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Russian Psychological Journal

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Colour discrimination in post-COVID-19 observers assessed by the Farnsworth-Munsell 100-Hue test

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Abstract

Introduction. Post-COVID-19, various ophthalmological symptoms and visual impairments have been reported. We hypothesised that colour vision may be affected too. **Methods.** We assessed colour discrimination using the Farnsworth-Munsell 100 Hue test (FM-100) in individuals who have had COVID-19 (N = 77; 18–68 years). **Results.** Total error score (TES) indicated superior colour discrimination in 34 observers. The Vingrys–King-Smith C-index (severity) exceeded the normal cut-off measure in 44 observers. In participants (N = 35) with average TES, the Vingrys–King-Smith analysis revealed subtle colour deficiencies – either a mild tritan defect ('blue' or blue-yellow) or moderate defect with a diffuse error pattern. A minor sub-sample manifested poor discrimination (N = 6) or colour vision loss (N = 2), with a tritan or diffuse error pattern. √TES negatively correlated with the post-illness period. In partial error score (√PES), B–Y errors prevailed, regardless of the elapsed post-illness period. **Discussion.** Overall, the results indicate that about half of those who have recovered from COVID-19 revealed mild Type III acquired colour discrimination loss, characteristic of retinal disorders and vascular disease. Conceivably, coronavirus infection caused hypoperfusion (reduced vascular supply) at the retinal and/or post-retinal stages of the visual system and affected neural mechanisms of colour discrimination. The mild impairment appears to be reversible with a favourite prognosis.

Keywords

colour vision, colour perception, chromatic discrimination, COVID-19, post-COVID syndrome, Farnsworth-Munsell 100-Hue test, Type III acquired colour vision deficiency

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Introduction

There is increasing evidence that patients who have recovered from COVID-19 exhibit various symptoms of visual impairment, such as photophobia, blurry vision, floaters or decreased visual acuity or tunnel vision (e.g. Gangaputra & Patel, 2020; Eleiwa et al., 2021). Clinically these symptoms were associated with various neuro-ophthalmological manifestations: raised intraocular pressure (IOP) and dilated retinal veins, the sign of retinopathy (e.g. Invernizzi et al., 2020; Costa et al., 2021). In some cases, acute macular neuroretinopathy was diagnosed (Eleiwa et al., 2021), that revealed reduced blood flow in the retina (Nagy, 2020), ischaemic optic neuropathy (Yüksel et al., 2022); also, as a vaccine reaction, optic neuritis developed, attributed to vasospasm (Haseeb et al., 2022).

In the great majority of COVID-19 related ophthalmological studies colour vision (CV) was reported to be normal. However, in a few case studies dyschromatopsia was reported, where macular neuroretinopathy was diagnosed or optic nerve involvement suggested (e.g. Clarke et al., 2021; Giacuzzo et al., 2022; Nagaratnam et al., 2022). In all cases CV loss was assessed by correct readings of the Ishihara plates (e.g. 10/17). Notably, later dyschromatopsia reversed in cases of macular retinopathy (Giacuzzo et al., 2022) or unilateral optic neuritis (Richardson-May et al., 2022); however, CV worsening was recorded in a case of progressing bilateral optic neuritis (Nagaratnam et al., 2022).

To our knowledge, no systematic studies of colour sensitivity post-COVID-19 have been undertaken. In this context we venture to relate the post-COVID adverse ocular events to earlier, non-COVID, studies, which reported IOP, neuroretinopathy and optic neuritis to be accompanied by an impaired CV – either blue-yellow or non-selective discrimination loss (both blue-yellow and red-green) (e.g. Schneck & Haegerstrom-Portnoy, 1997; Castelo-Branco et al., 2004; Bimler et al., 2014). The reader is reminded of Köllner's rule (Köllner, 1912), according to which acquired blue-yellow abnormalities are likely to arise due to changes in external retinal layers, while complex dyschromatic configurations that also involve red-green loss are manifestations of conditions affecting the optic nerve (for reviews, see Verriest, 1963; Hart, 1987; Simunovic, 2016).

During the pandemic, in an online experiment we explored colour naming in post-COVID participants (pCPs), as a proxy of (affected) CV, and compared their responses with those obtained before the pandemic in healthy controls with normal CV (Griber & Paramei, 2022a; 2022b). Our study demonstrated that, compared to the controls, pCPs more frequently used names 'brown', 'green', and 'grey', as well as achromatic modifiers 'dark', 'dirty', 'pale', 'dull', and 'pastel', hinting to general "darkening" and "desaturation" of perceived colours.

The purpose of the present study was to investigate colour discrimination of pCPs using the Farnsworth-Munsell 100-Hue test (FM-100) (Farnsworth, 1943; 1957) that has been widely employed to assess CV (for reviews see Lakowski, 1969; Birch, 2001; Dain, 2004; Paramei & Bimler, 2019). The FM-100 analysis of the cap arrangement allows to quantify an observer's colour discrimination in relation to normative scores for healthy normal trichromats of the corresponding age group (Verriest et al., 1982; Knoblauch et al., 1987; Roy et al., 1991; Kinnear & Sahraie, 2002), as well as to determine the predominant axis of colour confusion (Smith et al., 1985).

In clinical practice, the FM-100 was administered to diagnose the type and severity of acquired CV deficiencies (for pioneer studies, see François & Verriest, 1961; Verriest, 1963; Birch et al., 1979). In particular, the FM-100 was employed for assessing CV impairment caused by various visual system pathologies, such as maculopathy, multiple sclerosis and optic neuritis (e.g. Vingrys & King-Smith, 1988; Ménage et al., 1993; Schneck & Haegerstrom-Portnoy, 1997; Gundogan et al., 2013), pre- and post-surgery cataract (Ao et al., 2019), and systemic diseases, such as diabetic retinopathy (Barton et al., 2004; Shoji et al., 2011; Raman et al., 2018) or hypothyroidism (Racheva et al., 2020; 2023).

Methods

Participants

Participants were volunteers – staff and students from Smolensk State University and, also, from general public recruited by advertising the study on social media. CV was assessed in 80 participants, 28 men and 52 women, who received outpatient care after having developed mild symptoms (fever and/or cough) and who had tested positive for COVID-19, certified by a doctor. Two participants had suffered from COVID-19 twice, with the confirmed diagnosis. Data of one participant with self-reported diabetes and two with congenital CV deficiency were excluded. The final data set comprised 77 observers (50 women), aged 33.58 (SD = 13.31) years (age range 18–68 years). The duration of the illness varied between 2–74 days (mean 17.82 ± 11.56 days). By the time of the FM-100 testing (March–July 2022), the elapsed period since the recovery ranged between 21–871 days, i.e. from a few weeks to 2.5 years, with mean 331 ± 217 days.

Detailed information on demographic characteristics of pCPs, as well as on their self-reports on the disease duration, changes in various sensory modalities, and the post-

COVID period are presented in Table S1 of Supplementary Materials. Almost two thirds of the participants (N = 47) reported distorted sense of smell and more than half (N = 40) a changed sense of taste during or after the illness. Some participants commented that they had experienced various symptoms of visual impairment, such as photophobia, blurry vision, decreased visual acuity or increasing astigmatism.

The study was approved by the Ethics Committee of Smolensk State University and performed in accordance with the tenets of the Declaration of Helsinki. Prior to the FM-100 testing, informed consent was obtained from all participants.

Stimuli

The FM-100 test has 85 hues, representing the full colour circle, with the hues separated by approximately equal perceptual steps. In the Munsell notation, colour caps have equal Value 6 and Chroma 6, and vary only in hue. The FM-100 (X-Rite, 2024a; 2024b; Grand Rapids, Michigan, USA) has four sets (boxes) of colour caps. There are 22 caps in box A (caps 85–21), corresponding to the hues varying from red to red-orange, and 21 colour caps in the other three boxes representing the other three sectors of colour circle: yellow to yellow-green (box B, caps 22–42), green to green-blue (box C, caps 43–63), and indigo to indigo-magenta (box D, caps 64–84). Each set contains two "anchor" colour caps, whereas the remaining caps are movable. The colour difference (ΔE) between the caps is very small, which ensures that minute differences in colour discrimination can be captured. Note though, that ΔE is not uniform between the boxes, with the box A being the least difficult and the box C the most difficult (Lakowski, 1966). The spacing of the caps is smaller around caps 85 to 8 and 35 to 65 than in the other FM-100 areas, implying a more difficult task for an observer (Dain et al., 1991).

Procedure

The procedure and data processing were implemented according to Farnsworth's original instructions (Farnsworth, 1957). The FM-100 four boxes of colour caps were presented to each individual in random order. The participant's task was to arrange the caps in a continuous colour series within each box starting from the anchor cap. Prior to the testing, the colour caps in each box were re-shuffled. The FM-100 was administered binocularly, in a laboratory close to a window, under natural daylight, which in spring–summer months in Smolensk (55°N, 32°E) provided an illuminance of ca. 1000 lux, i.e. comparable to the illumination of 1000 lux (Roy et al., 1991; Mäntyjärvi, 2001; Woo & Lee, 2002) and higher than the illumination, 200 lux, in the classical Verriest et al. study (1982). The viewing distance was 45–50 cm; near vision glasses were used if needed. All participants performed the FM-100 as novices. There was no time limit imposed; the testing session usually took 15–20 minutes.

Analysis

Colour vision was assessed by the participant's score derived from the arrangement of the caps. We calculated the following (for details see below):

1. the total error score (TES) and its square root (√TES), for the whole sample and stratified for age groups
2. partial error scores (i) for ten specified hue bands; (ii) along the B-Y and R-G axes; (iii) for different hemispheres of the FM-100 diagram
3. the moment of inertia for colour difference vectors
4. clusters of cases based on similarity of the arrangement patterns.

The total error score

The total error score (TES), which represents chromatic discrimination in general, was calculated as the sum of scores for the caps in the four boxes (Equation 1). The score for an individual cap was calculated as the sum of the absolute difference between the error number for that colour cap and the error numbers of the adjacent caps minus 2 (Farnsworth, 1957):

$$TotalErrorScore(TES) = \sum_{i=1}^{4} iES = \sum_{i=1}^{4}\left(\left(\sum_{j=1}^{n+2} CE_j\right) - \left((n+2)\cdot 2\right)\right) \quad (1)$$

where $CE_j = |C_j - C_{j-1}| + |C_j - C_{j+1}|$; i is a counter for the four boxes (i = 1 is "A", 2 is "B", 3 is "C", and 4 is "D"); C_j is the cap number of the j^{th} cap; CE_j is the cap error of the j^{th} cap; n is the number of moveable caps in the box corresponding to i (n = 22 for box A, and n = 21 for boxes B–D). For this equation to work properly, the terms $|C_j - C_{j+1}|$ and $|C_j - C_{j-1}|$ must each be equal to 1 when the caps are ordered correctly. Since the first free cap in tray A is numbered 85, not 1, the calculation requires a dummy array that assigns cap 85 a value of 1, cap 1 a value of 2, and so on. The cap error (*CE*) was calculated for the end caps of the tray, otherwise scoring would be incorrect when errors are made near the tray's ends; this necessitates the (n + 2) term in Equation (1), whereby "2" accounts for each end cap (Esposito, 2019).

Following Esposito (2019), we denoted the standard error scores for individual boxes as *AES, BES, CES* and *DES*. Thus, for an observer who placed all caps in the correct order, TES = 0; the higher the number of cap transpositions the greater is TES. Since TES has a skewed distribution, a square root transformation has been suggested to provide a distribution closer to normal (Kinnear, 1970). Hence, square root of the total error score (√TES) was used for the following analysis.

Partial error scores for specified hue bands

Guided by Ao et al. (2019), we calculated partial error scores (PES) and the corresponding √PES for the following ten hue bands (cf. Figure 3):

(1) red to yellow-red (R-YR), caps 1–9; from the long-wavelength end to 590 nm

(2) yellow-red to yellow (YR-Y), caps 10–17; 590–580 nm

(3) yellow to green-yellow (Y-GY), caps 18–26; 580–560 nm

(4) green-yellow to green (GY-G), caps 27–35; 560–500 nm

(5) green to blue-green (G-BG), caps 36–45; 500–490 nm

(6) blue-green to blue (BG-B), caps 46–53; 490–470 nm

(7) blue to purple-blue (B-PB), caps 54–60; 470 –450 nm

(8) purple-blue to purple (PB-P), caps 61–70; 450 nm to the short-wavelength end

(9) purple to red-purple (P-RP), caps 71–77; 560*–500* nm

(10) red-purple to red (RP-R), caps 78–85 (complementary to green–yellowish-green).

Partial error scores for the B-Y and R-G axes

In order to evaluate whether errors are more common along the cardinal axes of perceptual colour space, we partitioned the TES into scores along the B-Y and R-G axes (Smith et al. 1985; Knoblauch, 1987; Racheva et al., 2020; 2023). B-Y PES (caps 1–12, 34–54 and 76–85) and R-G PES (caps 13–33 and 55–75) were calculated and analysed according to Smith et al. (1985). For further analysis, the corresponding √B-Y PES and √R-G PES were used.

Partial error scores for different hemispheres of the FM-100 diagram

Since errors may concentrate along specific colour confusion axes, we also quantified the type of error by assessing error distribution in the right and left, as well as the lower and upper hemispheres of the FM-100 diagram (Farnsworth, 1957; Birch, 2001) (see Figure S2). Following the approach of Bento-Torres and colleagues (2016), the left central point corresponded to the hue axis between caps 1–43 and the right central point to the hue axis between caps 44–85, in such a way that the cumulative score in the clockwise direction in the FM-100 diagram was equal to the error median in the respective hemisphere. The

upper central point corresponded to the hue axis between caps 27–70 and the lower central point to the hue axis between caps 71–26. √PES for the corresponding FM-100 hemispheres were used for statistical analysis.

Moment of inertia

Following Vingrys & King-Smith's (1988) analysis of colour difference vectors, we calculated the moment of inertia. The analysis yields three indices, which quantify an individual cap arrangement pattern: (1) *Angle of confusion,* or orientation of the resulting radius of gyration, which identifies the type of colour deficiency; (2) *Confusion index* (*C-index*), which quantifies the severity of CV loss; and (3) *Selectivity index* (*S-index*), the ratio of the major to minor radii, which quantifies the amount of polarity or lack of randomness in a cap arrangement. For the present analysis, V&K-S's computer program, originally developed in Basic (Vingrys & King-Smith's, 1988, pp. 61–62), was re-written in Excel VBA (see Appendix 2).

Cluster analysis of post-COVID participants' FM-100 data

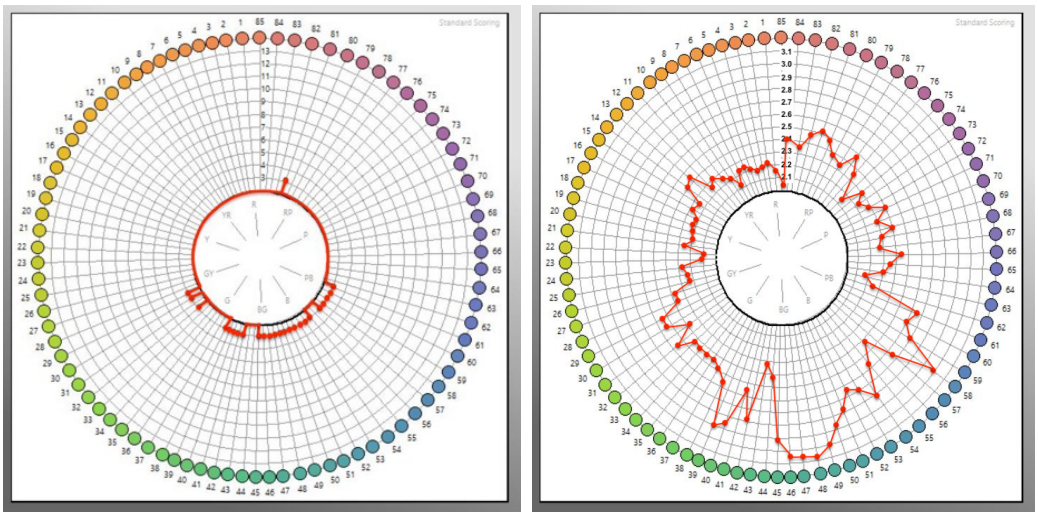
To explore subsamples of pCPs based on similarities of their FM-100 performance, we applied Ward's (1963) hierarchical clustering method, implemented as a program developed in scikit-learn in Python (https://scikit-learn.org/). Distances between clusters were calculated using the Ward's minimum variance criterion. We input total error scores (TES) and the three parameters of the V&K-S moment of inertia (Vingrys & King-Smith's, 1988). Our particular interest was in possible impact of the Angle on clustering outcome, since it indicates the type of CV loss and, unlike the C-index and S-index, does not correlate with TES (Bassi et al., 1993). For visualizing similarities between individual cases, t-SNE embedding initialization was applied to project high-dimensional data into a 2D map, which approximately preserves inter-item proximity, with each datapoint representing an individual participant.

Results

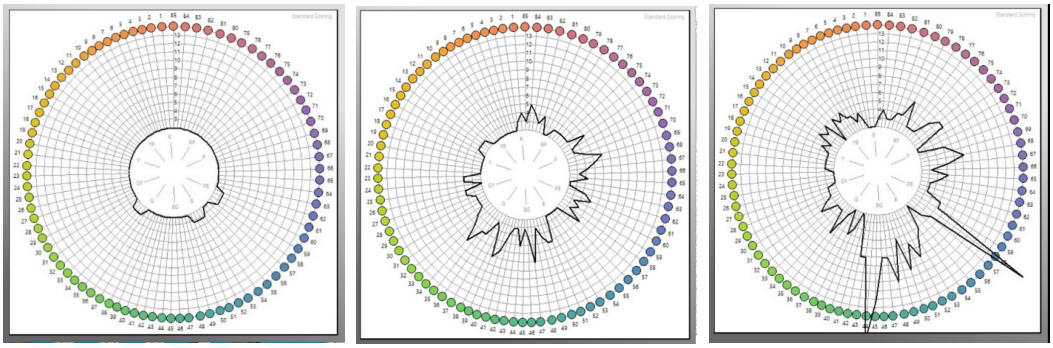
Total error score for post-COVID participants

Individual pCPs' total error scores (TES) are presented in Table S2 of Supplementary Materials and FM-100 diagrams in Appendix 1. Across the pCP sample, we estimated mean error scores for each cap, as illustrated in Figure 1a; since error score values are low, a magnified version of the FM-100 diagram is presented in Figure 1b. It is apparent that colour confusions prevail in the green-blue gamut (caps 40–60).

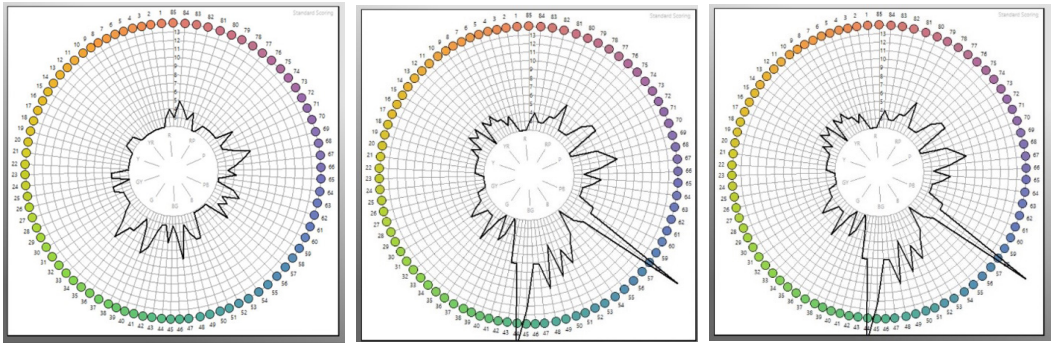
Figure 1
The FM-100 diagram for the post-COVID participants



(a) (b)



(c) (d) (e)



(f) (g) (h)

Note. *(a) Mean error score for each cap. (b) A magnified version of the the FM-100 diagram; note the radius scale 0–3.1 (unlike the conventional 0–13 radius scale). Exemplary FM-100 diagrams for post-COVID participants representing TES in different ranges: (c) #12: TES = 12; (d) #1: TES = 40; (e) #52: TES = 72, (f) #53: TES = 116; (g) #59: TES = 176; (h) #71: TES = 212.*

For the pCP sample, mean TES is 38.1 ± 37.8; median (mdn) is 28. However, as illustrated in Figure 1(c-h), there is a great individual variation of TES, between 0–212. Guided by Lakowski (1969), we estimated participant subsamples in relation to TES median. For more than half pCPs (N = 40), TES was ≤ 28, with superior colour discrimination (TES = 0–12) among these for 25% (N = 23). Further pCPs (N = 32; 90th percentile) demonstrated average performance, 28<TES≤ 84. Finally, TES of 5 participants (#53, 55, 59, 70, 71) was higher than the 95th percentile for their age group (Verriest, 1963); it overlaps with the subsample of 4 participants (#7, 53, 59, 71), whose TES, 116–212, >100, indicates colour deficiency (Farnsworth, 1957; Birch, 2001).

√TES mean for pCPs was 5.52 ± 2.77. Table 1 presents FM-100 means (SDs) of √TES for age-stratified groups and, for comparison, mean √TES for normal trichromats (Verriest et al., 1982; Roy et al., 1991; Kinnear & Sahraie, 2002). Table 1 indicates generally a good correspondence between the present and three earlier data sets for all age groups. Figure S1 shows √TES for individual pCPs as a function of age in relation to age groups means in (Verriest et al., 1982; Roy et al., 1991; Kinnear & Sahraie, 2002). It is noteworthy that in the 20–29 group more than half of the pCPs (16 out of 28) revealed higher mean √TES (7.98 ± 2.01) than the conservative mean √TES for the 20–29 y.o. (Verriest et al., 1982) (t = 4.56, p<0.01). Similarly, in the 30–39 pCP group almost half (5 out of 12) had higher mean √TES (8.48 ± 1.48) than the 30–39 y.o. (Verriest et al., 1982) (t = 2.69, p = 0.05).

Table 1

Mean and standard deviation of square root of the total error scores

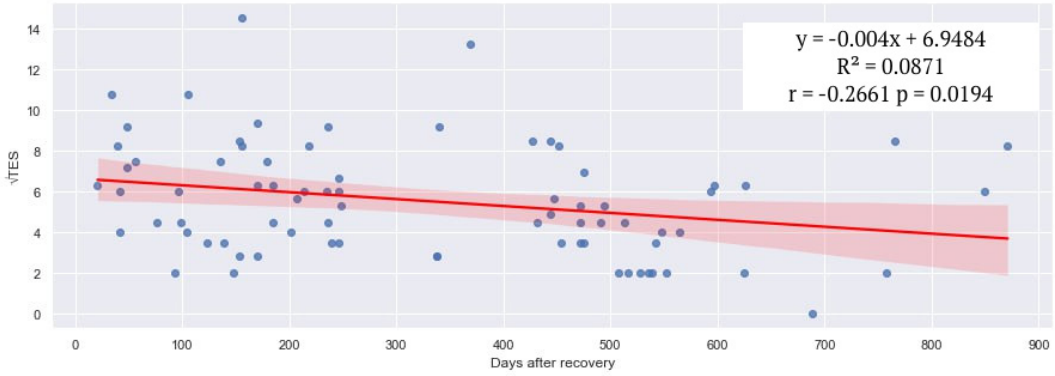
Age group (years old)	Post-COVID participants (present study)			Healthy normal trichromats								
				Verriest et al. (1982)			Roy et al. (1991)				Kinnear & Sahraie (2002)	
	No. of observers	Mean age	Mean √TES ± SD	No. of observers	Mean age	Mean √TES ± SD	No. of observers	Right eye mean √TES ± SD	No. of observers	Left eye mean √TES ± SD	No. of observers	Mean √TES* ± SD
15–19	9	18.2	3.45 ± 1.27	32	17.3	6.63 ± 1.91	13	7.2 ± 3.0	13	6.3 ± 2.9	68	7.2 ± 2.63
20–29	28	23.1	6.02 ± 2.90	29	24.8	5.69 ± 2.07	25	6.0 ± 2.2	25	6.0 ± 2.5	35	6.7 ± 2.88
30–39	12	34.2	5.79 ± 2.92	29	34.2	6.71 ± 2.90	16	6.7 ± 1.9	17	5.8 ± 2.7	10	7.3 ± 2.38
40–49	18	44.2	5.33 ± 3.03	30	45.3	8.23 ± 2.44	13	5.8 ± 1.1	12	5.3 ± 2.0	10	8.1 ± 2.66
50–59	6	52.2	5.25 ± 2.12	30	54.2	8.68 ± 2.64	10	8.2 ± 2.0	10	8.0 ± 2.7	10	9.5 ± 2.66
60–69	4	64.3	7.17 ± 2.21	28	64.9	9.57 ± 2.44	20	10.1 ± 3.0	18	9.6 ± 3.0	10	10.7 ± 2.52

Note. *(√TES) for the post-COVID participants stratified by age groups. For comparison, also shown are √TES for age-matched healthy normal trichromats reported in (Verriest et al., 1982, Table 1), (Roy et al., 1991, Table 1), and (Kinnear & Sahraie, 2002, Table 1). We calculated mean √TES for the two youngest groups (15–19 y.o. and 20–22 y.o.) in (Kinnear & Sahraie, 2002). For all age groups, we calculated SDs based on the (weighted) age group means and 95th percentiles provided in (Kinnear & Sahraie, 2002).*

Further, across the whole pCP sample we assessed √TES as a function of the time after the recovery (Figure 2). We found a weak negative correlation, r = –0.2661, p = 0.0194, indicating an improvement of colour discrimination with increasing of the elapsed post-illness time.

Figure 2

√TES for individual post-COVID participants as a function of the time (days) elapsed after the recovery, with a line of best fit (red) and 95%-confidence interval (shaded in pink)



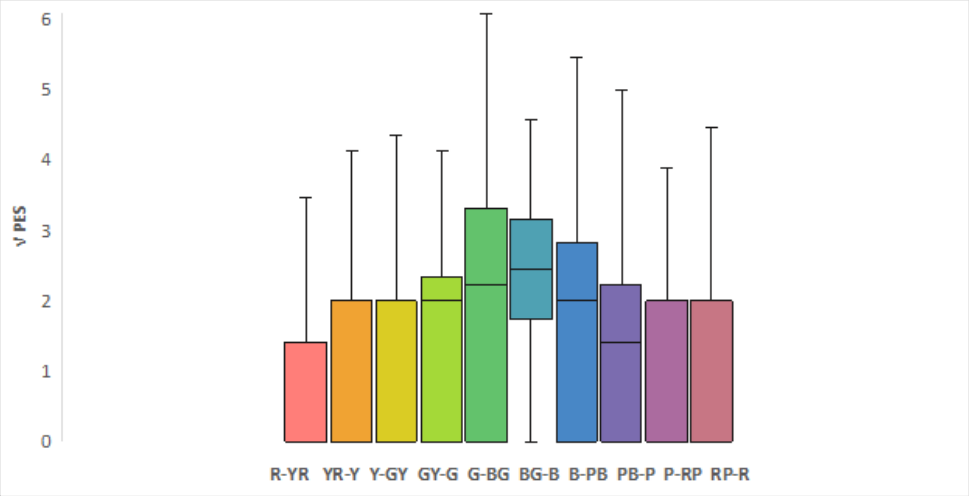
Colour discrimination in specified hue bands

For pCPs, √PES was higher in three (out of 10) of the specified hue bands, G–BG, BG–B, and B–PB, which comprise blue colours with admixtures of either green or purple (caps 36–60) (Figure 3). Note though that these bands greatly overlap with the FM-100 portion (caps 35–65), where the cap spacing is, in general, smaller (Verriest, 1963; Dain et al., 1991) and are part of box C (caps 43–63) with the lowest mean inter-cap difference (Lakowski, 1966).

To disentangle the two factors, i.e. difficulty of discriminating caps in these hue bands, as demonstrated for normal trichromats (e.g. Laeng et al., 2007; Ao et al., 2019; Racheva, 2020; 2023), from pCPs' possible impairment of colour discrimination, we compared √PES medians for each hue band with those obtained for the control group (Racheva, 2020). (We are grateful to the authors for providing their data.) For seven hue bands, we found no statistically significant differences ($p>0.119$); for three hue bands, R–YR, GY–G and P–PR, √PES for pCPs were significantly lower ($p\leq0.04$), which could be accounted for by a lower illumination (285–295 lux) in (Racheva, 2020).

Further scrutiny of individual data (Table S2, Appendix 1) hints that in cases with small PES elevation, colour confusion is mainly observed in the G–BG and BG–B bands (Figure 1d). In comparison, in cases of slightly higher PES (Figure 1e, f), errors in the green-blue region are complemented by relatively small error "peaks" in the B–PB and RP–R bands. Finally, in more severe cases with the highest PES (Figure 1g, h), the pattern of errors is diffuse.

Figure 3
√PES measures for the post-COVID observers in ten specified hue bands



Note. *Boxplots represent the interquartile range; horizontal lines indicate medians (otherwise are equal to 0) and whiskers the outliers below the 1st quartile (BG–B band) or above the 3rd quartile for the other bands.*

We also explored √PES values for each of the ten hue bands as a function of the time elapsed after the participant's recovery but no statistically significant correlations were found (Table S3).

Colour discrimination along the B–Y and R–G axes

Figure 4a presents pCPs' data partitioned into √PES scores along the B–Y and R–G axes. It shows that √B–Y (mdn = 4.00, sIQR = 1.42) is significantly higher than √R–G (mdn = 3.16, sIQR = 1.35; $Z = -3.761$, $p<0.001$). The observed prevalence of B–Y errors is similar to the tendency reported for normal trichromats, both for younger and older observers (Beirne et al., 2008). The present means of √B–Y (4.09 ± 2.33) and √R–G (3.34 ± 2.11) are comparable to respective values, 4.04 ± 1.66 and 3.51 ± 1.97, obtained at 1000 lux (Woo & Lee, 2002).

We stratified √B–Y, √R–G and their difference according to participants' age groups, as shown in Table 2. It is apparent that, compared to means in Smith et al. (1985), for all age groups √B–Y and √R–G of pCPs are higher and the difference is greater.

Table 2

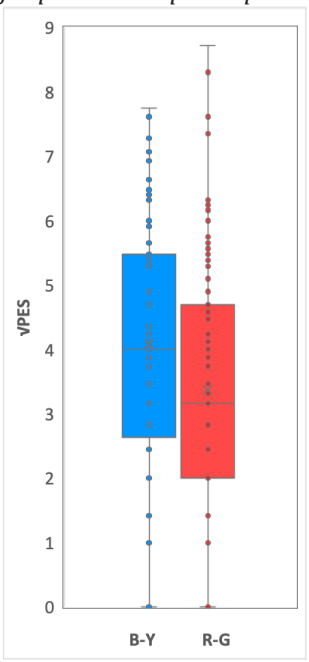
Mean √PES along the B–Y and R–G axes, and their difference for post-COVID participants, stratified for age groups, in comparison with Smith et al.'s (1985) means for normal trichromats

Age group	Post-COVID participants			Smith et al. (1985)		
(years)	√B–Y	√R–G	Diff.	√B–Y	√R–G	Diff.
15–19	+2.33	-1.59	+0.74	-	-	-
20–29	+4.35	-3.91	+0.44	+2.3	-3.3	-0.5
30–39	+4.27	-3.69	+0.57	+2.8	-2.8	+0.0
40–49	+4.09	-3.04	+1.04	+3.5	-2.1	+0.7
50–59	+4.16	-2.81	+1.35	+4.1	-1.5	+1.3
60–69	+5.61	-4.31	+1.30	-	-	-

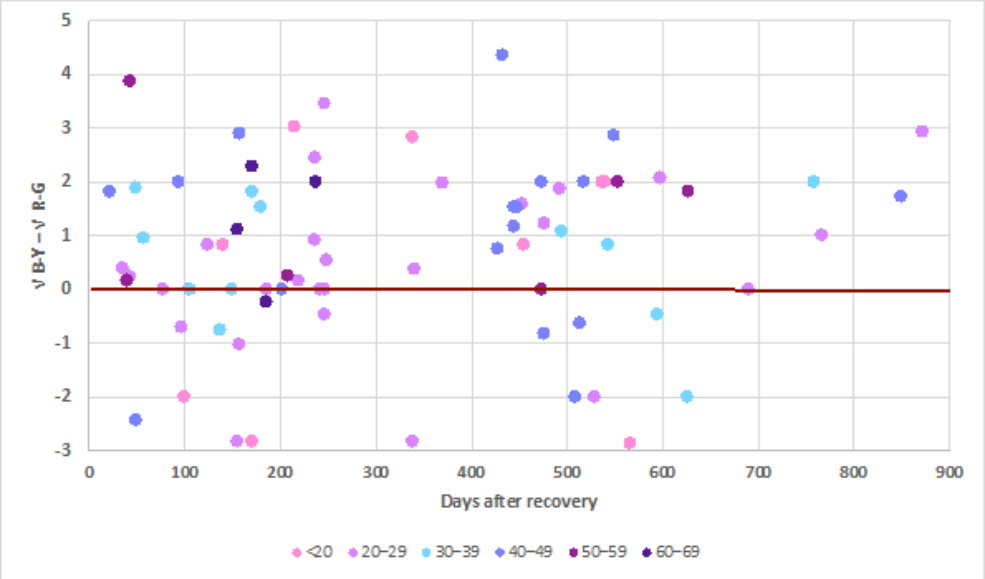
We also explored whether for pCPs the √B–Y and √R–G difference reduced with the elapsed post-illness time. The correlation was not significant: $r = 0.1324$, $p = 0.251$: for a great participant majority the B–Y errors prevail, regardless of the number of days elapsed after the illness (Figure 4b).

Figure 4

√PES along the B–Y and R–G axes for post-COVID participants



(a)



b

Note. *(a) Boxplots show the interquartile range of √B–Y and √R–G; whiskers indicate the values beyond the range*; (b) √B–Y – √R–G difference as a function of the time (days) elapsed after the recovery. Zero difference is indicated by a solid horizontal line. Colour-coded is participant's age group.*

Colour discrimination in different hemispheres of the FM-100 diagram

Figure S2 in Supplementary Materials presents √PES for pCPs for different FM-100 hemispheres. Figure S2a shows that colour discrimination was lower in the BG–B–PB–RP–RP gamut (right hemisphere) than in the R–YR–Y–GY–G gamut (left hemisphere): $Z = -4.144$, $p < 0.001$. Also, as expected (Figure 1a, b), Figure S2b shows that discrimination is lower in the green–blue (G–B) gamut (lower hemisphere) compared to the red–yellow (R–Y) gamut (upper hemisphere): $Z = -7.049$, $p < 0.001$. More frequent confusions in the G–B range, i.e. √G–B – √R–Y difference, persist regardless of the time lapse after the participant's recovery ($r = -0.0529$, $p = 0.6471$), as illustrated by Figure S2c, where almost all points for individual observers lie above the zero line.

Vingrys and King-Smith's moment-of-inertia Vector Analysis

Applying the Vingrys & King-Smith (1988) vector analysis, for each pCP we estimated the Confusion index (*C-index*), or severity of CV impairment, Selectivity index (*S-index*), the amount of polarity in a cap arrangement, and the axis of confusion (*Angle*), which identifies the type of the colour defect. All individual participants' indices are presented in Table S4.

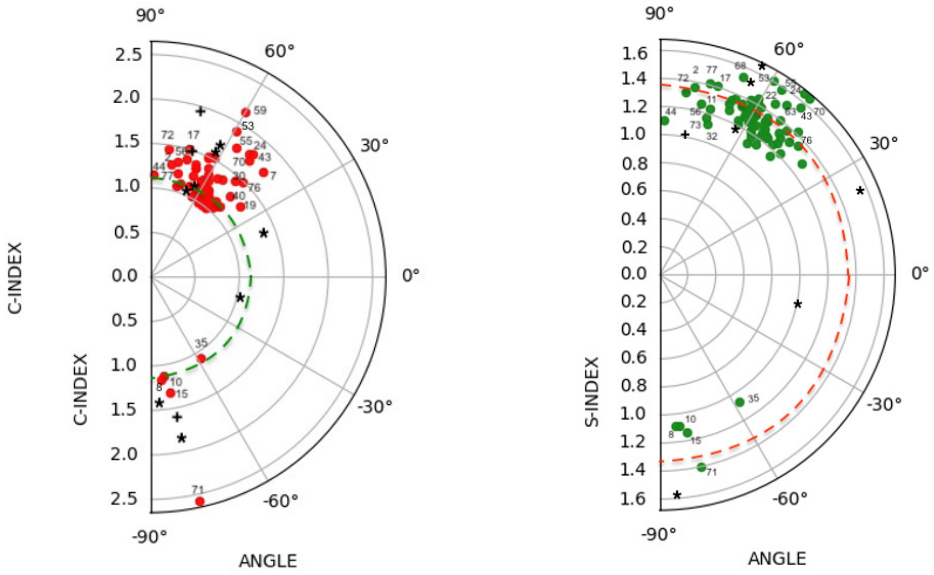
For the whole participant sample, the C-index highly correlated with √TES: ρ = 0.972 (p<0.001); the correlation of the S-index with √TES was medium: ρ = 0.421 (p <0.001); there was no significant association of √TES and the Angle: ρ = 0.101 (p = 0.381). We therefore agree with Bassi et al. (1993) that TES and the C-index are likely providing the same information.

Individual observers' C-index and S-index, as a function of the Angle, are shown as polar plots in Figure 5a, b. We start with considering the Angle index. Figure 5c indicates that for the overwhelming majority of pCPs (N = 72) the Angle was positive and ranged between 38°–88°, with mean 59.1°, i.e. very close to the 62.0° value reported for normal trichromats who made no errors in the D-15 test (Vingrys & King-Smith, 1988).

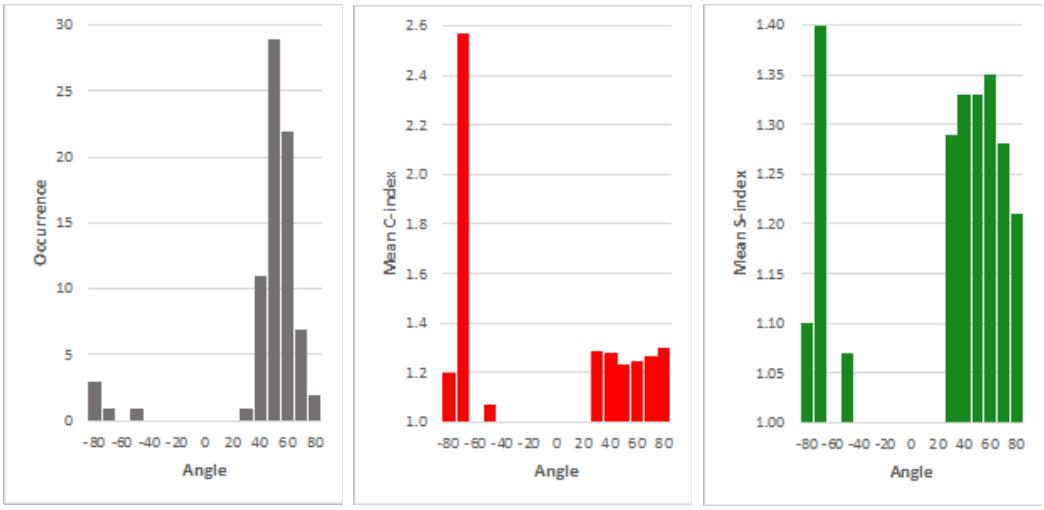
We also observe that for five pCPs, the Angle is negative. For four of these (#8, 10, 15, 71), the Angle >(–70°), characteristic for a tritan deficit (Vingrys & King-Smith, 1988; Bassi et al., 1993), and varies between (–77.7°) and (–84.2°). These Angle values are comparable with those of a patient with optic atrophy, OAB (–80.8°) and with mean Angle (–82.8°) for four congenital tritans (Vingrys & King-Smith, 1988). Descriptive statistics of FM-100 performance of the 'negative-Angle' pCPs is shown in Table S5. For comparison, also shown are corresponding means for other pCPs (N = 72) whose Angle values are positive.

Figure 5

The Vingrys and King-Smith indices for post-COVID participants; in (a) and (b), numbers indicate participant's ID



(a) (b)



(c)

Note. *(a) C-index as a function of the Angle (red points); green dashed line indicates the cut-off value, C = 1.12, estimated for Caucasian normal trichromats (Dain et al., 2004). (b) S-index as a function of the Angle (green points); red dashed line indicates the cut-off value, S = 1.38, estimated for no-error normal trichromats (Vingrys & King-Smith, 1988). For comparison also shown are indices for normal trichromats, who made errors (*), and observer(s) with acquired colour vision loss (+) (Vingrys & King-Smith, 1988). (c) Left: Histogram of the distribution of the Angle, and distribution of the C-index (middle) and S-index (right) as the function of the Angle. (Note the difference in the y-axis scale across graphs).*

The distribution of the C-index (severity) for pCPs, as the function of the Angle, is shown in Figure 5c (middle). The C-index ranged between 1.0 (perfect cap arrangement; #18) and 2.57 (#71). Notably, among the 'positive-Angle' participants (N = 72), for 31 $C \leq 1.12$, which we adopted as the cut-off criterion (Table S5), based on the C-index mean value obtained for Caucasian normal trichromats with light irides (Dain et al., 2004). However, for 41 observers the C-index >1.12 and varied between 1.14–2.14 (mean 1.40). For 4 (out of 5) 'negative-Angle' observers, the C-index varied between 1.07–1.32. The highest C-index, 2.57 (#71; Figure 1h) is comparable to that for four tritans, 2.70, and somewhat lower than the C-index for a patient with optic atrophy (OAA), 3.0 (Vingrys & King-Smith, 1988).

Figure 5c (right) shows distribution of pCPs' S-index, which ranges between 1.07–1.65. Among the 'positive-Angle' participants (N = 72), for the majority (N = 41) with C>1.12, the cut-off criterion, mean S-index is 1.37 (Table S5), i.e. comparable to S = 1.38

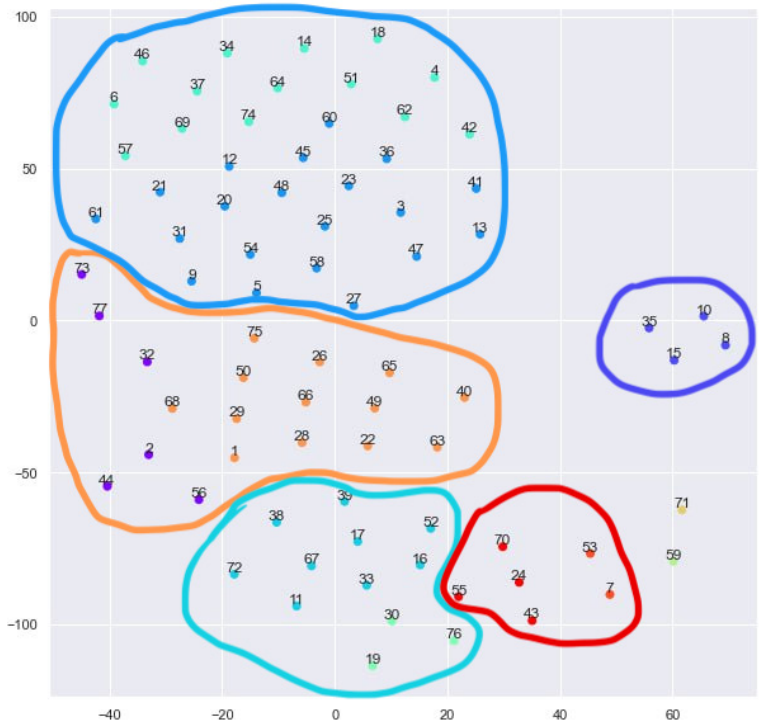
for no-error normal trichromats (Vingrys & King-Smith, 1988), i.e. indicating non-polar cap arrangements. For the four 'negative-Angle' observers, the S-index varies between 1.07–1.14. Participant #71's S-index, 1.40, is close to the upper limit, S = 1.38; it is similar to S-indices of the majority of glaucoma patients (Bassi et al., 1993) and definitely lower than mean S-index for four tritans, 3.94, or a tritanope's S-index, 4.74 (Vingrys & King-Smith, 1988).

