, to overcome internal and external obstacles, difficulties and resistance (Bicheva, Kovchegova, & Gorshenina, 2022).

Personal competencies

The group of personal competencies (PCs) ensures the fullest possible realization of individual potential, active and productive life, effective functioning and comprehensive development. This group of competencies is the basis for maintaining mental and physical health, the need for self-knowledge, self-development, and self-realization. The most important skills include (a) adaptive and productive self-expression and self-

development, (b) high tolerance of frustration, resistance to personal deformations and stress, (c) adequate level of aspirations and internal control position, and (d) predominance of sanogenous cognitive schemes and absence of irrational attitudes (Dyachkova & Bayandina, 2021).

There are sufficient studies that confirm the existence of a wide variety of different experiences among parents of children with ASD that affect their condition, function and overall quality of life and their immediate environment. Chronic stress and a high level of neuropsychological tension, low predictability of children's behavior and conditions nourish and increase the fear of stigmatization, safety and children's overall well-being (Domalanta et al., 2017).

Problems and purpose

The existing scientific research of the authors on the problem of the culture of inclusion (Kudryavtsev, Kashtanova, 2023), modeling the assessment procedures for the inclusion potential of families raising different categories of children with disabilities (Kashtanova et al., 2023), has enabled the organization of a more detailed assessment of families of children with ASDs as a main sample of the experimental study and its presentation in the form of a detailed analysis of the measured characteristics of the aspects.

The purpose of this study is to highlight the results of an experimental assessment of the inclusive potential of families raising children with ASDs, in the context of individual competence groups and different degrees of expertise.

The analysis sample presented here defined the problematic area of this study, dedicated to the assessment and subsequent study of the inclusive potential of families raising children with ASD through the prism of parental effectiveness and the overall function of the family. An important measure in this case is the degree and nature of the expertise of parents themselves and its objectivity in relation to the characteristics obtained from support specialists.

Methods

The experimental analysis of the inclusive potential of families raising children with ASDs was based on the analysis and study of their subjective assessments, which were linked to objective data of experts carrying out training and support tasks for this contingent.

Instruments

The main methodology of research was the diagnostic complex developed by the authors, including the Self-Assessment of Parental Inclusiveness and the Expert Assessment of Inclusive Potential questionnaires.

The statistical processing was based on the analysis of contingency tables using the Pearson χ^2 criterion. The questionnaires are based on the identification of individual groups of competencies and parameters of parental effectiveness and include blank forms designed for quantitative and qualitative analysis using the R. Likert scale.

Participants

The main respondents were parents of 160 families with ASD children. The second sample included 164 experts who implemented direct psychological and educational practices in working with autistic children and their immediate environment. Factorial characteristics were individual competency groups – information-related, communicative, value- and meaning-related, personal and educational ones, which parameters constitute the family competence profile that characterizes its inclusive potential.

Results

Based on the author's approach to analyzing and assessing the inclusive potential of families raising children with disabilities of different categories, we developed diagnostic tools, including the Self-Assessment of Parental Inclusiveness and the Expert Assessment of Inclusive Potential questionnaires. These diagnostic tools are sufficiently described by the authors (Kashtanova & Kudryavtsev, 2024). In the analysis of primary data, in development, the indicator of the level of parental expertise in subjective assessments of individual parameters of their own inclusive competencies was taken into account. Differences in subjective and expert assessments of individual functional indicators were considered as result indicators. There were three categories of assessment – underestimation of subjective assessment (parents estimate the parameter lower than experts), overestimation of subjective assessment (parents estimate the parameter higher than experts) and expert accordance, if assessment positions were fully consistent.

Table 1 presents the percentages for the designated expert indicators. The first column indicates competencies according to their belonging to a group. Values are given at the end of the table.

Table 1

Primary indicators of self-assessment of parental inclusiveness in relation to individual groups of competencies (%)

N ^o	Parameters of functionality	Underestimation of subjective assessment (-)	Overestimation of subjective assessment (+)	Expert accordance
IC1	Availability and quality of channels for receiving assistance	59.4	11.8	28.8
IC2	Parent awareness	53.7	13.7	32.6
CC1	Ecological compatibility in relationships	25	40.6	34.4
CC2	Culture of social interaction	36.8	15.6	47.6
CC3	Interaction with teachers/specialists	21.2	30.6	48.2
CC4	Interaction with other parents of children with disabilities	31.2	43.7	25.1
CC5	Orientation in communication tools	28.1	33.7	38.2
VMC1	Attitude towards the "defect"	32.5	35.6	31.9

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N ^o	Parameters of functionality	Underestimation of subjective assessment (-)	Overestimation of subjective assessment (+)	Expert accordance
VMC2	Continuity of generations	25.6	41.2	33.2
PC1	Personal maturity	26.8	50	23.2
PC2	General cultural development	17.5	57.5	25
PC3	Individual resource state	33.7	37.5	28.8
PC4	Self-education	20.6	58.7	20.7
EC1	Rationality of educational strategies	30.6	20.6	48.8
EC2	Mentoring	34.4	28.1	37.5
EC3	Educational potential	38.1	40.6	21.3
EC4	Involvement of the immediate environment in the educational process	36.2	28.7	35.1
EC5	Adaptability of educational resources	41.2	27.5	31.3

Note. Legend: IC – information-related competency; CC – communicative competency; VMC – value- and meaning-related competency; PC – personal competency, EC – educational competency.

The data are presented in percentages, and the row is 100 %, representing a sample of 160 families raising children with ASDs. The second column reveals the content of each competency, which may help navigate the following data tables.

Further analysis of the data enabled us to classify them not by individual competency groups, but by the statistical significance of the relationship between the factor and the result characteristics. We should note that all indicators have acceptable thresholds for the admissibility of differences in statistical data, but have different threshold values. Table 2 shows the competencies with the highest significant relationships ($p < 0.001$) which shows the regularity of these indicators.

Table 2

Competencies with the highest values of statistical significance for expert competency (%)

Factors	Effective signs			Sum
	Underestimation of subjective assessment (-)	Overestimation of subjective assessment (+)	Expert accordance	
IC1	<u>59.4</u>	11.8	28.8	100
IC2	53.7	13.7	32.6	100
CC1	25	40.6	34.4	100
CC2	<u>36.8</u>	15.6	<u>47.6</u>	100
VMC2	25.6	41.2	33.2	100
PC1	26.8	50	23.2	100
PC2	17.5	57.5	25	100
PC4	20.6	<u>58.7</u>	<u>20.7</u>	100
EC5	41.2	27.5	31.3	100
Total	306.6	316.6	276.8	900

Note. $df = 16$, $\chi^2 = 146.857$, Critical value $\chi^2 = 39.3$ ($p = 0.001$), relationships between factors and effective signs are significant at the $p < 0.001$ level.

We should note that parents considerably underestimated their assessments of information-related competency (IC1 – Availability and quality of channels for receiving assistance; IC2 – Parent awareness), educational competency (EC5 – Adaptability of educational resources), and communicative competency (CC2 – Culture of social interaction). At the same time, parents have quite high values when they overestimate their own assessments of these competencies. First of all, this concerns the group of personal competencies, including PC4 – Self-education, PC2 – General cultural development, and PC1 – Personal maturity. We should also note VMC2 – Continuity of generations and CC1 – Ecological compatibility in relationships.

About 40 % of parents of children with ASDs assess ecological compatibility in relationships, ecological relations, the ability to listen, hear and understand each other, and the right to make mistakes in their own or other people's actions as very high. At the same time, 50 % of respondents expressed concern about children's inclusion in a single social and cultural space in the family.

Regarding the adaptability of educational resources, it is necessary to emphasize some of the positions that are lacking from the point of view of parents themselves. Approximately 52 % of respondents believed that in their families there was insufficient attention to equipping places for games, activities, organizing daily life and using special means. This result emphasizes the importance of implementing the environmental approach in the education of children with autism in families. 47.8 % of parents raising autistic children say they have not yet developed a unified, sustainable and effective system to stimulate and encourage children. For most highly rated indicators, a low level of agreement with experts – expert accordance – was observed.

The group of value-related and meaning competencies, in particular the Generational continuity parameter, was revealed through the level of generational conflict, the implementation of the function of spiritual communication in the family and the priority of family values. 60 % of the respondents rejected the existence of a conflict between adults and children in the family; 40 % assessed the relationship between parents and children as a conflict.

Table 3 shows the second block of indicators with a pronounced indicator of the reliability of differences scores ($p < 0.01$).

The lowest expert accordance value was for EC3 educational competency – Educational potential (overestimated by parents in their subjective assessments), and a relatively high expert accordance value was for EC1 – Rationality of education strategies. In the context of PC3 parameter (Individual resource state), more than 80 % of respondents expressed constant fears about their children's lives, health and well-being that they would not overcome alone.

In our study, 43.8 % of respondents felt psychologically comfortable and 27.5 % felt strongly uncomfortable; 51.3 % of parents who participated in the study indicated

the presence of toxic people and their relationships in their environment; 43.1 % of respondents reported a predominance of pessimistic attitudes and 41.3 % complained about the lack of stable and reliable sources of psycho-emotional support.

Table 3

Competencies with the highest values of statistical significance for expert competency (%)

Factors	Effective signs			Sum
	Underestimation of subjective assessment (-)	Overestimation of subjective assessment (+)	Expert accordance	
PC3	33.7	37.5	28.8	100
EC1	30.6	20.6	48.8	100
EC2	34.4	28.1	37.5	100
EC3	38.1	40.6	21.3	100
EC4	36.2	28.7	35.1	100
Total	173	155.5	171.5	500

Note. $df = 8$, $\chi^2 = 21.410$, critical value $\chi^2 = 20.09$ ($p = 0.01$), relationships between factors and effective signs are significant at the $p < 0.01$ level.

The next parameter block has the lowest differences scores, while remaining in the acceptable value corridor (Table 4). First, we should note here the existence of the main part of the parameters relating to the group of communication competencies.

Table 4

Competencies with the minimum acceptable values of statistical significance for expert competency (%)

Factors	Effective signs			Sum
	Underestimation of subjective assessment (-)	Overestimation of subjective assessment (+)	Expert accordance	
CC3	21.2	30.6	48.2	100
CC4	31.2	43.7	25.1	100
CC5	28.1	33.7	38.2	100
VMC1	32.5	35.6	31.9	100
Total	113	143.6	143.4	400

Note. $df = 6$, $\chi^2 = 13.389$, critical value $\chi^2 = 12.6$ ($p = 0.05$), relationships between factors and effective signs are significant at the $p < 0.05$ level.

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These results indicate that the expert compliance indicator for the CC3 parameter - Interaction with teachers/specialists - is quite high. There is also a tendency to overestimate the quality and intensity of their interaction with other parents of children with different disabilities. At the same time, only 18.7 % of respondents considered they were of a certain weight and authority in the parent community, 50 % emphasized it was difficult to respond, and 31.3 % assessed themselves negatively.

An important parameter is the attitude of parents towards their child's deficiency (VMC1), which, among other things, emphasizes the level of identification with the child and his condition. The position of "I am my child; my child is me" was shared by 41.4 % of the parents surveyed.

Discussion

Analyzing indicators should be started with information-related competency, i.e. with the IC1 parameter – Availability and quality of channels for receiving assistance. According to the survey, most parents believe that their children do not receive sufficient medical assistance and support - the average assessment score is 2 out of 4 possible. The low assessment of the availability and quality of assistance and support provided by public organizations was somewhat unexpected (only 28.8 % of respondents evaluated positively). Parents receive more tangible support from educational institutions (57.5 % of respondents evaluated positively).

Regarding the IC2 parameter – Parent awareness, there is no coincidence that close attention is currently paid to the issue of informing persons with disabilities and their family members about the nature of disabilities and the prognosis, prospects, assistance options and possible development paths and routes (Bogacheva, Ivanov, & Simashkova, 2019). The greatest involvement of parents of children with disabilities in their development, education, and socialization, based on the principles of the participative approach, will ensure the maximum effectiveness and efficiency of comprehensive support for children (Shkitina & Kasatkina, 2019; Bystray, Belova, Shtykova & Orlova, 2022).