Clusters of post-COVID participants based on FM-100 performance indices

The outcome of the hierarchical cluster analysis (Figure 6) visualizes, as a 2D map, similarities of FM-100 performance, TES and the three moment-of-inertia parameters, of individual pCPs. Detailed numerical information on performance of the participants performance constituting each cluster is provided in Table S6.

Figure 6

A 2D map illustrating similarity of FM-100 performance of post-COVID participants



Note. *Proximity measures are based on TES and the three vector analysis parameters. (Sub) clusters are colour-coded in the program outcome. Data-points are accompanied by participants' ID.*

As is prompted by Figure 6 and Table S6, FM-100 performance of almost all pCPs is encompassed by five clusters:

- The top cluster includes cases of *superior discrimination* (N = 34), with TES<28, pCPs' median. In the "turquoise" sub-cluster (N = 14), the "severity" parameters are very low: TES = 0–8, C = 1.00–1.09; in the "blue" sub-cluster (N = 20), the corresponding parameters are slightly higher: TES = 8–24, C = 1.01–1.17.
- The middle cluster is constituted by cases of *average discrimination* (N = 19), with TES mostly between 50%–80%. In the "hazel" sub-cluster (N = 13), TES varies between 28–44; however, C = 1.17–1.34, i.e. C>1.12. In the "violet" sub-cluster (N = 6), TES is slightly higher, 16–68, as are the C = 1.07–1.49. In both sub-clusters, in a few cases S>1.38.
- The bottom cluster encompasses, too, cases of *average discrimination* (N = 12; "cyan" and "light green") with TES = 52–72, slightly higher C = 1.29–1.53, and some *blue-yellow error polarity* reflected S = 1.24–1.42.
- The abutting "red" cluster (N = 6) denotes cases of *poor discrimination*: TES = 84–116, C = 1.72–1.90, S = 1.35–1.65.
- A small "dark blue" cluster (N = 4) includes cases with negative Angle indicating a tritan defect; the discrimination is good or average (TES = 20–56); C = 1.07–1.32, though in two cases C>1.12; S = 1.07–1.14 indicating no error polarity.

The two cases, #59 and #71, unambiguously manifest CV loss, both with the highest √B-Y. For #59, TES = 176, C = 2.14, S = 1.26. Colour discrimination of #71 is affected most in the sample, reflected by TES = 212, C = 2.57, S = 1.40 and a negative Angle.

Discussion

We have investigated colour discrimination in pCPs, using the FM-100 to assess whether an acquired CV deficiency existed and if that was the case, the deficiency's severity and type. For the whole sample, mean TES = 38.1 ± 37.8 is comparable to normal trichromats' mean 34.1 ± 28 (Laeng et al., 2007) or 37.4 (at 275-lux illumination) (Mahon & Vingrys, 1995), and lower than 43 ± 3 (Shepherd, 2005), 45.8 (Cranwell et al., 2015) or 62.1 (Verriest, 1963). Mean √TES was 5.52 ± 2.77, slightly higher than 5.48 ± 2.27 for Caucasian observers tested at 1000 lux (Woo, & Lee, 2002). It is also higher than √TES for observers with varying iris colour – dark (5.04 ± 1.76), medium (4.59 ± 1.82) or light (4.18 ± 1.64) respectively (250-lux testing illumination) (Dain et al., 2004).

For age groups, there was generally a good correspondence between pCPs' mean √TES and earlier data sets for normal trichromats (Verriest et al., 1982; Roy et al., 1991; Kinnear & Sahraie, 2002) (Table 1). Beyond mean √TES, rather unexpectedly, we found that CV was affected in considerable pCP subsamples of the 20-29 y.o. and 30-39 y.o. groups (Figure S1), whose scores were elevated compared to the corresponding normal trichromats' means (Verriest et al., 1982), although in the latter the FM-100 was administered at 200-lux illuminance, which implies decreased chromatic sensitivity (Knoblauch et al., 1987).

The FM-100 diagram presenting pCPs' mean error scores for individual caps (Figure 1a,b) shows a minor but definite peak in the G–BG–B–PB region and another minor crest in the RP–R region. This observation is buttressed by the finding that discrimination is lower in the G–B gamut compared to the R–Y gamut (Figure S2). Critically, notwithstanding mean √TES for all pCPs' age groups comparable to those in previous studies (Verriest et al., 1982; Roy et al., 1991; Kinnear & Sahraie, 2002), √B–Y and √R–G were higher and the (√B–Y – √R–G) difference was greater compared to the means obtained at 170-lux illuminance by Smith et al. (1985) (Table 2) confirming, cross-sectionally, a mild tritan deficiency in pCPs. Furthermore, the B–Y errors prevail in the great majority of participants, regardless of the recovery time elapsed after the illness.

Notably, among pCPs we found a significant inter-individual variation, TES = 0–212 (Table S2, Appendix 1). Based on TES, the great majority of pCPs revealed either superior performance, 0≤TES≤24, below the median (Figure 1c), or average colour discrimination, 28≤TES≤84 (90th percentile; Figure 1d,e), while a minor subsample had poor discrimination (Figure 1f) or unambiguous CV loss (Figure 1g,h).

The Vingrys & King-Smith (1988) vector analysis provided additional information (Figure 5, Table S4) for a more precise estimation of severity and type of mild CV impairment in pCPs, who made errors. We adopted the conservative cut-off criterion, C = 1.12, mean C-index for Caucasian normal trichromats with light irides obtained using the FM-100 (Dain et al., 2004), rather than C = 1.60 recommended by Vingrys & King-Smith (1988) based on D-15 data; for the S-index, we applied the cut-off criterion, S = 1.38, as recommended in (Vingrys & King-Smith, 1988). The Vingrys & King-Smith (1988) analysis enabled us to identify 5 participants with a negative Angle indicating a tritan defect. Moreover, among the 'positive-Angle' participants (N = 72), in many cases (N = 41) the C-index, 1.14–2.14, exceeded the cut-off criterion (Table S5), pointing to a subtle colour discrimination abnormality.

Cluster analysis, based on both TES and the Vingrys & King-Smith (1988) indices, allowed a greater scrutiny of subsamples of pCPs with regard to colour discrimination and, particularly, the kind of mild CV impairment (Figure 6, Table S6). The analysis confirmed that a substantial number of pCPs (N = 34) demonstrated *superior* performance (cluster 1).

Importantly, it revealed variation among pCPs with *average* colour discrimination (N = 31), with clusters (2) and (3) differing not as much in TES range but in the pattern of errors pointing to subtle tritan defects, or Type III acquired colour deficiency, according to Verriest (1963). Cluster (2) discerns cases with the *monopolar blue* error pattern (Figure 1d), or Type III mild solely 'blue' colour deficiency, in accord with a revised classification of Pokorny & Smith (1986). In comparison, cluster (3) comprises cases of mild tritan defects with the error pattern along the *blue-yellow* axis (Figure 1e).

Still another minor subsample (cluster 4, N = 6) manifested *poor discrimination* (>95th percentile; Figure 1f) classified as Type III moderate defect (Pokorny & Smith, 1986). It is noteworthy that the cases of the "light green" sub-cluster are characterised by a *diffuse*

error pattern; the Angle, 38°–46°, deviates from the 62.0°, mean value for no-error normal trichromats (Vingrys & King-Smith, 1988). We observe that similar Angle range is characteristic for protanomals (Vingrys & King-Smith, 1988) and some glaucoma patients (Bassi et al., 1993). In the abutting #59 case (Figure 1g) all severity indices are still greater and the error pattern is diffuse, thus, unambiguously indicating CV loss.

Finally, cluster (5) comprises pCPs with negative Angle (N = 4). For 3 of these, the C-index exceeded the cut-off criterion (Table S5). For the adjoining negative-Angle case #71, the most severe in the sample (Figure 1h), all severity indices are above normal and polarity indices indicate a tritan defect.

We address the finding that mean √TES of pCPs, estimated at ca. 1000 lux, appears to be comparable to mean √TES obtained at lower photopic levels (200 lux Verriest et al., 1982)) or higher than these (250 lux (Dain et al., 2004)); also, mean √B–Y and √R–G are greater than the corresponding values assessed at 170 lux (Smith et al., 1985). According to Verriest (1964, cit. in (Dain et al., 2004)), in pCPs this could be the sign of 'mesopization' of colour discrimination attributed to reduction in luminosity efficiency. The FM-100 performance, specifically, that reveals a mild acquired deficiency is likened to that of normal trichromats at lower illuminance levels, or colour discrimination loss that resembles its senile decrease and the congenital tritan type (Verriest, 1963; Knoblauch et al., 1987). Lakowski (1966) attributed it to reduction in luminosity efficiency of the retinal receptor system; Dain et al. (2004) conjectured that 'mesopization', or tritan deficiency, could arise without postulating specific damage to the blue-yellow system.

General "darkening" of perceived colours by pCPs was hinted by our recent colour-naming study (Griber & Paramei, 2022a; 2022b): supposedly, perceived colour dimming translated into a greater prevalence than in pre-COVID controls of the terms 'brown' and 'grey', and higher frequency of achromatic modifiers 'dark' and 'dirty', which were elicited particularly frequently in combination with 'green', 'blue', and 'purple'.

One may query loci and mechanism(s) that underlie mild colour discrimination impairment in about half of those who recovered from COVID-19. Leaning on our findings of increased naming "darkening" of colours by pCPs (Griber & Paramei, 2022a; 2022b), we pondered that it might manifest an accelerated brunescence of the crystalline lens, resulting in an increased absorption of light, in particular, in the blue and purple gamut. Further, if lens brunescence has developed over a short illness time span, the affected colour perception could not have been compensated (at the level of colour naming), since the compensation process is being developed across the age span (Hardy et al., 2005). However, the improvement of colour discrimination with increasing post-illness time lapse, found in the present study (Figure 2), suggests that that the lens brunescence hypothesis is to be rejected.

Notably, a case of sudden (transient) darkening of the visual field following COVID-19 vaccination was reported (Santovito & Pinna, 2021) and attributed to hypoperfusion (reduced vascular supply) of either the retina, or optic nerves, or parts of the visual pathway extending to the visual cortices (Eleiwa et al., 2021). A COVID-19-caused reduction of

blood/oxygen supply at the retinal and/or post-retinal stages of the visual system is a more parsimonious explanation. This hypothesis is plausible in view of pCPs' mild and moderate Type III defects, identified in the present study, that are characteristic of vascular retinopathies and optic atrophy (Pokorny & Smith, 1986; Simunovic, 2016). Indeed, retinal changes and alterations of retinal vasculature in response to oxygen decrease (Invernizzi et al., 2020), and disorder of retinal capillaries (Giacuzzo et al., 2022) were reported in those exposed to coronavirus. Relevant are in this regard findings in two studies that applied the FM-100 and reported mild hypoxia-induced CV impairment, with reduced discrimination along the blue-yellow axis (Smith et al., 1976) or a generalised depression of both blue-yellow and red-green sensitivity (Vingrys & Garner, 1987).

We would like to remark that in our colour-naming study of pCPs (Griber & Paramei, 2022a; 2022b) we found that, along with "darkening", these respondents also revealed an increased frequency of 'pale'-, 'dull'- and 'pastel'-modifiers, which hint at desaturation of perceived colours. Notably, comments that colours looked duller, paler or less glossy were recorded from patients with optic neuritis (Mullen & Plant, 1987). Also, the pCPs' "desaturation" naming alludes to the finding for migraine patients, whose settings of colours were consistently paler than in controls (Shepherd, 2005).

We suppose that joint "darkening" and "desaturation" in the colour-naming pattern of pCPs may be indicative of an affected processing of colour and luminance contrast. As conjectured by Bimler et al. (2009), at a hypothetical stage in the visual system the two post-receptoral opponent systems feed into the channel that combines Brightness and Chrominance (saturation) information, whereby a depressed input signal to this channel produces black induction and desaturation of perceived colours, which appear matt and dull. One can only speculate about the visual system stage affected by coronavirus.

Mullen and Plant (1987) assumed that the deficits of perceived saturation in patients with optic neuritis were caused by the affected ganglion cells with small diameter axons (projecting to the parvocellular layers of the lateral geniculate nucleus), which respond to colour differences. Shepherd (2005) considers that migraine participants' perception of colours as paler likely arises at a site in the visual pathways proximal to the retina, but could arise throughout the visual pathway or at one of many stages within it. She argues that specific subjective desaturation of the S-cone colours (purple, yellow) "suggests a stage or stages before the signals from the colour opponent pathways combine" (Shepherd, 2005, p. 421). This contention is echoed by Mahon & Vingrys' (1996) view that disease-related desaturation may occur at any pre-cortical level or at multiple levels within the visual system. Their model (Mahon & Vingrys', 1996) supports clinical observations of saturation losses occurring early in disease; the authors argue that saturation discrimination thresholds may yield added clinical information in detecting dysfunction.

Cross-sectionally, we found a weak negative correlation between pCPs' √TES and the elapsed recovery time (Figure 2). In our cautiously optimistic forecast of further improvement of colour discrimination with increased post-illness period we are encouraged by ophthalmological reports that most cases of dyschromatopsia later

reversed (Giacuzzo et al., 2022; Richardson-May et al., 2022); also, medium-term findings of subtle retinal changes suggested a good visual prognosis in patients recovering from COVID-19 (Costa et al., 2021).

Our study presents some limitations. Two oldest age group were represented by only a few participants. Further, in relation to the elapsing recovery period, TES was assessed cross-sectionally; thus, the estimated negative correlation is indicative rather than decisive with regard to potential colour discrimination improvement.

In our final remark, we note that CV loss identified post-COVID in ophthalmological examination using the Ishihara test (Clarke et al., 2021; Giacuzzo et al., 2022; Nagaratnam et al., 2022; Richardson-May et al., 2022) conceivably captured moderate and/or relatively severe CV loss. Intended to diagnose red-green deficiencies, the Ishihara test cannot reveal subtle tritan defects (Lakowski, 1969), as those that we identified in more than half of pCPs by employing the FM-100. We are aware that in routine clinical practice, use of the FM-100 is limited by its relatively long test times, and complicated and time-consuming analysis. The Ishihara test could be complemented by an arrangement test in cases, where detection and diagnosis of subtle CV defects is reasonable, as suggested by Lakowski (1969). As a proxy, the Lanthony D-15 desaturated test, which has predictive ability for assessing the severity of CV loss in patients (Bassi et al., 1993), can be administered at a fraction of the time of the FM-100.

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Supplementary Materials

The following supporting information can be downloaded at: https://figshare.com/s/6900f26033c71afc7888: Data analysed in this study. Appendix 1: Error distribution in the FM-100 diagram for post-COVID participants (N=77). Appendix 2: Computer program for calculating major and minor axes for the D-15, D-15d and FM 100-Hue tests. Supplementary Materials: Table S1 – Demographic characteristics of post-COVID participants, and self-reported duration of the illness and symptoms. Table S2 – FM-100 parameters for post-COVID participants: total error score (TES), error scores for four FM-100 boxes (AES, BES, CES, DES), and partial error scores (PES) for the specified hue bands, B-Y and R-G axes, and hemispheres of the FM-100 diagram: left (caps 1–43), right (caps 44–85), upper (caps 27–70) and lower (caps71–26). Figure S1 – FM-100 scores (ÖTES) for individual post-COVID participants as a function of age. For comparison, plotted are mean ÖTES scores for each age group of normal trichromats27,29,30, as presented in Table 1. Numbers accompanying points correspond to IDs of post-COVID participants, whose values exceed the lowest normal trichromats' mean. Table S3 – Spearman's correlation coefficient (p) between √PES in different hue bands and the number of days elapsed after the recovery of post-COVID participants. Figure S2 – √PES for post-COVID participants in different hemispheres of the FM-100 diagram: (a) √PES in left and right hemispheres; (b) √PES in upper and lower hemispheres; (c) √G–B – √R–Y difference (lower vs. upper hemisphere) as a function of the time elapsed after the participants' recovery. Zero difference is indicated by a solid horizontal line. Colour-coded are participants' age groups. Table S4 – The Vingrys and King-Smith indices of moment of inertia. Highlighted are values exceeding the cut-off values for normal trichromats, C-index >1.12 and S-index >1.38, and negative Angles, indicators of a tritan defect. Table S5 – Descriptive statistics of FM-100 indices for post-COVID participants (N=5) with negative Angle in comparison with mean values for 72 participants with positive Angle stratified as two groups in accord with the severity C-index cut-off value, C=1.12. Table S6 – Clusters of post-COVID participants based on their FM-100 performance, TES and the three parameters of moment of inertia35, obtained using the hierarchical clustering method. In each cluster, participants' IDs are given in colour, as coded in Figure 6. Highlighted (in grey) are individual participants' indices that assume an acquired (mild) colour vision deficiency: TES>90th percentile, C-index and S-index exceeding the cut-off values, negative and relatively low positive Angle.

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Author Contributions

Yulia Aleksandrovna Griber contributed to the study design; supervised the experiment, collected, analyzed and interpreted the data; participated in writing the manuscript and formatted it in line with the journal requirements.

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Using the Mobile Eye-tracking System in Sports

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Abstract

Introduction. The study of the oculomotor activity of athletes is of interest to sports psychologists and sports training specialists. Oculomotor activity is an integral part of sports activity, and its training and optimization with the development of effective oculomotor strategies can contribute to the improvement of both sports performance and the health and functional state of the athlete. **Theoretical justification.** Research on athletes' oculomotor activity considers its various aspects, including visual search, the difference between eye movements of professionals and beginners. It also considers the relationship between effective oculomotor strategies and athletic performance success. Due to technology development, mobile eye-tracking technology has emerged that can be utilized in real-life sports activities. Mobile eye-tracking provides high ecological validity of research, combination with psychophysiological methods and virtual reality. The disadvantages of the mobile eye-tracking system include low, compared to stationary systems, measurement accuracy and the possibility of recording only macromovements of the eyes (fixations and saccades). **Discussion.** As a result of the theoretical analysis, the relevance and significance of studying athletes' oculomotor patterns have been outlined. In addition, the possibilities of using mobile eye-tracking in sports for these purposes to analyze athletes' oculomotor patterns have been described. Researchers may encounter problems when using mobile eye-tracking systems to record athletes' oculomotor patterns are highlighted. In particular, loss of eye-tracking data, difficulties selecting an optimal algorithm for data analysis, and ambiguity in interpreting the obtained information. In spite of the described problems, mobile eye-tracking systems

represent an optimal means of recording eye movements in athletes for the purpose of further optimizing training and performance.

Keywords

sport psychology, eye-tracking, eye movement registration, eye macromovements, saccades, fixations, sport eye-tracking

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Introduction

Vision plays a major role at all stages of athletes' activity. During education and training, the athlete assimilates information visually provided by the coach (Gorovaya, Korobeinikova, 2013). During training, the ability to quickly analyze the sport situation and make optimal technical and tactical decisions based on the available visual information is improved (Hüttermann, Noël & Memmert, 2018; Brams et al., 2019). During motor skill development, visual information is essential for movement control and adjustment (Piras, Raffi, Lanzoni, Persiani & Squatrito, 2015). With experience, the athlete can anticipate events in a time-pressured situation based on available visual information (Kredel, Vater, Klostermann & Hossner, 2017). The athlete's tactical decision making in a sports situation is dependent on information received from sensory systems, and most often the vision system is the leading one (Hüttermann et al., 2018).

For many years, vision in sports has been studied from the perspective of various sciences, including ophthalmology, psychology, physiology, and biomechanics (Blinnikova & Ishmuratova, 2021; Menshikova & Pichugina, 2021; Pronina, Grigoryan & Kaplan, 2018; Smirnova, 2022). The undoubted importance of vision as a sensory system for the athlete was noted, but on the other hand, many studies were private, scattered, and isolated (Tambovsky, 2003). Scientific papers on eye-tracking technologies in sport appeared in the 1980s. Since then, many studies have been conducted on athletes' oculomotor activity using different eye-tracking technologies. These studies have examined aspects of oculomotor activity such as visual attention, oculomotor search,

decision making based on visual information, the difference between eye movements of professionals and non-professionals, and the relationship between effective oculomotor strategies and athletic success (Mann, Williams, Ward & Janelle, 2007; Hüttermann, Noël & Memmert, 2018; Kredel, Vater, Klostermann & Hossner, 2017).

In Russian sports science, the need for a comprehensive approach to the study of the visual system in sports was stated in the nineties of the last century. This was when the foundations of sports ophthalmology direction in the system of training athletes were laid. In this connection, a system of analysis and optimization of athletes' oculomotor patterns was developed to improve technical and tactical skills (Tambovsky, 2003). The first attempts to clarify the nature of the athlete's vision revealed visuokinematic pictures of the sports situation (VKKSS), which are certain trajectories of the athlete's eye movements during visual perception of the picture of the sports situation. VKSSS is formed by the coordinated work of the eye and ciliary muscles. It depends on the type of sport, the athlete's fitness level, psychological state, experience, role, level and peculiarities of thinking. However, the VKSSS parameters are often far from optimal, which entails many mistakes made by the athlete. The reason for this can be explained by the intuitive nature of VKKSS formation, as well as the lack of knowledge in this area by both the coach and his pupils (Tambovsky, 2003).

Training athletes in the optimal oculomotor strategy (optimal visokinematics) during the performance of sports activities leads to reduction of fatigue of the visual system, to increase the efficiency of technical and tactical actions, and to increase the speed and efficiency of tactical thinking of athletes (Tambovsky, 2003; Jin & Tambovsky, 2017; Polikanova, Leonov, Yakushina, Chertopolokhov & Isaev, 2022). With the growth of sportsmanship of an athlete (with all the variability of sports situations), the formation of several (from 2 to 5 variants) stable visokinematic pictures of a sports situation is observed. It is critical to note that the effectiveness of such training will be higher if it takes place in natural, dynamic sports conditions. In this regard, it is especially relevant to use modern eye-tracking systems, which register eye movement data under real training conditions.

Thus, the main **aim of this review** was to study the advantages and disadvantages of using modern eye-tracking systems to analyze athletes' oculomotor patterns.

Theoretical Justification

Use of modern eye-tracking systems in sports

Modern eye-tracking systems provide opportunities for studying athletes' oculomotor activity while performing sports activities (Grushko & Leonov, 2013; Espino Palma et al., 2023; Sáenz-Moncaleano, Basevitch & Tenenbaum, 2018; Menshikova, Kovalev, Klimova & Barabanschikova, 2017). Mobile eye-trackers, which have advantages over

stationary ones and allow natural studies, have found wide applications in the field of sports training.

The operation of modern non-contact mobile, i.e. head-worn, eye-tracking systems, is based on a methodology based on the principle of video registration of eye movements in the infrared radiation range and determination of gaze direction by the vector of displacement between the centers of the pupil and corneal glare (Barabanshchikov & Zhegallo, 2014).

Mobile eye-tracking systems used to investigate athletes' oculomotor activity can be categorized into two types:

1. Eye-tracking systems worn on the subject's head (usually in the form of goggles or caps). They consist of a mini-video camera that records the actual situation in front of the subject and an infrared light source.
2. Eye-tracking systems embedded in virtual reality helmets (Leonov, Polikanova, Bulaeva & Klimenko, 2020). In virtual reality helmets, an eye-tracking module usually consists of cameras and a light source placed in a ring-shaped structure between the user's eyes and the display. Algorithms interpret the cameras' data and generate a real-time stream of eye-tracking data (such as pupil size, gaze vector, and eye openness).

Opportunities of mobile eye-tracking systems

The reasons for choosing mobile eye-tracking systems for sports research are related to their capabilities and advantages over fixed systems.

Thus, mobile eye-tracking systems allow a high degree of ecological validity of the experiment: they make the conditions of the experiment close to the conditions of the studied sports activity (Tambovsky, 2003; Barabantschikov & Zhegallo, 2014; Gorovaya & Korobeinikova, 2013). Also, mobile eye-tracking systems (especially glasses) have minimal impact on the studied athlete's activity and on the recorded oculomotor activity parameters. During sport-specific tasks, the subject should be able to move freely in space, including head movement, which is possible only using mobile eye-tracking systems (Tambovsky, 2003). The obtained eye-tracking data make it possible to analyze and compare the peculiarities of oculomotor activity of athletes of different sports and skill levels (Leonov & Grushko, 2015). For example, based on the data recorded using an eye-tracking system, characteristic patterns of eye movements in professional baseball players have been identified (Houze, Spaniol & Paulison, 2023), identified differences in the number and location of fixations among volleyball players of different skill levels (Afonso, Garganta, McRobert, Williams & Mesquita, 2012), and noted a variety of gaze fixation points in soccer players depending on the phase of play (Aksum, Magnaguagno, Bjørndal & Jordet, 2020). The obtained data allow the optimization of oculomotor activity

to reduce fatigue of the visual system, increase the efficiency of technical actions and improve tactical thinking in athletes (Tambovsky, 2003; McGuckian, Cole, Jordet, Chalkley & Pepping, 2018; Kredel et al., 2017; Martell & Vickers, 2004).

Thanks to mobile systems of eye-tracking, fixation of athletes' oculomotor activity can be combined with registration of various psychophysiological indicators, including electroencephalography, skin-galvanic response, heart rate measurement by biofeedback, stability of the vestibular system (Anisimov, Ermachenko, Ermachenko, Tereshchenko, Latanov, 2012; Ermachenko, Ermachenko, Latanov, 2011; Isaev, Isaichev, 2015; Calabrò et al., 2017; Janelle, Hillman & Apparies, 2000; Fujiwara et al., 2009; Mann, Coombes, Mousseau & Janelle, 2011; Barfoot, Casey & Callaway, 2012). In addition, mobile eye-tracking systems can be used in virtual reality research (Menshikova, Kovalev & Klimova, 2014; Pastel et al., 2020; Wirth et al., 2021; Heilmann & Witte, 2021) and tracking human movements in space (Helsen & Starkes, 1999; Kishita, Ueda & Kashino, 2020).

Limitations of mobile eye-tracking systems

However, despite the many advantages of using a mobile eye-tracking system in sports practice, limitations can also be highlighted.

Thus, in studies using mobile eye-tracking systems, oculomotor activity is analyzed by such indicators as fixations and saccades, i.e., eye macromovements (Piras, Lobietti & Squatrito, 2010; Di Russo, Pitzalis & Spinelli, 2003; Aoyama et al., 2022). This is due to the fact that mobile eye-tracking systems have certain limitations and experiments are conducted under conditions that approximate real-world conditions. The study of eye micromovements (tremor, drift, microsaccades) is possible only in stationary conditions, in the laboratory, where the subject's head is rigidly fixed during the experiment, and the equipment has a high frequency and accuracy of eye position registration. In addition, mobile eye-tracking systems have low temporal and spatial resolutions compared to stationary systems. The data obtained with a mobile eye-tracking system allows analysis of oculomotor activity only at the fixation sequence level.

It is also worth noting that mobile eye-tracking systems have low, compared to stationary systems, measurement accuracy, temporal (registration frequency) and spatial resolution capabilities declared by the manufacturer. Mobile eye-tracking systems register video at 30–60 Hz (fixed systems – 500–1250 Hz). Most modern eye-trackers have an accuracy of about 0.5–1 angular degrees (stationary systems – 0.25 – 0.5 angular degrees) (Barabantshchikov & Zhegallo, 2014).

In addition, the quality and stability of eye movement registration depend on various factors: room illumination, makeup, wearing glasses (Barabanshchikov & Zhegallo, 2014; Holmqvist, Nyström & Mulvey, 2012), as well as individual facial features (e.g., thick eyelashes or large brow arches (Turitsyn, Anokhin, Volovod, Gerasimchuk, Mashkovtseva, 2016). The quality of data received from eye-tracking systems embedded in a virtual

reality helmet can be affected by motion sickness (vertigo), neck muscle fatigue from the helmet, visual focus-accommodation conflict, loss of focus, and fogging of helmet screens (Clay, 2019; Holmqvist et al. 2012).

Discussion

To minimize the above-mentioned disadvantages and to improve the quality of recording oculomotor patterns of athletes at the stage of preparation and carrying out eye movement registration, it is necessary to calibrate the eye-tracker before each measurement, to set the position of trackers relative to the eyes correctly and to monitor the stability of the position of the participant in the experiment.

However, difficulties may arise not only at the stage of eye-tracking data registration, but also when analyzing them.

Problems arising at the stage of acquisition of eye-tracking data, and ways to solve them

Problem with loss of eye-tracking data

As a result of the subject's blinking or due to the failure of the algorithm for pupil and corneal glare detection, skips of eye-tracking values may occur, i.e. frames with undefined eye position and unspecified gaze direction. In this case, all eye-related fields (gaze coordinates, pupil sizes, etc.) are filled with zeros. Missing values can affect the fixation detection algorithm by breaking one large fixation into separate shorter fixations. Various methods that include mathematical and empirical data recovery algorithms can be applied to solve this problem (Turitsyn et al., 2016). Also, an eye-tracker can lose sight of one of the two eyes and data is written from only one eye. If the binocular disparity is small, it is acceptable to fill in the gaps with data from the registered eye (Turitsyn et al., 2016).

Selection of the algorithm and thresholds for detection of the sought events (fixations, saccades)

The choice of an algorithm for detecting events (fixations and saccades) is a crucial consideration when analyzing raw eye-tracking data, as different algorithms based on the same data may produce different results (Salvucci & Goldberg, 2000). In addition, the choice of threshold values of the values used by a particular algorithm also affects the sensitivity and the results of the algorithm (Llanes-Jurado, Marín-Morales, Guixeres & Alcañiz, 2020).

The analysis of fixations and saccades requires preliminary separation of fixations as moments of visual information processing (and, accordingly, saccades between them as moments of rapid gaze movement when no information processing occurs) from the

raw data set (Veraksa, Korobeinikova, Leonov & Rasskazova, 2016; Grushko, 2017). This approach allows us to simplify the analysis of eye-tracking data by highlighting their main characteristics, on the basis of which oculomotor behavior can be analyzed (Salvucci & Goldberg, 2000). The choice of specific thresholds depends directly on the goals and objectives of the study and the nature of the activity being studied (e.g., values for reading or looking at pictures will be one, while those for detecting and responding to a rapidly moving object will be different) (Widdel, 1984, Rayner, 1998).

Problem of interpreting received information about oculomotor activity

Additional information is needed to correctly interpret the subject's oculomotor activity data. Not always the delay of gaze in the direction of an object indicates fixation of attention on this object. Saccades may be caused not by a visual stimulus, but by an auditory stimulus, etc. Interviewing the subject, videotaping the experiment, and collecting statistics can provide additional information for the experimenter.

It is necessary to study oculomotor activity at a higher level – the level of integral structures, patterns, which are determined not only by the objective characteristics of external stimuli, but also by the characteristics of the subject of perception himself (his past experience, intentions, peculiarities of the oculomotor system, etc.). This is due to the fact that quite often studies use such an indicator as the number of fixations in the selected area, which is associated with a number of cognitive aspects and can be interpreted in different ways: the number of fixations can indicate 1) the semantic significance of the image area, 2) the level of complexity of the search task, 3) the presence of experience in solving such tasks, and even 4) the presence of a number of psychiatric and neurophysiological diseases.

To improve the system of eye-tracking in sports, it is necessary to describe in detail the procedure of conducting the study: equipment specification, algorithm, threshold values, criteria for excluding data from the analysis, approach to processing omissions ("zero" values), the percentage of rejected eye-tracking data, detailed interpretations of the obtained data, taking into account the specifics of the conducted experiment and the characteristics of the sample.

Conclusion

Despite some limitations of mobile eye-tracking systems in sports, gaze tracking seems to be a possible method for investigating athletes' gaze behavior, provided it is used in a meaningful and correct way. In particular, working with mobile eye-tracking systems is a promising way to analyze cognitive aspects of athletes' professional performance and its impact on results. The eye-tracking system allows us to learn about athletes' attention and gaze direction at different stages of sportsmanship formation. This makes it possible to identify characteristic patterns of eye movements for beginners and professionals. This

can help improve the technical and tactical components of skill and movement control. Taking these points into account can potentially lead to the development of specific training methods and improve competitive performance.

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The Role of Confidence and Competence in the Social Verification of Judgments in a Dyadic Interaction

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Abstract

Introduction. When making judgments under uncertainty, people often use social verification, i.e., comparing their judgments with the opinions of others. In some cases, social verification leads to increased accuracy of judgments (the "two heads are better" effect). However, to improve accuracy, it is important to take into account the partner's competence and current confidence in the answer. The ways in which confidence is conveyed in computer-mediated dyadic interaction situations are still poorly understood. The present study allowed us, for the first time, to isolate direct (confidence judgment) and indirect (response time) confidence transfer pathways and to test their effects on the success of social verification judgments in computer-mediated interaction. **Methods.** The experiment followed a between-subjects design, with groups differing in the way confidence was conveyed (direct / indirect). There were a total of 70 participants (50 females, 20 males) aged 18 to 33 years (M = 22.2, SD = 3.15). Participants worked in pairs at the same computer, with a non-transparent screen separating them so that they could not see each other. In the first stage, participants completed the reading experience test independently, and in the second stage they had the opportunity to compare their answers with a partner and to revise them. Between stages, information about the success (competence) of both participants was presented. **Results.** The concurrence of participants' responses increased significantly after they revised them. Confidence conveyed both indirectly and directly had a significant effect on the likelihood of response change. There was no significant effect of participants' relative competence. However, only the group with direct conveyed confidence significantly increased the accuracy of revised responses. **Discussion.** A possible explanation could be that accuracy

is increased by orienting to the partner's confidence, which was easier to accomplish in the direct confidence transfer group. An alternative explanation may be that explicit confidence evaluation not only conveys information to the partner, but also helps the person themselves better understand where they are more likely to be wrong.

Keywords

social verification, computer-mediated interaction, decision making, confidence judgment, competence

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Introduction

When we're not sure what decision to make, we often seek help from others in the hope of increasing the accuracy of our decisions. This phenomenon was described by A. Bandura in The Social Learning Theory: "When experiential verification is either difficult or impossible, people evaluate the soundness of their views by comparing them against the judgments of others." (Bandura, 2000, p. 250). He also introduced the term "social verification", under which modern researchers understand the assessment of the validity of knowledge based on the comparison of one's own knowledge and judgments with the opinions of other people (Allakhverdov, 1993; Gershkovich, Moroshkina, Naumenko, Allakhverdov, 2010; Tikhonov, Ovchinnikova, 2016; Tikhonov, 2020). In the process of social verification, people focus on the coincidence of answers as a signal about the correctness of the answer. At the same time, the independence of initial judgments is an important condition to ensure exactly informational rather than normative social influence (Rader, Larrick & Soll, 2017). However, a reasonable question arises: are "two heads always better than one"? To what extent does social verification improve accuracy in cognitive tasks, and on what factors does this depend?

Birnbaum & Stegner (1979) showed that people who combine information from different external sources take into account the expertise of those sources. However, Harvey & Fischer (1997) later found that even experts listen to advice from novices, i.e.,

despite obvious differences in expertise, people do not completely reject the help offered to them. In addition, they found the effect of "egocentric discounting", according to which people tend to rely more on their own knowledge and less on the opinions of others, which can lead to suboptimal decisions. However, this tendency weakens when advice is given by someone more experienced than the decision maker. The greater the difference in the level of competence between the advisor and the decision maker, the more likely the advice was to be accepted. A recent meta-analysis by Bailey and colleagues (Bailey, Leon, Ebner, Moustafa, & Weidemann, 2022), combining results from 129 independent datasets, found that information about the advisor that measures the quality of their advice was the only unique predictor of the overall weight of advice ("weight of advice" is a quantitative measure of how much the original decision shifts toward the advice when the two disagree).

However, information about the advisor's competence is not always available; moreover, the advisor may be judged to be of equal competence to the decision maker. Research shows that in the absence of objective feedback on the quality of advice, participants' confidence becomes an important factor in social verification. For example, ample empirical evidence suggests that people who are uncertain about their answers tend to seek social information more and rely on it more when making decisions (Gradassi, van den Bos & Molleman, 2022; Pescetelli, Hauperich & Yeung, 2021; Tikhonov & Moroshkina, 2023; Undorf, Livneh & Ackerman, 2021). That said, participants can use their own confidence quite flexibly. When self-confidence is low, it acts as a signal to seek advice, and when self-confidence is high, it is used to test the competence of the advisor (Carlebach & Yeung, 2023).

Research on joint decision making has shown that in situations of inconsistent opinions, people tend to use confidence heuristics, i.e., to focus on the opinion of the more confident participant (Thomas & McFadyen, 1995; Swol & Sniezek, 2005; Zarnoth & Sniezek, 1997). A. Koriat has shown that the use of confidence heuristics can improve the accuracy of joint decisions over individual decisions (the "two heads are better" effect), but only if confidence is initially correlated with correctness (Koriat, 2012).

Thus, confidence can fulfill several important functions at once: to act as a trigger of social verification, to be used as a criterion for choosing the answer of one of partners in joint decision-making, and to contribute to the assessment of the partner's competence and the building of epistemic trust in him/her (Moroshkina, Zverev, Nezdoymyshapko, Tikhonov, 2023). It is important that in order to apply the confidence heuristic, partners need not only to monitor their own confidence, but also to somehow compare it with the partner's confidence, which raises the question of channels and ways of communicating information about confidence.

Most studies investigate the verbal transmission of confidence in face-to-face interactions through explicit evaluations (Eskenazi et al., 2016; Bahrami et al., 2011). However, it is known that observers are able to correctly determine partner confidence

even in the absence of verbal communication, relying only on nonverbal cues of confidence, such as facial expression, movement patterns, and response time (Mori & Pell, 2019; Savina & Moroshkina, 2019; Slepian, Young, Rutchick, & Ambady, 2013; Vuillaume, Martin, Sackur, & Cleeremans, 2020). Pulford and colleagues (Pulford, Colman, Buabang & Krockow, 2018) investigated whether the use of confidence heuristics is affected by the format of the interaction. They found that participants were equally successful in applying confidence heuristics in both face-to-face and computer-mediated interaction conditions (where participants could not see each other). The authors concluded that it was the verbal communication of confidence that was important to participants. In addition, the authors found that more confident partners tended to communicate their opinions first. Consequently, the factor of response speed could also serve as an indirect channel of confidence transmission, including in computer-mediated communication.

Unfortunately, there are currently not many studies that compare different ways of conveying confidence. In one such paper (Bang et al., 2014), researchers built two algorithms that simulated different confidence heuristics in dyadic decision making based on the results of an experiment already conducted (Bahrami et al., 2012) and then compared them to the original data. The first algorithm was based on subjective confidence estimates (MCS) and always chose the most confident participant's answer when there was a mismatch. The second algorithm was based on response time (MRTS) and selected the response of the fastest participant. The results showed that by using both algorithms, a collective improvement in the response accuracy could be achieved, although MCS showed a significantly higher performance than MRTS. Comparing the results of the algorithms with the real data of the experiment, the authors obtained that the algorithms performed significantly better only for dyads with the same competence of the participants, and in dyads where the participants differed greatly in competence, their real interaction was more effective than the algorithms. It should be noted that in the experiment, participants received feedback after each trial, which allowed them to evaluate their partner's competence. The authors conclude that when making joint decisions, people take into account each other's competence, which presumably makes them less susceptible to those situations in which the more confident participant turns out to be less competent, so that the "two heads are better" effect is possible. In future research, the authors suggest building models that include a competence factor.

Modern research shows that social verification plays an important role in decision making. To understand the mechanisms of social verification, it is necessary to simultaneously take into account a set of factors, the most important of which are information about the competence of partners and their subjective confidence in the answer. At the same time, both explicit (verbal) assessments and non-verbal signs of confidence (including the time of decision making), which are read by interaction partners, can act as channels of confidence transmission. Because much of communication takes place through modern technologies, the question arises as to what extent these technologies take into account the ways of sharing confidence (and metacognitive cues in general)

described above. When verbal communication is not possible, or when communication is hampered by asynchronous time delays or blurred images, as on video conferencing platforms, it is important to understand what verbal and nonverbal cues a person relies on.

Purpose of the study

The purpose of our study was to test whether the ways to share confidence (direct - confidence judgment or indirect - speed of response) and partner competence affect whether the partner's opinion will be taken into account when making judgments in computer-mediated interaction.

Hypotheses of the study

1. In the absence of objective feedback, response change will be influenced by whether the partners' initial responses match or mismatch: matched responses are more likely to be retained than mismatched responses.
2. When responses are mismatched, if a participant's confidence is lower than his partner's, he is more likely to change his response in favor of his partner in both the direct and indirect confidence transfer groups.
3. Information about the partner's competence will influence whether the participant will consider the partner's opinion: if the participant's competence is lower than the partner's, the participant will be more likely to change the answer in the partner's favor.
4. Participants' revised responses will be more accurate than their initial responses (the "two heads are better" effect). This effect will be stronger in the group with direct confidence transfer.

Methods

Sample

The study involved 70 volunteers (50 females, 20 males) aged 18 to 33 years (M = 22.2, SD = 3.15) recruited through an online social media advertisement. All participants were divided into pairs such that they did not know each other, were of the same sex, and were approximately the same age. One pair of participants did not make it into the final sample because the post-experimental interview revealed that they had not paid attention to feedback after the first phase. Participant pairs were randomly assigned into two groups:

- EG-d was the group in which confidence information was conveyed directly in the form of a confidence judgment;
- EG-i was a group in which confidence information was communicated indirectly through reporting who gave the answer faster.

Stimulus material

To examine the social verification process and how confidence and competence contribute to it, we required the following conditions:

- tasks would be difficult enough to create uncertainty;
- all participants would have relevant but unequal knowledge for completing these tasks. In this case, they could improve the accuracy of each other's answers through social verification.

The tasks from the Reading Experience Test (Chernova, Bakhturina, 2021) were used as stimulus material. The participant's task was to determine which of the presented names and surnames belong to real writers. To provoke feelings of uncertainty, we selected the names of those writers who, according to Chernova and Bakhturina's (2021) study, people recognized as writers the worst (mean recognition rate of 33% (SD = 15%)). We selected a total of 60 names (30 were writers and 30 were not), from which two balanced lists of 30 names each were compiled.

Experimental procedure

The experiment was conducted in person. Pairs of participants worked at one computer with two keyboards: the one who sat at the left keyboard became participant #1, the one who sat at the right keyboard became participant #2. The monitor was placed in the middle so that both participants could see the entire screen. A non-transparent screen was placed between the participants so that they could not see each other. During the whole experiment, the participants worked in silence without direct contact with each other.

The procedure of the experiment consisted of two stages.

1. At the first stage, participants completed the tasks individually. On the screen, 30 names appeared sequentially in random order with the question "Is this the name of a real writer?". Within 10 seconds, the participants had to press the (Yes/No) key. Each participant entered their answer using their own keyboard. After 0.2 sec after both participants had entered their answers, the next trial began. After all trials were completed, the percentage of correct answers of each participant was displayed on the screen, allowing them to evaluate who was more competent in the given tasks.

2. A second phase with 30 new tasks was then initiated, in which participants completed the tasks together: they first entered their initial response, then read their partner's opinion, and then entered their revised response. Each task was presented in the same way as in the first phase, for a maximum of 10 seconds. Within 10 seconds, participants had to select their answer and press the appropriate key (Yes/No).

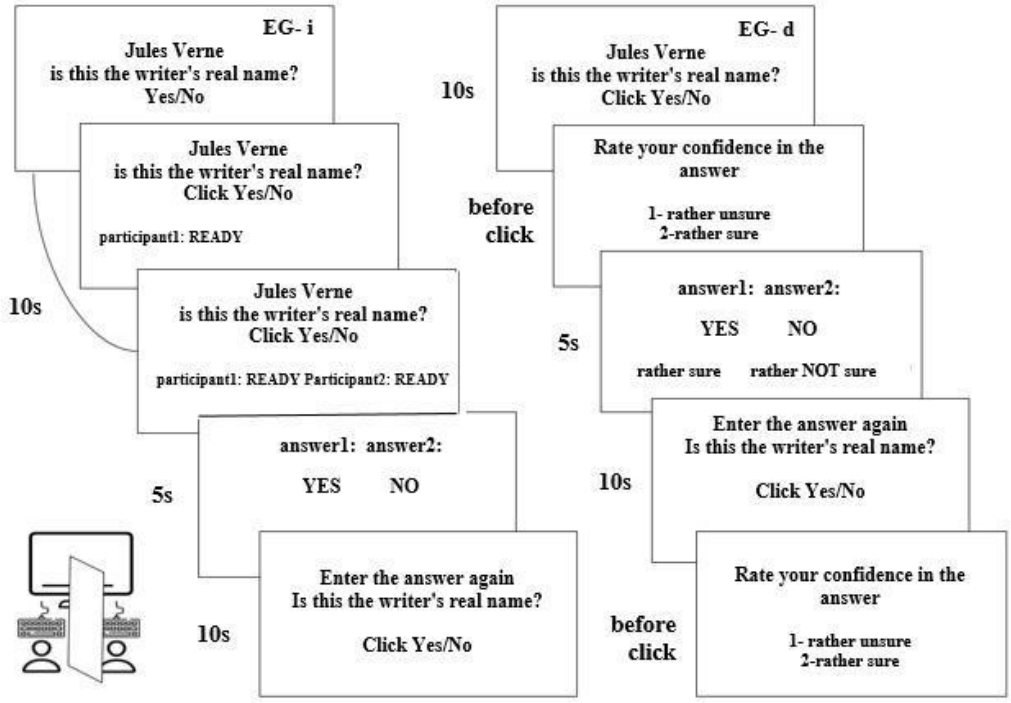
2.1 In EG-i, as soon as one participant entered his or her answer, the corresponding message "participant #1(2) ready" appeared on the screen. As soon as the second

participant entered his or her answer, the message "participant #2(1) ready" was added (Figure 1). These messages were displayed on the side of the screen that was closer to the responding participant. Both participants' responses were then displayed on the screen for 5 seconds. Participants were then asked to enter their revised response within 10 seconds. The next trial then began after 0.2 seconds.

2.2. In EG-d, in the second phase, the tasks were also presented for a maximum of 10 sec. After both participants gave an initial response, they were asked to indicate their confidence in the answer by pressing the appropriate key (1 - "rather sure", 2 - "rather unsure") (Figure 1). After both had responded, there was a time delay (which varied randomly from 0.5 to 1 sec). This was done so that participants would not know which one responded earlier and which one responded later. Both participants' responses, as well as their confidence judgments, were then presented on the screen for 5 sec. Participants were then asked to enter their revised response and final confidence judgment within 10 seconds.

Figure 1

Procedure of the second stage in the EG-i group (left) and EG-d group (right)



The results were analyzed using the SPSS Statistics 23 program. To test all hypotheses, repeated measures analysis of variance with aggregation across subjects was used. In an additional analysis of the relationship of competence and response change with initial response time, analysis of variance was used without aggregation across subjects.

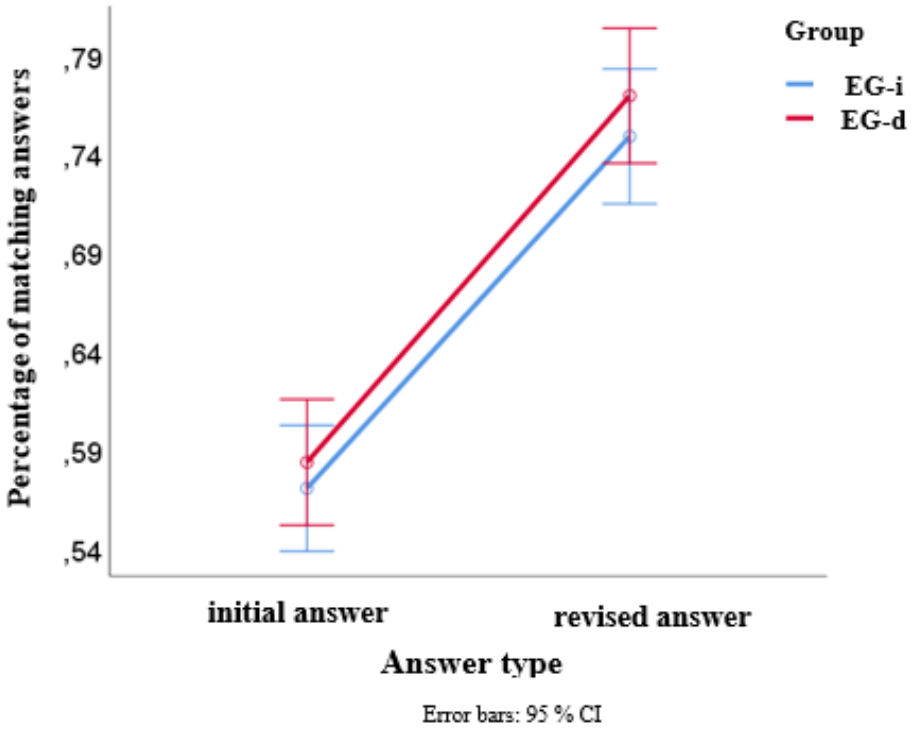
Results

Analysis of the coincidence of initial and revised responses of partners in groups at the second stage

To test the hypothesis of social verification, we took the share of matching answers as the dependent variable, the independent variable was the type of answer (initial/revised), and the between-group factor was the type of group - with direct or indirect transfer of confidence. It was found that in both groups the proportion of matching responses increased with revised response: in EG-d from 0.58 (SD = 8.9) to 0.77 (SD = 9.5), in EG-i from 0.57 (SD = 9.7) to 0.75 (SD = 10.4), this increase was statistically significant ($F(1, 66) = 267.84$; $p < .001$; $\eta^2 = ,802$). No effect of the group factor was found ($F(1, 66) = .672$; $p = .415$; $\eta^2 = .01$), as were factor interactions ($F(1, 66) = .111$; $p = .74$; $\eta^2 = ,002$). Thus, the response match statistically significantly increased with revised response regardless of group (Figure 2).

Figure 2

Average share of matched answers depending on the group and type of answer



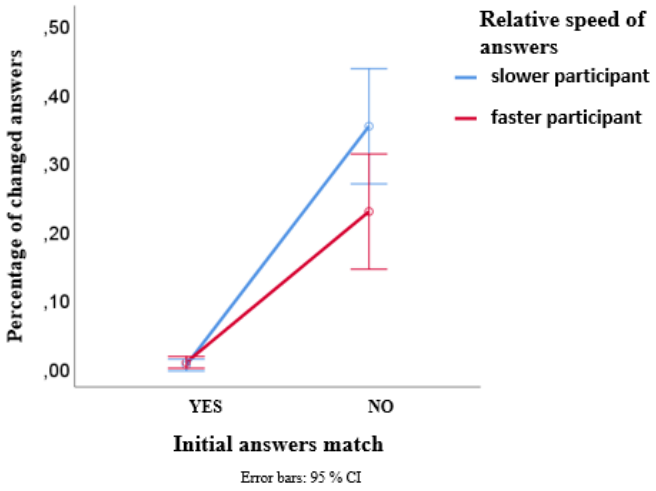
Analyzing the contribution of confidence and the way it is conveyed to the probability of answer change

Next, we analyzed the relationship between response time and confidence in the direct confidence transfer group (EG-d). This served as an independent validation that, in our task, response time can indeed be used as a cue of confidence. Confident initial response times averaged 2.6 sec (SD = 0.68) and uncertain responses averaged 3.44 sec (SD = 0.87), this difference was statistically significant (t (66) = 4.387; p < 0.001; d = 1.064). Thus, in EG-d, uncertain responses were significantly slower than confident ones.

Next, we tested the hypothesis that in the group with indirect confidence transfer (EG i), confidence conveyed through the message of response speed influences the change of the initial response. The dependent variable was the proportion of changed responses, the independent variable was the presence of an initial response match (yes/no), and the relative speed of the initial response (gave the response first, before the partner / gave the response second, after the partner). A significant influence of the confidence factor (F(1, 62) = 4.052; p = .048; η^2 = .061), the factor of matching initial responses (F(1, 62) = 90.82; p < .001; η^2 = .594) and their interaction (F(1, 62) = 4.628; p = .035; η^2 = .069) was found (Figure 3). If the responses matched, it did not matter whether the person answered faster or slower than their partner, as the mean percentage of change in response was small. And if the responses did not match, the person who initially responded slower was more likely to change the response.

Figure 3

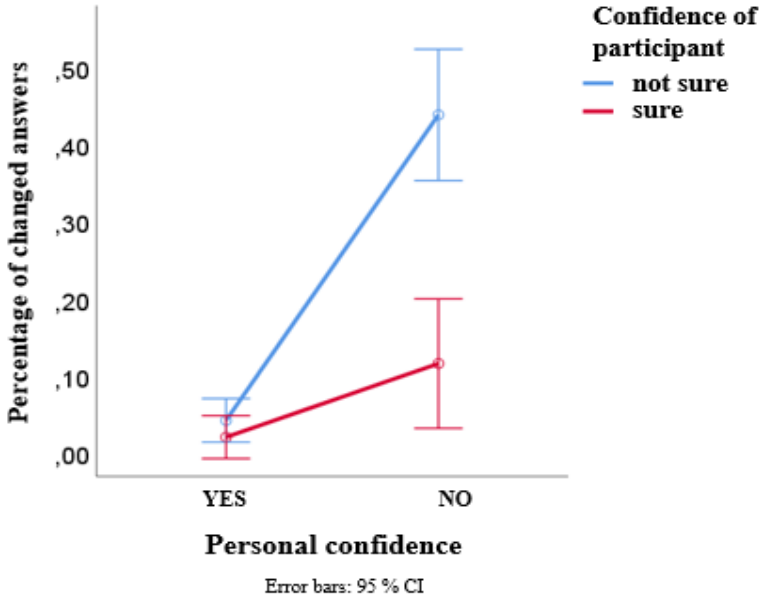
Proportion of changed responses as a function of matching and relative speed of initial responses in EG-i



We then tested the effect of confidence conveyed through explicit evaluations in EG-d, and found a significant effect of the confidence factor ($F(1, 65) = 33.736$; $p < .001$; $\eta^2 = .342$), the factor of matching initial responses ($F(1, 65) = 54.449$; $p < .001$; $\eta^2 = ,456$) and their interaction ($F(1, 65) = 20.383$; $p < ,001$; $\eta^2 = ,239$) (Figure 4). It turns out that if the answers matched, confidence does not affect the answer change because the average percentage of answer change is small. And if the answers did not match, the person who was uncertain is more likely to change the answer. Thus, hypothesis 2 was confirmed because confidence in both groups influenced the answer change.

Figure 4

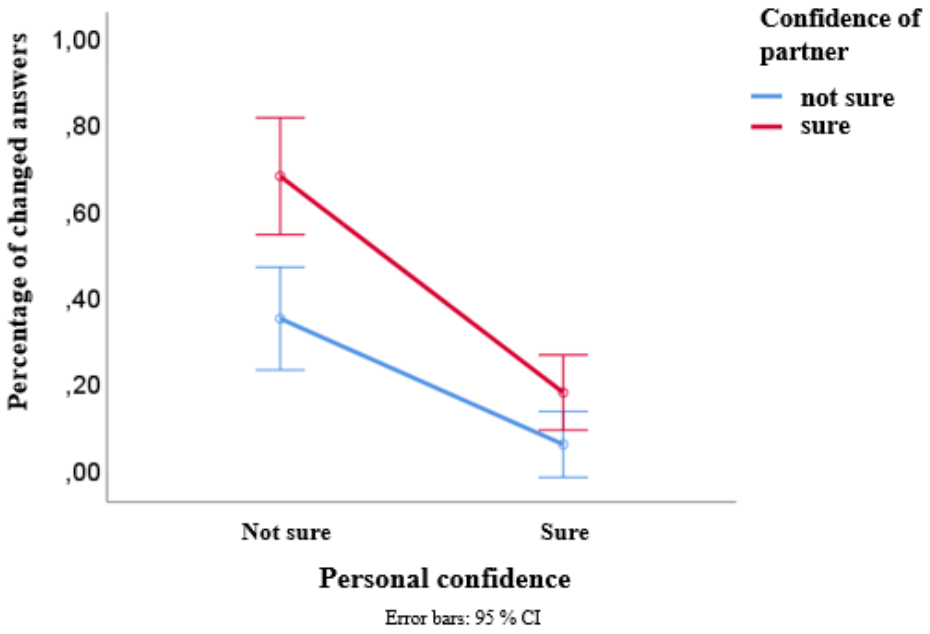
Proportion of changed answers depending on matching and own confidence in initial answers in EG-d



Additionally, we decided to check the contribution of both participant's own confidence and the confidence of the partner to the change of the answer in EG-d. Only initially non-matching answers were analyzed, since the previous analysis showed that matching answers hardly change at all. A significant effect of the factor of participant's own confidence ($F(1, 50) = 75.1442$; $p < .001$; $\eta^2 = .592$), partner's confidence ($F(1, 50) = 12.202$; $p = .001$; $\eta^2 = .207$) and their interaction ($F(1, 50) = 5.209$; $p = .027$; $\eta^2 = ,092$) was found. Thus, when a participant is confident, they generally do not change their responses much, regardless of their partner's confidence. And when the participant is uncertain, he or she is more likely to change the answer when the partner is certain than when both are uncertain (see Figure 5).

Figure 5

Percentage of changed answers depending on participant's own confidence and partner's confidence in EG-d



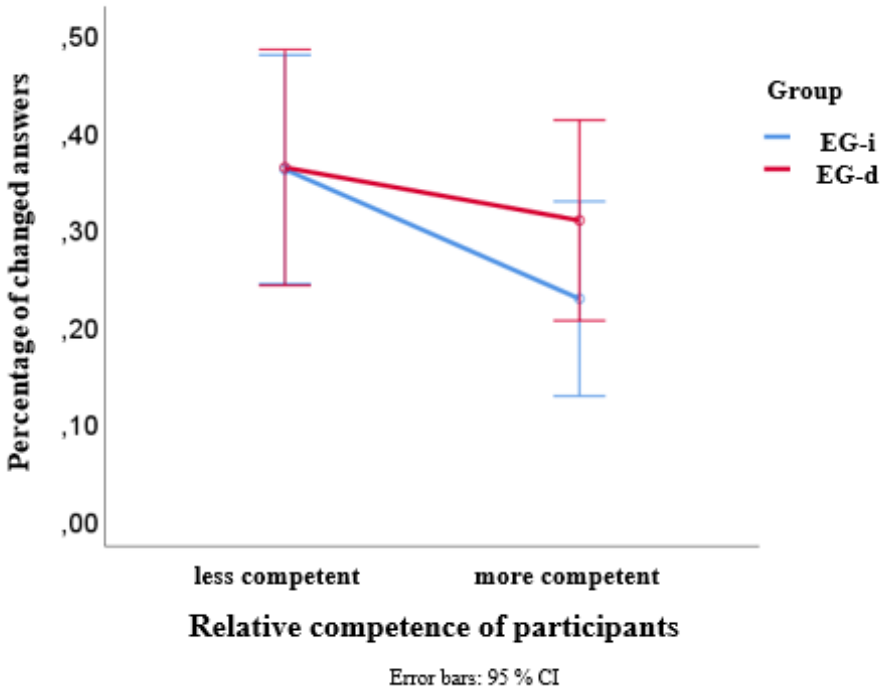
Analyzing the response accuracy (competence) at the first stage and its contribution to the probability of changing answers in the second stage

To test the effect of partner competence on the probability of changing answers, we first calculated the percentage of correct answers in the first stage of the experiment for each partner in the pair and determined who was more competent (relative competence factor). The mean competence in EG-d was 57% (SD = 10.3%) and in EG-i was 59% (SD = 12.1%). We compared the mean proportion of correct answers with the level of random guessing (50%) and found significant differences for both experimental groups: EG-d - ($t(33) = 3.715$; $p = .001$; $d = 0.637$), EG-i - ($t(33) = 4.445$; $p < 0.001$; $d = 0.763$), i.e. the tasks were challenging enough to provoke uncertainty, but still participants were able to solve them correctly. The mean difference in competence between partners was 12% (SD = 9.7%) in EG-d, and 17% (SD = 10%) in EG-i. We took only the non-matching responses for analysis, as the matched responses were hardly changed by the participants. The dependent variable was the proportion of changed responses, while the independent

factors were the experimental group (EG-d / EG-i) and the relative competence of the partner in the pair (more competent / less competent). The influence of the competence factor (F(1, 31) = 2.452; p = .127; η^2 = .073), the group factor (F(1, 31) = .73; p = .399; η^2 = ,023) and their interaction was not found (F(1, 31) = ,431; p = ,516; η^2 = .014) (Figure 6).

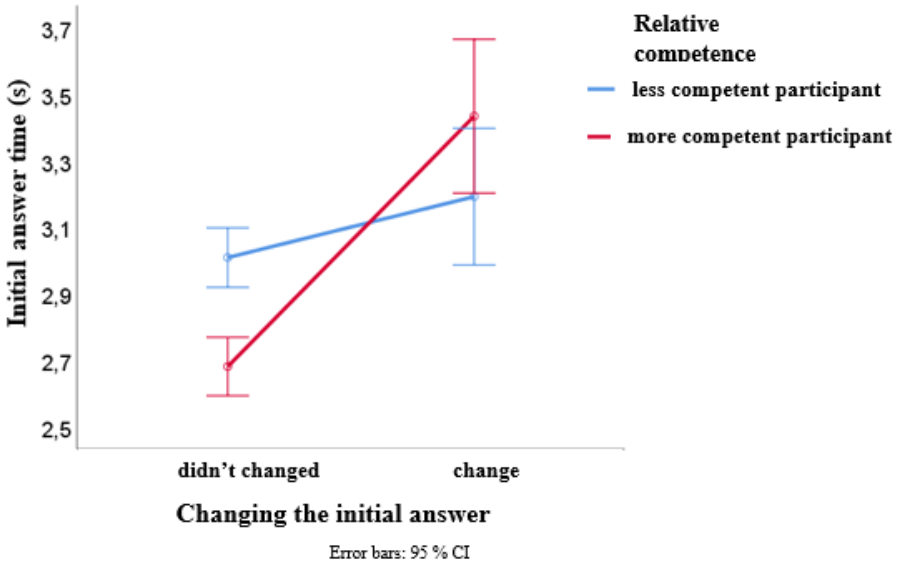
Figure 6

Proportion of changed answers for more and less competent participants by group



Because the main analysis did not reveal an effect of competence on the likelihood of changing a response, an additional analysis was conducted. We hypothesized that competence might act as a factor mediating the extent to which a participant relies on his or her own confidence to revise a decision. As in the previous analysis, we only took nonmatched responses. The dependent variable was the time of initial responses (as a proxy for confidence), while the independent factors were the presence of change in responses (changed/not changed) and relative competence (more competent/less competent). No significant effect of the competence factor was found (F(3, 1954) = .254; p = .614; η^2 < .001), but a significant effect of the response change factor (F(3, 1954) = 30.188; p < .001; η^2 = .015) and their interaction (F(3, 1954) = 11.183; p = .001; η^2 = ,006) (Figure 7).

Figure 7
Relation of initial response times to the probability of changing responses in more and less competent participants



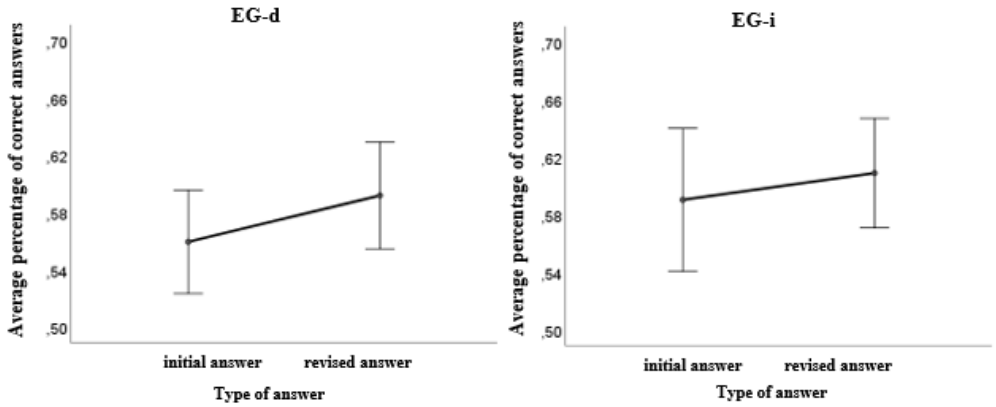
Thus, the time of an initial response significantly predicts the likelihood of its subsequent change (the slower the response, the higher the likelihood of its change). In more competent participants, the time of initial responses correlates more strongly with the likelihood of their subsequent change: fast responses are significantly less likely to change later than slow responses. For less competent participants, the same trend is observed, but it is significantly weaker (as evidenced by the interaction effect of factors).

Analysis of the share of correct answers in groups at the second stage

In testing the fourth hypothesis of an increase in the proportion of correct answers in the second stage after comparing with a partner, it was found that the mean proportion of correct answers in EG-d increases from 0.56 (SD = 10) to 0.59 (SD = 11) and this difference is statistically significant ($F(1, 33) = 9.022$; $p < .005$; $\eta^2 = ,215$). The mean proportion of correct answers in EG-i also increases slightly from 0.59 (SD = 14) to 0.61 (SD = 11), this difference did not reach a statistically significant level ($F(1, 33) = 1.528$; $p = .225$; $\eta^2 = .044$) (Figure 8).

Figure 8

Proportion of correct answers in the group with direct and indirect confidence transfer depending on the type of answer (initial/revised)



Discussion

The first hypothesis was aimed at testing the effects of social verification on making judgments in computer-mediated partner interaction. The analysis of the results confirmed the hypothesis. In the absence of objective feedback, participants in both groups focused on matching responses with a partner and were more likely to change non-matching responses. This led to the fact that the proportion of matching answers increased significantly in revised answers (by about 20%) and amounted to about 75-77% of the total in both groups. Given that the proportion of correct answers in this case averaged about 60%, the consistency effect is not a consequence of matching only correct answers. These results are consistent with previous studies (Tikhonov, 2020; Gershkovich et al., 2010), which also showed that partners come to greater consistency. Thus, the methodology we developed allows us to capture the effect of social verification in making judgments in computer-mediated interaction, which opens up prospects for future research.

The second hypothesis assumed the influence of the confidence factor on the probability of response change. Let us first turn to the results of the analysis of response time and certainty / uncertainty reports in the group with direct confidence transfer. Response time was found to be related to confidence - the faster the response is given, the higher the probability of certainty report and vice versa (consistent with previous findings: Kiani, Corthell & Shadlen, 2014; Pulford et al., 2018; Vuillaume et al., 2020). This suggests that response time is an indirect way of conveying confidence in our chosen task.

As expected, in both experimental groups, the results showed that confidence conveyed in both indirect and direct ways was related to the likelihood of subsequently changing a response: those who were less confident or slower than their partner were significantly more likely to change their response. This is broadly consistent with previous studies of confidence heuristics (Pulford et al., 2018; Bang et al., 2014). In these works, the authors attempted to separate the ways in which confidence is communicated, distinguishing between verbal transmission and nonverbal transmission via facial expressions and gestures (Pulford et al., 2018), as well as post-hoc algorithms based on response times and explicit confidence ratings (Bang et al., 2014). However, to date, the factors of response time and explicit confidence ratings have generally not been isolated from each other in studies of synchronous computer-mediated communication (see, e.g., Pulford et al., 2018; Tikhonov & Moroshkina, 2023). In our study, we were able to experimentally separate these factors and show the influence of confidence heuristics in each condition.

Additional analysis of the EG-d results allowed us to separately test the contribution of the participant's own confidence and the partner's confidence to the probability of response change. The results showed that self-confidence was more important, as partner confidence was only taken into account when self-confidence was low. This is consistent with research suggesting that low confidence is a trigger for advice requests (Undorf et al., 2021; Pescetelli et al., 2021) and its acceptance (Tikhonov & Moroshkina, 2023; Carlebach & Yeung, 2023).

The third hypothesis aimed to examine the competence factor. Information about competence in our study was varied in a quasi-experimental way: after the first stage, participants saw a message about what was the percentage of correct answers they and their partner had. These results were used to determine which participant was more competent in their pair, and this variable was included in the analysis. In summary, we were unable to document a relationship between the partner competence score and the likelihood of response change, although earlier studies have shown that advisor competence is one of the important predictors of acceptance (Harvey & Fischer, 1997; Bailey et al., 2022). This may be due to the fact that the difference in partners' accuracy rates was not too significant in the first stage (15% on average, corresponding to 4-5 responses out of 30 tasks). It is also possible that the way of informing participants of their partners' competence was not very valid and participants did not rely heavily on the information obtained. Nevertheless, we obtained results indicating that participants' competence factor was related to the extent to which they relied on the time of their initial response when changing it later. More competent participants were significantly less likely to subsequently change their fast responses than their slow responses. Since we found that the time of the initial response correlates with confidence in the response, this may mean that more competent participants are more focused on their confidence when deciding to change their response.

The fourth hypothesis was aimed at testing the "two heads are better" effect. It was found that in both groups, the average proportion of correct answers slightly increased after revision (by 2-3% on average), and the effect reached statistical significance in the group with direct confidence transfer. Previously, the "two heads are better" effect was obtained in some studies (Bahrami et al., 2010; Koriat, 2012) and not in others (Tikhonov, 2020; Gershkovich et al., 2010), which may be related to the type of tasks presented to the subjects. Importantly, the effect was significant only in the group with direct confidence transfer. A possible explanation could be that explicit confidence reports not only communicate information to the partner, but also help the individuals themselves to better understand where they are more likely to be wrong. It has previously been shown that people, although they can monitor their cognitive processes, do not use this capability in all situations (Goldsmith, 2016; Undorf et al., 2021). It seems that social interaction that provokes confidence explication may act as a trigger for more accurate metacognitive monitoring (see also the review by Moroshkina et al., 2023). An alternative explanation could be that success is enhanced not by increasing the accuracy of one's own confidence estimates, but by orienting to one's partner's confidence, which was easier to accomplish in the direct confidence transfer group (Bang et al., 2014). To test the proposed explanations, an additional study could be conducted with the introduction of a third group, in which participants would also make an estimate of their own confidence in the answer, but only the message of response speed would be broadcast to the partner. Comparison of the results with the data of the conducted study will allow us to assess which factor contributes more to the improvement of judgment accuracy: the need to explicitly assess one's own confidence or to receive an explicit assessment of the partner's confidence. Thus, our results raise new questions for future research.

Conclusion

The results of our experiment confirmed that partners making joint decisions in computer-mediated interaction use social verification, i.e., comparing one's own judgment with the partner's opinion. It was shown that in the absence of objective feedback, participants are oriented toward matching answers with their partner and are more likely to change answers that do not match. Confidence conveyed both indirectly (through reporting response ready time) and directly (through reporting confidence judgment) had a significant effect on the likelihood of changing a response, which is consistent with previous research. However, only in the group with direct transfer of confidence social verification contributed to an increase in accuracy of revised responses. Further research is needed to clarify the reasons for this effect and to test our proposed explanations.

At the same time, we did not manage to find the influence of the competence factor on the processes of social verification in making judgments. This can be explained by some methodological aspects of our experiment, as well as by the fact that the competence of the participants did not differ significantly in the selected dyads. Further research could include pre-tests to better target participant pairs and vary differences in competence.

Overall, we believe that the results obtained in our study can be generalized to a wide range of situations in which people make judgments based on general knowledge and share them in real time with other participants of similar social status and background.

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Review of Artificial Intelligence Methods Used in the Analysis of Functional Near-Infrared Spectroscopy Data

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Abstract

Introduction. Recently, machine learning methods, which are core components of artificial intelligence, have gained popularity in analyzing neurophysiological data. Functional near-infrared spectroscopy (fNIRS) is actively used to study neurocognitive mechanisms. This technology for recording hemodynamic data has a number of advantages, including spatial resolution, non-invasiveness, and the feasibility to conduct studies in natural settings, which has made the technology popular among researchers.
Theoretical justification. The analysis of fNIRS results relies on the sequence and selected methods for preliminary processing of raw data, as well as on the classification models employed. This review evaluates various preprocessing methods and examines the approaches to classifying fNIRS data. An essential aspect of preprocessing involves detecting and eliminating physiological artifacts from raw data, utilizing algorithms such as filtering, signal whitening, principal component analysis (PCA) and independent component analysis (ICA), short-channels removal. Methods such as wavelet filtering,

spline interpolation, and Kalman filtering are employed to address motion artifacts. **Discussion.** The review aims to provide an in-depth exploration of machine learning methods, specifically recurrent neural networks (RNN) and convolutional neural networks (CNN), which have been used in various studies for analyzing fNIRS data. The review highlights that leveraging deep learning neural networks can streamline signal preprocessing while achieving higher accuracy compared to traditional approaches in processing neurocognitive data.

Keywords

functional near-infrared spectroscopy, neurophysiological data, machine learning methods, deep learning neural networks, convolutional neural networks, recurrent neural networks

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Introduction

Currently, there are several ways to register brain activation data in neurocognitive research. These methods are typically divided into invasive (which involves directly registering data from the cerebral cortex or its structures by inserting electrodes into brain tissue) and non-invasive (which involves registering data from the surface of the scalp). Non-invasive methods used to obtain brain activation signals include electroencephalography (EEG) (Light et al., 2010); magnetoencephalography (MEG) (Cohen, 1968); functional magnetic resonance imaging (fMRI) (Seliverstov, Seliverstova, Konovalov, Kotenkova, Illarioshkin, 2014); functional near-infrared spectroscopy (fNIRS) (Scholkmann et al., 2014; Pinti et al., 2018; Quaresima & Ferrari, 2019).

Functional NIRS register changes in the blood flow of local capillary networks, which are induced by the activation of brain neurons. This method uses near-infrared signals in the cerebral cortex to detect changes in hemoglobin concentration. There

are two types of hemoglobin chromophore: oxyhemoglobin (HbO2) – oxygen-saturated, and deoxyhemoglobin (HHb), which is oxygen-free. FNIRS is a modern, non-invasive technology for measuring changes in concentrations of oxyhemoglobin, deoxyhemoglobin and total hemoglobin (Sitnikova & Malykh, 2021). FNIRS spectroscopy technology is based on two main principles: human tissue is relatively transparent to near-infrared light; hemoglobin is the primary absorbent of light in the near-infrared range. In this range, oxyhemoglobin and deoxyhemoglobin exhibit oxygen-dependent absorption, that varies across different wavelengths (Chen et al., 2020).

Recently, the use of machine learning technologies in the psychophysiology domain has gained popularity. Specifically, machine learning methods are actively employed to analyze fNIRS data in both neurocognitive research and for applications in brain-computer interfaces.

Theoretical background

Preprocessing of neurophysiological data using machine learning technologies

There is a different set of parameters and methods for signal cleaning and conversion, depending on the type of research and the machine learning model being used. However, there are several uniform steps in the signal preprocessing, which include converting the raw signal from different wavelength into optical density, and then into the concentration of oxy- and deoxy-hemoglobin. The conversion to total hemoglobin is optional. Multiple sources of signal interference can complicate signal interpretation and pose a significant challenge.

The main sources of noise may include head movements, changes in the optode (source and detector) scalp coupling index (SCI index), and changes in blood flow unrelated to neural activity. For example, the heart rate can be recorded by fNIRS and may be present in the neurophysiological signal. This occurs because near-infrared waves first pass through the meninges, skull, and scalp, and physiological changes in these tissues can cause changes in light absorption between source and detector that are not associated with functional changes in neural activity (Osharina, Ponchel, Aarabi, Grebe & Wallois, 2010). Overall, sources of physiological noise include heart rate, blood pressure fluctuations, respiratory rate, and scalp blood flow. Physiological noise can be removed using several techniques, including digital filtering, pre-whitening, and adaptive filtering. Techniques such as principal component analysis (PCA) and independent component analysis (ICA) can also be used to remove physiological noise from fNIRS signals. Additionally, registering short-wavelength channels has become increasingly common, allowing for the measurement of activation on the surface of the head (Brigadoi & Cooper, 2015). Each source of biological noise is characterized by its own frequency

range in the recorded signal (Cordes et al., 2001; Blanco, Molnar & Caballero-Gaudes, 2018). Therefore, digital filtering can reduce and/or completely eliminate the influence of noise sources that occur in frequency ranges different from the frequency ranges of the brain activity signal evoked by the task (Cordes et al., 2001; Liu, Ayaz, & Shewokis, 2017). However, fluctuations in blood pressure (0.08–0.12 Hz) and heart rate at rest (1–1.5 Hz) tend to overlap with the frequency range of the task-related brain activation signal (Huppert, 2016).

In addition to signal filtering, physiological noise removal is available through signal pre-whitening (Blanco et al., 2018). Signal whitening is used to remove autocorrelated signals such as heart rate by decorrelating task-irrelevant physiological signals (Barker, Aarabi, & Huppert, 2013). Some researchers (Blanco et al., 2018; Barker, Aarabi, & Huppert, 2013) have determined pre-whitening filter coefficients using an iterative autoregressive model to reduce residual error in task-evoked activity estimated from a general linear model analysis (GLM) (Luke et al., 2021; Yücel et al., 2021). It is worth noting that the pre-whitening is sensitive to motion artifacts (Blanco et al., 2018); therefore, motion artifacts must be removed from the signal before applying this procedure.

Another source of artefacts in fNIRS signal is global blood flow in the scalp. Principal component analysis (PCA) is used to remove such artefacts associated with scalp blood flow (Zhang, Noah, & Hirsch, 2016). The effectiveness of using PCA is justified in case of one dominant source of variation. If there are several sources that significantly can influence the overall signal variation, then PCA may not provide the desired effect (Zhang, Noah, & Hirsch, 2016). Another option for removing the global blood flow component from the signal can be the use of ICA (Hyvärinen & Oja, 2000). For example, ICA was used to eliminate global blood flow interference during Gate experiments by exploiting temporal coherence between channels to identify large signal components with a high coefficient of spatial homogeneity (Kohno et al., 2007).

Improvements in fNIRS technology have led to the development of short wavelength channels (~8 mm source to detector distance) that are used to measure and remove scalp blood flow data from analysis (Gagnon, Yücel, Boas & Cooper, 2014; Funane et al., 2015; Nguyen, Yoo, Bhutta & Hong, 2018). Short distances prevent light from penetrating the cortical surface, limiting blood flow measurements in the scalp. Thus, adding short-wave channels as a regressor to the fNIRS model allows to reduce the noise from the blood flow of the scalp.

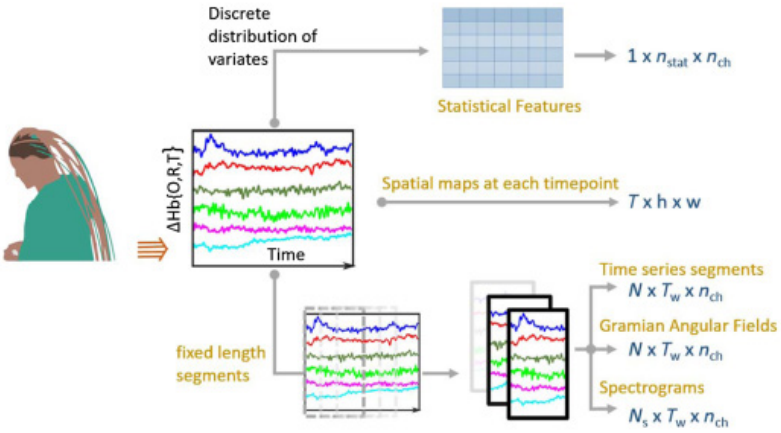
Another typical source of noise in the fNIRS signal is motion artifacts that occur during conversation or facial, head, and/or upper body movements (Izzetoglu, Chitrapu, Bunce, & Onaral, 2010; Jahani, Setarehdan, Boas, & Yücel, 2018). Motion can cause the optode shift, resulting in sharp high-frequency peaks, slow-wave drifts, or a shift in the baseline of the fNIRS signal (Jahani et al., 2018). To remove motion artifacts, methods such as wavelet filtering, spline interpolation, and Kalman filtering are used. Specifically, wavelet-based methods divide the fNIRS signal into wavelet coefficients and remove

those that fall outside a predefined distribution (Molavi & Dumont, 2012; Robertson, Douglas, & Meintjes, 2010). Spline interpolation methods model motion artifacts as a series of spline functions and subtract them from the data, achieving significant error reduction (Scholkmann, Spichtig, Muehlemann, & Wolf, 2010). Thus, the authors (Jahani et al., 2018) showed that combining spline interpolation with a Savitzky-Golay filter can correct baseline shifts and high-frequency peaks without removing additional artifacts from the signal (Jahani et al., 2018).

Obtaining features and augmenting input data before analysis using artificial intelligence methods

After the preprocessing of fNIRS signal, time series of oxyhemoglobin, deoxyhemoglobin and the total change in hemoglobin are formed. Each research team decides which combination of signals to use for further analysis. Figure 1 presents various options for transforming oxy- and deoxy-hemoglobin in time series before analyzing using mathematical methods or training machine learning models (Eastmond, Subedi & Intes, 2022).

Figure 1
Options for extracting features from signal samples (Eastmond, Subedi & Intes, 2022)



Researchers employ the following approaches to transform the signal before using it in the models:

1. Discrete probability distribution of concentration changes and extraction of statistical features (such as mean, slope, variance, skewness, kurtosis, maximum and others). Statistical characteristics can describe the time series of oxy- and deoxy-hemoglobin and incorporate the distinctive features of the series. The drawback of this this approach is that researchers themselves determine the available features that the model will analyze. This approach is valid when using

machine learning methods such as random forests or support vector machines. However, for neural networks, this approach is not valid, as in this case, the neural network can't independently model original features from the raw signal.

2. In another approach, fNIRS data in the form of a spatial map or raw time series is used by machine learning model (Tanveer, Khan, Qureshi, Naseer & Hong, 2019; Ghonchi et al., 2020a; Saadati, Nelson & Ayaz, 2019). In some research, data segments are converted to the form of Gramian angle fields (Gao et al., 2020) or spectrogram maps (Chhabra, Shajil & Venkatasubramanian, 2020). This approach allows machine learning methods, particularly deep learning neural networks, to independently extract features from the input signal. In this case, nonlinear features may be formed that are not understandable to researchers.

Approaches based on manual feature extraction and artifact removal are a challenge for creating a real-time signal processing system, in particular brain-computer interfaces. Deep learning neural networks can solve this problem with a sufficient set of training data. At the same time, deep learning methods can be used both as independent classifiers and as a method for extracting features, which can be used subsequently in the classifier. This fact is due to the good parallelization of calculations in neural networks, as well as the ability of neural networks to study and extract unique feature maps. Thus, Tanveer et al. (2019) used deep learning neural networks to extract features that were used in a K-nearest neighbors' classifier.

Some researchers use raw data in the classifier. In these approaches, a neural network extracts feature maps, based on which classification layers recognize patterns of brain activity. In Rojas and colleagues (2020) research, raw fNIRS data was used as an input for a LSTM neural network, achieving a classification accuracy of 90.6%. In a study evaluating methods for motion artifact reduction (Kim, Lee, Dan, & Tak, 2022), the authors compared convolutional neural networks with wavelet denoising and autoregressive denoising. The results showed that the root mean square error is approximately two times lower compared to the best combination of wavelet and autoregressive noise reduction methods. The present research confirms that deep learning neural networks can classify brain activity patterns from raw, non-preprocessed data, bypassing the steps of data preprocessing and feature extraction. It is worth noting that this approach is actively developing and has demonstrated effectiveness on certain tasks.

Neurophysiological studies are often characterized by small sample size. Deep learning neural networks require large amounts of data to be effectively applied. Large data samples enable machine learning methods to develop the ability to generalize classifiers across a broad data set. Consequently, researchers have recently become interested in generating large samples of fNIRS data (artificially generating fNIRS data), using neural networks. using neural networks. The generated data is based on, but distinct from the original data set. Generative adversarial neural networks (GAN) are employed to address this issue. For example, in a study by Wickramaratne and Mahmud (2021), GANs were

utilized to expand the fNIRS data set. When training a CNN on the original data set, an accuracy of 80% was achieved. However, when the data set was expanded with synthetic data using GANs, the trained CNN classifier achieved an accuracy of 96.67%. Similar results were observed in a study by Woo, Kang, and Hong (2020), where the addition of synthetic data increased the accuracy of the CNN classifier from 92% to 97%.

Artificial intelligence methods for analyzing fNIRS data

The fNIRS signal is converted into concentrations of oxyhemoglobin and deoxyhemoglobin, which can be considered as a multivariate time series. The numerous channels placed on the head's surface create multidimensionality. Modern neural network architectures aim to solve complex problems by minimizing the number of parameters required for training the network, utilizing innovative approaches to neural network structures.

Despite recent advancements in the field of machine learning, some researchers still rely on multilayer perceptron (MLP) neural networks. For instance, in a review by Naseer, Qureshi, Noori, and Hong (2016), a comparative analysis of classification accuracy between MLP and other methods such as kNN, Naive Bayes, SVM, LDA, and QDA was carried out. In a mental workload task, the MLP classifier achieved an accuracy of 96%, slightly outperforming certain classifiers such as QDA, Naive Bayes, and SVM. However, predefined feature extraction approaches were used for the classifiers the study. In another study by Erdoğan and colleagues (2019), MLP with predefined fNIRS features was used to classify imagined movements, achieving an accuracy of 96.3% for distinguishing between tasks involving finger tapping and resting state.

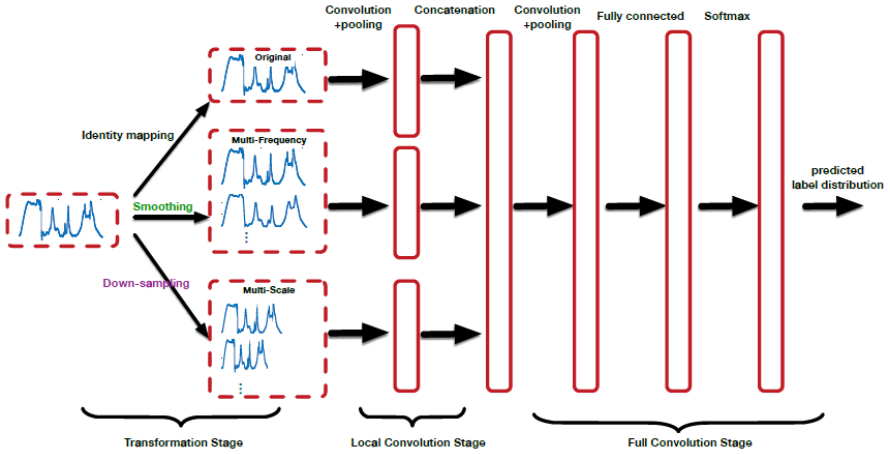
Recurrent neural networks (RNNs) specialize in processing sequences, such as time series, where the chronological order of events is crucial. This is achieved by using loops, that transfer information from the current layer to the previous ones, allowing for the processing of current data alongside previously processed data. However, a limitation of these architectures is the short-term memory, which hinders their ability to effectively handle long sequences while maintaining connections between data points. To address this issue, the long short-term memory (LSTM) neural network architecture was introduced as a solution (Hochreiter & Schmidhuber, 1997; Graves, 2012; Van Houdt, Mosquera & Nápoles, 2020).