The next indicator with a very high level of reliability of differences is CC2 - Culture of social interaction, which has the highest percentage of coincidences between subject assessments and expert assessments, and can also indicate a fairly unified understanding of the content of this competency.

Most parents focus on the development, education and socialization of their children in heterogeneous groups, among children of different categories, which is perfectly consistent with their constant focus on ensuring the maximum inclusion of children with ASDs in all areas and types of activities (Andreeva, 2021). At the same time, 36.8 % of respondents felt that this competency was not sufficiently developed, mainly due to the lack of skills in non-conflict communication, forecasting, prevention and effective conflict resolution.

Let us examine a number of indicators for which parents make higher assessments compared to specialist assessments, which also have reliable differences ($p < 0.001$). First, we should pay attention to three indicators of the group of personal competencies, including PC4 - Self-education, PC2 - General cultural development, and PC1 - Personal maturity. For example, 58.6 % of parents of children with ASDs overestimate their own level of education and self-education. The greatest difference in assessments is observed in relation to the level of parental awareness of knowledge deficits and the need for further education (Mohammadi, Rakhshan, Rakhshan & Gillespie, 2019).

Regarding the issue of general cultural development, attention is drawn to the relatively high parental assessment of the subjective importance of aesthetic, environmental and cultural and historical education of the child in the family. It is very difficult to overestimate the role of artistic and aesthetic education in the development and education of children, regardless of their level of development and health (Kostenko, 2014). According to the results of several studies, art therapy, which introduces children to visual arts, music, theatre and applied arts, effectively compensates and neutralizes disorders related to social relationships, language, undesirable behavior and emotional breakdown (Wypyszyńska, Zaboklicka, Stachura, Sito, & Męcik-Kronenberg, 2021). More than 72 % of parents interviewed indicated a high level of this competency. However, these assessments correspond to the opinions of experts in 15 % of cases.

The findings suggest that 50 % of respondents assess their own level of personal maturity high, while among the main criteria they highlight the critical attitude towards themselves and their actions, the willingness to speak openly about the problems of children and families (which differs considerably from the assessment of experts, who estimate that this indicator is 28.6 % lower). The same difference in assessments is observed in relation to the needs of parents in the interests that are not related to the child, which characterizes the degree of disidentification of parents with their children, parents seem to be more dependent on the situation of the child than they try to demonstrate. It should be noted that the personal maturity of parents first manifests itself in the establishment of emotional contact with the child, in the understanding of his condition, wishes and experiences, in the presence of a stable and consistent strategy of interaction with him and his immediate environment (Evlampieva, 2016).

The high assessment of the VMC2 parameter – Continuity of generations – reflects the focus on family values and the function of spiritual communication among family members. At the same time, both parents' subjective self-assessment and specialists' assessments indicated a high level of intergenerational conflict. Thus, 40 % of respondents emphasized the presence of problems between adults and children in extended families.

In general, in personal competencies there are the smallest coincidences in assessments, with a clear tendency to overestimate in subjective self-assessments of parents. The main predictor of family and social negative reactions to the individual characteristics of autistic children is insufficient and distorted views on the category of

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persons with disabilities and the opportunities for helping and supporting these persons (Morozov, Morozova, Tarasova, & Chigrina, 2023).

The second block of indicators with a quite pronounced indicator of the reliability of differences scores ($p < 0.01$) consists mainly of indicators of the group of so-called educational competencies. We should immediately note that there is a tendency to overestimate the EC3 parameter - Educational potential – with the lowest level of agreement between parents and experts, which indicates different interpretations and approaches to the content of this definition. We believe that the EC4 parameter – Involvement of the immediate environment in the educational process – deserves special attention. 36.2% of parents surveyed gave this indicator a low rating, while it is noted that parental satisfaction is 37.5% for the parameter of Involvement of the immediate environment in the educational process. We should note that even in formally complete families, almost all the activities related to an autistic child fall on the shoulders of the mother, while other family members are often excluded from direct participation in supporting an autistic child (Morozov & Chigrina, 2022). Both parents and specialists rated the ability of family members to organize activities and various forms of leisure with children, as well as to implement rational education strategies (EC1) relatively high.

The assessments of the Individual resource state parameter were distributed evenly; more than 33 % of respondents indicated that their own psychological and emotional resources are quite low. In particular, 56.8 % of respondents considered themselves to be individuals with insufficient stress resistance. In the modern literature, there are many studies confirming that parents, especially mothers, of children with ASDs report more frequent symptoms of depression and increased psychological stress (Shahbaz, Khalid, Amir, & Yaqoob, 2023).

It should be noted that parents are less critical and assess themselves quite highly in the Interaction with other parents indicator, and they themselves rate the quality and intensity of their own communication with parents of normotypical children more highly. Experts believe that parents are more successful in building relationships with parents of children who also have limited health and functioning capabilities. Parents also rated their social role position in the parent community quite low. A fairly high percentage of coincidences is noted in the assessments of the interaction of parents of children with ASD with teachers/specialists (CC3). According to experts, parents are not inclined to belittle the contribution of specialists working with the child. Parents, in turn, are not inclined to exaggerate their importance and belittle the contribution of specialists in the development of the child and overcoming existing difficulties.