Asgher et al. (2020) successfully tackled the challenge of mental workload analysis using LSTM, achieving an accuracy of 89.31%. Hamid et al. (2022) examined the distinction between walking and resting states with LSTM, achieving an accuracy of 78.97%. When compared to classical algorithms, the accuracy rates were as follows: kNN at 68.38%, SVM and LDA at 66.63% and 65.96%, respectively. In a study by Zhao, Li, Xu & Jin (2019), LSTM was employed to address a motor activity task, achieving an accuracy of 71.70%, surpassing the SVM accuracy of 66.6% on the same task. Wickramaratne & Mahmud (2020) demonstrated the efficacy of bidirectional LSTM architecture in classifying tasks like mental arithmetic, motor imagery, and resting state using fNIRS data, achieving a classification accuracy of 81.48%.

Another increasingly popular architecture neural networks for analyzing fNIRS data is convolutional neural networks (CNNs While CNNs are traditionally used for image processing, recent research has shown their effectiveness in handling time series data. Time series can be treated as one-dimensional vectors and convolved accordingly. For example, a multiscale convolutional neural network (MCNN) proposed by Cui, Chen, & Chen (2016) uses parallel convolution and pooling operations both on original time series and its transformations (scaling and smoothing of the series). The pooling results are concatenated into a single vector for further processing through fully connected and softmax layers (Fig. 2). This approach shows the possibilities to extract features from various transformations of the original time series.

Figure 2

MCNN neural network architecture (Cui, Chen & Chen, 2016)



Wang & Oates (2015) propose a method of using CNN to classify a time series by converting the original time series into an image to which CNN is applied. This approach involves constructing two matrices: the Gramian angular field (GAF), which retains all information about the series, except for the original boundaries of the values, and the Markov transition field (MTF), which preserves the original boundaries and values distribution. Figure 3 illustrates the structure and parameters of the neural network for processing GAF and MTF matrices.

The neural networks' architectures depicted in Figures 2 and 3 allow for the consideration of various key aspects of time series in classification tasks. However, they require representation of time series in various forms to extract unique feature maps. Specifically, the GAF matrix converts a row of N length into a matrix of size NxN. The authors suggest that their approaches also be extended to multidimensional time series.

The classification method based on multi-channel deep learning convolutional neural networks MC-DCNN, proposed in the research (Zheng, Liu, Chen, Ge & Zhao, 2014),

offers a solution to increasing the dimensionality of time series. Figure 4 presents the architecture of this network, where each channel (row) serves as an input for eight convolutions of size 1x5. Subsequently, an average pooling of size 1x2 is applied to each convolution result. The following layer applies four convolutions of size 1x5 and another average pooling of size 1x2 to the rows. The resulting vectors are then concatenated and used in the fully connected layer.

Figure 3

GAF-MTF-CNN architecture (Wang & Oates, 2015)

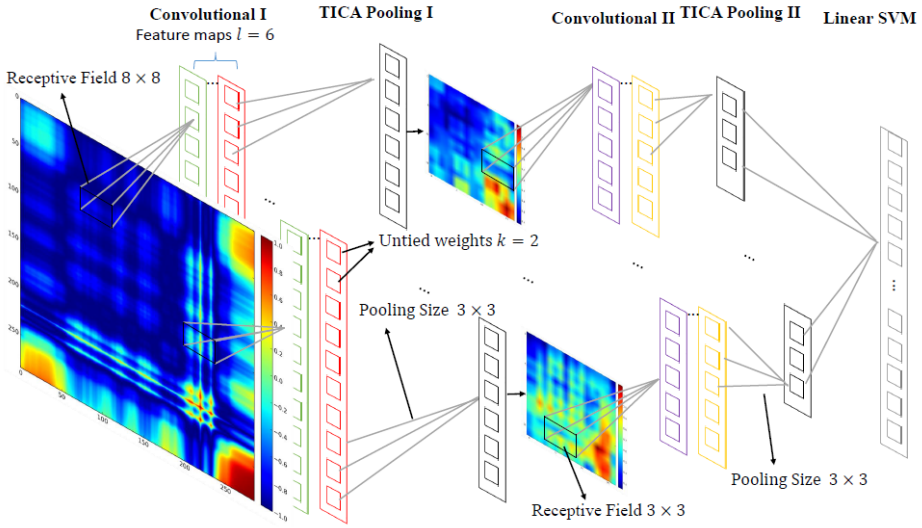
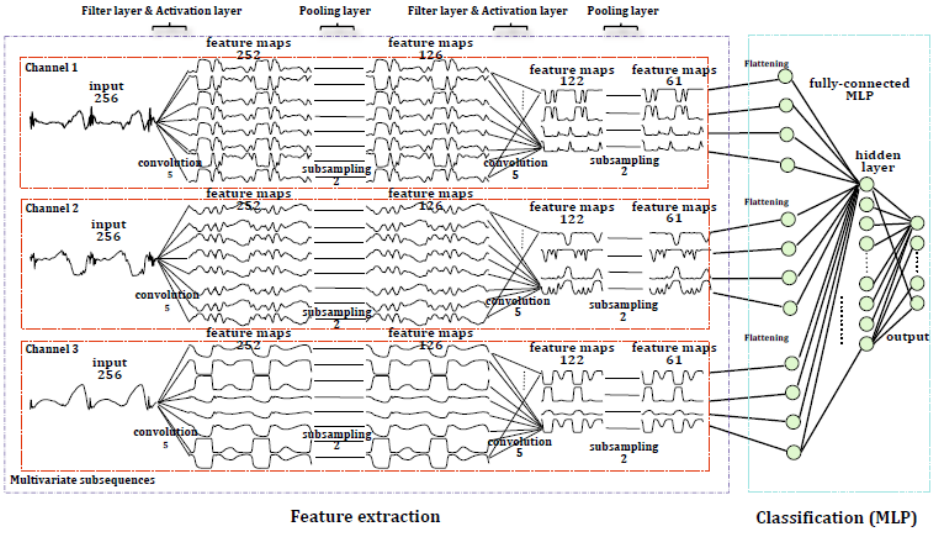


Figure 4

MC-DCNN network architecture (Zheng et al., 2014)



In conclusion, convolutional neural networks provide effective options for analyzing time series data. Kwon & Im (2021) addressed the problem of classifying mental calculation of arithmetic problems using CNN, achieving an accuracy of 71.2%, surpassing the LDA classifier's accuracy of 65.74% under similar conditions. Wickramaratne and Mahmud (2021) also employed CNN for classifying mental arithmetic tasks, achieving an accuracy of 87.14%. Ho et al. (2019) utilized CNN for classifying mental workload tasks by converting signals to spectrograms and applying two-dimensional convolutions, resulting in an accuracy of 82.77%. In another study by Hakimi, Jodeiri, Mirbagheri & Setarehdan (2020), CNN was used to analyze mental states during stress and resting states, achieving an accuracy of 98.69%. Trakoolwilaiwan, Behboodi, Lee, Kim & Choi (2018) achieved an accuracy of 92.68% using CNN for motor movement classification tasks. Ortega & Faisal (2021) examined differences between left- and right-handed grasping tasks, reducing the dimensionality of time series data using PCA before applying CNN, resulting in an accuracy of 77%. The classification of motor movements becomes much more difficult if the movements are imaginary. When dealing with imaginary motor movements, Ma et al. (2021) utilized a residual neural network (ResNet) to achieve an accuracy of 98.6%.

Discussion

Various artificial intelligence methods, particularly machine learning techniques for analyzing hemodynamic data obtained by NIRS, are discussed in the review. The analysis of scientific research literature revealed the advantages and disadvantages of most commonly used methods for preprocessing the raw signal before applying them to specific neural network models. Thus, the discrete probability distribution of concentration changes of oxy- and deoxyhemoglobin and the extraction of statistical features are often used in the preprocessing of neurocognitive data in applying random forests and support vector machines. Whereas constructing spatial maps or original time series allow deep learning neural networks to independently extract features from the input signal. In general, artificial intelligence algorithms require denoised data to function effectively. studies have shown that arbitrary feature extraction and artifact removal can cause problems in real-time signal processing and subsequent use in brain-computer interfaces. However, deep learning neural networks can efficiently handle this task with a sufficient training dataset. Deep learning neural networks are employed both as independent classifier models and as feature extraction methods that are subsequently used in any classifier model. This approach is highly promising and continues to evolve actively. Despite modern AI methods, such as deep learning neural networks, being capable of summarizing and interpreting the original "raw" data, the data preprocessing step remains crucial and mandatory, especially with small samples of neurocognitive data.

An important challenge in the application of deep learning neural networks is the requirement for large datasets, while research on neurocognitive mechanisms typically

involves small sample sizes. A potential solution to this challenge currently is generating artificial fNIRS data from existing small sets of registered data using generative adversarial neural networks (GAN).

The most common methods for analyzing preprocessed and denoised fNIRS data include convolutional neural networks (CNN) and recurrent neural networks (RNN), particularly with LSTM (long short-term memory) architecture. The review indicated that applying these deep learning neural networks reduces the number of signal preprocessing stages while achieving high classification accuracy.

Therefore, the primary applications of artificial intelligence methods (Orrù et al., 2020), particularly those based on deep learning, for processing and analyzing neurocognitive data are:

(1) feature extraction or data augmentation (Gao et al., 2022; Lu, et al., 2020; Yücel et al., 2021);

(2) signal classification in brain-computer interfaces (Dolmans, Poel, van't Klooster & Veldkamp, 2021; Glorot, Bordes & Bengio, 2011; Dargazany, Abtahi & Mankodiya, 2019; Saadati, Nelson & Ayaz, 2019);

(3) analysis of neurocognitive mechanisms (Tanveer et al., 2019; Gao et al., 2020; Ma et al., 2020; Wang et al., 2021; Sirpal et al., 2019; Xu et al., 2019; Yang et al., 2020; Ortega & Faisal, 2021; Ghonchi et al., 2020b; Chiarelli et al., 2018; Sun et al., 2020; Cooney, Folli & Coyle, 2021).

Conclusion

The key findings of the theoretical review on using machine learning technologies for processing and analyzing neurophysiological data are:

- the hierarchical structure of deep learning neural networks allows for the potential learning of features directly from raw or minimally preprocessed data, thereby diminishing the necessity for multi-stage processing and feature extraction pipelines when analyzing fNIRS data;
- features derived through deep learning neural networks more precisely capture task-induced neural activation in the brain compared to those manually extracted using traditional methods;
- deep learning methods exhibit superior performance levels in analyzing fNIRS data.

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Children's Understanding of Death: Formation of the Concept of Death and Its Main Characteristics

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Abstract

Introduction. Already at an early age a child learns what death is, faces the fact of his or her own mortality and the mortality of loved ones. The death anxiety caused by the realization of one's own mortality affects the mental and psychological well-being of the individual. Discussion of death contributes to its understanding - for this purpose, programs of death education are created. To work effectively with the topic of death in children and adolescents, it is important to know the age norms for the development of the concept of death. The concept of death is an understanding of death, awareness of its main characteristics, described through a number of components (universality, irreversibility, non-functionality/cessation and causality). **Theoretical justification** The conceptualization of death is influenced by various factors: age, cognitive and intellectual characteristics, culture, family, religion, and media. The maturity of the concept of death is achieved through the development of its components, which leads to the formation of a natural-scientific understanding of death. **Discussion.** Age is one of the leading factors for the formation of the concept of death. For children under 3 years of age the understanding of death is practically inaccessible: the absence of a parent is perceived as his death, emotional reactions to the loss are formed. From 3 to 6 years of age, understanding of individual components of the concept of death develops actively, but unevenly. Children begin to describe death as a biological phenomenon, fear of death arises. From ages 6 to 9, most develop a relatively mature understanding of death, but biological ideas coexist with supernatural ones. Children 9–11 years old think about death abstractly, are interested in religion, the concept of death becomes "fuzzy". Understanding of the irreversibility of death deteriorates. Fear of death decreases by adolescence. Adolescents rarely talk about death, but may ask questions when they do.

Belief in their uniqueness, immortality is revealed; interest in death increases, religious knowledge is replaced by atheistic knowledge. Understanding the age specifics of the formation of the concept of death will help to make programs of work with children and adolescents in the framework of the theme of death.

Keywords

understanding death, concept of death, childhood, developmental psychology, thanatopsychology, fear of death, anxiety, death anxiety

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Introduction

At a fairly early age, an individual is confronted with the realization that life is finite. The psychological well-being of the individual depends on how successfully he or she manages to cope with the anxiety arising from the realization of the finality of life. More and more researchers are delving into the study of thanatopsychological issues (understanding the concept of death, attitudes toward death, awareness of automortality, the relationship between thanatic factors and psychological well-being, etc.) due to the understanding of the importance of the problem and the impact of death anxiety on everyone.

According to the existential paradigm, our psychological well-being depends on how we deal with the fear of death. I. Yalom believes that death anxiety represents one of the basic factors in the development of psychopathology: a child at an early age is confronted with the thought of death, and in response to this, anxiety arises in his consciousness. Psychopathology represents a failed, ineffective way of coping with anxiety (Yalom, 2008; Iverach, Menzies & Menzies, 2014).

The topic of death can touch a child at any time: relatives may die, pets may die, the child may face a serious illness or life-threatening situations. The family, teachers and psychologists should be ready to provide support in such moments. In order to provide quality support, we need to have a good understanding of how children see this phenomenon, how they feel about it, what exactly scares them, and what factors influence children's perception of death.

Purpose of the study

Our goal is to collect and summarize the data obtained in foreign and domestic works reflecting the main factors influencing the formation of the concept of death. Based on the age factor, we have identified groups of children, listed the features of understanding of death in each group.

The specifics of understanding death are described using the four-factor concept of death, originally developed by Speece and Brent. This conceptualization is widely accepted among Western studies (Slaughter, Griffith, 2007; Bonoti, Leondari & Mastora, 2013; Panagiotaki, Hopkins, Nobes, Ward & Griffiths, 2018; Agrawal, 2019, etc.). The four-factor conceptualization of death includes such categories as cessation (with death, the inherent life functioning of the organism ceases), universality (all living beings will die one day), irreversibility (it is impossible to reverse death; once someone has died, they will not come back to life), and causality (realistic internal and external causes) of death. In our opinion, such generalization will help specialists to better orient themselves when working with a child of any age, which will improve the quality, effectiveness of any preventive and psycho-corrective measures.

Theoretical justification

Research on children's understanding of death began in 1934, when P. Schilder and D. Wechsler conducted a study on children and adolescents 515 years old, compiling a detailed description of children's conceptions of death. Wechsler conducted a study on children and adolescents 5–15 years old, compiling a detailed description of children's conceptions of death. They noted that (Schilder & Wechsler, 1934):

- children are not able to realize their own mortality; it is prevented by the very fact of realizing their existence in the current moment;
- children have little understanding of the distant past and future, and this may affect their ability to predict their death;
- Despite their inability to realize their own mortality, children believe in the death of others, but this, in their view, is as a result of a violent act;
- death from disease and old age seems unrealistic to children;
- the child is not afraid to die, but he is afraid to be killed;
- Suicidal ideation is an avoidance tool for the child. Death is seen as a way out of the situation of deprivation.
- Adult teachings about life after death are largely accepted by the child, although they are taken more literally. God appears as a stage magician, ghosts are seen as real and dangerous.

As one grows older, the conceptualization of death becomes more complete and realistic, from complete ignorance and lack of interest in the topic of death to a fairly complete logical or biological description of it (Anthony, 1971).

M. Nagy (1948) distinguished 3 stages of development of understanding of death depending on age:

- 3–5 years – death is not final, it is separation - the dead person continues to live elsewhere;
- 6–9 years – death is finite, but its inevitability and true causality are not realized. Death begins to be personified. The main function of personification is to alleviate anxiety (Yalom, 1980). At this stage, death seems distant from the child, and the child does not realize or acknowledge that he or she and his or her loved ones will die someday (Swain, 1978);
- from 9 years old – death is finite, irreversible, inevitable (Nagy, 1948).

The four-factor concept of death

In 1984, M. W. Speece & S. B. Brent attempted to define the main components of the concept of death, they are irreversibility, cessation, universality. The authors report that the majority of healthy children in modern urban industrial societies reach understanding of all three components at the age of 5 to 7 years (Speece & Brent, 1984). Later, the list of components varied from author to author, including such subconcepts as non-corporeal continuation (belief in the continuation of existence after the death of the body - reincarnation in a new body or the ascension of the soul to heaven), unpredictability (anyone can die at any time), and old age (understanding the biological sequence of life: birth, adulthood, aging, and death) (Brent & Speece, 1993; Lee, Lee, & Moon, 2009).

As a result, 4 components of generally accepted importance were identified. These were (Jaakkola & Slaughter, 2002):

- Inevitability/universality (death will happen to all living things);
- Irreversibility (the dead do not come back to life);
- cessation (death is characterized by cessation of body functions);
- Causality (death is ultimately caused by impaired bodily function).

Factors influencing the formation of the concept of death

A variety of factors influencing the formation of the concept of death are actively studied:

- family influence (Bonoti et al., 2013; McIntire, 1972); lower family socioeconomic status is associated with a more realistic understanding of death (Tallmer, Formanek, & Tallmer, 1974); children who have experienced prolonged separation from family during the first two years of life have a significantly poorer understanding of the concept of death than children without such experiences (Portz, 1965); parents who

are reluctant to engage children in conversations about death because of their own fear or out of a desire to protect their child from unpleasant experiences do not help their child develop a full understanding of life-cycle changes (Hunter & Smith, 2008);

- having experiences related to death (Cotton & Range, 1990; Hunter & Smith, 2008; Reilly, Hasazi, & Bond, 1983); children who faced the death of a parent due to terminal illness understood death better than their classmates who did not have such experiences (Hyslop-Christ, 2000);
- child's health status (Clunies-Ross & Lansdown, 1988; Redpath & Rogers, 1984; Spinetta, 1974; Bates & Kearney, 2015). Children with life-threatening illnesses show a greater understanding of death compared to healthy and chronically ill children (O'Halloran & Altmaier, 1996); children with cancer are less likely than healthy children to perceive death as a punishment (Jay, Green, Johnson, Caldwell, & Nitschke, 1987).

The influence of religion and culture on attitudes towards death is also studied. Thus, the success of coping with automortal anxiety (anxiety and fear of a person about his or her own death) is determined by whether a person is religious or not (Andrievskaya, 2017). Religious education expands children's conceptions of the meaning of life beyond ordinary existence (McIntire, 1972). Children's conceptualization of the afterlife is significantly influenced by parental religious beliefs (Wong, 2019). Some studies report that children's understanding of the components of death conceptualization is more influenced by culture than religion. This is particularly true for urban or rural experiences – children living in rural areas had a more realistic view of the causes of death and also developed an earlier understanding of the irreversibility of death compared to urban children (Panagiotaki, Nobes, Ashraf & Aubby, 2015). In another study, we find that a group of Chinese participants are more likely to report that death causes cessation of biological and psychological functions than a group of American participants, and Chinese participants are also less likely to speculate about the supernatural aspects of death than American participants. The authors attribute this to China's recent history of discouraging religious expression (Lane, Zhu, Evans, & Wellman, 2016). We can find domestic works concerning attitudes toward death of religious individuals, but we find a lack of such information for a child sample (Andrievskaya, 2017; Zabelina, & Fenvesh, 2019).

An important contribution to the field of research on attitudes towards death was the work of L. Iverach, R. G. Menzies, R. E. Menzies (2014), R. E. Menzies, R. G. Menzies (2023). The authors found correlations between attitudes toward death and psychopathology. Psychopathology is an ineffective way of coping with death anxiety (negative experiences that arise in a person when realizing one's own mortality, approaching death). Fear of death can be a transdiagnostic variable contributing to the development and maintenance of many chronic mental health problems (Menzies, Sharpe & Dar-Nimrod, 2019). Death anxietyis one of the primary fears underlying a range of mental health disorders, including hypochondria, panic disorder, depression, and eating disorders (Zuccala & Menzies, 2022).

Among the current studies, we find those that describe the role of video games in the process of death concept formation (high involvement in violent video games is associated with worse understanding of the concept of death, as well as lower fear of death) (Kai Yee et al., 2019; Nicolucci, 2019), the use of death imagery in animated films for children (Tenzek & Nickels, 2017; Bridgewater, Menendez, & Rosengren, 2021), ultimately leading to the development of the field of death education (Death Education – DE).

Death education

Discussing death in family and educational settings leads to a better understanding of death in children and adolescents (Schonfeld & Kappelman, 1990; Lee, Lee, & Moon, 2009), reducing alexithymia (Testoni et al., 2021). Death education - death education (DE) has been shown to temporarily increase death anxiety, but significantly reduce it in the long term (Testoni et al., 2018; Testoni, Ronconi et al., 2019; Testoni, Cordioli et al., 2019; Testoni, Biancalani et al., 2019; Moore, 1989; Jackson & Colwell, 2001).

Unfortunately, in our country the practice of DE remains underdeveloped both in theoretical and methodological terms and in practical terms. This, in particular, may be due to parents' unwillingness to discuss the topic of death with children because of their own fears, lack of knowledge about what and in what form to tell a child of a certain age. Talking about death is often avoided, adults distract the child from such issues or talk about death from a religious position, based on cartoons, use euphemisms ("flew away on a cloud") - all this can lead to the formation of an unrealistic view of death, as well as show that talking about death is undesirable. (Gavrilova, 2004; Shvareva, 2012; Bakanova, Andreeva-Co-Sen-Din, 2018; Bakanova, Andreeva-Co-Sen-Din, 2019). Death education could solve a number of urgent tasks. First of all, to weaken the taboo imposed by society on the topic of death and dying, which would open new opportunities for discussion within this field and help to work more effectively with childhood and adolescent fears, suicidal ideas, and the experience of loss. We could also achieve a decrease in alexithymia among children (Bakanova, Andreeva-Ko-sen-din, 2018). The movement towards DE, creation and dissemination of specialized educational programs would contribute to the formation of a more complete view and realistic expectations of death among children and adolescents, which would inevitably lead to a more complete view of life and realistic expectations from it.

We see that the accumulating knowledge about children's understanding of death is increasingly being put into practice in the world - through DE.

Among domestic ones there are a number of works that reveal the issue of adolescent attitudes to death, in particular – in adolescents with deviant or addictive behavior, with suicidal tendencies (Zhukova, 2016; Bogatyreva, Bespoldenov, 2017; Zhukova, Soldatova, 2019; Chistopolskaya, Enikolopov, Chubina, 2019; Abramyan, Khlomov, 2021; Andronnikova, 2022). There are also reviews of foreign studies of attitudes to death (Soldatova, Zhukova, 2018). There are studies of the ways of children's

coping with the fear of death (Bakanova, 2019), the personification of death is studied (Gavrilova, Barnashova, 2016). A significant part of domestic research is conducted on the adolescent sample (Novikova, Isaev, 2003; Gavrilova, Shvets, 2010; Khoziev, Vasenichev, 2015). The systematization of existing data is complicated by the fact that the use of the four-factor concept of death is insufficiently widespread in domestic studies, besides, methodological and ethical issues are still quite acute in domestic psychology.

Understanding death and psychological characteristics

Understanding of death is formed over the course of a child's life and can be considered mature when the major components of the concept of death are complete, resulting in a natural-scientific view of death. The more mature the understanding of death, the less pronounced the fear of death (Slaughter & Griffiths, 2007).

A significant part of studies emphasizes the relationship between age and the level of development of the concept of death, but not only age has weight here. A number of works find correlations between the intellectual level, as well as features of the cognitive sphere and understanding of death. It was noted (Anthony, 1971) that the relationship between the intellectual age of the child (the level of general intellectual development) and the maturity of the concept of death was higher than between the maturity of the concept of death and chronological age. The most significant changes in death conceptualization occurred between 7 and 8 years of age, attributing this to the influence of education (Anthony, 1971).

Child perceptions of death have been found to develop in parallel with the general cognitive and intellectual development formalized by Piaget: younger children create biological images of death, while older children describe the nature or essence of death, including personification, attributions of the death state, and symbolic or religious descriptions of death (Koocher, 1974; Schonfeld & Smilansky, 1989; Tamm & Granqvist, 1995; Wenestam &Wass, 1987; Yang & Chen, 2002). Death conceptualization may be influenced by measures of cognitive ability based on specific operant tasks (Cotton & Range, 1990; Kenyon, 2001; White, Elsom, & Prawat, 1978; Reilly, Hasazi, & Bond, 1983). Other studies find direct links between children's understanding of death and verbal abilities (Jenkins & Cavanaugh, 1986) or performance on Piaget's seriality, retention, and classification tasks (e.g., Cotton & Range, 1990, Hunter & Smith, 2008, Reilly et al., 1983). But there are also those who report no relationship between cognitive ability and death cognition (Mahon, 1999; Panagiotaki, Hopkins, Nobes, Ward & Griffiths, 2018). Discrepancies in findings may be due to differences in the designs and assessment measures used (Hopkins, 2014).

Intelligence helps to systematize knowledge about death, especially aspects of abstract thinking and logic. At the same time, life experience provides a better understanding of the causes of death (Orbach, Gross, Glaubman & Berman, 1986). Orbach, Weiner, Har-Even & Eshel (1995) highlight the intellectual prerequisites necessary for a mature understanding

of death: high verbal ability; understanding of time and permanence; understanding of causality; distinguishing between " self" and "nonself "; and distinguishing between objects and living beings.

Individual levels of anxiety also influence children's understanding of death. Anxious children were less likely to demonstrate an understanding of the biological realities of death (Slaughter & Griffiths, 2007). Anxiety about death involves defense mechanisms that reduce children's understanding of death. For example, suicidality is associated with poor understanding of death (Orbach & Glaubman, 1979). Rates of death comprehension were worse in anxious children than in non-anxious children (Orbach et al., 1985; Orbach et al., 1986). It is separation anxiety that is thought to play a significant role in underlying death comprehension (Orbach et al., 1995). Moreover, people with secure attachment types experienced less fear of death than people with insecure attachment (Mikulincer, Florian & Tolmacz, 1990).

Discussion

Understanding death and biological age

Biological age is still the leading, most popular factor among researchers in understanding death, and it is this factor that is analyzed in particular detail.

0 to 3 years old

In a child from 0 to 3 years of age, object permanence is not fully developed; the child has no idea that the parent continues to exist when he or she is not in sight. This peculiarity imposes its imprint on the perception of death - for a child at a very early age, it is the same absence as leaving the room. Since death is an abstract concept, it is inaccessible to the child at this stage. The only things he or she can notice are the unmet needs, as well as the grieving moods of those around him or her (Krepia, Krepia & Tsilingiri, 2017).

As cognitive processes become more complex, the child is already able to recognize the mother. When she dies, the child may react with intense crying and sadness (Bowlby, 1980; Dmitrieva, 2019; Kaytez, 2020).

3 to 6 years old

At the 3- to 6-year age stage, children have a more accurate understanding of death than is traditionally expected (Hoffman, & Strauss, 1985; Ji, Cao, Han, 2017). For example, Nagy's (1948) now classic study argues that children 3-5 years old consider death to be inconclusive and reversible, i.e., the irreversibility component is incomprehensible to children, but by now a body of evidence to the contrary has accumulated (Lazar & Torney-Purta, 1991; Nguyen & Gelman, 2002; Panagiotaki et al, 2015; Mahmood Ashiri & Khodabakhshi-Koolaee, 2020; Agrawal, 2019; Slaughter & Griffits, 2007; Slaughter & Lyons, 2003). But evidence is also found to support that for children in this age group,

death seems reversible, temporary (Isaev, 1992; Weininger, 1979; Willis, 2002) and is perceived as a dream, a temporary passing (Kaytez, 2020; Candy-Gibbs, Sharp, & Petrun, 1984–1985; Lonetto, 1980). A number of studies have documented that death is perceived as a biological phenomenon by 4-6 year old children (Slaughter, Jaakkola, & Carey, 1999; Slaughter, 2005; Panagiotaki et al., 2018; Wong & Power, 2022). At the same time, there are examples of biological and religious concepts coexisting simultaneously (Callanan, 2014; Wong & Power, 2022). Part of the research shows that the universality component was understood by most children between 3–5 years of age (Agrawal, 2019; Panagiotaki et al., 2018; Miller, Rosengren, & Gutiérrez, 2014; Slaughter, 2005; Candy-Gibbs, Sharp, & Petrun, 1984–1985), but other authors argue that universality may remain incomprehensible until 7–8 years of age, the same applies to cessation;

At age 4, children may believe that physical and mental functions in humans and animals are preserved after death (nonacceptance of cessation); by age 6, such beliefs weaken but become common again by age 7 (Lane, Zhu, Evans, & Wellman, 2016). It is also interesting that children understand the cessation of physical processes earlier than they realize that mental processes, such as thoughts and emotions, also cease with death (Bering & Bjorklund, 2004; Bering et al., 2005; Misailidi & Kornilaki, 2015).

Causality as the most complex component is learned later than the others. At this age stage, the foundations are laid: causality in plants can be understood by children as early as 4 years of age (children choose the correct option among pictures of plants and inanimate objects when asked to show "what can die if a person harms it" or "what can die if it gets sick," etc.) (Nguyen & Gelman, 2002), but the causality of human death is not understood until 8–10 years of age (Panagiotaki et al, 2015, Slaughter & Griffiths, 2007). There is also a view that states that by age 6, children begin to understand that death can be caused by many factors, not just old age (Panagiotaki et al., 2018).

This heterogeneity may suggest that at this age stage there is an active but uneven development of understanding of the individual components of the concept of death. Hyslop-Christ (2000) in his study also shows that none of the groups of children surveyed (3–5 years and 6–8 years) had an understanding of all four components. Fear of death often occurs at this age stage, with approximately 26% of 4–6 year old children reporting a fear of death (Slaughter & Griffiths, 2007).

6 to 9 years old

Some authors argue that between the ages of 5 and 8, most children develop a mature understanding of death (Smith & Hunter, 2008), while other data suggest that this occurs between the ages of 7 and 11 (Speece & Brent, 1992). Research indicates children's understanding of the universality and irreversibility of death during this age period (Gartley & Bernasconi, 1967; Vianello & Marin, 1989; Lansdown & Benjamin, 1985; Lazar & Torney-Purta, 1991; Stambrook & Parker, 1987; Childers & Wimmer, 1971; Cuddy-Casey & Orvaschel, 1997; Bering & Bjorklund, 2004; Panagiotaki et al., 2018; Kuzmina, 2021). Some surveys show that 7–8-year-old children provide biological explanations for death

that also reflect a criterion of cessation (Talwar, Harris & Schleifer, 2011; Melear, 1973), mixed with supernatural ideas (Harris & Gimenez, 2005). American 6-year-old children also understood all 4 major components, but also relied on religious and metaphysical explanations of the afterlife (Rosengren, Gutiérrez, & Schein, 2014). According to some reports, automortality may be denied up to age 7–8 (Vianello, & Marin, 1989; Willis, 2002), irreversibility is also denied - children may have ideas that the dead can be resurrected if suitable measures are taken to do so. Older children may accept the universality of death but believe that only external influences or old age can cause death, indicating an incomplete understanding of causality (Meadows, 2006). All of this may be due to the fact that the child is actually aware of the universality and irreversibility of death, but chooses to deny it. Denial is also discussed by Yalom, who states that children understand the concept of death at a very early age, but adults train them to fear death (Yalom, 1980). When asking children about the causes of death, children are more likely to name unnatural causes (e.g., violence) at age 5-6, and natural causes (e.g., illness) at age 8–9 (Kenyon, 2001). Fear of death is one of the most common fears among children 7 years and older, with 50% or more of children over the age of 7 reporting a fear of death (Zakharov, 2005; Slaughter & Griffiths, 2007; Muris et al., 2000).

9 to 11 years old

Traditionally, it is believed that at this age stage, an "adult" understanding of death is already established (Kenyon, 2001; Slaughter & Griffiths, 2007; Ellis & Stump, 2000; Brent et al., 1996; D'Antonio, 2011). Nevertheless, based on other findings, it appears that the concept of death is not fully matured. Panagiotaki et al. (2018) argue that causality remains poorly understood in 10-11 year olds, there is no meaningful improvement in the understanding of cessation between 4 and 11 years of age. Irreversibility is understood worse in 10–11 year olds than in other age groups (Panagiotaki et al., 2018). A similar phenomenon is observed by Labrell & Stefaniak (2011), who note that only 55% of 11-year-olds provide correct answers to questions about irreversibility, although previous research indicates understanding of this aspect at an earlier age.

During this age period, children begin to think about death in more abstract, religious, metaphysical concepts (Panagiotaki et al., 2018), and as a result, the concept of death may become "fuzzy" (Koocher, 1973). Children aged 10-11 may be more likely to rely on supernatural ideas than younger children. The proportion of biological explanations for death may decrease in children of this age. Apparently, children need to recognize the universality and irreversibility of death in order to then begin thinking about the afterlife (Astuti & Harris, 2008; Harris, 2011). Thus, religious and biological explanations of death coexist simultaneously in the mind of a 10–11 year old child (Harris & Giménez, 2005; Legare, Evans, Rosengren, & Harris, 2012).

Against the background of increased religiosity, the understanding of both irreversibility, universality and cessation of death and its causality are weakening: children aged 11–12 are more likely to give spiritual explanations of death (e.g., claiming that the

time of the deceased has come) (Kenyon, 2001). It is confirmed that understanding of causality and universality is influenced by religious context (Gavrilova, 2009). A study on a sample of Spanish children ages 4-12 found that those who attended Catholic schools demonstrated a weaker understanding of cessation than children attending a secular school (Bering, Blasi & Bjorklund, 2005). A survey of American children ages 4 and 7–8 found that they had a poorer understanding of cessation compared to their Chinese peers, also attributed to the influence of religious context (Lane, Zhu, Evans, & Wellman, 2016).

Fear of death, which is more pronounced earlier in life, begins to subside closer to adolescence (Westenberg et al., 2004). It is important to note that a more mature understanding of death is associated with lower fear of death (Slaughter & Griffiths, 2007). Additionally, fear of death was lower in those children who had the opportunity to talk about their emotions and discuss death with their family (Slaughter & Griffiths, 2007; Stylianou & Zembylas, 2018).

Ages 12 and up

At this age period, the phenomenon of " personal fable" - the child's belief in his/her uniqueness and immortality - manifests itself. The age of 12-15 years is characterized by the belief that other people are mortal, but the child himself will not be affected by it (Elkind, 1967). With age, this belief wanes. Adolescents rarely talk about death with friends or family, but if the opportunity arises, they may ask questions that concern them ("How do people prepare for death?", "Do some people really die happy?"). Adolescents are chronologically distant from the future, they face new challenges that require solutions, they are oriented toward life and their youth, but at the same time they are living through loss: the loss of childhood, of naive ways of knowing, of "ideal" parents-all leading to "normal adolescent mourning" (Sugar, 1968). And it is precisely such contradictions - between the seemingly optimistic features of adolescence and its losses - that create a special attraction to the topic of death, a need to understand it, and, at the same time, a heightened fear caused by these experiences (Noppe & Noppe, 1991).

Adolescents may also experience "social death"-isolation from their peer group for a variety of reasons, leading to feelings of loneliness and anxiety (Noppe & Noppe, 1991).

In younger adolescence, the cognitive component of the attitude to death is characterized by the predominance of religious knowledge, but in older adolescence atheistic knowledge begins to prevail (Bogatyreva, Bespoldenov, 2017). In 13–14 years old adolescents are characterized by fear of unexpected death, in 15-16 years old - fear of painful death and worries about the transience of time (Gavrilova, 2004). Adolescents realize their own finitude. The fear of death in adolescents may be associated with the unknown, loss of loved ones and loneliness; the fear of death is characterized by a pronounced desire to live (Novikova, Isaev, 2001; Novikova, 2002; Novikova, Isaev, 2002; Novikova, Isaev, 2003).

Conclusion

Realization of one's own mortality and understanding of death are topics of concern for every person regardless of gender, age, nationality and other factors. Every individual faces reflection on the topic of death, and already at the age of four a child begins to familiarize with the phenomenon of death, all components of the concept of death develop. The quality of development of death components can be influenced by different factors: family, health status, experience of encountering death, age and level of psychological development.

The development of the concept of death is uneven, and future studies are yet to identify the regularities of this process. It is also important to determine the strength of factors other than age that influence the formation of the concept of death. This will allow for the development of tools through which professionals can effectively adjust children's understanding of and attitudes toward death. Another important task to be accomplished is the creation of a common methodology for future research.

The data presented in this article can form the basis of recommendations for parents and professionals. The data from our survey will help adults to understand what, depending on the age stage, children think about death and what may be troubling them. Also, based on the survey, psychological support programs can be created for children and adolescents facing anxiety about death.

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Why Do People Want to Look Younger Than Their Age? Psychological Correlates and Predictors of Desired Perceived Age

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Abstract

Introduction. Researchers have found that the desire to look young in modern people has increased as a result of the emergence of the concept of active aging and the 'cult of youth', which has been cultivated for at least a hundred years. Besides the social conditions of this desire, there are also reasons to assume its psychological determination. The purpose of the study was to identify the influence of gender- and age-specific factors (gender, age) and psychological factors (subjective age, attitude toward appearance) on the severity of individuals' need to look younger than their age. **Methods**. *Sample*: 637 participants aged 21-75 years (235 men, 402 women). *Diagnostic tools*: (a) a set of diagnostic tools for assessing individuals' attitudes towards their own appearance by V. A. Labunskaya, (b) the Self-Esteem of Age questionnaire by T. A. Vorontsova, and (c) the Photo-Video Presentation of External Appearance procedure by T. A. Vorontsova. Methods of mathematical statistics: descriptive statistics, Student's T-test, Mann-Whitney U-test, Levene's test of equality of variances, Spearman correlation analysis, Kruskall-Wallis test, and multiple regression analysis. **Results.** (a) 88.5% of the participants indicated that they needed to look younger than their age. (b) The severity of the need was influenced by the gender- and age-specific factors (in a sample of young participants aged 21-34 years). (c) The psychological correlates of the need of adults to look younger than their age are described, including subjective age, self-assessment of perceived age and ideas about other people's estimates of perceived age, actual perceived age, appearance perfectionism, importance of appearance, assessment of the correspondence of individual appearance to age, and expected lifespan. (d) A regression model of the need

of adults to look younger than their age has been constructed, which includes predictors such as subjective and chronological age. **Discussion**. The study was the first to examine the severity of the need of adults to look younger in different gender and age groups and to identify its correlations and predictors. The results are discussed in relation to the development of an empirical model of perceived age construction.

Keywords

appearance, age, perceived age, subjective age, age construction, need, desired perceived age

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Introduction

The desire of modern people to look younger is based on managing the impression of their age created by others who perceive them, or on the so-called "apparent age", "perceived age", which is defined as "the age attributed to a person (object of perception) by another person (subject of perception, assessor) as a result of his/her appearance perception." (Shkurko & Labunskaya, 2018, p. 450).

We form an impression of the age of an unacquainted subject of perception based on the "construction" of his/her age. Therefore, both the characteristics of the object and the subject of perception have an impact on this process (Andreeva, 2000; Bodalev, 2015). In this study, we considered the desired perceived age, which we define as the age that a person wants to look like. The difference between a person's passport (chronological) age and the age he/she wants to look like in the eyes of other people is defined by us as the need to look younger than his/her age (NLY). Considering the discrepancy between chronological and desired perceived age as a need, we relied on one of the definitions of need as a necessity for something (Zinchenko & Meshcheryakov, 2008), which determines a person's behavior as an individual (biological needs) and his social behavior (social

needs). The NLY is a social need formed and realized through social interaction with other people, and its manifestation is influenced by some of the social factors discussed below.

First, people want to look younger because of the concept of active ageing that is widespread in our time. A. V. Yurevich writes that the basis of the 20th-century philosophy of life was "the cult of youth": "... respect for old age is weakening even in traditional societies, negative stereotypes of old age dominate, but at the same time its "rejuvenation" is observed – a change in the traditional ideas about this age in relation to the increase in average life expectancy" (Yurevich, 2018, p. 5). V. A. Buryakovskaya (2015) also believes that the cult of youth is one of the myths of mass consciousness. K. Shemet and E. N. Makovetskaya (2021) write that the cult of eternal youth and fear of aging form the basis of the new age philosophy of modern man; modern society imposes cultural stereotypes on a person who, by all means, delays the beginning of old age and tries to maintain youth – a man through union with a younger woman, a woman through the use of surgical and cosmetic technology. In the context of the concept of active aging, the "youthfulness" of appearance is a standard of aging and self-care. Many authors (Campos, Cheban, 2018; Shemet, Makovetskaya, 2021) emphasize the inconsistency of this concept, which "forces a person to live in pursuit of elusive beauty and youth" (Shemet, Makovetskaya, 2021, p. 253), encourages him/her to return to early stages of their life path, compete with young people for a youthful appearance, "play on someone else's field" with minimal chances of winning.

The age stereotype associated with this concept is that "young people are better than older people", which existence has been documented in a number of studies (Diaz, Arsentieva, 2018; Folster, Hess & Werheid, 2014). It has therefore been shown that there are phraseological units in different languages that disparage elderly people (Dias, Arsent'eva, 2018). Older people who want to date have been found to post older photographs of themselves as young people on dating sites (Gewirtz-Meydan & Ayalon, 2018). The authors conclude that sexuality is socially conditional: "Intimacy and friendship are only intended for those who are "forever young". It is also recorded (Vorontsova, 2022b) the dynamics of attitudes towards older people who have obvious changes in their appearance associated with their age: a decrease in sympathy (hostile ageism) and an increase in respect (benevolent ageism).

The above-mentioned age stereotype – "young people are better than older people" – has a gender-specific dimension. Thus, the description of the age of an elderly woman in English phraseological units defines her appearance and has a negative emotional connotation: "old cat" (old witch); "old trout" (old nag). The description of a man's age, on the contrary, is a reference to his internal state: "a man is as old as he feels, and a woman as old as she looks" (Akhmedova, 2018).

From a psychological point of view, in English language discourse, it is stated that the age of a man is the result of his internal self-determination (the subjective age), and the age of a woman is the result of her perceived age. Scientists have discovered the

existence of a 'double standard about aging' (Berman, O'Nan & Floyd, 1981; Grigor'eva, 2018; Kletsina & Ioffe, 2019; Kletsina, 2020): society places higher demands on aging women than men. For example, taking care of one's appearance is prescribed by norms for female role behavior (Kletsina & Ioffe, 2019). At the same time, I. S. Kletsina (2020) points out that the status of an older man in traditional society is significantly higher than that of an older woman. The philosopher Pascal Brückner, in his book On the Philosophy of Life (Brückner, 2021), describes gender- and age-related stereotypes: "A woman becomes ugly with age, but a man becomes more beautiful." I. A. Grigor'eva (2018), in her work with the powerful title "Older women: "Down the ladder" of age and gender", analyzes the specificity of the "prescribed" scenarios of elderly women in our country and concludes that "old women are subject to double stigmatization – as women and as the elderly" (Grigor'eva, 2018, p. 5).

Individual personal factors also influence the realization of the need to look younger. As a result, the growing need to look younger can be seen as a way for aging people to deal with "the stress of aging". A. A. Os'minina, T. L. Kryukova (2020) showed that natural age-related changes in appearance that accompany aging are a stress factor that actualize the intensity of resorting to various practices of care and transformation of appearance, including surgical interventions, in order to improve the appearance towards a more youthful age. A study conducted by O.V. Kurysheva and S.V. Tarasova (2014) showed that appearance and two other issues (health, general attitude to life) are the main aspects of people's experiences in old age.

Modern men started living much longer than 30 years ago, not to mention life expectancy of 100 or 200 years ago. P. Brückner writes about modern people aged 50 to 60 years: "these people wanted to retire, but they have to remain in service" (Brückner, 2021, p. 26); they "expect about another thirty years of active life, which corresponds to the entire life expectancy of a European three centuries ago" (Brückner, 2021, p. 40). These ten years, which P. Brückner ironically calls a "delay," due to the increase in the retirement age and the achievements of modern medicine, become a period of active social life for a person who is "no longer young," but also "not yet old." A study focusing on the attitude of adults aged 50-60 years to their appearance (Vorontsova, 2022a) shows that during this period of life, the importance and value of the appearance increases, indicating an increase in the maturity of the person's understanding of the investment power of appearance and its influence on career, personal life, well-being, etc. This fact enables us to assume that various parameters of attitude towards external appearance can determine the severity of the NLY.

Another possible reason for the increase in the NLY is the gap between the chronological and subjective age of mature and older people, as recorded in some works (Melekhin, 2018; Melekhin, Sergienko, 2015; Pavlova, Sergienko, 2019; Sergienko & Kireeva, 2015). Scientists have described the age-specific dynamics of the difference between subjective and chronological age, which is called the **"cognitive illusion of age"** (Sergienko & Kireeva, 2015). This illusion increases with age – the older they

become, the younger they feel. That is, in the process of aging, an individual faces the contradiction between his/her subjective perception of age (which corresponds to a younger age group) and the reactions/behaviors/attitudes of others, which are based on their perceptions of age (the age of this individual which is based on perceptions of his/her external appearance). This contradiction (like cognitive dissonance) will lead to the fact that the individual will either age internally (correlating his/her subjective age with attitudes/treatments/perceptions of others), or actively transform his/her external appearance in accordance with his/her self-perception of age.

Therefore, the realization of the NLY in modern people is a result of the influence of social factors (active aging concepts, gender- and age-related stereotypes) and personal factors that we consider to be subjective age (and its difference from chronological age), as well as individuals attitudes toward their own appearance (awareness of value, importance, desire for improvement, etc.), which together set the practice of transformation, design, appearance care, aimed at managing the impression of age, creating a younger "apparent" perceived age.

Research hypotheses

Analysis has enabled the formulation of a number of research hypotheses: 1) The NLY may depend on age and gender. 2) Adult NLY severity may be associated with age self-perception and attitude parameters. 3) Subjective age and parameters of an individual's attitude towards his/her own appearance may predict the NLY severity.

Purpose of the study

The purpose of the study is to identify the influence of gender- and age-specific and psychological factors (subjective age, attitude toward appearance) on the severity of the NLY in adults aged 21–75 years.

The subject of the study was the NLY (the difference between chronological and desired perceived age), subjective age, and the attitude of adults aged 21–75 toward their appearance.

The theoretical and methodological foundations of the study were (a) ideas about perceived age as a socio-psychological phenomenon associated with complex biopsychic and psychophysiological processes (Vorontsova, 2022a, 2022b; Shkurko & Labunskaya, 2018; Christensen et al., 2009; Ganel & Goodale, 2022; Uotinen, Rantanen & Suutama, 2005), (b) the psychology of social cognition (Andreeva, 2000; Bodalev, 2015), (c) the social psychology of external appearance by V. A. Labunskaya, understanding external appearance as a phenomenon that reflects "different stages of life based on dynamic, variable relationships of three components: 1) physical, 2) social appearance, 3) expressive behavior" (Labunskaya , Drozdova, p. 202); and (d) gender methodology (Semenova, Semenova, 2014; Grigor'eva, 2018; Kletsina, Ioffe, 2019; Kletsina, 2020).

Methods

Study sample

The study sample comprised of 637 individual participants aged 21–75 years (235 men, 402 women).

The study sample was divided into the following age subgroups (Elkonin, 1971):

1. "Youth" (21–34-year-olds, n = 114, 28 men, 86 women, mean age: 26.48 years);
2. "Maturity up to 50 years" (35–49-year-olds, n = 153, 52 men, 101 women, mean age: 42.35 years);
3. "Maturity after 50 years" (50–59-year-olds, n = 215, 90 men, 125 women, mean age: 53.93 years);
4. "Older age" (60–75-year-olds, n = 155, 65 men, 90 women, mean age: 64.93).

Each participant in the study signed an ethical agreement allowing the use of photographic images in scientific research.

Diagnostic tools

1. The Photo-Video Presentation of Appearance procedure (Shkurko, 2018) was used to determine the perceived age of the study participants. The procedure includes:

- photographing participants (portrait photo / full-length photo);
- exposing photographs to assess the age of subjects of perception;
- calculating perceived age (the arithmetic mean of all age estimates obtained);
- calculating the coefficient of the difference between chronological and perceived age, or the "years saved" indicator (Zimm, Modabber, Fernandes, Karimi, Adamson, 2013). The indicator can take negative (participants look older than their age) and positive (participants look younger than their age) values.

2. The Self-Assessment of Age questionnaire by T. A. Vorontsova (Labunskaya et al., 2019) was used to record chronological age (CA), subjective age (SA), self-assessment of perceived age (SPA), desired perceived age (DPA), ideas about other people's estimates of age (OEA), as well as expected lifespan (EL) (respondents were asked, "What age do you plan to live to?"). Next, the coefficients of discrepancy between chronological and other types of age were calculated, which reflect how old the study participants feel (CA-SA), think they appear (CA–SPA), want to appear (CA–DPA), report that other people perceive them to appear (CA–OEA) younger or older than their age. We interpret the indicator CA-DPA as the severity of NLY.

3. A set of diagnostic tools for assessing individuals' attitudes toward their own appearance by V. A. Labunskaya (Labunskaya & Serikov, 2018):

- The Attitude Towards Own Appearance: Satisfaction and Concern by V. A. Labunskaya, E. V. Kapitanova;
- The Value and Importance of Appearance in Various Spheres of Life questionnaire by V. A. Labunskaya;
- The questionnaire for the Evaluative and Informative Interpretation of Individual External Appearance in Various Spheres of Life by V. A. Labunskaya;
- The Appearance Perfectionism Scale by K. Srivastava.

Methods of mathematical statistics

Descriptive statistics, Student's t-test, Mann-Whitney U-test, Levene's test of equality of variances, Spearman correlation analysis, Kruskall-Wallis test, and multiple regression analysis.

Results

In the first phase of the study, descriptive statistics on the severity of the NLY (CA–DPA) were used in various gender- and age-specific subgroups (Table 1). For the overall sample, the CA–DPA parameter ranges from -7 to 55 years, M = 9.85, standard deviation = 7.67. Negative values (respondents want to look older than their age) of the CA–DPA parameter were found in only 5 participants (0.8%), zero values (respondents want to look at their age, which indicates that they do not have NLY) were found in 68 participants (10.7%). Positive values of the CA–DPA parameter, which indicates the presence of NLY, were found in 564 (88.5%) respondents.

Most respondents (88.5%) had a need to look younger than their chronological age.

Table 1
Descriptive statistics for the CV-LIV parameter in gender- and age-specific subgroups

Minimum	Maximum	Arithmetic Mean	Standard deviation
OVERALL SAMPLE (21-75 years, N = 637)			
-7	55	9.85	7.67
Men (N = 235)			
-7	55	10.08	9.41
Women (N = 402)			
-2	33	9.72	6.45
YOUTH (21-34 years, N = 114)			
-7	10	2.67	2.94
Men (N = 28)			
-7	5	0.57	2.52
Women (N = 86)			
-2	10	3.36	2.74

Minimum	Maximum	Arithmetic Mean	Standard deviation
MATURE UP TO 50 YEARS (25-49 years, N = 153)			
0	26	8.59	5.08
Men (N = 52)			
0	22	7.77	6.08
Women (N = 101)			
0	26	9.01	4.45
MATURE AFTER 50 YEARS (50-59 years, N = 215)			
0	35	11.77	6.73
Men (N = 90)			
0	35	10.90	7.25
Women (N = 125)			
0	33	12.39	6.29
OLDER AGE (60-75 years, N = 155)			
-1	55	13.68	9.42
Men (N = 65)			
-1	55	14.89	12.25
Women (N = 90)			
0	32	12.81	6.61

The arithmetic mean of the CA–DPA indicator increases with age, as well as its maximum value. Let us analyze the significance of the differences in the studied subgroups in terms of age and gender. The analysis of indicators of the NLY severity of representatives of different age groups according to Kruskall-Wallis test is presented in Table 2.

Table 2

Impact of the age-specific factor on the severity of NLY (CA–DPA parameter), Kruskall-Wallis test

Age group	CA–DPA Arithmetic Mean	Average rank by group	Criterion statistics
Youth	2.67	113.02	Chi-square = 201.058; p = 0.000
Maturity up to 50 years	8.59	298.28	
Maturity after 50 years	11.77	378.97	
Older age	13.68	404.38	

The results presented show the influence of the age-specific factor on the severity of the NLY: The NLY increases significantly with age. If at a young age, the difference between the desired age and the chronological age is only 2.67 years, then at the age of 'maturity before 50 years' it is already 8.59 years, at the age of 'maturity after 50 years' – 11.77 years, and at the old age – 13.68 years.

To identify the influence of the gender-specific factor, we used the Student's t-test to compare the CA-DPA parameter in male and female subsamples, first in the overall sample, and then separately in age-specific subgroups (Table 3). If the Levene's test of equality of variances showed the inappropriateness of using the Student's t-test, then we used the Mann-Whitney U test.

Table 3

Impact of the gender-specific factor on the severity of NLY (CA–DPA parameter), Student's t-test or Kruskall-Wallis test (in age-specific subgroups)

Age group	M men	M women	Criterion statistics
Overall sample	10.08	9.72	The Mann-Whitney U test was used: Group 1 average rank = 311.61; Group 2 average rank = 322.54; Z = -0.725 at p = 0.468
Youth	0.57	3.37	The Student's t-test was used: t = -4.767 at p = 0.000
Maturity up to 50 years	7.77	9.01	The Mann-Whitney U test was used: Group 1 average rank = 69.57; Group 2 average rank = 80.83; Z = -1.493 at p = 0.136
Maturity after 50 years	10.90	12.39	The Student's t-test was used: t = -1.609 at p = 0.109
Older age	14.89	12.81	The Mann-Whitney U test was used: Group 1 average rank = 79.28; Group 2 average rank = 77.08; Z = -0.302 at p = 0.763

As can be seen from Table 3, the influence of the gender-specific factor was found in the Youth subsample. Women are focused on a younger perceived age than men; they want to look younger than their age (on average by 3.4 years), compared to men who want to look younger on average by 0.6 years. Therefore, their desired perceived age is close to chronological. In the Maturity before 50 and Maturity after 50 subgroups; the arithmetic mean of the CA–DPA parameter is greater in women than in men. However, the difference is not significant. In the elderly, the CA–DPA parameter in men even exceeds the same parameter in women, but the difference is also not significant from in terms of mathematical statistics. Therefore, we cannot draw a conclusion about the

influence of the gender-specific factor on the severity of the NLY at the age of 35–75 years. Also, no significant gender-specific differences in this parameter were found in the overall study sample.

Spearman's correlation analysis was used to identify psychological correlates of the CA–DPA parameter. Table 4 presents significant correlations (at a 0.05 and 0.01 significance levels).

Table 4

*Correlation analysis of the NLY (CA–DPA) severity with the parameters of the respondents' self-assessments of their age and attitudes toward their own appearance (Spearman correlation coefficient / significance level; ** 0.01; * 0.05).*

Parameter	Correlation coefficient	Significance level
Difference between chronological age and subjective age (CA-SA)	0.521**	0.000
Difference between chronological age and self-assessment of perceived age (CA-SPA)	0.513**	0.000
Difference between chronological age and the assessment of perceived age (CA–OEA) according to the respondents	0.495**	0.000
Difference between chronological age and perceived age (CA–SPA, 'the saved years')	0.363**	0.000
Expected lifespan	0.139**	0.002
Appearance perfectionism	0.155**	0.000
Value, the importance of appearance for academic performance	0.164**	0.000
Value, the importance of appearance for career	0.099*	0.021
Value, the importance of appearance for lifestyle	0.123**	0.004
Assessment of the correspondence of appearance to age	-0.099*	0.013

The highest correlation coefficients of the CA–DPA parameter were found with other indicators of self-assessment of age (CA-SA, CA-SPA, CA-OEA), as well as with the real perceived age of respondents, measured using the Photo-Video Presentation of External Appearance procedure (CA-SPA). In other words, the participants in the study with a severe NLY (a) have a younger subjective age (CA–SA parameter), (b) believe that they are much younger than their age (CA-SPA parameter), (c) report that others consider them to be younger than their age (CA-OEA parameter), (d) actually appear younger than their age ('the saved years', CA-SPA parameter).

Connections were also found with the cognitive (importance of appearance for academic performance, career and lifestyle, assessment of the correspondence of appearance to age) and behavioral (appearance perfectionism) components of the respondents' attitudes towards their own appearance. The participants in the study with a severe NLY record that their appearance does not correspond to their age. Also of interest is the relationship that we discovered between the EL (expected lifespan) parameter and CA–DPA: The higher the expected life span parameter, the longer the life expectancy a person determines for himself/herself.

In the next stage of data processing, multiple regression analysis (stepwise method) was performed to identify psychological predictors of the NLY. Prior to the procedure, we conducted correlation analysis between possible predictors and excluded variables with a correlation above 0.5 (the existence of these variables reduces the value of regression analysis).

The final list of possible predictors was as follows:

- difference between chronological and subjective age;
- difference between chronological and perceived age;
- expected lifespan;
- economic status (was included in the final list of predictors, as it showed its influence on the variable being studied at the stage of preliminary calculations);
- satisfaction and concern with appearance;
- importance of appearance in communication;
- integral assessment of external appearance;
- severity of appearance perfectionism.

The results of multiple regression analysis are presented in Table 5.

Table 5

Multiple regression analysis (dependent variable: severity of NLY (CV-DPA); method: stepwise)

Model	B	Standard error	β	t	p
(Constant)	12.472	1.642		7.597	0.000
Difference between chronological age and subjective age (CA-SA)	0.357	0.040	0.368	8.885	0.000
Difference between chronological age and perceived age ('saved years')	0.252	0.065	0.160	3.873	0.000
Economic status	-1.685	0.475	-0.143	-3.550	0.000
Overall regression rates	**R = 0.445; R^2 = 0.198; F = 40.982; p = 0.000**				

The results of the regression analysis showed that **the main NLY predictors** are subjective age (β = 0.368), perceived age (β = 0.160) and economic status (β = –0.143), with the first 2 parameters increasing the need, and economic status decreasing it.

The determination coefficient was 19.8%, which indicates that other factors affecting this need, which is considered in this study to be a number of social factors, exist. The previous evidence showed that age-specific factors had an influence on the parameter studied, so we conducted a regression analysis (Table 6); the list of independent variables included CA-SA, CA-SPA and the age of the subjects.

Table 6
Multiple regression analysis (dependent variable: NLY severity (CV-NLY); method: stepwise)

Model	B	Standard error	β	t	p
(Constant)	-3.989	0.929		-4.294	0.000
Age	0.239	0.020	0.425	12.096	0.000
Difference between chronological age and subjective age (CA-SA)	0.247	0.033	0.262	7.467	0.000
Overall regression rates	**R = 0.579; R^2 = 0.335; F = 159.3902; p = 0.000**				

Analysis showed that the highest determination coefficient (33.5%) was obtained from a model in which the NLY predictor was the chronological age (β = 0.425) and subjective age (β = 0.262): The older the person, the pronounced discrepancy between subjective age and chronological age was, the greater the NLY realization.

Discussion

The study enabled the first hypothesis to be proven, i.e. the influence of the age-specific factor on the severity of the individuals' need to look younger than their age was determined. It has been found that the NLY increases with age. The empirical data confirmed the conclusions made in some papers (Buryakovskaya, 2015; Yurevich, 2018; Campos & Cheban, 2018; Shemet & Makovetskaya, 2021).

Effects of the gender-specific factor was found, but only in subgroups between 21 and 34 years of age; in other age groups, there are no significant differences between men and women: the NLY is relevant to both women and men. Given the stereotypes related to gender and age and the above-mentioned 'double standard about aging', we expected gender-specific factors to have a more serious impact (Berman, O'Nan & Floyd, 1981; Grigor'eva, 2018; Kletsina & Ioffe, 2019; Kletsina, 2020). To determine gender impacts, additional variables such as income levels, residence types (urban/rural), and marital status are likely to need to be introduced. Identification of such factors may provide opportunities for further research.

The second hypothesis of the study was confirmed. ***Psychological correlates of individuals' desire to look younger than their own age*** have been discovered, making it possible to clarify the psychological portrait of a person striving for a younger age. This is a person who (a) has a young subjective age and actually looks younger than his/her age (has a younger perceived age), (b) describes himself/herself as looking younger than his chronological age, (c) reports that other people tell him/her that he looks younger than his age, (d) has a high level of appearance perfectionism, (e) has a high value and importance of appearance (especially in the areas of academic performance, career, lifestyle), (f) has a low assessment of the correspondence of his/her appearance to his/her age (believes that his/her appearance does not correspond to his/her age), and (g) intends to live for a long time (has a longer expected lifespan).

The third hypothesis has been partially proven. We assumed that the NLY severity would be influenced by both individuals' self-assessments of age and attitudes towards their own appearance. Multiple regression analysis showed that the NLY predictors were chronological, subjective and perceived age, as well as economic status. We proposed two regression models: 1) The predictors of the need to look younger are subjective and perceived age, as well as economic status – the coefficient of determination of this model is 19.8%. (2) The predictors are chronological and subjective age – the coefficient of determination of the model is 33.5%.

The second model has the greatest prognostic value, in which ***subjective and chronological age are the NLY predictors.*** This enables us to understand the logic of the formation of a person's perceived age (the final point – how he/she looks in the eyes of others), starting with the starting point – his/her NLY. The older a person becomes and the younger he/she feels (in relation to his/her age), the more pronounced his/her NLY becomes. In accordance with fundamental ideas about social needs as the leading factor of social behavior (Andreeva, 2000; Zinchenko, Meshcheryakov, 2008; Bodalev, 2015), the NLY triggers a complex of interrelated forms of behavior and its cognitive-

emotional components, including attitudes towards own appearance, which leads to real rejuvenation of a person in others' eyes. The data obtained confirm the role of subjective age and individuals' attitudes towards their own appearance in life activity organization and in the choice of practices for caring for appearance (Melyokhin, 2018; Sergienko & Kireeva, 2015; Labunskaya, Serikov, 2018; Labunskaya, Serikov, Shkurko, 2019).

Thus, our study enabled us to record the NLY severity in various gender- and age-specific groups, as well as its socio-psychological correlations and predictors.

The study's ***prospects*** are to develop an empirical model to construct perceived age, based on generalization and systematization of all the factors that have been studied to date affecting perceived age. In this study, we have identified a part of this model: The location of the NLY was indicated and its predictor was identified.

Conclusions

In the sample of adults aged 21–75 years, the difference between the chronological age and the desired perceived age ranges from -7 to 55 years with an average of 10 years. The vast majority of respondents (88.5%) indicated the presence of the NLY – the need to look younger than their age.

The severity of the NLY increases significantly with age. In 'youth' (21–34 years), the difference between chronological age and desired age is six months; in 'maturity up to 50' (35–49 years) – 8 years; in 'maturity after 50' (50–59 years) – 11 years; in 'older age' (60–75 years) – 15 years.

The NLY is relevant both for women and for men. In the subgroup of young people aged 21 to 34, gender-specific differences have been found (the difference between chronological age and desired perceived age for women is greater than for men).

Psychological correlates of individuals' desire to look younger than their own age were discovered. These are (a) subjective age, (b) self-assessment of perceived age and perceptions of others' assessments of perceived age, (c) actual perceived age, (d) appearance perfectionism, (e) the importance of appearance (in the areas of academic performance/career/lifestyle), (f) assessment of the correspondence of appearance to age, and (g) expected lifespan.

Subjective age and chronological age are the NLY predictors. Individuals' attitudes towards their own appearance do not affect the severity of this need.

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Meaning-in-Life Orientations and Characteristics of Communication and Motivation of Students Studying at Gifted Education Centers

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Abstract

Introduction. This paper is the first to examine the psychological characteristics of students studying at gifted education centers of various types – basic and supplementary education. The aim of the study is to analyze the relationship between meaning-in-life orientations and academic motivation and communicative characteristics of students studying at gifted education centers and secondary schools. **Methods.** The study population comprised 280 students of the Specialized Educational Scientific Center of the Southern Federal District (SESC SFD) (n = 54), the Sirius Educational Center (n = 75) and secondary schools in Rostov-on-Don (n = 150) aged from 12 to 18 years (mean age = 15.3 years), of whom 157 were females and 123 were males. The psychological testing method was used. The diagnostic tools included the Meaning-in-Life Orientations test (MLO) by D. A. Leont'ev (Leont'ev, 2003), the test of the Structure of Schoolchildren's Educational Motivation by M. V. Matyukhina (Matyukhina, 1984), and the test of Self-Regulation and Success of Interpersonal Communication by V. N. Kunitsyna (Kunitsyna, Kazarinova, Pogol'sha, 2001). Data processing was performed using mathematical statistics using the R 4.1.3 programming language. **Results**. Compared to school students, 21% of whom have a high level of meaningfulness of life, students studying at gifted education centers, 40% of whom have a high level of meaningfulness of life, have higher rates of academic motivation. Significant differences were found in cognitive motivation, achievement motivation, motivation for self-development and a student's position in the groups of students with low and high rates of meaningfulness of life. Meaning-in-life orientations

were positively related to characteristics that facilitate communication and negatively related to characteristics that complicate communication. Studying in Sirius significantly increases the likelihood that students achieve a high level of success in life. **Discussion.** Compared to secondary school students, those studying at gifted education centers have a higher level of meaningfulness of life. Communication characteristics depend more on the level of meaningfulness of life than on the type of educational institution. Based on the research results, methodological recommendations were developed for teachers and psychologists who work at gifted education centers using the SESC and Sirius models.

Keywords

meaning-in-life orientations, communicative characteristics, academic motivation, regression analysis, gifted students, education centers, comprehensive schools

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Introduction

Talented and gifted people are a powerful resource for social development. Modern society needs creative, active, intelligent citizens who know their strengths and growth points, know what they want to learn and what they will do in the future. The existing system of school education process makes it difficult for teachers to meet the growing needs of such students.

Today, there are different approaches to teaching high ability children: acceleration, deepening, enrichment, and problematization of education (Yakovlev, Gafarova & Klimovich, 2015; Baccassino & Pinnelli, 2022; Smith, 2021). At the same time, it is the enrichment and problematization of education that is considered the most promising. They focus on changing the content of the curriculum towards broadening views, going beyond standard topics, and using original explanations of problems. Approaches to teaching high ability children are implemented in various forms of educational organization, among which collaborative learning stands out. *Collaborative learning*

is a system of comprehensive schools, in which special conditions are created for the differentiation of children's education and separate special classes. Moreover, *long-term training* is possible, which involves complete immersion in the educational environment at the stage of preparation for passing state exams in institutions attached to universities or specialized centers, so that students can more accurately choose their educational path. Short-term programs with a high level of preparation and in-depth study of subjects provided by institutions of additional education are also used (Shumakova, 2020; Lewis & Boswell, 2020; VanTassel-Baska, 2021).

Specialized centers for general and additional education of gifted children, operated independently and in universities, are becoming increasingly popular among teachers and parents (Shmeleva, 2018). As of February 20, 2024, 17.009 "Growth Point" educational centers for students of general education organizations in rural and small towns, 280 "Quantorium" technology parks for children (including 145 technical parks based on general education organizations), 261 "IT-cube" digital education centers, 30 key centers for additional education of children, 85 "Quantorium" mobile technology parks have been established and operate in Russia. In 76 constituent entities of the Russian Federation, regional centers are established to identify, support, and develop the talents and abilities of children and young people ("Mini-Sirius") ("Education" National Project, 2024). Among such centers, the most prominent are the Sirius Educational Center of the Talent and Success Foundation in Sochi (hereinafter referred to as Sirius), as well as the Specialized Educational and Scientific Centers (hereinafter referred to as SESC). In 2020, the SESC SFD was established in the Southern Federal District (SFD) at the Southern Federal University. Although schools actively introduce project and research activities aimed at developing students' research, presentation and evaluation skills, this is not enough to meet the interests of motivated students. In addition to improving cognitive abilities, it is also necessary to support life strategies, motivation, strengthening responsibility, communication skills, cooperation, critical thinking and error analysis.

Selection for supplementary and gifted education centers is based on an assessment of student portfolios and subject and psychological tests. Particular attention is paid to such a criterion for student selection as "...effective participation in All-Russian Olympiads and competitions, various kinds of regional and international competitions" (Shmeleva, 2018, p. 34). Olympiads and competitions enable students not only to fill their lives with academic activities, but also to participate in active extracurricular activities, and also to receive certificates that fill out their portfolio. On the other hand, it is difficult for students to define clearly the purpose of their participation when school conferences and competitions become common. As a rule, teachers can ask children to compete with students from other schools or regions to improve the status of the school. In this case, however, such events will be of little interest to students themselves. Motivation for high achievement may disappear, routine may contribute to a loss of the meaning of demonstrating extraordinary knowledge and abilities, and learning alienation may occur (Abakumova, Mironenkova & Pen'kov, 2019).

For modern gifted children and adolescents, in order to maintain and improve educational motivation, the usual warnings from teachers about lack of success in the future or low-paid work without education are no longer sufficient. They have already achieved a lot for their age, and now teachers need not only to stimulate interest in learning, but also to address their meaning-in-life orientations.

Meaning-in-life orientations represent an organized structure of meaningful views, life goals, assessments, and meaningful choices that reflect the individual's direction and ensure satisfaction and integrality of life activities (Leont'ev, 2003). Meaning-in-life orientations are an important indicator of the individual's values and orientation. This is a unique criterion for students with high educational needs, enabling them to come together in learning and knowledge acquisition.

The authors do not claim that respondents in this study are gifted. In this work, 'gifted' means students of the South Federal District Specialized Educational and Research Center and the Sirius Educational Center. These institutions are aimed at early identification, education and support for talented children and talented young people who have demonstrated exceptional abilities. These centers are created not only for professional training and advanced educational opportunities for children, but also for the formation of a global system for selecting and promoting the best psychological and educational solutions, technologies and practices that contribute to the achievement of this objective (Charter of Talent and Success Educational Foundation, 2021).

Research into the psychological, social, and emotional characteristics of secondary school students is a global trend in the field of maintaining and developing giftedness (Dikaya, Dikiy & Pokul', 2019). Psychologists and teachers study the relationship between high intellectual abilities and creativity and the psychological characteristics of adolescents.

Academic motivation, communication skills, and meaning-in-life orientations are predictive of academic success and future professional development. The meaning-in-life orientations of intellectually gifted students are considered to be a component of individual value-meaning sphere (Fedoseeva & Mineeva, 2020; Speshilova, 2011). The characteristics of talented students in the communication sphere (Grushetskaya & Shcherbinina, 2018) and academic motivation are studied as predictors of academic achievements (Abraamyan, 2019; Akovantseva, 2016; Makhina, 2018). Foreign researchers studied the motivational components of educational activities (Johnson, Irizarry, Nguyen & Maloney, 2018), considered the relationship of academic motivation with persistence and such concepts as 'grit', which has been studied as the diligence and perseverance of individuals in achieving goals or in defending views (Duckworth, Peterson, Matthews & Kelly, 2007; Steenbergen-Hu, Olszewski-Kubilius, & Calvert, 2020), with emotional intelligence (Casino-García, Llopis-Bueno & Llinares-Insa, 2021), with burnout among schoolchildren (Usán Supervía, Salavera Bordás & Murillo Lorente, 2020).

The high school age is considered sensitive to the formation of the individual's meaning-related sphere and meaning-in-life orientations. Many scientists regard this issue as both a relationship between student motivational structures and important life orientations (Alkanova, 2017; Martyushev, 2020; Paskar, 2021) and as a particular factor in academic motivation and value-meaning aspects of adolescents' lives (Klepach & Rubtsova, 2019; Badmaeva & Matyukhina, 2004).

Research on students with high educational needs shows that it is necessary to improve students' communication skills (Zinchenko, 2018). According to a study on student adaptation conducted at the Scientific Research Centre in the Southern Federal District, 20.6% of students reported difficulties in communicating with teachers (Zinchenko & Semina, 2020). Personal qualities that influence communication are important not only in relation to the collective structure of research activities, but also in relation to the high risks of problematizing this field.

The employees of the Foundation for Talent and Success used the Big Five and Dark Triad psychological methods to study students' socio-emotional characteristics at the Sirius Education Center (Likhanov et al., 2020). The authors state that students with weaker knowledge but high academic motivation and effort can be awarded higher grades than students with stronger knowledge but low motivation. In their research, scientists noted significant differences between students from Sirius and secondary schools on the scales of 'conscience', 'extraversion', 'openness', 'narcissism', 'general behavior', and also noted the influence of psychological characteristics on academic achievements, which determine the selection for educational centers.

Today, high academic motivation and the new form of organization of educational activities encourage not only established or aspiring scientists, but also university graduates and students, as well as high school and secondary students to conduct active research activities. In the course of their secondary education, students decide on their life plans for the near future both in general and in their professional career.

The aim of this study is therefore to investigate meaning-in-life orientations in relation to academic motivation and communication characteristics of students studying at gifted education centers.

Methods

Sample

The study population comprised 280 students of the Specialized Educational Research Center of the Southern Federal District (n = 54), Sirius Educational Center (n = 75), and secondary schools in Rostov-on-Don (n = 150) aged from 12 to 18 years (mean age = 15.3 years), of whom 56% were females and 44% were males.

Diagnostic tools

The empirical study used the method of psychological testing. We used the following diagnostic tools: (a) the Meaning-in-Life Orientations test (MLO) by D. A. Leont'ev (Leont'ev, 2003), (b) the test of the Structure of Schoolchildren's Educational Motivation by M. V. Matyukhina (Matyukhina, 1984), and (c) the test of Self-Regulation and Success of Interpersonal Communication (SSIC) by V. N. Kunitsyna (Kunitsyna, Kazarinova, Pogol'sha, 2001).

Data processing

Data processing was performed using mathematical statistics using the R 4.1.3 programming language and the integrated RStudio environment.

To test the normality of the sample, we performed the Shapiro-Wilk test and found that the sample of this study is not normal, $W = 0.97$, p-value ≤ 0.05. Therefore, non-parametric methods were used for further analysis. To identify the characteristics of gifted students, a comparative analysis was carried out using the Kruskal-Wallis test. To identify reliable relationships in the motivational, communicative characteristics and meaning-in-life orientations of schoolchildren, correlation analysis using the Spearman coefficient and logistic regression analysis were used.

Results

Table 1 presents the results of a descriptive analysis of the non-standard scale of the MLO test for three subgroups of respondents divided by educational institutions. The results of other diagnostic tools are presented in Annex 1.

Table 1

Descriptive statistics of respondents' life-meaning orientations and comparative analysis, Kruskal-Wallis test

Overall sample, n = 280								
Males, n = 123				Females, n = 157				
School SESC Sirius				n = 150 n = 55 n = 75				
MLO scales	Institution	N	Mean	Sd	Median	Min	Max	H
Meaningfulness	School	150	92.32	21.69	97	8	136	17.22**
	SESC	55	104.07	21.04	104	54	152	
	Sirius	75	102.84	18.66	103	48	134	

Overall sample, n = 280								
Males, n = 123				Females, n = 157				
School SESC Sirius				n = 150 n = 55 n = 75				
MLO scales	Institution	N	Mean	Sd	Median	Min	Max	H
Life goals	School	150	27.79	7.62	28.5	8	45	19.29**
	SESC	55	33.34	9.61	35	14	66	
	Sirius	75	31.01	6.66	31	15	42	
Life process	School	150	27.57	7.57	29	7	42	11.89**
	SESC	55	31.47	10.60	32	8	80	
	Sirius	75	30.43	7.39	32	8	42	
Efficacy	School	150	22.8	6.38	23	7	35	17.12**
	SESC	55	27.84	10.65	28	13	80	
	Sirius	75	25.77	5.98	25	9	35	
Internal locus of control	School	150	19.03	5.13	20	7	32	12.13**
	SESC	55	23.05	11.65	22	12	100	
	Sirius	75	20.88	4.19	22	10	28	
External locus of control	School	150	28.08	7.27	29	7	42	19.04**
	SESC	55	32.8	8.97	33	16	75	
	Sirius	75	31.65	6.42	32	14	41	

Note: p-value ≤ 0.001 ***; 0.01 **; 0.05 *; H is the coefficient of comparative analysis, the Kruskal-Wallis test.

Because psychological diagnostic tools were evaluated at different numerical intervals, data standardization was used to simplify scales.

Following comparison analysis, we showed that the MLO test's Meaningfulness of Life score was significantly higher among students from the SESC than among students from other educational institutions ($p \leq 0.01$) (Table 1).

A comparison of academic motivation showed significantly higher results in the Cognitive Motivation, Self-Development, Student's Position and Achievement Motivation scales for gifted students compared to other students. At the same time, the Sirius students had a significantly lower communication characteristic ($p \leq 0.01$) (see Annex 1, Table 1).

Among communication characteristics, there were no significant differences between student groups in terms of expression, influence, openness, empathy, aggression, sensitivity, manipulative and authoritarian communication styles ($p \leq 0.05$) (see Annex 1, Table 2). Therefore, these scales were excluded from further analysis.

The SESC students showed, on the one hand, significantly higher results in communication ease and communication skills, and, on the other hand, the lowest results on the Shyness and Lack of Communication scales ($p \leq 0.01$).

The Sirius students had low levels of self-respect and communication ease and high scores on the Feeling of Loneliness and Alienation scales ($p \leq 0.01$). Secondary school students had high results on the Communication Skills and Shyness scales ($p \leq 0.01$). Furthermore, the group's representatives have the lowest level of confidence in the statistical trend.

Since students from secondary schools showed significant low scores in the scales of meaning-in-life orientations, and the SESC students showed high scores (Table 1), for further analysis, participants were divided according to the level of meaningfulness of life, allowing to identify the influence of personal characteristics on the meaning-related constructs of the respondents. The general Meaningfulness of Life scale was converted into binary format according to the following rule: All values greater than the average of half the standard deviation are equal to 1, otherwise equal to 0. Therefore, we could compare about 70% of respondents with a low level of meaningfulness with 30% of respondents with a high level of meaningfulness (Table 2).

Table 2

Distribution of respondents depending on the level of life-meaning orientations and educational institution

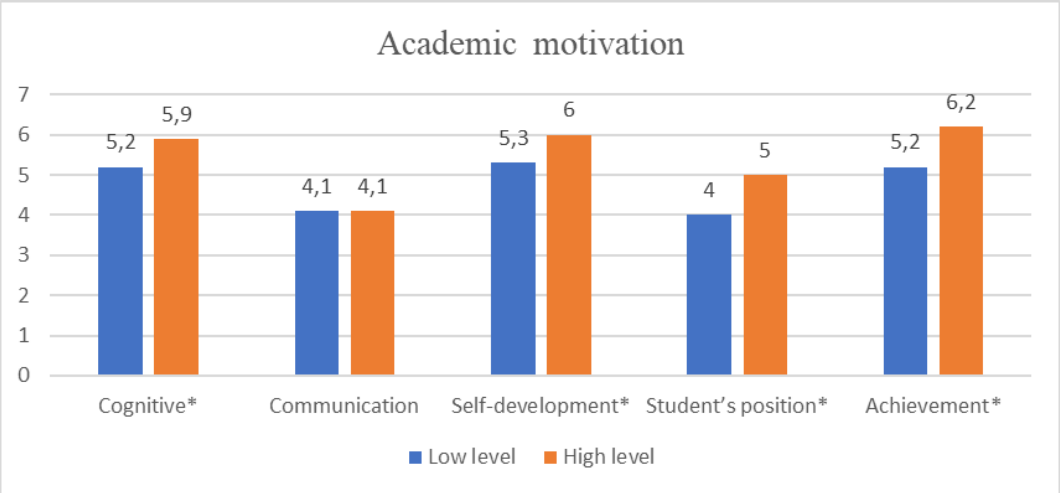
	School	SESC	Sirius	Overall sample
Low level of meaningfulness of life	79%	56%	63%	70%
High level of meaningfulness of life	21%	44%	37%	30%

Table 2 shows the distribution of the respondents from various educational institutions according to the meaning-in-life orientations levels in the above-mentioned ratio. However, when examined separately within each institution, it can be found that more than 30% of SESC students have a high level of meaning-in-life orientations. Furthermore, the groups of respondents were distributed almost equally in the Specialized Educational and Research Centre of the Southern Federal University. From this we can conclude that gifted students have greater motivational strength to seek themselves in life and strong self-control; they strive for greater expression of social desirability in relation to themselves.

As shown in Figure 1, representatives of the group with a high level of meaning-in-life orientations have higher scores of academic motivation, which promotes self-development, knowledge acquisition and new ways of solving problems. Comparison analysis showed statistical differences in cognitive motivation, motivation for self-development, student's position, and achievement motivation that were significantly higher among students with high scores in meaning-in-life orientations ($p \leq 0.05$).

Figure 1

Average scores of the academic motivation scales among the respondents with high and low integral parameters of Meaningfulness of Life, MLO test



Note: ** The statistical significance of differences is noted ($p \leq 0.05$).*

When comparing the communication characteristics of respondents, we found a different pattern. Students with high levels of meaning-in-life orientations demonstrated higher scores in communication facilitating characteristics, while groups with low levels of meaning-in-life orientations had higher scores in characteristics preventing social contacts (Table 3).

Table 3

Average values of the SSIC scales for students with different meaning-in-life orientations levels

SSIC scales	High level meaning-in-life orientations	Low level meaning-in-life orientations
Ease*	7.0	8.1
Skills *	7.2	8.1
Self-respect*	5.8	6.5
Lack of communication*	5.9	5.0
Alienation*	5.7	4.8
Shyness*	5.7	4.5
Loneliness*	5.5	4.4
Confidence*	6.8	7.8

Note: ** The statistical significance of differences is noted ($p \leq 0.05$).*

Next, to identify the relationships of meaning-in-life orientations with academic motivation and communicative characteristics of students, a correlation analysis using the Spearman correlation coefficient was performed between groups of students from SESC and secondary schools, as well as between students with high and low levels of meaning-in-life orientations (Table 4).

Table 4

Spearman correlation analysis of the MLO integral parameter with academic motivation for different groups

Academic motivation	SESC	Secondary school	High level of meaningfulness of life	Low level of meaningfulness of life
Cognitive	0.17*	0.2	0.08*	0.15
Communication	0.16	-0.05	0.11	0.01
Emotional	-0.04	-0.02	0.01	0.05
Self-development	0.12	0.19*	0	0.18*
Student's position	0.3*	0.1	0.08	0.13
Achievement	0.26*	0.23*	0	0.26*
External motivation	0.02	-0.08	-0.16	0.05

***Note:** * p-value ≤ 0.05*

The analysis results (Table 4) showed statistically significant correlations between academic motivation and meaningfulness of life ($r = 0.17$; $p \leq 0.05$), as well as meaningfulness of life and the student's position ($r = 0.3$; $p \leq 0.05$) and achievement motivation ($r = 0.26$; $p \leq 0.05$) in the group of students from gifted education centers. At the same time, we found a correlation with the 'self-development' scale in the group of students with a low 'meaningfulness of life' score ($r = 0.26$; $p \leq 0.05$) and from secondary schools ($r = 0.23$; $p \leq 0.05$).

Therefore, for students studying at gifted education centers, most of whom have a high level of meaning-in-life orientations, the priority during training is to acquire new knowledge, to understand the main principles and ideas of the area of interest. They can independently regulate their learning activities and formulate the results they want to achieve. On the other hand, students with a low level of meaning-in-life orientations enjoy the learning process more and have the goal of developing creativity and finding nontrivial solutions to problems.

Among all groups, there is a tendency to maintain negative relationships between meaning-in-life orientations and characteristics that impede communication and positive relationships with facilitative characteristics, regardless of the level of meaning-in-life orientations and educational institutions (Table 5), which is confirmed by comparison analysis data. In addition, students studying at gifted education centers showed the strongest correlations among all respondents, while students with a low level of meaning-in-life orientations showed a weaker relationship between meaningfulness of life and communication characteristics.

Table 5

Spearman's correlation analysis of the MLO Meaningfulness of Life integral parameter and the SSIC scales

Meaningfulness	SESC	Secondary school	High level of meaningfulness of life	Low level of meaningfulness of life
Ease	0.35*	0.16*	0.26*	0.19*
Communication skills	0.36*	0.2*	0.31*	0.22*
Self-respect	0.31*	0.17*	0.23*	0.17*
Lack of communication	-0.26*	-0.26*	-0.36*	-0.17*
Alienation	-0.36*	-0.17*	-0.24*	-0.18*
Shyness	-0.33*	-0.18*	-0.26*	-0.13
Confidence	0.29*	0.19*	0.18	0.17*
Loneliness	-0.39*	-0.29*	-0.29*	-0.28*

Note: * p-value ≤ 0.05.

At the next stage, using multiple regression analysis we calculated the probability of changes in students' meaning-in-life orientations depending on their academic motivation and communicative characteristics. Since the correlation analysis showed a significantly positive relationship between meaning-in-life orientations and achievement motivation, responsible for achieving goals or obtaining results, in the first logistic regression model the dependent variable was a binary indicator of life performance. Results above 0.5 standard deviations were interpreted as 1 (high), otherwise - 0 (low). The characteristics

of communication and the type of educational institution were considered independent variables. The control variables were the gender and age of the respondents. The results of the model are shown in Table 6, and the marginal effect is shown in Figure 2.

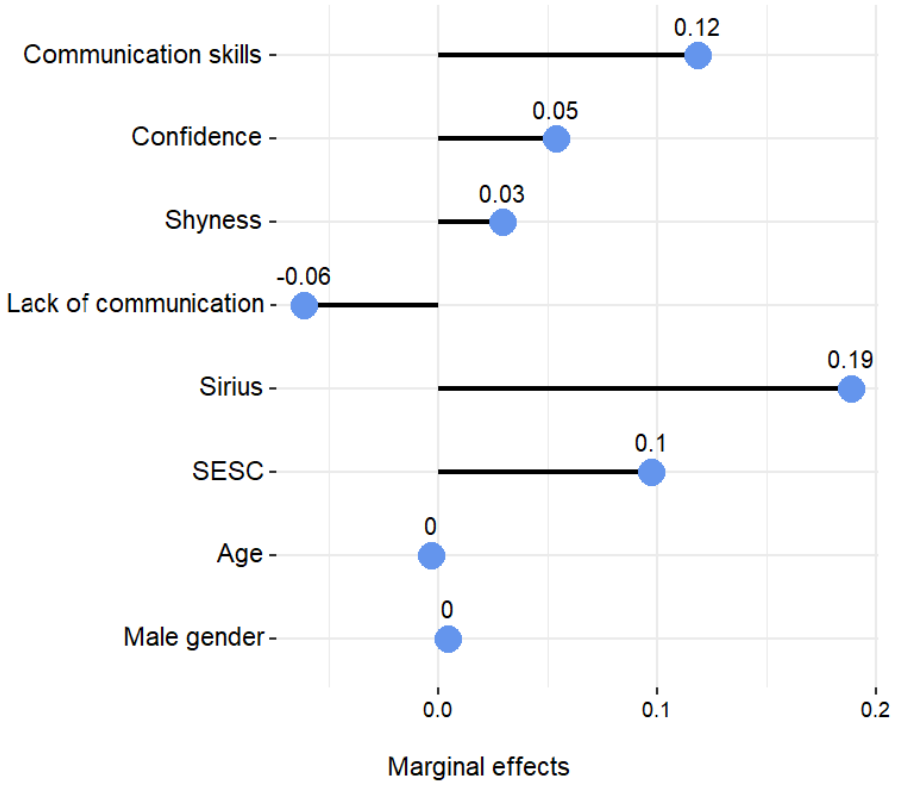
Table 6

Results of logistic regression of the impact of communication characteristics on students' self-efficacy in various educational institutions

Scales	Efficacy	Marginal effect
Communication skills	0.65 (0.18) ***	0.12
Confidence	0.29 (0.16) •	0.05
Shyness	0.16 (0.18)	0.03
Lack of communication	-0.34 (0.17) *	-0.06
Sirius	0.98 (0.33) **	0.19
SESC	0.54 (0.38)	0.1
Age	-0.02 (0.1)	0
Male gender	0.02 (0.3)	0
Intercept	-1.05 (1.62)	-
Pseudo R^2	0.13	
N	280	

Note: *p-value ≤ 0.0001 ***; 0.001**; 0.01 *; 0.05 • Reference group for educational institution – secondary school; reference group for gender – female.*

Figure 2
Marginal effects of predictors influencing a high level of life efficacy



The results of the model showed that students with strong communication skills are 12% more likely to be in a group with high life efficacy. Confidence increases the likelihood of a high life efficacy by up to 5%, while Uncommunicativeness reduces this probability by up to 6%. Shyness did not show the required statistical significance. The Sirius students (up to 19% reliably) and the SESC students (up to 10% at the level of a statistical trend) are more likely to be in a group with a high score in the Life Efficacy scale, compared to secondary school students. The factors of gender and age showed a slightly small marginal effect.