Finally, let us draw attention to two parameters that are not very pronounced, but not less interesting. First, it is necessary to note the assessment of the parents' own ability to orientate in communication tools (CC5). Of the parents interviewed, 47.4 % did not assess their oral, written and non-verbal communication skills sufficiently; 69.8 % of parents reported low levels of competency in alternative communication tools. Significant

differences in parents' and experts' assessments of parental positions were observed in terms of the ability to recognize non-verbal signals (facial expressions, gestures, posture, etc.), i.e. social facial perception abilities. The experts assess them much lower than parents; the difference in assessments is 25 %. Our analytical series is closed by such a parameter as Attitude towards the "defect", related to value- and meaning-related competencies. The most important manifestations of this group of competencies are the willingness and ability to accept a child (as well as other persons) as an unconditional value, regardless of developmental characteristics, behavioral characteristics and external data (Daniel & Govender, 2022). A lack of sufficient assessment of the unconditional acceptance of a child with ASDs by family members has been revealed; 27.4 % of respondents doubted the full and unconditional acceptance of the child in the family. We should note that value- and meaning-related competencies are often referred to as the main and leading force in the development of all other types of competencies. This feature is directly linked to the phenomenon of parents' identification with their child, which determines and strengthens pathological forms of attachment in the parent-child system, preventing the child from achieving a certain level of social adaptation (Giannotti, Venuti & Falco, 2023).

The study obtained reliable characteristics of the inclusive potential of families raising children with ASDs, which can be trusted when selecting constructive strategies for psychological and educational support. In particular, more than half of parents raising children with ASDs indicated a lack of knowledge and skills in providing space and environmental conditions for children's games and activities in the context of family education. The difficulties with relationships with parents (mothers, grandfathers) were also identified, which also affects family resources and reduces the functionality of educational potential. The lack of a culture of social interaction manifests itself in the absence of stable skills in non-conflict communication and in the willingness to open and close cooperation with different categories of subjects in the educational and socio-cultural environment.

More than 50 % of parents do not have the desired level of psychological comfort, and more than 40 % of respondents are pessimistic about the prospects for child development and report the lack of stable psychological and emotional support. Personal resources are characterized by a high degree of fear for children's life, health and well-being.

The presence of a phenomenon such as parents' identification with the child and its state is observed in more than 40 % of cases. This hypertrophied attachment can also be seen as a factor in reducing the possibility of inclusion and, therefore, as a subject of psychological correction work with family members.

The simultaneous analysis of the shortcomings and potential abilities of parents and the immediate environment, which are presented differently in the structure of competency profiles, shows targets to increase parental effectiveness. Priority areas for further correction, development, counselling and education in this area are based on identified shortcomings in the competency area based on the available resources of a particular family. Technological solutions to develop the comprehensive potential of

families raising children with ASDs can be implemented within the framework of specific thematic blocks of the event activities space of psychological and educational support corresponding to the competency groups discussed in this article.

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Author Contribution

Vladimir A. Kudryavtsev developed the concept of the research strategy, worked with English-language sources, processed the data, and interpreted the results.

Svetlana N. Kashtanova prepared the plan and edited the text of the article, overviewed Russian studies, wrote the Abstract and Keywords, and formulated conclusions.

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The authors have no conflicts of interest to declare.

Complex Express-Diagnostics of Rehabilitation Potential of Combatants With Disabilities

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Abstract

Introduction. The article presents the development of express-methodology for diagnosing the psychological component of rehabilitation potential of persons who received disability during combat operations and special military operations. Based on the experience of diagnostic examinations of other components of rehabilitation potential (psychophysiological, professional and pedagogical, social and environmental), the indications and indicators for complex express-diagnostics were selected, the optimized structure of which formed the basis of the corresponding methodological tool. Cognitive, affective and conative representants were identified as structural elements of the psychological component of the rehabilitation potential of the personality. **Methods.** For the purpose of approbation and formalization of the methodology, 345 respondents aged 18 to 42 years, 54% female and 46% male, took part in the study. The methods used as a basis for validation were the test "Assessment of personality adaptability" (S.I. Yakovenko), J. Endicott quality of life assessment scale, I. Schuller, A. Komuniani optimism and activity scale, "Self-assessment of conflict" test (A.Y. Antsupov, A.I. Shipilov), "Resilience test" by S. Muddy, express-diagnostics of cognitive abilities (G.S. Nikiforov). **Results.** The obtained instrument was tested for reliability, the optimal number of indicators presupposes 22 items. Based on confirmatory factor analysis, they are combined into a three-factor model, which has high values of verification indicators of compliance of this model with the data. High indicators of convergent and divergent validity were obtained by comparing the data with the results of existing standardized methods. **Discussion.** Three factors in the model of the psychological component of the rehabilitation potential of the individual are represented by the factor "Behavior", including "Adaptability", "Quality

of life" and "Optimism", the factor "Emotionality", including "Intrapersonal conflict" and "Neurosensory stability" and the factor "Cognition", including "Logic", "Memory" and "Attention". The levels of assessment of both individual factors and the complex indicator of the psychological component of the rehabilitation potential of the individual are identified, which allows us to speak about the suitability of this tool for use by specialists when working with individuals with disabilities acquired during combat operations and special military operations.

Keywords

rehabilitation potential, psychological component of rehabilitation potential, persons with disabilities, combat operations, special military operation, express diagnostics

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Introduction

One of the main priorities of Russian state and social policy at the present stage is the issue of support and targeted assistance to military personnel participating in a special military operation in Ukraine, as well as their family members. The focus of special attention is on participants of warfare who have been injured, physical and psychological injuries and injuries that have led to disability. According to the researchers, this contingent is experiencing difficulties in readaptation to peaceful life due to a changed state of health, and, consequently, needs comprehensive rehabilitation, including in order to restore professional skills and normal social functioning (Bonkalo, 2023).

In this regard, the tasks of the scientific and practical plan for the development of a system of professional and psychological rehabilitation of persons with disabilities acquired in the course of hostilities and their own on the basis of theoretical and empirical research are being updated.

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Psychological rehabilitation of the disabled in the modern sense assumes its focus on the personality of the patient and is carried out based on the rehabilitation potential. Rehabilitation potential is personality traits and its resource capabilities necessary to overcome the negative consequences of disability (Gudilina, 2012; Kulagina, Senkevich, 2015; Rogacheva, 2008; Porokhina, 2004; Solovyova, 2023; Khokhlova, 2020; Burton, 2015; Goodwin & Allan, 2019; Wade, 2023).

In our understanding, professional psychological rehabilitation is a complex of psychophysiological, psychological, professional and pedagogical and socio-environmental directions aimed at identifying and updating the rehabilitation potential in the totality of its relevant components (Borozinets et al., 2023).

The implementation of the psychological direction of professional and psychological rehabilitation, taking into account the characteristics of the individual and its resource capabilities, makes it possible to achieve success in carrying out a complex of rehabilitation measures that contribute to the return of a person to a full life, professional and social self-realization.

A theoretical and methodological analysis of the problem, as well as a thorough study of methodological tools for solving the problem of identifying and developing the rehabilitation potential of a disabled person, showed that today there is no formalized diagnostic tools that allow to quickly assess the level of rehabilitation potential and form a targeted trajectory of assistance and support to the rehabilitator (Solovyova, 2023; Rogacheva, 2008; Mosqueda, 1993; Wade, 2023). This conclusion served as the basis for the development of a methodology for rapid diagnosis of the psychological component of rehabilitation potential, based on the principles of systematic study of mental phenomena, transparency of stimuli of mental activity, brevity of the procedure, capacity and unambiguity of interpretation of the results.

Identification of the level of the psychological component of the rehabilitation potential will allow not only to determine the condition of the diagnosed object, but also to outline the content of psychological rehabilitation of the recovery period, as well as to form a forecast for the future life of a person with disabilities, the realization of his abilities in conditions of limited opportunities. In this regard, the prognostic value of determining the rehabilitation potential is important primarily for the patient himself, giving him the opportunity to realize his personal resources, based on which compensation and the most complete readaptation are carried out.

The methodology "Rehabilitation potential of personality", developed by I.Y. Kulagina and L.V. Senkevich, is a questionnaire that includes 28 closed questions (Kulagina, Senkevich, 2015). However, this technique does not meet the goals and objectives of our research, the priority of which is the task of express diagnostics for the rapid identification of strong and weak personality characteristics. The rapid and accurate identification of strength factors and risk factors in the development of psychological rehabilitation potential will allow us to develop a strategy and find the most optimal methods of

psychological rehabilitation, psychological correction and psychotherapeutic work with people who have received disabilities during combat operations and special military operations.

In the logic of scientific research, it is justified to study the psychological component of the rehabilitation potential of persons with disabilities according to a three-component structure, which is described by A.V. Yurevich at the level of general psychology and methodology of psychology and is represented by cognitive, affective and conative representatives (Yurevich, 2005). Interpreting the listed mental representatives as parameters for assessing the psychological component of rehabilitation potential, we have identified indicators and indicators for each of them from the point of view of taking into account the strengths and weaknesses of the individual as markers of rehabilitation potential. For cognitive – the ability to solve problems based on logic, calculations, comparisons, generalizations, as well as the basic properties of attention and memorization, for affective – neuropsychic stability (resilience) and intrapersonal conflict, for conative - the general level of adaptability, subjective assessment of quality of life, optimism and activity (Borozinets et al., 2023).

Methods

The study involved 345 neurotypical respondents aged 18 to 42 years ($M = 27.4$, $SD = 9.23$), 54% of them female and 46% male.

Reflection on the experience of practical psychodiagnostics allowed us to compile an express methodology that includes indicators aimed at revealing cognitive, affective and conative parameters related to the psychological component of the rehabilitation potential of persons with disabilities.

The selected indicators of the methodology were analyzed for reliability using the Cronbach's coefficient α to optimize the model.

The optimal model was subjected to a confirmatory analysis to identify the necessary number of factors explaining the overall variance of the studied trait.

The verification of convergent and divergent validity was carried out using diagnostic data according to available standardized methods, scales in which may reflect content similar to ours. The following measurement tools served as the basis for validation:

- the test "Assessment of the state of adaptation of the personality", which allows to identify integral indicators of the states of adaptation and satisfaction of the subject (Yakovenko, 1996);
- the scale of assessment of the quality of life of J. Endicott adapted by N.E. Vodopyanova, revealing the spheres of life activity that cause the greatest discomfort or dissatisfaction (Vodopyanova, 2005);
- the scale of optimism and activity I. Schuller, A. Komuniani adapted by N.E.

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Vodopyanova and M.V. Stein. The test allows you to assess the level of self-confidence and success (Vodopyanova, Stein, 2009);

- the "Self-assessment of conflict" test, reflecting the assessment of the overall level of intrapersonal conflict (Antsupov, Shipilov, 2018);
- "Resilience Test" by S. Muddy (Personal Views Survey, PVS III-R) adapted by D.A. Leontiev and E.I. Rasskazova, revealing resilience as a belief system that prevents the emergence of internal tension in stressful situations due to coping with stress and perceiving them as less significant (Leontiev, Rasskazova, 2006);
- express diagnostics of cognitive abilities, revealing the level of development of attentional, mnemonic, thinking and other abilities (Nikiforov, 2005).

At the last stage of data analysis, quartile standardization was carried out, which allows us to identify the boundaries of the values of the trait reflecting the levels of its severity.

IBM SPSS Statistics 23 and Amos SPSS-23 programs were used for data processing.

Results

To verify the reliability of the methodology, a traditional analysis method was used – the Cronbach's coefficient α , which allows us to assess the contribution of each indicator to the internal consistency of the scale. Note that the initial model included 30 indicators. The analysis results for the initial set of indicators are as follows: $\alpha = 0.568$ for $N = 30$. This means that the coefficient can be increased by eliminating indicators that are insignificant for the methodology model. We excluded items on the scale with low and underestimated values of the correlation coefficient. For the newly obtained results of the adjusted Cronbach model, α is 0.942 for $N = 22$. As you can see, the fitness statistics have increased; further exclusion of any of the 22 points gives a value of α less than at 22 points. That is, the remaining points form the optimal composition of the scale. In our case, the internal consistency of the scale is close to the maximum possible (at $\alpha > 0.9$ – "excellent", according to the recommendations (Heritov, 2011).