In the second logistic regression model, the Meaningfulness of Life variable was used as Y. The Student's Position, Cognitive Motivation, Self-Respect, Feeling of Loneliness and educational institution were taken as independent X. The gender and age of the respondents were also taken as control variables. The results of the model are shown in Table 7; the marginal effects are illustrated in Figure 3.

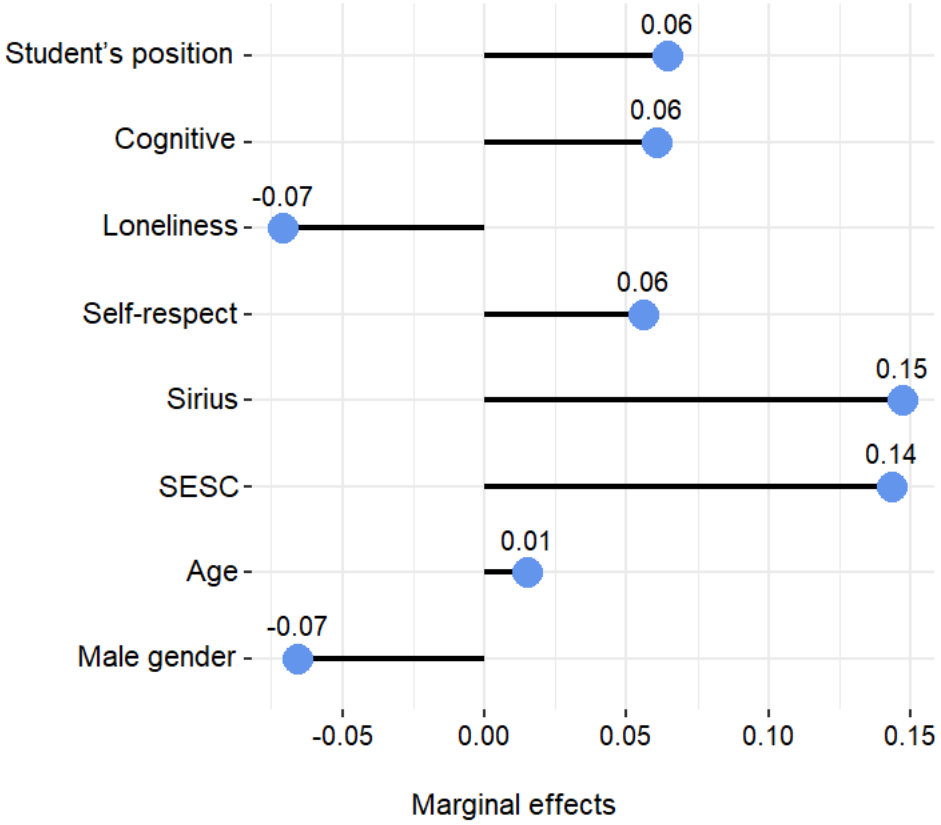
Table 7

Logistic regression of the impact of academic motivation and communicative characteristics on the meaningfulness of life of students in various educational institutions

Scales	Meaningfulness of life	Marginal effect
Student's position	0.36 (0.15) *	0.06
Cognitive motivation	0.33 (0.15) *	0.06
Loneliness	-0.39 (0.15) *	-0.07
Self-respect	0.31 (0.15) *	0.06
Sirius	0.79 (0.34) *	0.15
SESC	0.77 (0.38) *	0.14
Age	0.08 (0.1)	0.01
Male gender	-0.37 (0.3)	-0.07
Intercept	-2.47 (1.58)	-
Pseudo R2	0.12	
N	280	

Note: *p-value ≤ 0.0001 ***; 0.001 **; 0.01 *; 0.05 • Reference group for educational institution – secondary school; reference group for gender – female.*

Figure 3
Marginal effects of predictors influencing a high level of the Meaningfulness of Life integral parameter, MLO



Regression analysis showed that the Student's Position and Cognitive Motivation can increase the likelihood of a high level of meaningfulness in life by up to 6%. At the same time, Self-Respect, when increased by one standard deviation, can significantly increase the Meaningfulness of Life integral parameter up to 6%. The feeling of loneliness can reliably reduce the Meaningfulness of Life integral indicator by up to 7%.

An interesting result is the statistically significant effect of training in a specialized center on high levels of meaning-in-life orientations. Compared to secondary school students, the SESC students have up to 14% and the Sirius students have up to 15% higher meaningfulness of life.

Discussion

Respondents studying at the Sirius Educational Center and secondary schools have a significantly lower level of meaningfulness of life than the SESC students. This may be

due to the fact that the SESC conducts a multi-stage selection of students, and students consciously choose an educational institution with strict admission criteria and a more intensive educational program. Accordingly, they better understand and are able to distribute available resources and opportunities, demonstrate more conscious behavior, which is confirmed by the results of a study by A. A. Rodina and N. G. Abrahamyan devoted to the connection between meaning-in-life orientations and academic performance (Rodina & Abrahamyan, 2019). This assumption is also consistent with the data we obtained for the Life Goals and Efficacy scales, MLO test by D. A. Leont'ev. T. E. Fedoseeva and E. D. Mineeva also found that the results of the activity (89%) were more important for gifted students than its process (77%). Gifted students limit their social circle, focus on internal sensations, count only on their own abilities, and determine successes and failures exclusively by internal factors (Fedoseeva & Mineeva, 2020).

When comparing groups with low and high integral parameters of meaningfulness of life, significant differences were found in cognitive motivation, motivation for self-development, achievement motivation, and the student's position ($p \leq .005$), which is also confirmed by correlation analysis. The results showed that students studying gifted education centers, 40% of whom have high scores in meaningfulness of life, also have higher rates of academic motivation, compared to schoolchildren, only 21% of whom have high scores of meaning-in-life orientations. At the same time, among the SESC students, we found relationships of achievement motivation and the student's position with meaningfulness of life. Similar results were obtained by T. A. Dvoretskaya and L. R. Akhmadieva, "the internal motive of success as a result of individual activities is associated with the scale of the life process and life efficacy" (Dvoretskaya & Akhmadieva, 2018, p. 173).

On the other hand, a relationship between self-development and achievement was revealed among schoolchildren and students with a low level of meaning-in-life orientations. Perhaps these students strive for learning and self-development, but the focus of their efforts is aimed at solving specific here-and-now problems, which does not affect their meaning-in-life orientations.

Correlation analysis showed significant positive relationships between meaning-in-life orientations and characteristics that facilitate communication, such as self-respect, and negative relationships with characteristics that hinder communication, such as Lack of Communication, Shyness, and Feeling of Loneliness ($p \leq 0.05$). We should note that among students studying at gifted education centers and among students with a high level of meaning-in-life orientations, the relationships are more pronounced than among representatives of other groups. The comparative analysis also showed that respondents with a high level of meaning-in-life orientations had significantly ($p \leq 0.05$) higher scores in communicative characteristics that facilitate communication, while, on the contrary, the group with a low level of meaning-in-life orientations had higher scores in communicative characteristics that hinder communication. Thus, communicative characteristics depend on the level of meaningfulness of life, but do not depend on the type of the educational institution.

To test the hypothesis that educational institutions have an impact on the level of meaningfulness of life, several regression analyses have been carried out.

The first model showed that studying in the Sirius Educational Center significantly increased the probability that the student would achieve a high level of success in life. At the Sirius, training is structured around an intensive, accelerated learning schedule that includes daily master classes, advanced classes, and experiments. Students discover new opportunities for developing their talents through meetings with scientists and specialists in narrow fields, consultations with highly qualified teachers, as well as working on their own projects, intellectual products and creative works. N. B. Shumakova notes that such acceleration and enrichment of the educational program confirms the positive effect on academic motivation and academic success, and the development of students' social intelligence (Shumakova, 2020).

Over a short time of education, young researchers cover new areas of personal development previously unavailable in order to continue to work in their schools in a new way and continue to promote their efforts at competitions and conferences. The strict selection of students enables the formation of classes/teams with an optimal psychological environment where talented students develop their talents among equally strong students who have research interests in a similar field of science. Therefore, support for academic motivation in learning processes is confirmed by the data obtained from the second regression model: Achievement motivation and the student's position are statistically higher among the Sirius and SESC students than among secondary school students.

Conclusion

This article analyzes various aspects of teaching children with high educational needs, taking into account their meaning-in-life orientations, academic motivation, and communicative characteristics.

Compared to secondary school students, those studying at gifted education centers have a higher level of meaningfulness of life. In turn, academic motivation is significantly higher among students with a high Meaningfulness of Life integral parameter, MLO. Students have formed a better idea of their strengths and possible growth points, and are prepared to undergo a multi-stage selection. In contrast to secondary schools, such centers offer 'enriched education' which includes additional extracurricular disciplines in the educational program, stimulating children's research interests, promoting the development of motivation, intellectual abilities and creativity.

Communication characteristics are largely dependent on the level of meaning-in-life orientations than on the educational institution in which the respondent studies. Consequently, when implementing an educational program in gifted education centers, the use of project-based and asynchronous learning technologies, massive open online courses, accelerated learning instruments (intensives), foresight sessions and

brainstorming, as well as an effective combination of summer programs, make it possible to best stimulate social-emotional, creative and intellectual development of students.

Methodological recommendations for teachers and educational psychologists

The findings of the study provided the basis for methodological recommendations for teachers and educational psychologists working in gifted education centers such as SESC and Sirius. The following are the main ideas for the recommendations we have developed.

- First, psychologists and program staff should acquaint students with the program of psychological and pedagogical support. This promotes rapid psychological adaptation, helps recognize a trusting relationship and enables children to understand that they can be supported in selecting an individual learning path, assists in socialization and career guidance, and facilitates interactions with the teaching staff and management of the institution.
- To prevent conflicts and feelings of isolation, it is necessary to include in the educational process group training projects, master classes, foresight sessions, and seminars where students are also speakers.
- We should not forget the encouragement and motivation for self-development. It is important to invite students to find solutions independently, to guide their desire to seek answers to questions about unknown and discovered phenomena, and to reveal the creative ways of understanding the world.
- To develop cognitive motivation and strengthen self-confidence, it is necessary to use reversal and problem-based learning methods, project-based and interactive technologies to best demonstrate children's extraordinary abilities.

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Annex 1

Descriptive statistics for the scales of the test of the Structure of Schoolchildren's Educational Motivation and the test of Self-Regulation and Success of Interpersonal Communication

Table 1

Descriptive statistics, Structure of Schoolchildren's Educational Motivation

Academic motivation scales	Institution	N	Mean	Sd	Median	Min	Max	H
Cognitive	School	149	5.03	1.69	5	1	9	14.13**
	SESC	55	5.8	1.61	6	2	9	
	Sirius	75	5.84	1.58	6	3	9	
Communication	School	150	4.27	1.81	4	0	9	14.78**
	SESC	55	4.58	1.90	5	1	9	
	Sirius	75	3.37	1.79	3	0	7	
Emotional	School	150	4.33	1.99	4.5	0	9	3.38
	SESC	55	4.89	2.14	5	0	9	
	Sirius	75	4.28	1.75	5	1	9	
Self-development	School	150	5.11	1.81	5	0	9	15.40**
	SESC	55	6.04	1.71	6	1	9	
	Sirius	75	5.89	1.93	6	1	9	
Student's position	School	150	3.94	2.15	4	0	9	10.79**
	SESC	55	5.16	2.5	6	0	9	
	Sirius	75	4.36	2.51	4	0	9	
Achievement	School	150	4.9	2.24	5	0	9	21.79**
	SESC	55	6.4	1.94	7	2	9	
	Sirius	75	5.95	2.31	6	0	9	
External motivation	School	150	4.39	1.98	5	0	9	3.74
	SESC	55	4.71	2.08	4	1	9	
	Sirius	75	3.92	2.02	4	0	9	

Note: p-value ≤ 0.001 ***; 0.01 **; 0.05 *. *H is the coefficient of comparative analysis, the Kruskal-Wallis test.*

Table 2

Descriptive statistics, Self-Regulation and Success of Interpersonal Communication

Communication characteristics scales	Institution	N	Mean	Sd	Median	Min	Max	H
Ease	School	150	7.19	2.79	7	1	14	19.76**
	SESC	55	8.80	3.08	10	0	12	
	Sirius	75	6.45	3.12	6	0	12	
Communication skills	School	150	7.29	2.18	7.5	2	14	9.27**
	SESC	55	8.35	2.20	8	3	12	
	Sirius	75	7.32	2.40	7	2	12	
Self-respect	School	150	6.03	1.88	6	2	12	6.24**
	SESC	55	6.58	1.84	8	2	11	
	Sirius	75	5.67	2.44	6	1	11	
Lack of communication	School	150	5.75	2.04	6	1	13	8.39**
	SESC	55	4.85	2.24	5	1	10	
	Sirius	75	5.95	2.16	6	1	10	
Alienation	School	150	5.40	2.42	5	1	12	14.11**
	SESC	55	4.44	2.42	7	0	11	
	Sirius	75	6.13	2.46	6	1	11	
Shyness	School	150	5.53	2.47	6	0	12	8.89**
	SESC	55	4.40	2.64	5	0	11	
	Sirius	75	5.57	2.86	5	0	12	
Loneliness	School	150	5.25	2.50	5	0	12	8.03**
	SESC	55	4.35	2.60	4	0	10	
	Sirius	75	5.67	2.86	6	0	10	
Confidence	School	150	6.93	2.32	7	2	12	2.06
	SESC	55	7.56	2.46	7	2	12	
	Sirius	75	7.19	2.45	7	2	12	

Note: p-value ≤ 0.001 ***; 0.01 **; 0.05 *. *H is the coefficient of comparative analysis, the Kruskal-Wallis test.*

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Author Contribution

Liudmila Aleksandrovna Dikaya developed the main concept and methodology of the study, selected diagnostic tools, prepared the plan and edited the text of the manuscript, worked with foreign sources, and wrote the Abstract and Keywords.

Viktoriya Sergeevna Ryzhova overviewed relevant Russian studies, performed data processing using the R 4.1.3 software, interpreted the results, formulated conclusions, developed methodological recommendations.

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Psychological Barriers to Inclusive Interaction as a Risk Factor for the Safety of the Educational Environment for Students

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Annotation

Introduction. The risks of an inclusive educational environment are associated with the emergence of psychological barriers to the interaction of its subjects. In this study, we provided the results of cluster analysis characterizing the psychological barriers to interaction between students and teachers. **Methods.** The total number of subjects is 192 people (128 children aged 8–10 years (primary school students - both with disabilities and limited health, and ordinary children from educational organizations in Stavropol); 64 teachers of educational organizations (schools)). As the main method we used J. Kelly's method of repertory lattices. Factor, cluster and correlation analysis were used to process the obtained data. **Results**. As a result of the study, the presence and essence of psychological barriers to interaction in dyads of subjects of the inclusive educational process were revealed: teachers-children, children-children. The qualitative characteristics of psychological barriers in these dyads are shown in the context of the types of barriers we have identified: communicative, activity and personal. In the teacher-children dyad, all types of barriers were identified, the sources of which are the teachers themselves. In the child-child dyad, communication and activity barriers predominate. The degree of severity of psychological barriers to interaction among teachers is concentrated in the range from excessive to average, and in the sample of children from above average to low. **Discussion.** The results obtained were considered as risk factors for the safety of the educational environment. For subjects of the inclusive educational process, the presence

of psychological barriers leads to risks that hinder the success of educational outcomes and social integration.

Keywords

security risk factors, inclusive educational process, subjects of the inclusive educational process, psychological barriers to interaction

For citation

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Introduction

Psychological safety of the educational environment is one of the most important conditions for ensuring a high-quality educational process and the harmonious formation of students' personality (Andreeva, 2008).

Ensuring psychological safety during the interaction of subjects of the educational process makes it possible to reduce the number of stressful situations in teaching practice (Schouwenburg, 2004). Topical issues include modeling and designing a safe inclusive educational environment in which the individual is in demand and functions freely, and its subjects feel protected and have their basic needs (Baeva, 2017).

Scientific analysis of risks as a subject of psychological and pedagogical research identifies certain types of risks that exist in social reality, including in the educational environment, and tools for managing them from the point of view of prevention and overcoming (Koroleva, 2016).

The educational environment in modern educational organizations is inclusive. Inclusion is the process of including students with special educational needs in the general educational process (Egorova, 2022). The category of students with special educational needs includes: gifted children, migrant children, children with disabilities and disabilities (Laktionova, 2019). It is students with disabilities and disabilities who are more often objects of risk in the educational environment due to the fact that previously they studied only in special (correctional) educational organizations (Vincent-Lancrin, Urgel, Jacotin & Kar, 2019). The stereotype of the benefits of differentiated learning continues to exist among normative people (Kunitsyna, 2001).

Risks to the safety of the educational environment arise in the process of interaction between subjects of the educational process (Baeva & Tarasov, 2017). Inclusive interaction

in the context of our study is situationally determined personal contact between teachers and students with disabilities (Fishman, Dede & Means, 2017). Properly organized inclusive interaction in the educational process contributes to the development of non-linear thinking, creative problem-solving skills, and awareness of the resource aspects of personality by both categories of participants (Slusareva, 2019).

However, practice shows that inclusive interaction is a source of psychological barriers that have a negative impact on its quality characteristics (Maclellan, 2005; Kerr, 2015). Psychological barriers are a significant factor in violating the safety of an inclusive educational environment, primarily for students (Pisarev & Pisareva, 2009). As examples, we can identify the negative professional attitudes of teachers who do not want to teach children with disabilities and disabilities in the general class, explaining this by the negative impact on the quality of the educational process for normative students and the formation of negative stereotypes regarding students with disabilities and disabilities in the children's environment under the influence of attitudes of adults (Belinskaya 2003; Matuyshkin, 2009).

We have identified three groups of psychological barriers to interaction, which are typical in the interaction of subjects of the inclusive educational process.

Communication barriers are problems in the exchange of information between subjects of the educational process. Teachers experience difficulties in taking into account the peculiarities of students' perception of educational information (visually, auditorily, practically), children find it difficult to understand each other, show impatience and irritation in the communication process (Kondrashova, Mayorova & Kolesova, 2022).

Activity barriers characterize difficulties associated with pedagogical and collaborative activities. (Hansen, Cottle, Negrine & Newbold, 2005). Difficulties are associated with the level and nature of teachers' possession of inclusive competence, i.e. the ability to take into account the special educational needs of students when preparing and transmitting the subject content of the educational process, and in a children's environment - a willingness to cooperate and accept human diversity (Kochneva, 2018)

Personal barriers are complexes of values and attitudes that are negatively oriented towards interaction partners. They are manifestations of social stereotypes regarding disability (Noss & Kovaleva, 2019)

Thus, psychological barriers to inclusive interaction are specific psychological states of subjects of the educational process in relation to students with disabilities and disabilities, which impede the implementation of quality education and joint activities, the personal and social development of students and contribute to the emotional burnout of teachers (Filak & Sheldon, 2013) which, in turn, violates the safety of the educational process. **The purpose of the study** is to identify the essence of psychological barriers to interaction between teachers and students in the inclusive educational process by analyzing the personal constructs that determine their occurrence.

Methods

Sample

The following groups of subjects from educational organizations in Stavropol took part in the study (total number – 192 people):

- students of inclusive classes of primary school age (8–10 years old) with normotypical development in the amount of 112 people and with motor impairments and hearing impairments in the amount of 16 people;
- teachers of general education organizations in the amount of 64 people.

Research methods

We used J. Kelly's repertory grid technique. The technique allows you to update stable ideas, expectations and strategies of people's behavior in relation to certain objects, objects and phenomena of the surrounding world, which can be expressed in acceptance and constructive interaction or, conversely, non-acceptance (rejection) and destructive interaction (Taratuhina & Ionceva, 1997).

In our study, the repertory grid method was used to obtain information about the personal constructs of teachers and children in relation to the inclusive educational process for students with disabilities and disabilities functioning in various roles. Objects (roles) were developed in advance and assigned to respondents, and personal constructs were evoked using the triad method (Schoenenberg, Raake & Koeppe, 2014). Next, respondents were asked to rank the degree of expression of certain constructs on a scale from 1 to 7, where 7 is the most pronounced emergent (construct-similar) pole, and 1 is the most pronounced opposite pole. For children, the digital scale has been replaced by a color scale (Minor & Tierney, 2005).

To examine a sample of children, we selected the following role repertoire: "I am a student", "my friend", "a blind person", "a deaf person", "a person who cannot walk", "a good student", "a bad student", "my mother", "mother of a disabled child". To survey a sample of teachers, the following role repertoire was selected: "I am a teacher", "child (student) is disabled", "good student", "bad student", "disabled", "successful (known) disabled", "authoritative person (teacher, colleague)", "non-authoritative person (teacher, colleague)", "teacher who works with children with disabilities", "my supervisor (director, methodologist, head teacher)", "parent of a disabled child" (Jaasma & Koper, 1999).

Based on the role list, each respondent filled out a repertoire test form using the following algorithm: comparing three people from their own environment, identifying two people who are more similar to each other based on some characteristic that distinguishes them from a third person. Next, the construct developed in this way is entered into the answer form, after which an assessment occurs by assigning it to one of the poles of the construct. As a result, a matrix is formed, which is subject to

further processing. We used hierarchical cluster analysis as the main method of scientific search. To construct tree diagrams (dendrograms), we used the methods of single linkage (the "nearest neighbors" method) and complete linkage (the "distant neighbors" method), because clustered objects (variables) are not homogeneous in their indicators. Statistical calculations were carried out using computer processing of the results using the STARTSOFT STATISTICA 6.1 program.

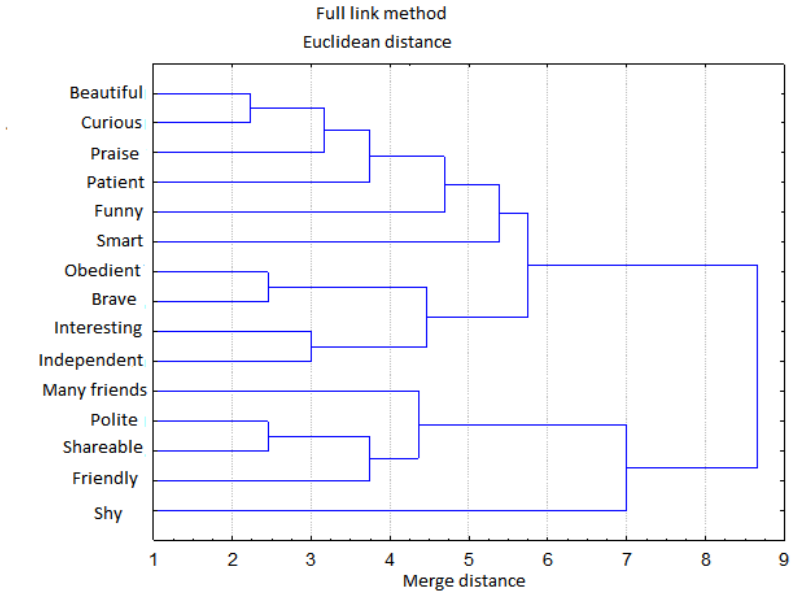
Results

When processing the results of the sample of children, 15 personal constructs were used.

Hierarchical cluster analysis of children's personal constructs

The results of the cluster analysis of children's personal constructs are presented in the form of a dendrogram in the figure 1.

Figure 1
Dendrogram of children's personal constructs (15 variables)

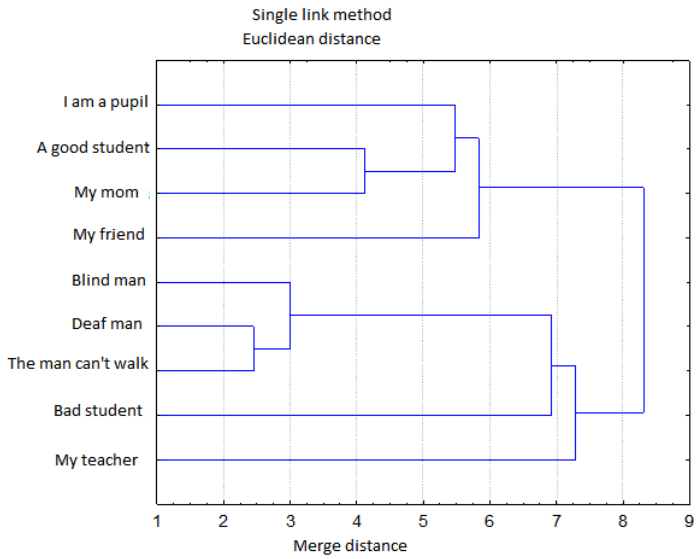


According to the results of hierarchical cluster analysis, exactly three clusters were identified, characterizing the personal, communicative and activity spheres. This suggests that children's personal constructs are simple, less differentiated, and therefore more amenable to change, which in turn confirms the process of formation of individual self-awareness.

The first cluster combined constructs characterizing personality traits. This cluster includes the construct "beautiful – scary (unpleasant)", relating to appearance. In the sample of children, an external feature that was important to them was identified. So, the key here has become the construct of "adults praise – scold" the child, as well as such constructs as "inquisitive – indifferent", "patient – touchy", "cheerful – sad", "smart (a good student) – stupid (failing student)." Consequently, the system of evaluating others in children of primary school age is formed by adults (teachers, parents). It should be noted that the role of the teacher is higher, because Grades at this age are based on success in educational activities. The second cluster includes characteristics of activity: "obedient – spoiled (harmful)", "brave – cowardly", "interesting – boring", "independent – dependent".

The third cluster includes characteristics of the communicative sphere and communication: "many friends – no friends", "polite – rude (impudent)", "sharing – greedy", "friendly – intrusive", "shy – arrogant". We also subjected the objects of children's personal constructs to cluster analysis. The results are presented as a dendrogram in Figure 2.

Figure 2
Dendrogram of role repertoires (objects) of children (9 observations)



This analysis identified 2 clusters and 2 monoclusters.

The first cluster combined the roles: "I am a student", "a good student", "my mother", "my friend". We can say that the child evaluates himself unambiguously positively in close connection with significant subjects who also have subjective positive evaluations. The second cluster concentrated the roles of people with disabilities: "blind person", "deaf person", "person who cannot walk". This suggests that children slightly differentiate the characteristics of people with disabilities and disabilities, because, perhaps, they have

little experience interacting with them. The important thing is that these roles are neutral. We can say that children have not yet developed a stereotype of disability as a negative phenomenon. The "bad student" monocluster and the "my teacher" monocluster emphasize the significant role of the teacher in shaping children's assessments of the world around them.

Qualitative analysis

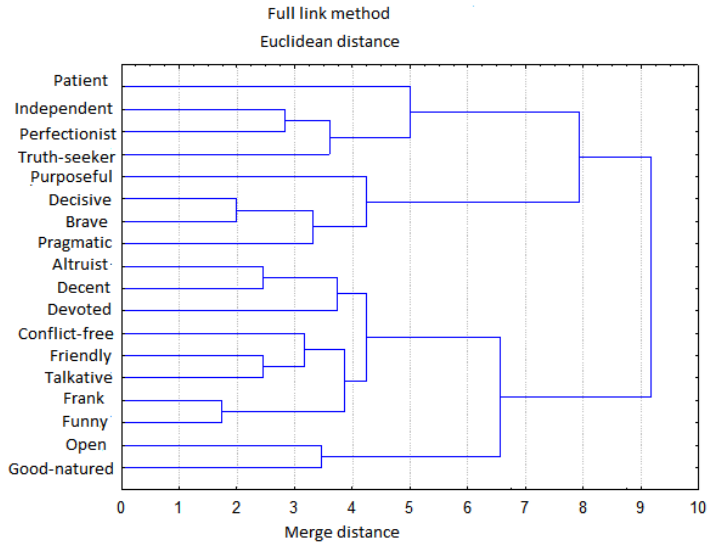
Analysis of the results obtained by ranking personal constructs in relation to the proposed roles shows that the assessments of children, both normotypical and children with disabilities and special needs, are still poorly differentiated and concentrated mainly in the emergent (similar construct) pole. People with disabilities score low on measures of attractiveness (rank 1–3 out of 7), academics (rank 2–3 out of 7), courage (rank 2–3 out of 7), and interest in children (rank 2–3 out of 7 possible). We can say that when assessing children with disabilities and disabilities, normotypical children notice external manifestations of disability, opportunities for interesting pastime and the quality of their studies. The expert transmitting the assessment is the teacher.

When processing the results of the sample of teachers, 18 personal constructs were used.

Hierarchical cluster analysis of personal constructs of teachers

The results of the cluster analysis of personal constructs of teachers are presented in the form of a dendrogram in Figure 3.

Figure 3
Dendrogram of personal constructs of teachers (18 variables)



From the dendragram it is clear that personal constructs are divided into 4 clusters. Moreover, when characterizing them, it can be noted that personal constructs are grouped from the periphery to the center.

The first and fourth clusters combine constructs characterizing personal qualities. Moreover, the fourth cluster combines 2 constructs "open - closed" and "good-natured – embittered", which characterize individual typological characteristics of a person, which, in turn, reflect the characteristics of a person's temperament. The first cluster unites 4 constructs "patient – touchy", "independent – dependent", "perfectionist – careless", "truth-teller – hypocrite", which can be interpreted on the one hand as acquired character traits, and on the other – as behavioral strategies or manipulation mechanisms.

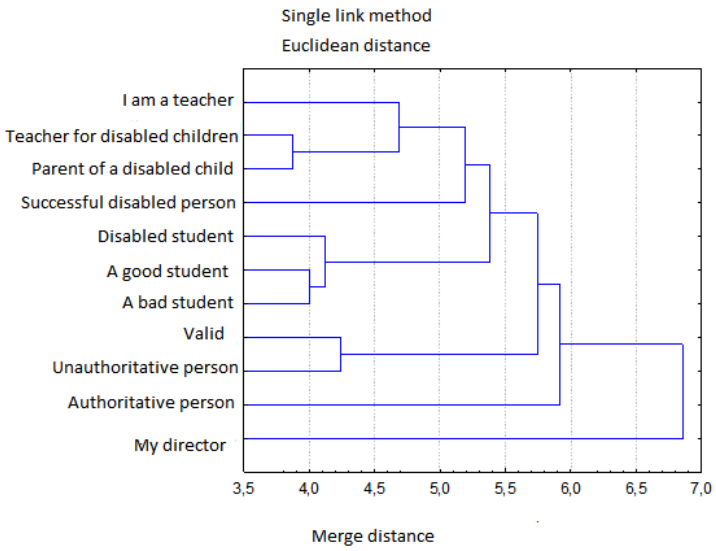
The second cluster combines 4 constructs "purposeful – weak-willed", "decisive – cautious", "brave – cowardly", "pragmatic – impractical", which are directly related to the characteristics of activity.

The third cluster combines 8 constructs: "altruistic – selfish", "decent – mean", "loyal – traitor", "conflict–free – quarrelsome", "benevolent – envious", "talkative – silent", "frank – distrustful", "cheerful – serious", which are revealed only in relationships with other people and can be designated as communicative characteristics of the individual.

We also subjected the objects of personal constructs of teachers to cluster analysis. The results are presented as a dendrogram in Figure 4.

Figure 4

Dendrogram of role repertoires (objects) of teachers (11 observations)



Here, 3 clusters and 2 monoclusters are distinguished, clearly reflecting the role and evaluative positions of objects.

Within the first cluster, the objects "I am a teacher", "Teacher for children with disabilities", "Parent of a disabled child" are closely united and the unifying object "Successful (known) disabled person" is defended. This clustering suggests that respondents are generally able to associate themselves with the role of a teacher working with children with disabilities and disabilities and their parents, but subject to success (fame), i.e. ability to achieve some success.

The second cluster unites the role positions of children: "child (student) is disabled," "good student," "bad student." The closeness of the connections shows that for teachers the assessment is more important: good or bad. The role of disability remains neutral. That is, teachers do not deny that a student with a disability can be either a bad student or a good one.

The third cluster combines the roles "disabled" and "non-authoritative person", which corresponds to the stigmatizing attitudes that exist in our society. This idea persists despite the fact that there is a more loyal attitude towards children (students).

Isolating the "authoritative person" monocluster shows that teachers do not associate their profession as highly authoritative. They also do not give authority to people with disabilities or recognize this personality characteristic in children.

The presence of the "leader" monocluster suggests that recognition of a leader in the teaching environment will take place regardless of the level of his authority, and, consequently, professionalism and personal qualities. That is, the formal role in this case is decisive and can influence the positions of the teaching staff, including in matters of inclusive education.

Qualitative analysis

The results obtained were subjected to ranking of personal constructs in relation to the proposed roles. It was revealed that average and low ratings for most personal constructs prevail among the objects "disabled person", "non-authoritative person", "parent of a disabled child" and "manager". A disabled person is rated as a cautious, touchy, selfish, quarrelsome, envious, hypocritical person (rank 3 out of 7 possible) and less pronounced as weak-willed, embittered, distrustful, withdrawn, mean, cowardly, treacherous and impractical (rank 4 out of 7 possible). He is united with an unauthoritative person by such indicators as touchy, selfish, withdrawn, embittered, quarrelsome, envious, distrustful, mean-spirited, cowardly, treacherous and impractical (rank varies from 2 to 4 out of 7 possible).

Characteristics of a parent of a disabled child are predominantly characterized at an average level by the following traits: touchy, withdrawn, embittered, distrustful, does not care about the result, hypocritical, quarrelsome (rank 4 out of 7 possible).

The leader is endowed with such qualities as selfish, embittered, quarrelsome, envious, pragmatic (rank varies 1—3 out of 7 possible).

As for a disabled child (student), the most clearly highlighted positive qualities are determination (perseverance), openness, good nature, decency (rank 7 out of 7 possible), the most striking negative quality is touchiness.

Psychological barriers to interaction in dyads of subjects

We identified the following dyads as the main dyads for analyzing psychological barriers to interaction: teachers–children, children–children. Next, we used the method of correlation analysis to process the data. Having applied it, we obtained the data shown in Table 1.

Table 1
Psychological barriers to interaction between children and teachers in an inclusive educational environment

Diad	Barriers to interaction
Teachers-children	Personal barriers (-0,58)
	Communication barriers (-0,72)
	Activity barriers -(0,72)
Children-children	Communication barriers (0,88)
	Activity barriers (0,83)

Table 1 shows that in the teacher-children dyad all types of barriers are observed; in the child-children dyad, communication and activity barriers predominate. The strength of the correlations is uneven. Negative values mean a one-way correlation of psychological barriers in "teacher-children" dyads and point to teachers as the source of barriers.

Next, we analyzed the intensity of manifestation of psychological barriers to interaction in children and teachers based on their personal constructs. The results are presented in Table 2.

Table 2

Quantitative analysis of the manifestation of psychological barriers to interaction between children and teachers in an inclusive educational environment

Barrier type	Degree (%)							t – criterion
	Excessive	High	Above average	Average	Below the average	Low	Absent	(p<0,05)
				Children				
Personal				8,6	60,8	30,6		6,2646
Communicative			45,2	54,8				6,0365
Active	15,6	14	27,3	43,1				8,2441
General indicator	5,2	4,6	24,1	35,5	20,2	10,2		6,8636
				Techers				
Personal		37,5		62,5				11,8429
Communicative		78		22				14,8540
Active	21,9	20,3	37,5	20,3				14,7829
General indicator	7,3	45,3	12,5	34,9				13,8187

The degree of severity of psychological barriers to interaction among teachers is concentrated in the range from excessive to moderate, and in the sample of children from above average to low.

Discussion

This article examines psychological barriers to interaction between subjects of the inclusive educational process as risk factors for the safety of the educational environment. Identifying, preventing and overcoming risks allows you to manage them without compromising the psychological well-being of students (Baeva, 2017; Laktionova & Gayazova, 2019; Slyusareva & Plugina, 2021).

Psychological barriers are considered as states of experiencing obstacles that arise in the process of interaction between subjects of an inclusive educational environment, caused both by the characteristics of joint activities (activity barriers) and by the personality characteristics of the subjects of interaction (personal barriers) (Slyusareva, 2019, Goryanin, 2008).

Our study revealed that teachers of general education organizations are characterized not only by personal and activity barriers, but also by communication barriers in interaction with children with disabilities and disabilities (Dubrovina, 2019). They perceive disability as a social stigma with all its negative attributes, and are willing to reconsider their beliefs regarding inclusive education only in a guaranteed situation of success. However, expectations of negative trends on the part of management and parents block these trends and aggravate the barriers. These conclusions are consistent with the provisions of scientific works (Koroleva, 2016; Fominykh, 2017; Dunaevskaya, 2018).

At the same time, children studying in inclusive classes are not sources of psychological barriers to interaction, however, all negative trends from the groans of adults come down to the children's team (Efimova, 2011). Refracting all types of teachers' barriers, children begin to transmit them to each other, although initially only external formal signs can cause difficulties in interaction (Bogdanova, 2016; Godovnikova, 2017; Kostina, Dunaevskaya & Bogomyagkova, 2020).

Conclusions

Children have a neutral attitude towards disability, including because they do not have much experience interacting with disabled children. The assessments of adults, especially teachers, are of decisive importance in the formation of relationships between children. The key positions that children themselves focus on are the appearance of other children and the characteristics of joint activities. In childhood, psychological barriers to interaction predominate in the communicative (difficulty of mutual understanding) and activity spheres (difficulty in organizing interesting joint activities). The degree of severity

of psychological barriers to interaction in the sample of children varies from above average to low.

Teachers of general education organizations are subject to negative attitudes towards persons with disabilities, but at the same time they are more loyal towards children, which suggests a potential readiness to organize an inclusive educational process, but only in a situation of success. A wide range of activity and communicative characteristics of the individual, assessed negatively in the context of disability, as well as the identification of personality traits interpreted as mechanisms of manipulation, indicate that the attitude to interaction is wary with the expectation of problems from parents and management. The role of the head of an educational organization is recognized on formal grounds, which emphasizes the tendency towards conformity in matters of corporate policy. The prerequisites for the emergence of psychological barriers to interaction with subjects of the inclusive educational process among teachers occur in the personal (stigma of disability), communicative (expectation of manipulation and problems) and activity (conformity, avoidance of failures) spheres. The degree of severity of psychological barriers to interaction among teachers is concentrated in the range from excessive to moderate degree.

All identified trends on the part of teachers create safety risks in the inclusive educational environment for students, which must be taken into account and mitigated.

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Yulia Vladimirovna Zhikrivetskaya – data collection, statistical analysis, technical preparation of the article text;

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Psychological and Psychobiological Approaches to the Study of Adolescent Behavior in the Digital Environment

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Abstract

Introduction. The volume of the Internet audience is rapidly growing, which encourages psychologists and medicals to study Internet addiction, psychology and psychobiology of overly Internet-addicted individuals. Internet addiction has a number of specific properties, but it has common features with chemical addictions. The question of the differential diagnosis of Internet addiction and the validity of its inclusion in the glossary of neuropsychiatric diseases remains open. The aim of the study is a theoretical analysis of the similarities and differences of dependence on digital media in comparison with chemical forms of addiction, the development of methods for differential diagnosis of Internet addiction. **Theoretical justification**. Neuroplasticity and interactions of genes with the environment, identified in patients with mental and neuropsychiatric disorders of an affective nature, are considered as mechanisms for the transition of excessive Internet involvement into Internet addiction. Neuroplasticity and genetic control of dopamine synthesis and metabolism in cyber-gaming have been founded to be important. Dopamine regulates emotional experiences and cognitive functions characteristic of Internet addicts. In previous studies, we experimentally confirmeda high correlation the R-R-intervals fluctuations as a marks of the autonomic nervous system (ANS) function, which is involved in the formation of negative emotions and reactions to stress, and the behavior of adolescents on the Internet. **Discussion.** The main directions of the development of differential diagnosis of Internet addiction are psychodiagnostics of adolescents' behavior on the Internet and their individual and personal characteristics, psychophysiological study of the characteristics of ANS in relation with the behavior of adolescents on the Internet.

Keywords

Internet addiction, alcohol dependence, chemical dependence, gene-environment interaction, neuroplasticity, adaptation, differential diagnosis of Internet addiction

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Introduction

In recent decades, new phenomena related to the technological revolution of the 21st century have entered public life. New forms of deviations in the form of over-involvementat Internet or dependence on gadgets, online games and communications have joined the various and already studied forms of developmental deviations and maladaptation of behavior of adolescents and young people. Typical forms of developmental and behavioral deviations in adolescence are character and personal accentuations, as well as more difficult to correct and prevent variants of deviations in the form of chemical addictions. Technological advances in the late twentieth and early twenty-first centuries led to the emergence and sharp growth of new types of entertainment and leisure (Kamenskaya, Tomanov, 2022). Immersion in the digital environment for the purpose of intensive communication on social media and fascination with cyber games leads to the formation of new types of addictions. Activity in the blogosphere began to bring teenagers and young people incommensurable financial incomes compared to their parents; participation in cyber games also became profitable. Another factor that has increased interest in digital devices is the emergence and rapid technical improvement of various mobile phone models that ensure freedom of use in any place where network providers operate(Baert, Amez, Claeskens,Daman&de Marez, 2020). All these circumstances have significantly increased the Internet audience in different countries, including Russia (Veraksa, Kornienko & Chursina, 2021).

For a relatively long time, the professional community did not attach importance to the cyber hobbies of young people, however, the rapid growth of consumers of Internet service providers, commercialization, and a sharp increase in the number of the Internet audience growth was reflected in the public consciousness as the idea of the

danger for young people of uncontrolled immersion in the virtual world (Tereshchenko & Smolnikova, 2020). First of all, concerns about the health of adolescents were based on a study of the impact of intensive Internet use on neuropsychiatric health (Li, Zhang, Cao & Zhang, 2023), on the characteristics of perceptual and cognitive processes (Ortiz de Gortary & Panagiotidi, 2023), the risk of Internet addiction as a special form of technological dependence in adolescents and young people. The authors point to the significant negative impact of using smartphones during school lessons (Sunday, Adesope & Maarhuis, 2021), as children and adolescents solve many learning tasks in smartphones, rather than using their cognitive abilities without resorting to the prompts of digital devices. Baert et al. (2020) found a decrease in academic success at universities and colleges due to the use of smartphones in the classroom. It has been established (Lin, Liu, Fan, Tuunainen & Deng, 2021) that games, social media communication, watching movies and entertainment programs really worsen learning, whereas specially designed applications, on the contrary, contribute to improving cognitive processes and relieve the fear of being "out of touch".