To determine the effectiveness of differential diagnosis of the phenomenon of rehabilitation potential of a personality (its psychological component), we solved the problem of identifying and substantiating factors within the scale that evaluate different sides of the subject under study. At the same time, we applied the analysis to two variants of the methodology model – three- and one-factor - for the purpose of comparing them. We excluded the intermediate two-factor variant for this case due to the blurring of the boundaries of the two factors and the low cumulative percentage of explaining the cumulative variance (Heritov, 2011; Kenny & McCoach, 2003; Rosseel & Lavan, 2021). Confirmatory factor analysis was used. The results are shown in table 1.

Table 1

Factor loads of the questionnaire items on the rehabilitation potential of the individual (two models, N=345)

Indicators	Model 1			Model 2
	Factors			1
	1	2	3	
The behavioral component				
Adaptability				
Not knowing what I want from life	,435			,636
Feeling vulnerable	,642			,641
The unsolvability of problems	,810			,745
Feeling like a bad, worthless person	,800			,666
Meaninglessness of life, emptiness	,799			,797
Quality of life				
Feeling like an unhappy person	,776			,823
Life satisfaction	,671			,698
Dissatisfaction with loved ones	,708			,661
Lack of achieved goals	,791			,765
Optimism				
Loneliness and lack of support	,525			,734
Difficulty in achieving goals	,562			,675
Problems with the difficulties of life	,437			,733
Weak faith in anything good	,530			,743

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Indicators	Model 1			Model 2
	Factors			
	1	2	3	1
The affective component				
Intrapersonal conflict				
Simultaneous desire for opposite things		,546		,661
Contrast of feelings towards the same person		,904		,689
The polarity of desires		,673		,681
Neuropsychic stability				
Inappropriate anger		,640		,649
Hostility to others		,625		,672
Mood swings		,622		,598
The cognitive component				
Cognition				
Difficulties with logic tasks			,536	,559
Low concentration of attention			,799	,667
Memory problems			,835	,653

The traditional approach and the experience of modern research shows that the compliance of models with the data obtained can be assessed on the basis of the following indicators (Aliyev, Kashirsky, Urozhenko, 2023; Gulevich, Krivoshchekov, Guseva, 2022; Suchkova, Lyusin, 2023; Nestik, Gagarina, 2022; Chen, 2007; Kenny, Kaniskan & McCoach, 2015; Kline, 2016):

- comparative model fit index (CFI) and Tucker-Lewis index (TLI), (acceptable fit = 0.90, and good fit = 0.95);
- chi-squared (chi-sq, χ^2), where significance is associated with the corresponding level (p);
- the standard error of approximation (RMSEA), where an acceptable match is between 0.05 and 0.08, and a good match is 0.05 and below;
- the standardized root of the root means square remainder (SRMR), whose values are lower than 0.08, are considered good.

The results with the corresponding symbols are presented in Table 2.

Table 2

Parameters for two versions of the rehabilitation potential measurement methodology

Indicators	CFI	TLI	chi-sq		RMSEA	SRMR
			χ^2	p		
Model 1	0,924	0,903	59,219	0,001	0,047	0,037
Model 2	0,813	0,832	39,112	0,053	0,064	0,053

Note. Model 1 is a three-factor version of the questionnaire; Model 2 is a one-dimensional version of the questionnaire.

In conclusion, a confirmatory factor analysis was conducted primarily for one factor, the results of which showed that such a model does not fully meet the reliability conditions: for example, slightly reduced values were found for the parameters being tested: CFI = 0.813, TLI = 0.832, $\chi^2 = 39.112$ ($p = 0.053$), RMSEA (90% CI [0.064 0.085]) = 0.064, SRMR = 0.053. The adjusted model for three factors (Model 1 in Tables 1 and 2) demonstrated higher fitness indicators: CFI = 0.924, TLI = 0.903, $\chi^2 = 59.219$ ($p = 0.001$), RMSEA indices = 0.047 (90% CI [0.052; 0.074]), SRMR = 0.037 at a high and good level of significance, which indicates a good agreement with the model of the methodology, which includes exactly three factors.

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The validity (convergent and divergent) of our methodology for measuring the psychological component of the rehabilitation potential of persons with disabilities acquired during combat operations and special military operations was assessed using tools that have already been tested – for adaptation, satisfaction, conflict, resilience, cognitive abilities. At the same time, in table 3, three factors are shown in columns, somewhat detailed by scales, represented by sets of scales (blocks) for each of the factors. Scales of standardized techniques are given along the lines.

Table 3

The correlation between the scales of the developed methodology for measuring the psychological component of the rehabilitation potential of a person and the available standardized methods

Scales	Adap- tability	Quality of life	Opti- mism	Intra- personal conflict	Neuro- psychic stability	Cognition
Adaptation	0,513**	0,398*	0,419*	-0,170	0,201	0,123
Satisfaction	0,329*	0,498**	0,377*	-0,210	0,280	-0,079
A positive attitude to life	0,388*	0,219	0,429**	-0,291	0,255	0,276
Self- assessment of conflict	-0,102	0,019	-0,228	0,539**	-0,368*	-0,129
Resilience	0,227	0,239	0,293	-0,533**	0,644**	0,299
Cognitive abilities	-0,119	0,204	-0,018	0,113	0,172	0,532**

Note. * – $p < 0.05$, ** – $p < 0.01$

As can be seen in Table 3, the scales of adaptation, satisfaction and positive attitude to life directly correlate with the corresponding scales of our methodology related to the first factor "Behavior": $r = 0.513$, $r = 0.398$ and $r = 0.419$ in the first methodology for the scales of adaptability, quality of life and optimism, respectively; $r = 0.329$, $r = 0.498$ and $r = 0.377$ for the second method for the same scales, respectively; $r = 0.388$, $r = 0.219$ (no connection) and $r = 0.429$ for the third method for the same scales, respectively. That is, high convergent and divergent validity is visible – there are links with the corresponding

similar scales of the standardized methods developed by us and already available, and there are no links with other scales. The scales of self-assessment of conflict and resilience correlate with the corresponding scales of our methodology related to the second factor "Emotionality": $r = 0.539$ and $r = -0.368$ for the first methodology for the scales of intrapersonal conflict and neuropsychic stability, respectively; moreover, in the first case, this relationship is direct, in the second – reverse, i.e. the higher the self-esteem of conflict, the higher the intrapersonal conflict and the lower the neuropsychic stability; for the second method – $r = -0.533$ and $r = 0.644$ for intrapersonal conflict and neuropsychic stability, respectively, i.e. the higher the resilience, the lower the intrapersonal conflict and the higher the neuropsychic stability. There is also high convergent and divergent validity. Finally, the scale reflecting cognitive abilities directly correlates with the third factor – "Cognition" ($r = 0.532$), while there are no links with other scales, which also indicates high convergent and divergent validity.

To determine the general level of severity of the psychological component of a person's rehabilitation potential and its individual parameters, we used quartile standardization for the initial data, which allowed us to identify high, medium and low values of the indicator represented by specific points, which is convenient for the purposes of computerization of the methodology and the corresponding accelerated processing of the results of a psychodiagnostic examination. In general, according to the methodology, the following scale of severity of the general level of the psychological component of rehabilitation potential can be fixed:

- high level – from 1 to 1.02 points;
- average level – from 1.03 to 2.77 points;
- low level – from 2.78 to 5.0 points.

Discussion

The results sum up that the psychological component of the rehabilitation potential of persons with disabilities acquired during combat operations of special operations can be diagnosed using the original express methodology developed by us, which includes 22 indicators combined into three factors. This is justified by checking the reliability and validity of the tool.

According to the data obtained, we have the following content of three factors in the model of the psychological component of the rehabilitation potential of the individual:

1. The "Behavior" factor (the conative component) includes the enlarged elements "Adaptability", "Quality of life" and "Optimism".

The allocation of this conative factor is consistent with the research data of the authors who studied the rehabilitation potential in terms of the importance of functional and behavioral activity in the subject during recovery after a traumatic event (Gudilina, 2012; Khokhlova, 2020). Special attention is paid in research to the psychological aspect

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of rehabilitation potential associated with the choice of coping behaviors, protective mechanisms used by the subject and strategies of conflict behavior, where the subject focuses on constructive strategies, adaptive coping and productive psychological defenses with high rehabilitation potential (Porokhina, 2004; Rogacheva, 2008).

2. The factor of "Emotionality" (affective component) includes the enlarged elements "Intrapersonal conflict" and "Neuropsychic stability".

This factor, highlighted by us, becomes one of the basic explanatory elements in research models of rehabilitation potential, which emphasizes the need for emotional and volitional regulation of the subject's behavior in managing mental states associated with a traumatic event (Kulagina, Senkevich, 2015; Wade, 2023). The works of various authors note the role of certain diagnostically significant mental qualities and properties of the subject in the formation and development of an emotionally colored attitude to the situation of disability in different modalities – anxiety, aggressiveness, frustration tolerance, psychological resistance, empathic abilities (Solovyova, 2023; Mosqueda, 1993).

3. The factor "Cognition" (cognitive component) includes logic, memory and attention.

The element of knowledge as a resource of the subject's activity, according to a number of authors, plays a special role in restoring its full functioning at the stage of rehabilitation after a traumatic event. Thus, in studies of rehabilitation potential from this point of view, emphasis is often placed on the preservation of the cognitive functions of the subject, primarily at the level of intellectual development and the ability to cognitive reflection, as well as at the level of particular manifestations – stability and concentration of attention, memorization and preservation of material, stability of spatial representations, abstract-logical and inductive-deductive thinking (Boncalo, 2023; Cowley, 2021; Goodwin & Allan, 2019).

The determined three-factor structure is consistent, on the one hand, with general psychological ideas about the structure of any object of the subject's mental reality (Yurevich, 2005), and on the other, allows us to clarify the specifics of this idea for a specific subject - the psychological component of the rehabilitation potential of the individual (Gudilina, 2012; Kulagina, Senkevich, 2015; Rogacheva, 2008; Porokhina, 2004; Solovyova, 2023; Khokhlova, 2020; Burton, 2015; Goodwin & Allan, 2019; Wade, 2023).

Thus, the obtained methodological tool can be used to diagnose the psychological component of the rehabilitation potential of persons with disabilities acquired during combat operations of special operations, in terms of its three parameters (behavioral, affective and cognitive) with the option of allocating assessment levels for each separately and its complex indicator.

Conclusions

Rehabilitation potential is defined by us as the characteristics of a personality and its resource capabilities necessary to overcome the negative consequences of disability, consisting of psychophysiological, psychological, professional, pedagogical and socio-environmental components. It is advisable to study the psychological component of the rehabilitation potential of persons with disabilities according to a three-component structure represented by cognitive, affective and conative representatives.

The developed rapid diagnostic technique has shown high reliability. The high constructive validity of the methodology has been established – the three-factor structure based on the confirmatory analysis has been substantiated. High convergent and divergent validity is shown by comparing the results obtained with data from existing standardized methods. Quartile standardization made it possible to distinguish between high, medium and low levels of severity separately by three factors and a general indicator of the psychological component of the rehabilitation potential of the individual.

Based on the results of the testing, we can talk about the suitability of this methodological tool for use for research and practical purposes, and recommend it for use by specialists working with persons with disabilities acquired during combat operations and special military operations to assess the psychological component of rehabilitation potential.

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Author Contributions

Olga V. Solovyova – description of the psychological component of the rehabilitation potential of persons with disabilities acquired during combat operations of special military operations; development of express diagnostic methods.

Alexey S. Lukyanov – implementation of secondary mathematical processing of data obtained during diagnostics; checking the diagnostic tool for validity and reliability; editing the final version of the article.

Natalia M. Borozinets – a conceptual idea and design for the study of the rehabilitation potential of persons with disabilities acquired during combat operations of special operations.

Yulia V. Prilepko – collection, processing, primary analysis and interpretation of diagnostic data; participation in the development of express diagnostic methods.

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Conflict of Interest Information

The authors have no conflicts of interest to declare.