These circumstances and the accumulating database on the deterioration of the physical and mental health of young people determine the high relevance of theoretical and experimental developments regarding the psychological characteristics of teenagers who are passionate about digital gadgets. Studies of psychophysiological changes in the brain and autonomic nervous system of subjects involved in the virtual world are relevant.

This form of addiction – Internet addiction – is caused by technical innovations and has a number of specific properties:

- the possibility of using modern digital tools depends on the socio–economic conditions of the development of children and adolescents, and therefore the involvement of young people in the Internet has a certain degree of regional specificity;
- the risk of Internet addiction is determined by the family climate, the type of child-parent relationship, the system of relationships in the school team and academic success;
- The risk of over-involvement with the Internet is determined by the type of accentuation of a teenager's character, the frequency and intensity of stress, including those related to learning problems (Bong Mun, 2023).

At the same time, Internet addiction is characterized by common features with the main previously emerged and relatively well-studied forms of addiction, primarily chemical ones: alcoholism and drug addiction (Zalmunin & Mendelevich, 2014; Nikolaeva & Kamenskaya, 2020; Ershova & Semenyak, 2021). Internet addiction manifests itself in compulsive attraction to social networks or games to reduce feelings of anxiety, obsessive thoughts and actions. Internet dependence as the chemical addictions is characterized by reduced control of both his behavior on the Internet, and time for entertainment and recreation, an increase in irritation and aggression in the case of forcing a teenager to end his activity with digital devices.

Similar features of Internet addiction, recorded in an experiment with other forms of addiction, do not have statistically high significance, which is also not always taken into account by researchers. The question of the validity of including Internet addiction in the glossary of neuropsychiatric diseases remains open (Egorov, 2015, Sunday, Adesope & Maarhuis, 2021).

There is an idea in the literature that high immersion in a virtual environment can be a special form of deviation of personal development (Rooijetal, 2014; Egorov, 2015), which is reflected in a large number of synonyms associated with this field of study of deviations: over-involvement, Internet addiction, cyber addiction, information and technological dependence. The uncertainty of the concept of "over-involvement" with the Internet and gadgets, the complexity of its qualification as a certain form of addiction allow us to determine the purpose of our work.

The purpose of the study is a theoretical analysis of the similarities and differences ofdependence on digital devices and virtual environments in comparison with chemical forms of addiction (alcoholism and drug addiction) in order to develop methods for differential diagnosis of Internet addictions.

The practical significance of the study lies in the development of objective methods for assessing the transition of over-involvement with the Internet and gadgets into addiction with all the main signs of its manifestation.

The article uses a method of collecting and analyzing literature covering the socio-psychological conditions of the emergence and development of dependence on digitalenvironment. The main attention is paid to the study of psychophysiological and neurobiological manifestations in the morphofunctional structure of the brain (with the constant use of the Internet and gadgets by adolescents), as well as its neuroplasticity as manifestations of genetically determined mechanisms of human adaptation to changing environmental conditions.

Theoretical justification

Socio-psychological aspects of the phenomenon of excessive Internet use

The study of socio-psychological conditions, the peculiarities of the formation of teenagers' involvement in the virtual environment, the commonality and differences of this new form of developmental deviation, dependence on digital means, with already known forms of deviations was the beginning.There have been works studying the psychological and social causes of the formation of Internet addiction (Perezhogin, 2020; Veraksa, Kornienko & Chursina, 2021), as well as individual typological features of fans of the virtual world (Nikolaeva & Kamenskaya, 2020). Objective methods for determining the risk of accelerated development of Internet addiction in adolescents and young people

are becoming increasingly important in research (Hong et al., 2013; Tereshchenko & Smolnikova, 2020; Zainuddin, Chu, Shujahat & Perera, 2020).

It is assumed that Internet addiction is the result of a complex system dynamics of mental processes in adverse and/or stressful conditions of the developmental environment, which can partly be genetically determined (Uncapher & Wagner, 2018; Marín-López, Zych, Ortega-Ruiz, Hunter &Llorent, 2020; Schønning, Hjetland, Aarø & Skogen, 2020). Individual and personal reactions when diving into the Internet and mastering its resources differ. The reaction to immersion in the virtual world is individual, as is the reaction to the first use of a drug or alcohol. The further history of a teenager's development in connection with his behavior in a virtual environment is determined by both premorbid socio-psychological characteristics and the degree of normativity of his physical and cognitive development (Bogacheva, 2017; Nikolaeva, Kamenskaya, 2020).

In any case, loneliness or alienation, which occur with a high degree of probability in adolescence, is directly associated with the risk of low self-esteem, and, as a result, exposure to external influence, which can be a convenient ground for the development of over-involvement with the Internet and further Internet addiction.

A possible assumption regarding the formation of addiction is the well-known mechanism of gene-environment interaction in psychogenetics. Reduced stress tolerance, determined genetically at the biological level, increases with frequent experiences of negative feelings in the family, at school (about school failure, for example) and among peers (in the case of social rejection), forming the first manifestations of social maladaptation. The behavior as a loser or neurotic reduces self-esteem, giving rise to further deterioration of stress tolerance and activity in the search for opportunities to reduce negative experiences. It is likely that the central trigger element of the transition of over-involvement in leisure activities on the Internet into Internet addiction is the spectrum of dominant negative emotions and a way to alleviate negative experiences.

Neuroplasticity and gene-environment interaction as endogenous determinants of addiction

Addictions are complex biosocial phenomena by origin. Chemical forms of addiction, as the more famous, may differ in the mechanisms of determination from Internet addiction and cyber addictions (Kibitov, 2013). The emergence of Internet addiction became possible only at a certain stage of technological development, when the means of interacting with information became individual and financially accessible to many members of consumer society, including adolescents, not only in the field of education, but also in leisure activities (Kamenskaya & Tatyana, 2023). Due to the "youth" of Internet addictions and cyber addictions, the etiology and pathogenesis of these maladaptive behaviors have not been studied to the extent that would allow us to make assumptions about the neurophysiological and psychogenetic mechanisms of their formation, methods of accurate diagnosis and further correction measures.

It is known that genetic factors, including the expression of certain genes, are important in the pathogenesis of chemical forms of addiction (Kibitov, 2013). Clinical studies emphasize that the main forms of neuropsychiatric disorders and maladaptations as a mandatory component include psychoemotional disorders and pathological reactions to stress. According to a number of researchers (Czeh et al., 2007; Lu et al., 2003; Bremner, 2006, Bong Mun, 2023, Zhou, Xin, Wang & Ga, 2023), chronic stress, depression and other affective circle diseases are accompanied by neuroatrophic lesions in various areas of the frontal cortex, hippocampus and striatum. It is worth noting that the above–mentioned brain structures, which suffer the most from depression and stress, are areas responsible for the formation of emotions, learning and memory processes.

Subtle neurophysiological processes can influence the occurrence of psychoemotional deviations. The features of human reactions of individual neurons and neural networks were not previously available for experimental research. Technological progress has provided the development of instrumental approaches that contribute to the study of not only the dynamics of individual neuron discharges, but also their destruction and the appearance of new neurons in place of the previous ones that died due to various circumstances. The prevailing view of the 1906 Nobel Laureate Santiago Ramon y Cajal regarding the inability of the nervous system to recover was experimentally refuted in neurophysiological studies (Maltsev, Podgorny, 2020; Pavlov, Mukhin, 2021). According to various data, the number of new neurons formed per day during neurogenesis reaches from 1400 to 9000 (Maltsev, Podgorny, 2020; Cameron & McKay, 2001). Newly emerging young neurons are integrated into existing neural networks, providing their morphofunctional rearrangements, forms permanent neuroplasticity.

Neuroplasticity is a way of adapting the nervous system to changes in homeostasis and the external environment. Neuroplasticity is defined as the ability of nervous tissue (neural networks and systems) to change its structure and function in response to external and internal factors, including reactions to the death of nerve and glial cells due to organic lesions of the central nervous system, injuries, strokes or neurodegenerative diseases (Galanin et al., 2015; Pavlov & Mukhin, 2021). Neurogenesis is regulated by endogenous molecular genetic mechanisms and environmental conditions. Molecular genetic control of postnatal neurogenesis is realized with the help of various growth factors of neurons and their parts, the formation of synapses, neurotransmitters and hormones (Leslie & Nedivi, 2011; Henley & Wilkinson, 2016), as well as changes in the structure of the nucleus chromosomes that control all processes in the body and brain (Pavlov, Mukhin, Klimenko & Anisimov, 2017). External factors affecting neurogenesis and neuroplasticity include: an enriched environment and social environment; the nature of relationships between members of a social group; cognitive and physical activity; learning new forms of behavior; the level of education. An enriched environment means an environment containing a variety of social and non-social stimuli that affect various aspects of brain development and function (Pavlov & Mukhin, 2021).

A review of the presented neurophysiological studies and genetics works suggests that neuroplasticity and gene-environmental phenomena typical for the formation of known mental and neuropsychic disorders with an affective content may be the causes of the formation of addictive behavior. It has been established that chronic alcoholism in humans is associated with a 20-fold increase in dopamine beta-hydroxylase, which disrupts catecholamine metabolism and affects the cognitive and adaptive functions of patients (Galanin et al., 2015). This process leads to rearrangements of gene control at dopamine synthesis, the crucial role of which in neurochemical adaptation to drugs and alcohol was previously confirmed in studies (Noble, 1993).

The genetic basis in humans has been studied for alcohol and caffeine dependences, the relationship between depression and alcoholism, alcoholism and smoking, alcoholism and other pharmacological drugs. In the work of Kibitova (2013), the leading role of the dopaminergic system and dopamine in the mechanisms of the emergence and development of two different addictions was confirmed at the molecular genetic level: from alcohol and heroin. Universal genetic markers of high risk of severe drug addiction and alcoholism are polymorphic loci of genes that control dopamine metabolism. In general, the study of the genome and gene expression in humans confirms the polygenic nature of drug and alcohol addictions. At the same time, individual characteristics such as impulsivity and loss of volitional control over drug consumption and, significantly, the difference in neurobiological and behavioral responses to stress are superimposed on the polygenic nature of human dependencies. Attempts to find certain genetic foundations of an "addictive" personality have failed.

The existence of genetic models of addiction formation indicates that the multilevel effects of their pathogenesis are largely predetermined by gene-environment interaction. The behavior of a person with a certain genotype always occurs in a certain environment, and behavior depends on this environment. The effect of genes on addictive behavior, however, should not be oversimplified. The gene for, in example, alcoholism, now seems outdated in the system of addiction and genome communication. It is suggested that genes contribute approximately 50% of the variations in human emotional behavior (Kurchanov, 2009), including pathological and deviant ones. Everything else in real behavior is determined by the social and psychological conditions of life and development.

For example, it was previously believed that addictive behavior can be conditioned by habits, that is, reflex mechanisms, and automatically triggered by situational environmental conditions that act as peculiar keys that trigger motivational arousal (Siegel, 1978; Gentile, Swing, Lim & Khoo, 2012). This automatic arousal takes place because of the strong connection between the key and the behavior, which arises from the constant repetition of certain stages of behavior in a certain environmental context. In narcology, there is an idea that not everyone who experiments with alcohol and drugs becomes chemical addicts (Zalmunin & Mendelevich, 2014; Ershova & Semenyak, 2021). Approximately 60% of adults have tried drugs at least once in their lives. If alcohol is included in the list of such samples, it turns out that the percentage of young people and adults who have tried

potentially addictive drugs in a situation of social stress (for example, during Covid-19) will increase to 90% (Mental Health Foundation, 2020). In other words, based on this infectious factor, the risk of developing addiction should be indicated as 90% in adults. In general, such a conclusion is incorrect and does not correspond to empirical facts, since not all those who try even strong drugs become addicted to them, that is, chemical addicts (Galanin et al., 2015).

The specific effect of drugs on the nervous system plays an important role in the formation of chemical dependencies. It is shown that drugs and alcohol are more or less involved in the activation of neural networks of the reinforcement system, which are normally responsible for pleasure, motivation, and learning. In particular, the activation of neural networks of the reinforcement system passes through the dopaminergic system (Buckholtz et al., 2010; Tereshchenko & Smolnikova, 2020). The reinforcement system receives dopamine projections from the subcortical parts of the brain: from the ventral region of the bridge, fibers go to the nucleus accumbens, striatum, and glutamate inputs – from the prefrontal cortex, amygdala, hippocampus. Neural networks of the nucleus acumbens mediate the effects of drugs, in addition, they are also responsible for survival: nutrition, water absorption, sexual behavior, safety, emotional reinforcement (Nikolaeva & Kamenskaya, 2020). Thus, these neural networks are critical for natural reinforcement and emotional control of behavior and are sensitive to the effects of alcohol and drugs.

At the same time, addictive drugs are not only involved in the activity of this brain reinforcement system, but also chemically change it. The constancy of drug-induced pathological adaptation in it manifests itself at the molecular, cellular, nervous and systemic levels. Drug-induced pathological neurochemical adaptation is crucial for the formation of neuropsychiatric pathology and addiction, including through common systemic mechanisms of the genesis of emotional reactions in normal and pathological conditions (Pavlov & Mukhin, 2021). It is clear, however, that the psychological functions of the individual as a consequence of the adaptations of the nervous system caused by these drugs can directly and directly manifest themselves in a pathological form of behavior far from all drug and alcohol users.

Addictive behavior in the case of interaction with digital devices has not been studied to the necessary extent in order to determine the neurophysiological and genetic processes that determine the risk of Internet addiction. However, the use of visualization techniques for studying the human brain allowed us to record certain structural changes in the central nervous system in adolescents with signs of Internet addiction: they showed a decrease in gray matter density in various parts of the cortex, including the prefrontal, orbitofrontal cortex and the cortex of the additional motor area (Yuan et al., 2013, Tereshchenko & Smolnikova, 2020). These regression organic changes in the brain are typical for patients with alcoholism and drug addiction, which emphasizes the commonality of neurophysiological mechanisms for the formation of chemical and information addictions.

It's known that a sense of control over a situation arises due to the activation of subcortical dopaminergic neural networks that activate large areas of the brain, including the fields of the frontal lobes (Declerck, Boone & DeBrabander, 2007). The role of dopaminergic metabolism has also been established in the occurrence of the risk of Internet addiction, which is insufficient for the necessary activation the dorsal part of the frontomedial cortex (Buckholtz et al., 2010), in order to organize socially adaptive behavior.

A particular effect on the rate of addiction development is exerted by increased activity in the reward-reward neural system (Kuss & Lopez-Fernandez, 2016; Hong et al., 2013), which revealed an increase in glucose consumption associated with impulsivity of behavior and the desire to repeat strong positively colored sensations and experiences (Park et al. al., 2010).The particular influence on the rate of addiction development is exerted by increased activity in the reward-reward neural system (Kuss & Lopez-Fernandez, 2016; Hong et al., 2013), in which the grows glucose consumption is associated with impulsive behavior and a desire to repeat strong positively colored sensations and experiences (Park et al., 2010).

A few studies (Tereshchenko & Smolnikova, 2020; Buckholtz et al., 2010; Yuan et al., 2013) showing changes in functional activity found in Internet-dependent adolescents indicate a certain proximity of information dependencies to chemical forms of addiction in brain activity. The role of emotionally colored behavior in the occurrence of addiction has been experimentally proven in samples of patients with alcoholism and drug addiction.

Currently, neuroplasticity is considered both a progressive and a regressive factor of development. Neuroplasticity has a wide range of adaptive capabilities. It is impossible to deny the possibility of positive changes in the neuronal networks of theaddicts brain responsible for adaptive behavior, in a similar way as it happens in the treatment of depression (Zhivolupov, Samartsev, 2009) under the influence of not only drugs, but also psychotherapeutic procedures. The study of neuroplasticity in the study of addictions, including Internet addictions, gives grounds for optimism in the search for methods of diagnosis and correction of psycho-emotional disorders in adolescents with a strong immersion in the virtual environment.

Discussion

Returning to the designated purpose of the study, it is worth referring once again to the few works (Tereshchenko & Smolnikova, 2020; Buckholtz et al., 2010; Yuan et al., 2013,) that showed changes infunctional brain activity found in Internet-dependent adolescents. These studies have established a certain proximity of information dependencies to chemical forms of addiction at the functional level of brain activity.

The analysis allows us to determine the similarities and differences between the manifestations of Internet addictions and chemical forms of addiction. The similarity of all forms of addiction is related to the dynamics and content of behavior and its emotional

accompaniment: all types of addiction are characterized by compulsive attraction to addictive factors that relieve or weaken anxiety, emotional tension, depression and possible aggression. The decrease these negative emotions after interacting with drugs or the Internet returns to the initial level after a while and the whole cycle starts again. This typical dynamics is formed due to the similarity of the functional activity of the reinforcement system (limbic structures, nuclei of the hypothalamus and prefrontal cortex, nuclei of the brain stem responsible for the synthesis and metabolism of dopamine). A few neurophysiological studies performed on patients with alcoholism, drug addiction and Internet addicts of adolescence confirm the similarity of the functioning of the reinforcement system of emotionally charged behavior in all addicts. An essential element of the similarity of information dependencies with chemical forms is a decrease in the activity of neural networks of the frontal pole that control emotionally charged behavior, which is reduced in all dependent adolescents. The similarity of the reinforcement and behavior control system is reflected in the personality and character of addicts who have obvious signs of accentuation and social maladaptation.

The forms of accentuation and variants of social maladjustment in Internet addicts differ from those typical for alcoholics and drug addicts. The formation of Internet addiction is facilitated in the presence of severe anxiety, depression and neurotic disposition with depressive syndrome and reduced stress tolerance. It is quite rare to detect a dysthymic component with pronounced aggression and impulsivity in the complex of accents in adolescents with Internet addictions. The latter is formed mainly by those gamers who prefer aggressive killing games as the content of games (Abbassi et al., 2022).

The fundamental difference between adolescents with risk of Internet addiction and severe Internet addiction is the lack of evidence of genetic control of the formation of accentuations and social maladaptations, which may be a determining factor in patients with alcoholism and drug addiction.The role of the gene-environmental interaction that determines the psycho-emotional status with preserved neuroplasticity of the adolescent brain at risk of developing dependence on the Internet and digital devices, should be experimentally proven. The results of this study can be used as a strategy for preventing Internet addiction.

The study of the links between the state of the autonomic nervous system (ANS) of adolescents who are excessively fond of the Internet and their behavior on the Internet may provide certain opportunities to assess the role of neuroplasticity of the nervous system in the prevention of addiction. The activity of the ANS varies significantly depending not only on health, but also on current psycho-emotional experiences, which is reflected in the pulse rate directly. Stress directly alters the functions of the ANS, primarily affecting the heart rate, which is characterized by high temporal variability (Fu, 2022), which indicates the high possibilities of adaptive rearrangements of the ANS.

Numerical estimation of fluctuations in the R-R interval (heart rate variability -HR) as the most important marker of normal or deviant activity ANS was performed on a group of high school students with varying degrees engagement in the digital environment

(Kamenskaya & Tatyanina, 2023). The study was carried out in the post-pandemic period with the students' health not fully restored. It has been established that the own choice of activities and with a positive attitude towards leisure on the Internet, as well as the time spent on leisure, have certain links with the characteristics of heart rate with a predominance of activity of the parasympathetic and sympathetic links of the ANS. Therefore, the study of the features of the ANS may be useful for the development of methods for psychodiagnostics of the transition of Internet over-involvement into Internet addiction.

Conclusion

Neuroplasticity and gene-environmental reactions found in patients with mental and neuropsychic disorders with an affective status may participate in the formation of the transition of over-involvement with the Internet into Internet addiction. It has been established that drugs and alcohol are involved in the activation of the neural circles of the reinforcement system, which are responsible for pleasure, motivation, and learning, through the dopaminergic system, which emphasizes the role of emotional experiences in the genesis of addictive behavior.

In adolescents and young people with Internet addiction, certain signs of neuron's rearrangements were recorded in experiments using visualization techniques, which showed structural changes in the brain in the form of a decrease in gray matter density in the prefrontal and orbitofrontal cortex responsible for emotional behavior, learning and cognitive functions. It is not necessary to exclude the participation of neuroplasticity and genetic control over the synthesis and exchange of neurotransmitters, primarily dopamine, in cyber-addicts, which requires further experimental study.

This assumption has indirect experimental confirmation in the form of the discovered connectivity of the highly variable activity of the autonomic nervous system with the peculiarities of adolescent behavior on the Internet.

The main directions of the development of differential diagnosis of Internet addiction can be:

1. The characteristics assessment teenagers' behavior on the Internet using the questionnaire "Psychological characteristics of the behavior of modern adolescents in the digital environment";
2. Psychodiagnostics assessment of personality structure in order to identify character accentuations; determination of dominant motivations and their accompanying emotions;
3. Psychophysiological examination using ECG recording of the autonomic nervous system functions and the determination the dominant control link, as well as the

plasticity of cognitive processes using a computer software package developed by the author.

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Illegitimate Police Task Stress Questionnaire: Development and Psychometric Evaluation

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Abstract

Introduction. In the police profession, illegitimate tasks have detrimental impacts on personal and organizational wellbeing. It affects job performance, job satisfaction level and relationship between law enforcement agencies and the communities they serve. There is no valid questionnaire to measure illegitimate police task stress. The objective of this study was to develop and evaluate the psychometric features of illegitimate police tasks stress questionnaire (IPTSQ). **Methods.** The present study employed a mixed-methods approach, integrating both qualitative and quantitative methods to explore illegitimate tasks among police officials (N=620) in Pakistan. We conducted exploratory factor analysis on 160 employees and later cross validated on best factor structure identified by way of confirmatory factor analysis on 460 police officials. **Results.** The result showed that the illegitimate police tasks stress questionnaire was composed of 21 items with 2 factors (unnecessary tasks and unreasonable tasks). The composite reliability of IPTSQ was 0.89. **Discussion**. In conclusion, it is valid, reliable and easy to use scale. The psychometric properties of this scale are satisfactory, making it well-suited for research purposes, policies, or decision makers in police department. This scale would help the police department evaluate and prioritize tasks in a way that is consistent with their fundamental goal of maintaining public safety and enforcing the law.

Keywords

Illegitimate tasks, police stress, unnecessary police tasks, unreasonable police tasks, police employees, scale, questionnaire

For citation

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Introduction

Stress is a mental and emotional state that increases in critical and demanding circumstances of a job. Employees are doing several tasks that do not meet the specified requirements. and surpass the reasonable expectations of employees (Semer et al., 2015), including unnecessary and unreasonable tasks. Tasks that fail to make sense are deemed unnecessary. Organizational inefficiency and leadership preferences are the usual outcomes of these sorts of activities. Additionally, unreasonable tasks are irrelevant to employees' core role or assignments, that impose undue constraints and making the employee feel unconformable (Pindek, Demircioğlu, Howard, Eatough & Spector, 2019). Illegitimate stressors are hard to avoid (Fein & McKenna, 2022) and it may experience adverse mental health concerns (Mensah et al., 2022). From an emotional standpoint, Pindek and colleagues discovered that employees' negative emotions stem from illegitimate tasks. From a behavioural perspective, they are linked to the inactive or passive activities of employees (Pindek et al., 2019). For example, Ouyang and his colleagues observed that employees experience more burnout when assigned illegitimate tasks (Ouyang et al., 2022). Another study indicated that illegitimate tasks drastically reduce proactive customer service performance (Zhao, Jolly & Zhao, 2023), lower wellbeing (Semmer et al., 2020; Mensah et al., 2022), and increase counterproductive behaviours among employees (Ahmad et al., 2022). In various workplaces, illegitimate tasks can be a serious obstacle including healthcare, (Kilponen et al., 2021; Valdivieso Portilla et al., 2021; Anskär et al., 2019; Stein et al., 2020), higher education (Bramlage, Julmi, Pereira & Jackenkroll, 2021), IT professionals (Apostel, Syrek & Antoni, 2018), teachers (Faupel, Otto, Krug & Kottwitz, 2016), engineers (Pindek et al., 2019), administrative staff (Eatough et al., 2015), blue-collar workers (Mauno, Minkkinen & Shimazu, 2022), and also Red Cross volunteers (van Schie, Güntert & Wehner, 2014). Illegitimate tasks are specified to profession. So measurement tool should be adapted or designed according to occupation. Recently, most of the studies use Bern Illegitimate Task Scale (Semmer et al., 2010) to investigate the illegitimate tasks among employees of different organizations (Cheng et al., 2022;

Ouyang et al., 2022; Zong et al., 2022; Faes et al., 2021; Mauno et al., 2022; Zeng et al., 2021; Semmer et al., 2021; Ilyas et al., 2020; Fila & Eatough, 2019), university faculty members (Ahmad et al., 2022), primary school teachers (van Niekerk et al., 2021) and general practitioners (Werdecker & Esch, 2021). There are several limitations for this scale, although, it is designed in academic settings and psychometrically evaluated on different occupations.

Very few scales are designed for targeted population. Anskär and his colleagues explored the illegitimacy of tasks among physicians and nurses (Anskär et al., 2022) and another study developed illegitimate scale for school teachers (van Niekerk et al., 2021). Illegitimate tasks are frequently observed in the workplace. The potential impact of these factors on organizational effectiveness may be detrimental. Additionally, these practices have the potential to negatively impact the overall well-being of employees and influence their behaviour within the organization, extending their effects beyond the workplace and into other aspects of their lives.

As far as the researchers' knowledge, no metric assesses the illegitimate tasks of police officials. In general, there is a need for a standardized scale to measure illegitimate police tasks. The primary objective of this research study was to develop a comprehensive and reliable scale that can be used to evaluate the illegitimate task stress of police officers. The development process involved several stages, including extensive literature review, expert consultation, and pilot testing. The resulting scale was then subjected to rigorous validation procedures to ensure its reliability, validity, and sensitivity to changes in performance. The scale is expected to provide an objective and standardized way of measuring the effectiveness of police officers in carrying out their duties, which can ultimately contribute to improving the quality of law enforcement services and enhancing public safety. It is essential for understanding the problem, identifying patterns of tasks, informing policies, ensuring accountability, and ultimately improving the professionalism and ethical standards within law enforcement agencies.

Methods

Design and setting

This study is a subset of mixed-method research. It was conducted on police officials in Pakistan in 2023. The scale underwent qualitative and quantitative phases for design and psychometric evaluation. Primarily, three phases were established (Boateng et al., 2018). The first phase involved item generation and content validity. The second phase entailed scale development which consisted on pre-testing of generated questions, survey administration, reduction of the number of items, and factor analysis. The third phase involved assessing the validity and testing the reliability of the scale, as well as testing the number of dimensions it contained, which are all necessary stages in the evaluation of the scale phase. The following sections detail all the steps performed in each stage.

Phase 1: Item Development

Identification of the Domain and Item Generation: The first step described the construct of illegitimate police task stress. After the domain is defined, its dimensions are explained to generate the item pool. This process is also known as scale development" (Kline, 2013) or "item generation" (Hinkin, 1995). This study used deductive and inductive methods (Hinkin, 1995). Combining deductive and inductive methods is considered best practice (Loevinger 1957; Clark & Watson 2016). Items were extracted through a review of the relevant literature and assessment of the existing Bern Illegitimate Tasks Scale (Semmer et al. 2010) and by an inductive method, purposive sampling was used to gather data with variation in terms of demographic variables (place of service, age, gender, work experience, and service area). In this phase, 15 police officials were interviewed. Each interview lasted 30-40 min. Semi-structured interviews with open-ended questions were employed. The primary key questions posed to the participants about tasks ...they must be done at all? as (impractical/outdated ways of working), ... they make sense at all? like (insufficient or dysfunctional information system and other technology), ... If things were organized differently, these tasks could either not exist or require less effort.? (like unnecessary procedures, operations, and measurement), ... Do they only exist because some people insist on having things that way? (as tasks related to bureaucratic demands, administration, and organizational structure). ... Should this task be delegated? Is it beyond your scope? (unclear or unreasonable demands of work),... put you into an awkward position? (as tasks with insufficient resources), ... are unfair for you to have to deal with? (as unethical tasks or difficult situations). Initially, 80 items were generated. The initial inventory pool was twice as large as the desired target scale (Kline 2013; Schinka et al., 2012). Five point Likert scale (never - frequently) was used to measure illegitimate tasks stress during work (Likert et al.,1932; 1993). Five point likert is more reliable than two or three points (Rossi et al., 2013).

Content Validity: Content validity was assessed through evaluation by 5 experts (2 qualitative research experts in psychology and 3 police officials) through the Delphi method which structures the group communication process (Keeney, 2011; Yousaf, 2019). Low-frequency items were discarded. Then choose the questions that were suitable, precise, and understandable. Then, impartial evaluations were conducted by an expert panel. Acceptance, rejection, or modification of item decision was based upon majority opinion (Augustine et al. 2012).

Content validity ratio (CVR) and content validity index (CVI) were utilized to assess content validity. To determine CVR, 5 experts were requested to review each statement on a 3-point scale (essential, not essential, and modify), and according to Lawshe's table the items with CVR $\geq$.90 were kept (Polit et al., 2007; Kaewkungwal, 2023). Intending to assess the CVI, five experts observed the relevancy of items on 3 point likert scale criteria. Every item's I-CVI and the total scale's S-CVI were subsequently calculated. The items that had an I-CVI score of 1 were retained in the scale because they were deemed appropriate.

To obtain scale scale-wise content validity index (S-CVI), for every item, the average of the computed item wise content validity index(I-CVI) was utilized. Polit and Beck proposed a score of ≥0.90 for items are considered accepted items (Polit et al., 2007; Kaewkungwal, 2023). Then high frequency items were retained. 32 items were finalized.

Phase 2: Scale Development

Pre-testing Questions: Following item development and expert judgment, ten cognitive interviews were conducted in order to fine-tune and evaluate the significance of the items and to polish the item structure so that respondents can articulate the cognitive process that went into giving their responses. Respondents represent similar characteristics to the target population. Before administering the survey, pre-testing is done to ensure that the questions are easily comprehensible by the target population. This helps to avoid any misunderstandings and poorly worded items, and facilitates revision of phrasing to be maximally understood. Additionally, it reduces the cognitive load on research participants (Beatty et al., 2007). 22 items were selected for final scale.

Survey Administration and Sample Size: The survey done on 160 police officials (Guadagnoli and Velicer, 1988) who were selected through simple random sampling from different police stations in Sindh, Pakistan followed by inclusion criteria (in-service police officials between 20-60 years age). The recommended sample size should be 5 to 10 times as much as the total number of items (Ebadi et al., 2019*).*

Extraction of Factors: In order to develop a scale with complete cases, it is important to ensure their availability. the author deleted or imputed missing cases before factor analysis. To find out how many factors or domains best fit a given set of elements, a factor analysis was conducted. In factor analysis, standardised, observable variables are regressed on latent, or hidden, variables. The bivariate regression coefficients, which represent the loading of each observable variable on each component, are also correlations because both the variables and the factors have been standardized. The degree of internal consistency between items and their underlying structure can be understood through factor analysis (McCoach et al., 2013).

For Exploratory Factor Analysis, the author used scree plots, parallel analysis, minimum average partial procedure. Factors extraction utilized to trim down the items. In the context of factor analysis, items that exhibit factor loadings of less than 0.30 are regarded as insufficient since they contribute less than 10% of the variation in the latent construct that is being measured. Consequently, it is generally recommended that items with factor loadings of 0.40 or higher should be retained. This approach ensures that the retained items are more likely to accurately represent the underlying construct and, therefore, provide more meaningful results. (Nunnally 1978; Raykov & Marcoulides, 2011). EFA was performed using SPPSS 28.

Phase 3: Scale Evaluation

Tests of Dimensionality: Dimensionality can be tested using independent cluster model (ICM) confirmatory factor analysis, bifactor modeling, or measurement invariance.

Confirmatory Factor Analysis: It was utilized to evaluate the most prevalent goodness of fit indicators of the proposed model against the maximum likelihood estimation threshold (Morin et al. 2016). CFA was performed using AMOS 21. Therefore, the chi-square test of exact fit, Goodness of fit index (GFI), Root Mean Square Error of Approximation (RMSEA), Tucker Lewis Index (TLI), Comparative Fit Index (CFI) were investigated (Bond & Fox 2013).

Tests of Reliability and Validity: A composite reliability index was used and Cronbach's alpha was applied to assess internal consistency. The validity of an instrument can be assessed in multiple ways. Content validity, which is performed before administering the instrument to the target population, is the most common validity test (as described in Step 2). Discriminant validity was tested by comparing the AVE of each variable factor with maximum shared variance (MSV) and average shared variance (ASV). AVE exceeded of shared variance which indicates that the construct has discriminant validity (Fornell & Larcker, 1981).

Ethical Considerations

The research was carried out with the approval of the Universiti Kebangsaan Malaysia Ethics Committee (UKM PPP/111/8/JEP-2023-475) and all subjects gave their informed permission before taking part.

Results

Table 1 displays the demographic information of law enforcement personnel that were used in the exploratory and confirmatory factor analyses. EFA had an average age of 3.01 ± 0.56 years, while CFA had an average age of 2.43 ± 1.16 years (Table 1). In the qualitative phase, initially, 80 items were obtained. Afterward, items were evaluated by experts. The expert team reviewed, rewritten or removed the items. Items agreed by experts by indicating items are essential, not essential or modified. At the end, 22 items remained in the final scale (Fig. 1). In the evaluation phase, the Cronbach value of IPTSQ was 0.88. All of the items in the column for Cronbach's Alpha value of if item deleted were greater than 0.85.

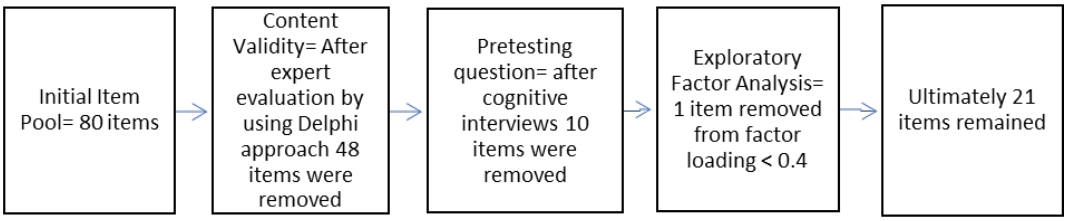
Table 1

Demographic Characteristics of Police Officials

Variables	Mean (SD)/ N(%)	Exploratory Factor Analysis	Confirmatory Factor Analysis	Variables	Mean (SD)/ N(%)	Exploratory Factor Analysis	Confirmatory Factor Analysis
Age:				Education		160 (100)	460 (100)
21-30 Years				M.Phil/above		1 (.6)	148 (32.2)
31-40 Years	Mean (SD)	3.01 (.56)	2.43 (1.16)	M.A	N (%)	6(3.8)	127 (27.6)
41-50 Years				B.A		30(18.8)	137 (29.8)
51-60 Years				F.A.		59(36.9)	46 (10.0)
				Matriculation		64 (40.0)	2 (0.4)
Gender		160 (100)	460 (100)	Work hours			
Male	N (%)	145 (90.6)	402 (87.4)	1-8	Mean (SD)	1.81 (.39)	1.72 (.44)
Female		15 (9.4)	58 (12.6)	9-16			

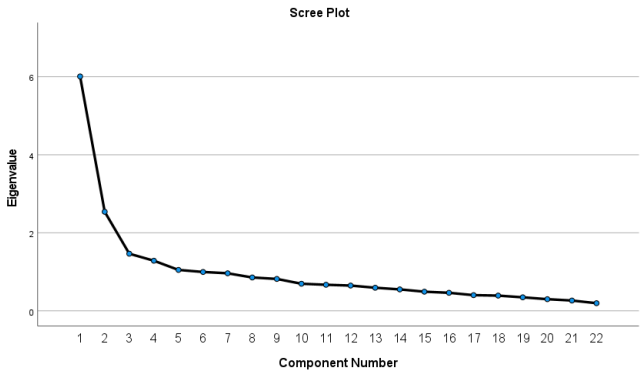
				Designation			460 (100)
Monthly income				Constable		160 (100)	143 (31.1)
35K-44K, 45K-54K 55K-64K 65K-74K 75K-84K 85K-94K 95K-1lac+	Mean (SD)	2.37 (.92)	2.69 (1.73)	Head-Constable	N (%)	5 (3.1)	139 (30.2)
				ASI		144(90.0)	55 (12.0)
				Sub Inspector		2(1.3)	88 (19.1)
				Inspectors		9(5.6)	35 (7.6)
Experience							
1-5 Years, 6-10 Years, 11-15 Years, 16-20 Years, 21-25 Years, 26-30 Years, 31-35 Years, >35Yeras	Mean (SD)`	3.64 (1.30)	3.51 (2.24)	Nature of work		160 (100)	460 (100)
				Office Work	N (%)	34 (21.3)	82 (17.8)
				Field Work		64 (40.0)	186 (40.4)
				Both		62 (38.8)	192 (41.7)
Shift of work		160 (100)	460 (100)				
Day,	N (%)	49 (30.6)	123 (26.7)				
Night		16(10.0))	33 (7.2)				
Both		95 (59.4)	304 (66.1)				

Figure 1
A summary of the development of IPTSQ



To conduct the exploratory factor analysis (EFA), 22 items were analysed using IBM SPSS 28.0 and the principal component analysis (PCA) method. Before running PCA, we made sure factor analysis was a good fit. The Kaiser-Meyer-Olkin test value was 0.833, which exceeds the recommended value of 0.60 (Kaiser, 1970). Barlett's Test of Sphericity was significant ($p<0.001$) (Bartlett, 2013). There was enough correlation between the variables to conduct an EFA, as shown by the correlation matrix, which had coefficients of.3 and higher. Factor analysis can now move forward because the study's total sample size was sufficient (Ehido et al., 2020; Muda et al. 2018, 2020; Shkeer & Awang, 2019). PCA showed the presence of five components with eigenvalues greater than 1, explaining 27.31%, 11.5%, 6.7%, 5.8%, and 4.77% of the variance, respectively. The observation of the scree plot showed a distinct break after the second component. Two factor solutions were suggested by the scree plot (Fig. 2).

Figure 2
Scree plot



The decision to investigate further was taken based on Catell's (1966) scree test, which concluded that only two components should be retained. The results from Parallel Analysis supported this conclusion, as only two components had eigenvalues

that exceeded the criterion values for a randomly generated data matrix of the same size. (22 variables × 160 respondents) see in Table 2 below.

Table 2
Decision of Retained Factors

Component number	Actual Eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	6.109	1.7361	Accept
2	2.540	1.6017	Accept
3	1.465	1.5003	Reject
4	1.285	1.4198	Reject
5	1.049	1.3416	Reject

Scree plot analysis was rerun with two factors with orthogonal rotation, because three factors did not seem sensible, so it was decided to rerun the analysis with two factor solution with (varimax) rotation. Factors' variances overlap by 10% or more when the correlations are greater than.32.so oblique rotation should be chosen. Otherwise, orthogonal rotation can be used. To better understand the correlation matrix, it is recommended to run oblique rotation initially, which is .24, its means that both components are unrelated so orthogonal rotation (varimax) was run.

It was clear from the eigenvalues that the first component accounted for 27.31% of the variance, second factor explained 11.55% of the variance, and in combination explained 38.86 % of the variance. The eigenvalues of two factor solution were 6.10 and 2.54 respectively. Factor loadings of the rotated component matrix were considered because it provided the well-structured factor solution. These two factors contained 12 (unreasonable police tasks) and 9 (unnecessary police tasks) respectively. Reliability analysis of these two factors revealed Cronbach's alpha for factor 1 unreasonable illegitimate police tasks stress = .87 and factor 2 unnecessary illegitimate police tasks stress.72. Loadings of the rotated component matrix were used to select items with a criterion of 0.40 or higher (Brown et al., 2012). See table 3:

Table 3
Illegitimate Police Task Stress Questionnaire exploratory factor analysis

Factors	Items	Factor Loadings	% Variance
Unreasonable illegitimate police task stress	It is unreasonable to compel investigation of false cases.	.843	27.31
	Forcing me to file false cases is unreasonable.	.800	
	It is unreasonable to perform illegal or unlawful work for political people's pleasure.	.757	
	It is unreasonable to abuse subordinates.	.736	
	Improper and inadequate weapons and untimely duty on processions are unreasonable.	.596	
	Deploying unorganized personnel on processions and crowds is unreasonable	.573	
	It gets me into trouble when not letting the right people into the investigation.	.539	
	It is unfair for employees to spend petrol from their own pocket for duty.	.538	
	Using the police for unconstitutional purposes is unreasonable.	.528	
	It is unreasonable to burden subordinate officials with personal affairs by removing them from departmental affairs.	.524	

Factors	Items	Factor Loadings	% Variance
Unnecessary illegitimate police task stress	Demonstration of work/work for show in the department is unreasonable.	.512	11.55
	It is unreasonable to alter the crime statistics.	.489	
	Giving VVIP protocol is unnecessary.	.629	
	In the age of modern technology, artificial blockade is unnecessary.	.606	
	Artificial blockade is unnecessary	.581	
	To present the accused from the judicial lockup to the court is unnecessary in the age of modern technology	.576	
	Additional duty is unnecessary	.565	
	It is unnecessary for the police to perform traffic duties on the roads.	.530	
	To investigate as per the will of the superior officers is unnecessary.	.517	
	Keep the traditional paper record is unnecessary in the presence of the front desk computer system	.412	
	Making political arrests are unnecessary.	.410	
	It is unnecessary to go to remote areas with very limited resources to catch criminals.	.396	

In exploratory factor analysis, one item (statement# It is unnecessary to go to remote areas with very limited resources to catch criminals) was taken off the scale because it failed to meet the minimum factor loading requirement. 21 items persisted in the final questionnaire. Item characteristics of IPTSQ are mentioned in table 4.

Table 4

Item Characteristics of Subscales of Illegitimate Police Task Stress Questionnaire (IPTSQ)

		M	SD	rit	**α** if item deleted
1	Additional duty is unnecessary	3.1	1.06	.31	.86
2	Artificial blockade is unnecessary	2.5	1.19	.28	.86
3	To investigate as per the will of the superior officers is unnecessary.	3.0	1.55	.32	.85
4	Making political arrests are unnecessary.	2.6	1.46	.20	.85
5	Keep the traditional paper record is unnecessary in the presence of the front desk computer system	3.4	1.47	.25	.86
6	In the age of modern technology, artificial blockade is unnecessary.	2.9	1.44	.35	.86
7	Giving VVIP protocol is unnecessary.	3.1	1.52	.31	.85
8	Using the police for unconstitutional purposes is unreasonable.	3.1	1.73	.18	.85
9g	It is unreasonable to alter the crime statistics.	2.7	1.70	.24	.85
10	To present the accused from the judicial lockup to the court is unnecessary in the age of modern technology.	2.9	1.65	.14	.86
11	Demonstration of work/work for show in the department is unreasonable.	3.0	1.72	.13	.85

		M	SD	rit	α if item deleted
12	It is unreasonable to burden subordinate officials with personal affairs by removing them from departmental affairs.	3.1	1.74	.18	.85
13	It is unnecessary for the police to perform traffic duties on the roads.	2.6	1.67	.16	.86
14	It is unreasonable to perform illegal or unlawful work for political people's pleasure.	3.7	1.65	.10	.85
15	It is unreasonable to abuse subordinates.	3.6	1.69	.01	.85
16	It gets me into trouble when not letting the right people into the investigation.	3.6	1.51	.06	.85
17	It is unfair for employees to spend petrol from their own pocket for duty.	4.4	1.2	.13	.86
18	Forcing me to file false cases is unreasonable.	3.8	1.57	.02	.85
19	Deploying unorganized personnel on processions and crowds is unreasonable.	3.7	1.49	.01	.85
20	Improper and inadequate weapons and untimely duty on processions are unreasonable	3.6	1.54	.13	.85
21	It is unreasonable to compel investigation of false cases.	3.8	1.50	.13	.85

Note: rit = Item total Correlation

The alpha reliability of all the subscales ranged from .72 to .87. The correlation among the factors is 0.40 wit ***p<.001 which shows that factor-1 (unreasonable illegitimate police tasks) was positively and significantly related to factor-2 (unnecessary illegitimate police tasks). There were moderate relationship between the two factors of Illegitimate

Police tasks. In exploratory factor analysis, one item removed from the scale for not reach the minimum factor loading. 21 items remained in the final questionnaire.