Appendix 1

Questionnaire "Rehabilitation Potential of Combatants With Disabilities"

Instructions

Dear survey participant! You are offered 22 questions regarding your psychological state. Carefully read each statement and choose to what extent it is true for you. We kindly ask you to approach the survey honestly, since the test results will help the psychologist to understand the content of psychological help and support that you can receive in order to alleviate symptoms and experiences to improve your condition.

Incentive material

1. I often think that I don't know what I want from life.
2. I often experience vulnerability, self-doubt.
3. Almost any problem seems to be an unsolvable task.
4. I am a bad, worthless person.
5. Sometimes life seems meaningless and empty to me.
6. I often want opposite things at the same time (for instance, to communicate and retire, work and loaf, etc.).
7. I often experience contrasting feelings towards the same person (for example, love and hate, anger and friendliness, etc.).
8. I can simultaneously experience polar desires (for example, to stay with a person or break up with him, change my occupation and stay in my former profession, etc.).
9. I often feel like an unhappy person.
10. At the moment, it can be said that I am completely dissatisfied with my life.
11. I am not satisfied with relationships with close people.
12. I have not achieved many goals and because of this I often feel like a failure.
13. I often feel inappropriate anger.
14. Lately, I often feel my hostility towards others.
15. I often have mood swings.
16. Lately, I have been feeling loneliness and lack of support more and more often.
17. I think my life goals are too difficult to achieve.
18. I have a hard time coping with life's difficulties.

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- 19. It is currently impossible to believe in anything good.
- 20. I have difficulties in solving problems and problems that require logic, comparison, generalization, etc.
- 21. I have low concentration of attention – I often get distracted and cannot concentrate on some business.
- 22. I notice that I do not remember and retain information well.

Key

School 1. BEHAVIORAL COMPONENT

- 1. High – answers: No and, Perhaps, no – 48-60 points.
- 2. Average – answers: Sometimes - 25-47 points.
- 3. Low – answers: Yes and, Perhaps, yes – 12-24 points.

School 1. BEHAVIORAL COMPONENT	
Indicators	Questions
Indicator 1. Adaptability of personality	1) I often think that I don't know what I want from life. No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

Indicator 1. Adaptability of personality	2) I often experience my vulnerability, self-doubt No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	3) Almost any problem seems to me to be an unsolvable task No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	4) I'm a bad, worthless person No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	5) Sometimes life seems meaningless and empty to me No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

CORRECTIONAL PSYCHOLOGY

Indicator 2. Quality of life	<p>1) I often feel like an unhappy person No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point</p>
	<p>2) At the moment, I can say that I am not completely satisfied with my life No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point</p>
	<p>3) I am not satisfied with relationships with loved ones No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point</p>
	<p>4) I have not achieved many goals and because of this I often feel like a failure No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point</p>

Indicator 3. Optimism and activity	1) Lately, I have been feeling loneliness and lack of support more and more often No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	2) I think my life goals are too difficult to achieve No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	3) I have a hard time coping with life's difficulties No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	4) It is currently impossible to believe in anything good No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

CORRECTIONAL PSYCHOLOGY

School 2. AFFECTIVE COMPONENT

1. High – answers: No and, Perhaps, no – 28-35 points.
2. Average – answers: Sometimes - 14-27 points.
3. Low – answers: Yes and, Perhaps, yes – 7-14 points.

School 2. AFFECTIVE COMPONENT	
Indicators	Questions
Indicator 1. Intrapersonal conflict	1) I often want opposite things at the same time (for example, to communicate and retire; to work and loaf, etc.) No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
Indicator 1. Intrapersonal conflict	2) I often experience contrasting feelings towards the same person (for example, love and hate; anger and friendliness, etc.) No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	3) I can simultaneously experience polar desires (for example, to stay with a person or break up with him; to change my occupation and stay in my former profession, etc.) No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

Indicator 2. Neuro-psychological stability (resilience)	1) I often feel inappropriate anger No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	2) Lately, I often feel my hostility towards others No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
	3) I often have mood swings No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

School 3. COGNITIVE COMPONENT

1. High – answers: No and, Perhaps, no – 12-15 points.
2. Average – answers: Sometimes - 7-11 points.
3. Low – answers: Yes and, Perhaps, yes – 3-6 points.

School 3. COGNITIVE COMPONENT	
Indicators	Questions
Indicator 1. Intelligence	1) Sometimes it is difficult for me to solve problems on logic, calculations, comparisons, generalizations, etc. No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

CORRECTIONAL PSYCHOLOGY

Indicator 2. Attention	1) I have a low concentration of attention – I often get distracted and can't focus on something No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point
Indicator 3. Memory	1) I notice that I don't remember and retain information well No – 5 points Probably not – 4 points Sometimes - 3 points Perhaps yes – 2 points Yes – 1 point

Interpretation of scales

1. High level of rehabilitation potential – 88-110 points:

- high degree of adaptability;
- subjective satisfaction with the quality of life;
- a high degree of optimism and activity;
- low degree of intrapersonal conflict;
- a high degree of neuropsychic stability (resilience);
- high level of cognitive functions (logic, attention, memory).

The following are shown: psychological and pedagogical consultation on request without instrumental influences; psychological support is recommended as part of professional rehabilitation.

2. The average level of rehabilitation potential is 45-83 points:

- average degree of adaptability;
- the average degree of subjective satisfaction with the quality of life;
- a tendency to optimism and activity;
- there is a tendency to intrapersonal conflict;
- the average degree of neuropsychic stability (resilience);
- the average level of cognitive functions (logic, attention, memory).

The following are shown: psychological assistance and support in the process of vocational rehabilitation.

3. Low level of rehabilitation potential – 22-44 points:

- maladjustment;
- subjective dissatisfaction with the quality of life;
- lack of optimism and activity;
- a high degree of intrapersonal conflict;
- low indicators of neuropsychic stability (resilience);
- low level of cognitive functions (logic, attention, memory).

The following are shown: psychocorrectional and psychotherapeutic assistance in the process of professional rehabilitation.