The confirmatory factor analysis's general fit indices pointed to the model's accuracy (Table 6). The variables in IPTSQ structure had appropriate factors (table 9). To assess the reliability of the scale 460 police officials were selected. The cronbach's alpha of the entire scale was 0.88. For the factor 1 unreasonable illegitimate police task stress alpha value is 0.89 and for factor 2 which is unnecessary illegitimate police task stress alpha value is 0.79.

For the factorial validity of the illegitimate police task Stress questionnaire, Confirmatory factor analysis was employed through the structural equation model using AMOS. Model fit presented in table 5. Standardized Regression Loadings of First Order Confirmatory Factor Analysis presented in fig. 3.

Table 5

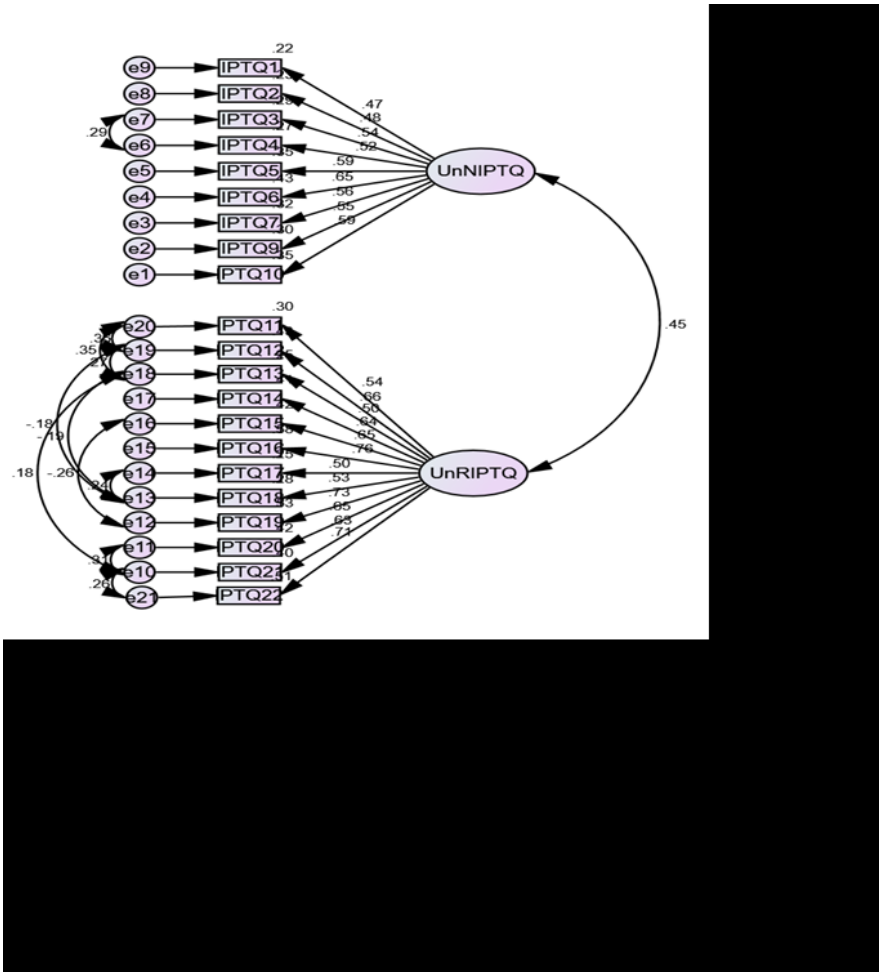
Fit Indices of Illegitimate Police Task Stress Questionnaire for Factor

Model	χ^2	χ^2/df	GFI	CFI	NNFI(TLI)	RMSEA
Initial model	810.308	4.31	.84	.82	.80	.08
Modified first order factor model	489.738	2.76	.90	.90	.89	.06

Note: N=460, All change in chi square values are computed relative to the model, χ^2 >.05. GFI= Goodness of fit index, CFI=comparative fit index, NNFI (TLI) =non-normed fit index; RMSEA=root mean square error of approximation, SRMR=Standardized root mean square, $\Delta\chi^2$ = chi square change.

The findings of the fit indices demonstrated for illegitimate police task questionnaire that shown in table 5. The absolute fit of the modified model for factors were χ^2 (N=460) =489.738, p = .000. The results showed that the data were well-fit by the tested model according to the fit indices. In one key step, the model fit was investigated. Here, we compared the absolute and relative fit indices, which comprise CFI, NFI, and RMSEA. Because of its sensitivity to parameter counts and sample sizes, the chi-square test of absolute model fit is not always the best choice for investigators looking to evaluate a model's overall data fit. According to Hu and Bentler (1999), a χ^2/df ratio between 1 and 3, RMSEA values of .08 or less, and CFI, TLI, NFI, and GFI values of .9 or higher are considered good, while .9 ≤ .8 is considered acceptable. Considering that the initial model had an RMSEA of.08, GFI, CFI, and NNFI values of.84,.82, and.80, respectively, and χ^2/df of 4.31, the model was determined to not fit well based on the descriptive measures of fit.

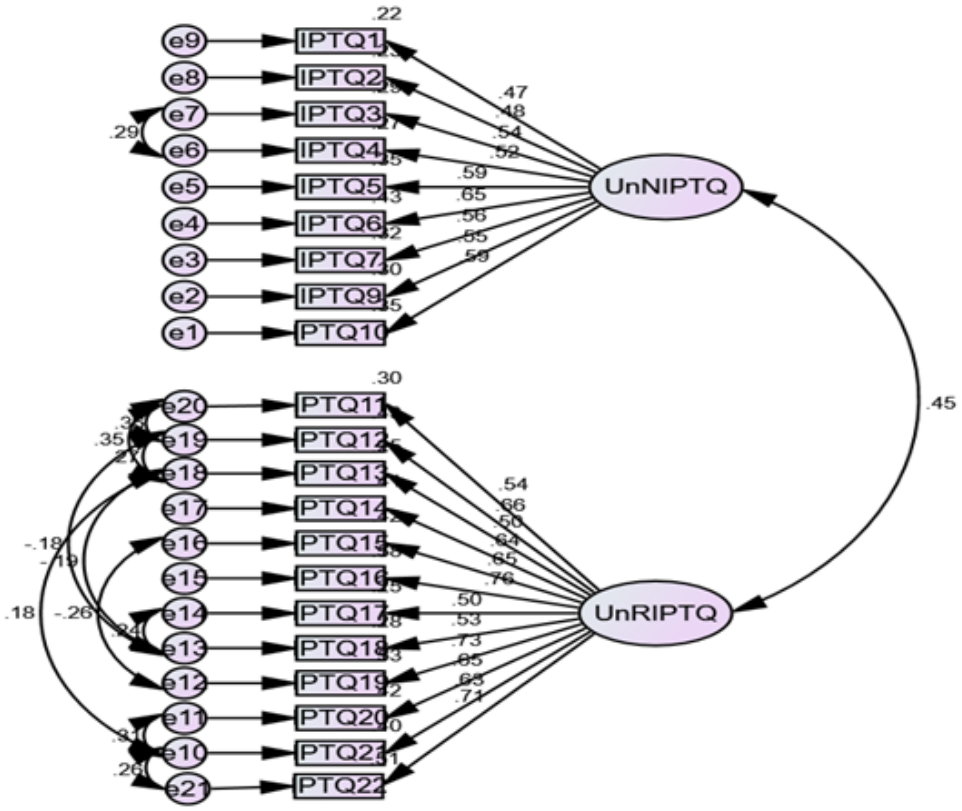
Figure 3
Standardized Regression Loadings of First Order Confirmatory Factor Analysis



Following the modification indices, the procedure of model modification commenced and it shown in fig. 4. Modification indices mentioned covariance between errors of items because they are similar in content (Kenny 2011; Tomás & Oliver 1999) the criteria of modification indices of error covariance should be at least 4.0 (Barnidge & De Zúñiga, 2017). Therefore, only the covariance with a chi-square value of 4 or higher was included. Once again, we compared the absolute and relative fit indices (RMSEA, GFI, CFI, and NNFI). The Root Mean Square Error of approximation (RMSEA) for the modified first and second order model after adding covariance was .06, whereas the GFI, CFI and NNFI values were.90, .90, .88 respectively, while χ^2/df was 2.76. These were accurate enough to fit the model as we can see from the figure 4.

Figure 4

Standardized Regression Loadings of First Order Confirmatory Factor Analysis after Adding Covariance



The two factors' standardised regression loadings of illegitimate police task questionnaire (see table 6).

Table 6
Standardized Regression Loadings of the Items

	Item Description	Loading
1	Additional duty is unnecessary	.47
2	Artificial blockade is unnecessary	.48
3	To investigate as per the will of the superior officers is unnecessary.	.54
4	Making political arrests are unnecessary.	.52
5	Keep the traditional paper record is unnecessary in the presence of the front desk computer system	.59
6	In the age of contemporary technology, artificial blockade is unnecessary.	.65
7	Giving VVIP protocol is unnecessary.	.56
8	It is unnecessary for the police to perform traffic duties on the roads.	.55
9	To present the accused from the judicial lockup to the court is unnecessary in the age of modern technology.	.59
10	It is unreasonable to burden subordinate officials with personal affairs by removing them from departmental affairs.	.54
11	It is unreasonable to perform illegal or unlawful work for political people's pleasure.	66
12	It is unreasonable to abuse subordinates.	.50
13	It gets me into trouble when not letting the right people into the investigation.	.64
14	It is unfair for employees to spend petrol from their own pocket for duty.	.65
15	Forcing me to file false cases is unreasonable.	.76
16	Deploying unorganized personnel on processions and crowds is unreasonable	.50
17	Improper and inadequate weapons and untimely duty on processions are unreasonable	.53
18	It is unreasonable to compel investigation of false cases.	.73
19	Demonstration of work/work for show in the department is unreasonable.	.65
20	Using the police for unconstitutional purposes is unreasonable.	.65
21	It is unreasonable to alter the crime statistics.	.71

Hair and his colleagues argued that the standardized loading should be 0.50 or greater. (Hair et al., 2017). Table 7 shows all item standardised loadings exceed 0.50. The factor load values of all except two items of factor-1 and one item of factor-2 had low loading however it is .47 to .48 which is not a serious issue regarding factor loading because it is approaching the cited criteria. Presents descriptive statistics, reliability, and validity (see table 7).

Table 7

Descriptive Statistics, Reliability, and Validity of the Factors

Factors	K	M	SD	CR	AVE	MSV	ASV
Unnecessary Police Tasks	09	24.08	8.40	0.79	0.30	.20	.20
Unreasonable Police Tasks	12	77.67	12.68	0.89	0.42	.20	.20

Note: k = no. of items CR = Composite Reliability, AVE = Average Variance Extracted, MSV = Maximum Shared Variance, ASV = Average Shared Variance

Table 8

Accepted index threshold and confirmatory factor analysis fitting model

Fitting Indexes	Acceptable Range	IPTSQ results
P-value	>0.05	0.000
RMSEA	Good <0.08, medium 0.08 to 0.1, and weak <0.1	0.08
CFI	>0.9	0.90
NNFI (TLI)	>0.9	0.89
GFI	>0.90	0.90
χ^2/df	Between 1 and 3	2.76

A composite reliability index was used to determine the measures' reliability. The composite reliability index is higher than the minimum recommended level of 0.70, as shown in Table 7. (Bagozzi and Yi, 1988). Hair et al. (2017) states that average variance extracted (AVE) values of 0.50 or higher are required. However, the AVE values for the factors of unnecessary illegitimate police task and unreasonable illegitimate police

task were below this recommended level. However, an acceptable level of convergent validity for a construct is defined by Fornell and Larcker (1981) as an AVE below 0.50 and a composite reliability greater than 0.60. To determine whether the variables have discriminant validity, we compared the AVE of each factor with the MSV and the average shared variance (ASV). AVE exceeded of shared variance which indicates that the construct has discriminant validity (Fornell & Larcker 1981).

Discussion

The current research set out and test a scale that police officers can use to quantify the illegitimate tasks during their duties. A total of twenty-one items and two components make up this survey including unreasonable police task and unnecessary police tasks. Illegitimate tasks are a major cause of stress among employees. They entail any duties that violate the norms of what an employee should be responsible for (Semmer et al., 2015; Wang & Jiang, 2023). World Health Organization define that stress arises when employees are presented work demands that are not matched with their knowledge and abilities (WHO, 2020). Police work is most exhausting and stressful profession. Work stress leads to distressing experiences, can have a substantial negative impact on psychological health (Ding & Kuvaas, 2023; Geronazzo-Alman et al., 2017).

These illegitimate police task stress is a fairly new construct that, in contrast to other stressor models, has not yet been absolutely investigated empirically. Since research into illegitimate tasks is yet limited, The primary focus of this research was to determine if this stressor is significant and applicable to the police profession.

At the very pinnacle of our scale, for both of the factors that contribute to illegitimate police tasks, the following statement was added: please provide your opinion on whether or not the following tasks are unreasonable or unnecessary, and rate them on a five-point Likert scale ranging from never to frequently appropriately. The present study's findings demonstrated satisfactory validity and reliability. An acceptable range of content validity was achieved. The present study's findings demonstrated satisfactory validity and reliability. An acceptable range of content validity was achieved. Polit and his colleagues suggested that in case of five experts the acceptable range of CVI is 1. IPTSQ's factor loading ranged from 0.47 to 0.76.The Spanish version of the Bern Illegitimates Task has a factor loading of 0.53 to 0.89. Moreover, The findings from this research demonstrated 38.86 of the variance in IPTSQ with 21 items and two factors. Another study was done to assess the psychometric properties of the Spanish version of Bern Illegitimate Task Scale on nursing staff. With 8 items and 2 factors (unnecessary and unreasonable). The general BITS of Spanish version described 51.86% of the variance corresponded to items 5–8; for the meantime, the other factor explained 22.1% of the variance for 1-4 items (Valdivieso Portilla et al., 2021). Most of the previous researches used Bern Illegitimate Task Scale (Semmer et al., 2010) for different populations (Bramlage, 2021; Apostel, 2018; Faupal 2016; Eatough, 2016). In contrast, current study is novel as it designed specifically for police

force. It measures unnecessary and unreasonable tasks in police profession. Furthermore, the overall cronbach's alpha reliability of IPTSQ was 0.88 and the Cronbash's alpha of its dimension ranged from 0.79 to 0.89. The other Spanish version of BITS had alpha value 0.89 (Valdivieso Portilla et al., 2021). The Cronbash's alpha for BITS used in another study was 0.92 (Wang, & Zong, 2023). Using confirmatory factor analysis and the chi-square test, authors made sure that the final IPTSQ factor structure model was a satisfactory fit. The significance of the Chi-square test results was determined by considering that the Chi-square value is highly sensitive to the sample size (Kyriazos, 2018), the model fit was also examined regarding other indicators. Two models were proposed by the researchers, and the best fit was chosen. All indications supported the final model fit with two factors.

Conclusion

The present research has played a significant role in developing an indigenous scale on illegitimate police tasks in the context of Pakistani culture. It also help to understand the nature and scope of stress among police employees. This study aimed to design an illegitimate police tasks stress questionnaire consisting of two dimensions and 21 items. The scale is scored on a 5-point Likert scale, ranging from "never" to "frequently". The scale was found to demonstrate good content, convergent and discriminant validity, as well as acceptable internal consistency. The IPTSQ is specifically tailored to be utilized by police officials. Furthermore, the use of the IPTSQ in policy-based research can provide valuable insights and information to police department authorities and decision-makers.

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Saleha Iqbal – significant contribution to the planning and conduct of the study, analysis and interpretation of the results.

Rozmi Bin Ismail – critical revision of methodology and results.

Abdul Rahman Ahmad bin Badayai – critical revision of results.

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Conflict of Interest Information

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Pre-Service Teachers Perspectives on Stem – Science, Technology, Engineering, and Mathematics

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Abstract

Introduction. Science, Technology, Engineering, and Mathematics which is commonly abbreviated as STEM is one of the contemporary teaching and learning approaches in education. STEM is closely related to education in schools. Several studies wanted to find out how STEM influences students in teaching and learning. Research at the level of higher education has not been done much. More specifically, research on STEM among pre-service teachers has not been widely conducted. This study aims to determine how pre-service teachers perceive each aspect of STEM. **Methods**. The research method used in this research is qualitative. The data collection techniques in this study were interviews with 49 Pre-Service Teachers. The data obtained were then analyzed using coding techniques. **Results and Discussion**. The results of the data show that Pre-Service Teachers suggest activities of: (1) Involving Science Concept, (2) Making Experiment, (3) Measuring, (4) Observing, (5) Involving Scientific Phenomenon, and (6) Asking Scientific Questions on aspects of science. In the Technology aspect, the activities are: (1) Using Software, (2) Using Computer, (3) Using Internet and (4) Using Smartphone. In the Engineering aspect, the activities are: (1) Designing Problem Solving Procedure, (2) Making Product, and (3) Operating Tool. Meanwhile, in the Mathematics aspect, the activities are: (1) Using Numbers, (2) Calculating, (3) Finding Patterns, and (4) Using Formulas.

Keywords

activities, engineering, mathematics, perspectives, pre-service teacher, technology, sciences, STEM activities, STEM education, teaching STEM

For citation

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Introduction

Science, Technology, Engineering, and Mathematics which is commonly abbreviated as STEM is one of the contemporary teaching and learning approaches in education (Chiang, 2020; Chiang et al., 2019; Liu, Chubarkova & Kharakhordina, 2020; Makino et al., 2018; Wang & Chiang, 2020). Teaching and learning that uses the STEM approach will include aspects of science, technology, engineering, and mathematics in its teaching and learning. This approach has been adopted by many countries in the world (Dinh & Nguyen, 2020; Hartmann, Mouton & Ertl, 2022; Lee, Hsu & Chang, 2019; Plutzer & Hannah, 2018; Thibaut, Knipprath, Dehaene & Depaepe, 2018). In Southeast Asia, the Philippines is a country that has included STEM in its education curriculum. STEM in the Philippines has become a subject taught at the secondary school level. Currently there is a wide range of digital tools that can be used in science, technology, engineering and mathematics education (the STEM disciplines) during primary and secondary school (de las Cuevas, García-Arenas & Rico, 2022; Lowrie & Larkin, 2020; Purzer & Shelley, 2018; Saat et al., 2021; Simó, Lagarón & Rodríguez, 2020).

Unlike the Philippines, Indonesia has not included STEM in the curriculum. The absence of STEM in the education curriculum in Indonesia could be due to the absence of operational guidelines for including or integrating STEM in teaching and learning (Amany, 2023; Mutmainah, 2023). Research on the topic of STEM activities has been widely carried out in several journals (Fung, 2020; Kefalis & Drigas, 2019; Levanova et al., 2020; López-Díaz & Peña, 2022; Salar, 2021). Although the research has the topic of STEM activities, this research has not examined what activities can be applied to include or integrate STEM in teaching and learning. Therefore, research that examines what activities can be carried out in each aspect of STEM is important (Nicol et al., 2019; Sterrett et al., 2020; Yıldırım, 2020).

STEM is closely related to education in schools (Falloon et al., 2021; López & Cabello, 2022; Morales-Doyle & Gutstein, 2019; Nguyen, 2020). Several studies wanted to find out how STEM influences students in teaching and learning. Research at the level of higher education has not been done much. More specifically, research on STEM among pre-

service teachers has not been widely conducted. From this description, this study aims to determine how pre-service teachers perceive each aspect of STEM.

Methods

The research method used is a qualitative research method. Meanwhile, the research approach in this study is the Grounded Theory approach. Grounded theory is a qualitative research approach that is used to create theories that explain problems at the level of a broad conceptual, process, action or interaction on a substantive topic (Creswell, 2009). The subjects in this study were Pre-Service Teachers from one of the universities in the city of Purwokerto.

Data Collection Tools

Data collection technique in this research is interview. Respondents from the interview were 49 Pre-Service Teachers. The interviews conducted consisted of 4 questions according to Table 1.

Table 1
Interviews Questions List

No.	Questions
1.	Tell me how did you integrating Science into your teaching and learning?
2.	Tell me how did you integrating Technology into your teaching and learning?
3.	Tell me how did you integrating Engineering into your teaching and learning?
4.	Tell me how did you integrating Mathematics into your teaching and learning?

Data Analysis

Data analysis is the process of systematically searching and compiling data obtained from interviews, field notes and other materials, so that they are easy to understand, and the findings can be informed to others (Bogdan & Bikien, 1998). Activities in qualitative data analysis are carried out interactively and take place continuously until complete until the data is saturated (Miles & A. Huberman, 1994). Activities in data analysis consist of data reduction, data display, and drawing conclusion/verification.

In addition to using these techniques, this study also uses qualitative data analysis techniques using coding. Coding is an activity to code an important information in a data. Code is a short word or phrase that summarizes, emphasizes the message, or captures

the essence of the data. In simple terms, code is a short word or phrase that has the essence of a segment in the data (Saldana, 2009).

Data Validity

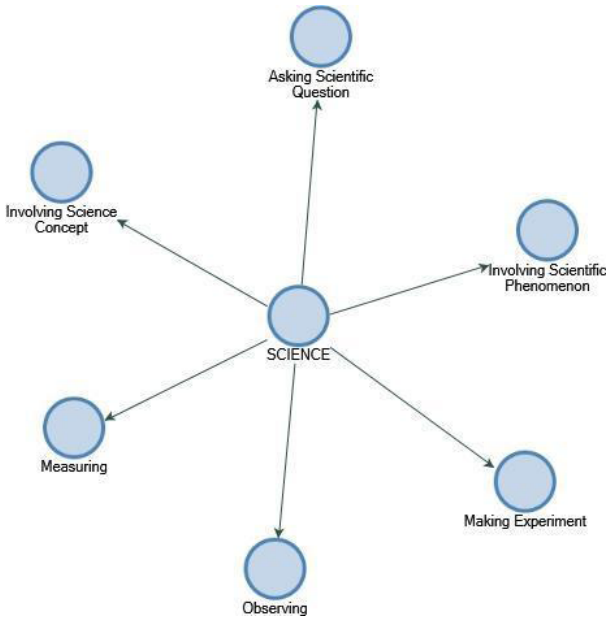
The data validity technique is an effort to check the accuracy of the results of qualitative research by applying certain procedures. There are 3 types of data validity techniques, namely triangulation, member checking, and external auditing (Creswell, 2009). The validity of the data taken in this study is triangulation. Triangulation consists of 3 types, namely time triangulation, source triangulation, and technical triangulation (Sugiyono, 2015). This research uses source triangulation. Source triangulation in this study is a procedure for comparing data from 1 respondent with other respondents. If a data is found in more than 1 respondent, it means that the data is valid.

Results

Pre-Service Teachers Perspectives about Science in STEM

Pre-Service Teachers have 6 suggested activities that can be done in integrating Science in teaching and learning. The six activities are shown in Figure 1.

Figure 1
Pre-Service Teachers Perspectives about Science Activities



The first activity that can be done to integrate Science in STEM is the Involving Science Concept. The statement of one respondent who mentioned the Involving Science Concept is as follows:

- "Science allows children to conduct experiments (experiments), what is meant in this case is not a complicated process that must be mastered by children to understand the concept of a thing but on how they can know the way or process of something happening and why something can happen."

This is also supported by other respondents as follows:

- "Science provides knowledge to students about the laws and concepts that apply in nature."

Some Pre-Service Teachers are of the view that Science in STEM can be done by Making Experiments. This was stated by one respondent as follows:

- "Inviting students to do experiments so that they can understand the concept of something, know the way or process of something happening and why something can happen."

In addition to the respondents above, there are other respondents who stated a similar statement as follows:

- "In each teaching and learning, it is expected that students are able to understand and apply the material that has been obtained during teaching and learning such as hands-on practice in places such as acid-base testing experiments, experiments using a microscope, etc. Educators must also be creative in teaching students so that students easily accept the material well."

Measuring is one of the activities that can be done in the Science aspect of STEM. This was stated by at least 2 respondents as follows:

- "By studying real events such as natural phenomena that occur that involve observation and measurement."
- "Science is an activity of exploring, observing, and conducting experiments. When they want to try a formula to calculate the height of a tree, students can be asked to go directly into the field, measure and observe for themselves."

Meanwhile, Observing is expressed by 5 respondents. Two statements are stated as follows:

- "Science is an activity of exploring, observing, and conducting experiments. When they want to try a formula to calculate the height of a tree, students can be asked to go directly into the field, measure and observe for themselves."
- "Linking teaching and learning materials with something that exists in nature. Bringing the teaching and learning process outside the room so you can observe the natural surroundings directly."

The last two findings found in the research were that several Pre-Service Teachers

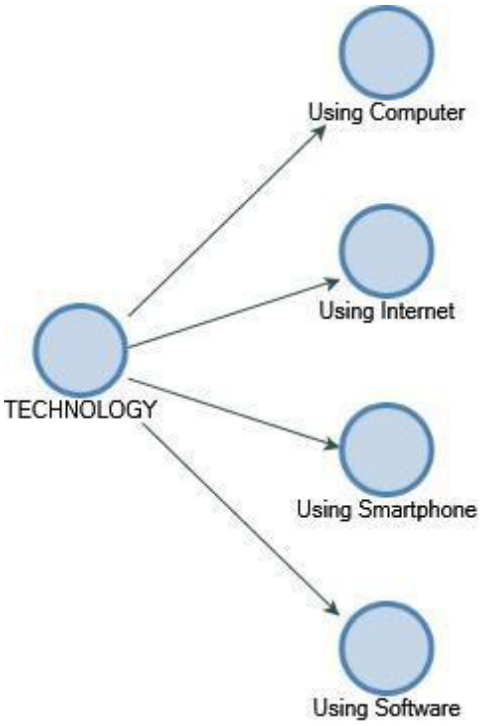
stated that the activities that could be done in the Science aspect were Involving Scientific Phenomenon and Asking Scientific Questions. Some of the respondents' statements about these 2 activities are as follows:

- "The element of science that I put into teaching and learning is about a logical thought about natural phenomena that is based on evidence."
- "Science is the study of natural events that involves investigation, research, and measurement to explain the causes and effects of natural phenomena."
- "To identify the evidence needed to answer scientific questions and answer(solve) problems in human life."
- "The trick is to relate the lessons learned to science by first asking scientific questions first."

Pre-Service Teachers Perspectives about Technology in STEM

In the Technology aspect, Pre-Service Teachers are of the view that integrating Technology in STEM can be done by using several assistive devices. Assistive devices that can be used such as Computer, Internet, Smartphone, and Software. This finding is in accordance with Figure 2.

Figure 2
Pre-Service Teachers Perspectives about Science Activities



In contemporary teaching and learning, Using Computer and Software has often been used in teaching and learning. This is what causes some respondents to state that Using Computer and Software is one of the roles of Technology in STEM. One of the respondents who stated the statement was as follows:

- "Technology can also make it easier for students to find and increase access to teaching and learning. For example, such as applications that are used as a tool to help students understand the material other than that delivered by the teacher in the classroom."
- "To include elements of technology in teaching and learning, you can train the use of applications that support teaching and learning to students."
- "Training students' critical thinking skills in solving problems through collaboration and communication using computer technology."
- "By studying computer technology to support teaching and learning."

Using Smartphone in teaching and learning is not easy. However, Using Smartphone is one thing that can be done in integrating Technology in STEM. This was stated by one of the Pre-Service Teachers as follows.

- "Using a Smartphone connected to the internet when teaching and learning and also a laptop."

This is in line with the statement of other Pre-Service Teachers as follows:

- "I include elements of technology in teaching and learning, for example using a laptop or Smartphone in which there are several applications or media for teaching and learning with skills or a system that is used to regulate society, organization, knowledge or design and use an artificial tool that can facilitate profession."

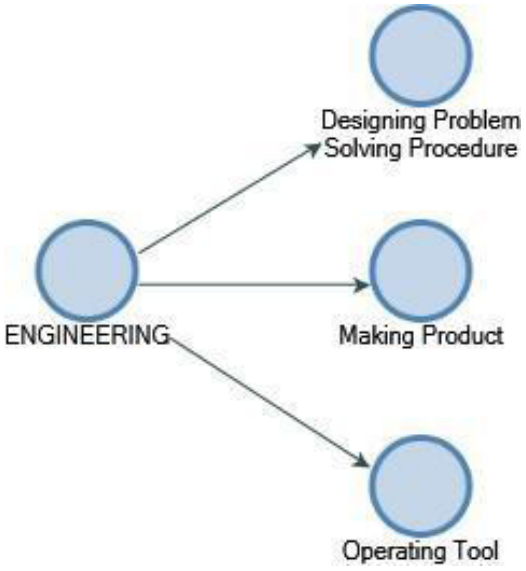
The last finding on the Technology aspect is that several respondents stated that Technology activities can be done by Using the Internet. This finding is based on information from several respondents as follows:

4. "Teaching and learning occasionally uses an LCD projector to play videos or deliver material in ppt format. Apart from that, they do teaching and learning using computer and internet media."
5. "Internet, computer programming, digital technology."

Pre-Service Teachers Perspectives about Engineering in STEM

In the engineering aspect, this study found 3 findings. These three findings are illustrated in Figure 3.

Figure 3
Pre-Service Teachers Perspectives about Engineering Activities



The first finding is Designing Problem Solving Procedure. This finding was stated by the most respondents compared to other findings. This finding was stated by 6 respondents. Some of his statements are as follows:

- "Provides knowledge to operate or design a procedure to solve a problem."
- "Operating or designing a procedure to solve a problem."

The next finding is Making Product. Product Making Activities are activities that can be done in the Engineering aspect in STEM. This is stated by the respondents as follows:

- "We can make or create something together with students to be able to learn something."

Other respondents also expressed the following opinion:

- "By making subjects on engineering where the goal is that students are expected to be able to make something useful in the future, with advanced technology, this is certainly very helpful."

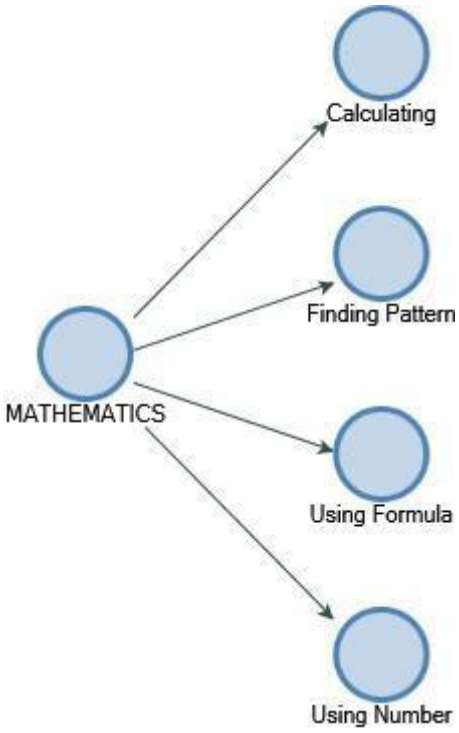
The last finding on the Engineering aspect is the Operating Tool. Only 2 respondents stated this statement as follows:

- "A person's skill in operating a tool/object or assembling something."
- "By inviting students to operate tools/objects or assemble something."

Pre-Service Teachers Perspectives about Mathematics in STEM

There are 4 activities that can be done in the Mathematics aspect in STEM according to Pre-Service Teachers. The four activities are in accordance with Figure 4.

Figure 4
Pre-Service Teachers Perspectives about Engineering Activities



Activities Calculating and Using Numbers are fundamental activities in Mathematics. Therefore, Calculating was expressed the most by Pre-Service Teachers when asked about the role of Mathematics in STEM. Some statements of Pre-Service Teachers are as follows:

- "Connecting between quantities, pattern numbers, and spaces requires only logical arguments without or accompanied by empirical evidence."
- "The linking of mathematical elements in teaching and learning can be provided by connecting quantities, numbers and spaces that only require logical arguments without or accompanied by empirical evidence."
- "Teaching logical calculations."
- "In everyday life, including in teaching and learning, students must relate to numbers or calculations. Students must be taught how to count carefully so that

there are no errors in the calculations. In solving math problems there are many strategies or methods that students can use in solving these problems so students must be able to choose what strategies are easy to use in solving the problem."

The next activity found in this research is Finding Pattern. Activities Finding Pattern is one of the core roles of Mathematics not only in STEM. These activities are described by one of the Pre-Service Teachers as follows:

- "Incorporating elements of mathematics in teaching and learning can be done by introducing through patterns and so on."

Another Pre-Service Teacher also supports this statement by providing the following statement.

- "By using and applying patterns, relationships, numbers, quantities, and spaces and providing a language for Technology, Engineering, and Mathematics."

The last activity found on the role of Mathematics in STEM is Using Formula. These activities are suggested by 8 Pre-Service Teachers with the following statements.

- "Incorporating some mathematical formulas or materials into teaching and learning."
- "Exemplifying the formulas that exist in mathematics in everyday life."

The STEM activities found in this study can be seen more easily in Table 2.

Table 2
STEM Activities

No.	STEM Aspect	Activities
1.	Science	1. Involving Science Concept 2. Making Experiment 3. Measuring 4. Observing 5. Involving Scientific Phenomenon 6. Asking Scientific Question

No.	STEM Aspect	Activities
2.	Technology	1. Using Software 2. Using Computer 3. Using Internet 4. Using Smartphone
3.	Engineering	1. Designing Problem Solving Procedure 2. Making Product 3. Operating Tool
4.	Mathematics	1. Using Number 2. Calculating 3. Finding Pattern 4. Using Formula

Discussion

Science, Technology, Engineering, and Mathematics (STEM) is an approach in teaching and learning that has been used for a long time. Research on STEM activities has been done. A study showed that giving videos to students during teaching and learning is one thing that can be done in STEM (Fung, 2020). However, there is no theory that provides explicit guidance in implementing STEM in the classroom. In fact, the provision of STEM in the classroom can improve student competence in the 21st century era (Hussin et al., 2019). Therefore, the activities found in this study can provide guidance in the use of STEM. These activities can help In-Service Teachers or Pre-Service Teachers in determining what activities can be done in each aspect of STEM (Salar, 2021).

STEM activities in the Science aspect include: (1) Involving Science Concept, (2) Making Experiment, (3) Measuring, (4) Observing, (5) Involving Scientific Phenomenon, and (6) Asking Scientific Questions. While in the Technology aspect, there are several activities including: (1) Using Software, (2) Using Computer, (3) Using Internet and (4) Using Smartphone. Activities in the Engineering aspect include: (1) Designing Problem Solving Procedure, (2) Making Product, and (3) Operating Tool. In the Mathematics aspect, STEM can be done through activities of: (1) Using Numbers, (2) Calculating, (3) Finding Patterns, and (4) Using Formulas. These activities can be used as a reference for other researchers in implementing STEM in teaching and learning in the classroom.

Conclusion

STEM is teaching and learning that integrates Science, Technology, Engineering, and Mathematics at once. In the Science aspect, In-Service or Pre-Service Teachers can perform activities of: (1) Involving Science Concept, (2) Making Experiment, (3) Measuring, (4) Observing, (5) Involving Scientific Phenomenon, and (6) Asking Scientific Questions. In the Technology aspect, the activities are: (1) Using Software, (2) Using Computer, (3) Using Internet, and (4) Using Smartphone. In the Engineering aspect, the activities are: (1) Designing Problem Solving Procedure, (2) Making Product, and (3) Operating Tool. Meanwhile, in the Mathematics aspect, the activities are: (1) Using Numbers, (2) Calculating, (3) Finding Patterns, and (4) Using Formulas.

- Science aspect activities in STEM are: (1) Involving Science Concept, (2) Making Experiment, (3) Measuring, (4) Observing, (5) Involving Scientific Phenomenon, and (6) Asking Scientific Questions.
- Technology aspect activities in STEM are: (1) Using Software, (2) Using Computer, (3) Using Internet and (4) Using Smartphone.
- Engineering aspect activities in STEM are: (1) Designing Problem Solving Procedure, (2) Making Product, and (3) Operating Tool.
- Mathematics aspect activities in STEM are: (1) Using Numbers, (2) Calculating, (3) Finding Patterns, and (4) Using Formulas.

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The authors have no conflicts of interest to declare.

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Cognitive Resources of Psychoemotional Stability of a Personality in Difficult Living Conditions

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Abstract

Introduction. The article explores the cognitive resources of the psychoemotional "response" to the difficult living conditions of the Covid–19 pandemic period (DLC). DLC is defined as the challenges of a global existential crisis that reflected in the image of the human world, in which a person experiences the limitations of subjective activity and self-realization in the main aspects of being: personal, environmental and socio-psychological. Cognitive resources in the context of DLC are considered as a set of certain aspects of the cognitive sphere, the mobilization of which determines the formation of programs and strategies in the mind of the subject aimed at ensuring personal adaptation in difficult living conditions. Objective: identify the cognitive resources of a psychoemotional "response" to difficult living conditions using the method of comparative analysis. **Methods.** The study involved 112 respondents - civil aviation pilots and medical workers. We used the "Anxiety and Depression" questionnaire (Spielberger), the test for assessing the motivational orientation of the individual (Kuhl), the "Assessing personality reflexivity" questionnaire (Karpov, Ponomareva), and the "Multidimensional-functional diagnostics of responsibility" technique (Pryadein). **Results.** According to the criterion of stability of mental states, two groups of subjects were identified: equilibrium (85 people; n1) and nonequilibrium (27 people; n2). An invariant component of cognitive resources has been established: reflection of activity. Specific resources have identified. In group n1 there were five factors (77.34%): reflection of activity (33.26%); cognitive responsibility (13.34%);

metacognitive control of failure activities (12.68%); responsible metacognitive control of planning activities (9.72%); metacognitive control of failure of retrospective and prospective activities (8.33%). The lack of cognitive resource provision in group n2 is due to three factors (70.30%): control of failure and self-centered responsibility (32.33%); cognitive awareness (23.15%); metacognitive control of activity planning and its success was based on reflection of retrospective activity and communication (14.82%). Specific cognitive resources for civil aviation pilots and medical workers are also highlighted. Discussion. The study made it possible to determine the factors of cognitive resource support for stable and nonequilibrium psycho-emotional states, which contributes to the verification of the concepts of semantic regulation of mental states, metacognitive, resource, subject-resource approaches in modern times.

Keywords

difficult living conditions, mental states, reflection of activity, metacognitive control, responsibility, cognitive resources

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Introduction

The study which we started in the midst of the pandemic of the new coronavirus infection Covid-19 has indicated its relevance in the current period. Human life activity is increasingly being realized in crisis conditions of biogenic, man-made, sociogenic risks. The stable image of the world "yesterday" is opposed by the complexity of the world "today" and the world "tomorrow" – the world of the future.

During the years of the pandemic and in the post-quarantine period, there were various psychological studies, including those involving established original concepts and approaches (e.g. Aspinwall & Taylor, 1992; Ivashkina & Dorofeeva, 2023), actively studied the resources of coping behavior (Kuftyak & Bechter, 2020), the resilience of doctors of "red zones" (Yasko et al., 2021); post-traumatic stress phenomena (Zihan, 2021),

images of individual and public consciousness formed under the stress of the pandemic (Yurevich, 2021). The various data obtained on the phenomenology of the psychological aspects of human life during the period of total biogenic threats they have not lost their relevance today. Moreover, they have the status of regular, stable phenomena in prolonged conditions of difficult life, the established psychological phenomena require further generalization and addition.

Problems

A person's experience of life periods in which he/she is faced with a set of stressful factors it is usually considered in modern literature in the context of concepts of difficult life situations (DLS). Despite the widespread using of the concept of "difficult life situation", it is difficult to talk about its clear operationalization. In V.S. Merlin's works, DLS was considered as a conflict of contradictions which is experienced by a personality between "various sides, properties, relationships and actions of a personality" (Merlin, 2005, p. 103). S.A. Lipatov attempts to identify elements of a difficult life situation, determining that this system is represented by a relatively stable set of needs, skills, values, ideas and the external conditions of life (Lipatov, 2004, p. 13). E.Y. Korzhova focuses especially on the concept of "life situation". The author considers the life situation as a system of objective and subjective elements (external and internal conditions) that combine in human activity at one time or another in his life (Korzhova, 2000, p. 156). Nowadays the concept of "difficult life situation" is used as a unifying for a wide range of phenomena that describes various life difficulties ("extreme situation," "crisis situation," "critical situation," "traumatic situation," "tense situation," "stressful situation," "conflict situation," "fruitful situation," etc.). Each of these concepts is used by different authors to clarify the content specifics of the phenomena being studied and described. Despite the differences in the available approaches, an essential component that unites them is obvious: reliance on the concept of "situation". From all the definitions, there is a very essential quality of the situation which is not clear: time limitation. It is this temporal concentration of the situation which can stimulate a person quickly, subjectively interpret its contents and meanings, and encourages immediate activity (Ermine & Titarenko, 2001, p. 116). During crisis periods of life, when a person's adaptive resources cannot cope with distress, time is refracted through the prism of emotions and feelings, reflection of what is happening. It is stimulate an increased activity in finding ways to overcome contradictions.

As the events of 2020-2022 showed, when the human world plunged into the trials of survival by an attack related to a new coronavirus infection, the analysis of psychological phenomena from the standpoint of a situational approach is not productive enough. The conducted research (Yasko, Babichkova & Pokul, 2021) became the basis for the introduction of the concept of difficult living conditions (DLC).

DLC is a challenge reflected in the image of the human world, a global existential crisis in which a person experiences unpredictably prolonged limitations of subjective

activity, self-realization in the main aspects of being: personal, environmental and socio-psychological. The established content of these aspects shows the pronounced existential and suprasituative nature of the DLC. A central component of all aspects of DLC is anxiety in the face of threats to health and life.

Two significant differences between DLC and DLS can be noted.

- **Temporal characteristic.** If a difficult life situation is limited in time and depends on the content of the crisis that caused it can be predicted in the time space of life, then the duration of the intensity of both the entire cycle and the individual phases of threats that cause difficult living conditions is difficult to objectively predict.
- **A difficult life situation is an individual or group phenomenon.** Difficult living conditions cover wide population segments (racial, national, demographic – gender, age, etc.), which are subjected to permanent anxiety for their own life and the lives of loved ones, for the prospects of the professional path, restriction or radical change in social activity (Yasko, Babichkova & Pokul, 2021).

In the psychology of stress and in determining strategies for overcoming it, maintaining viability, the methodology of resource, subject-resource approaches have been developed (Vodopyanova, 2009, 2016; Larionova, 2017; Tolochek, 2023; Masten & Reed, 2002; Taylor, 2018; Hobfoll 2002, 2003, etc.). Nowadays resources are generally understood as human capabilities (physical and spiritual), mobilizing which the subject implements certain programs and strategies to prevent stress or effectively counteract it (Bodrov, 2006). S. Hobfoll defines resources as objects that are "either very valuable in themselves or act as a means to achieve other important values" (Hobfoll, 2002, p. 307). He identifies four types of resources: objective, social, energy, personal. Personal resources, S. Hobfoll believes, play a crucial, primary role in overcoming stress, and ensure an individual's ability to adapt. The loss of resources or the threat of their loss is the cause of stress (Hobfoll, 2003).

One of the aspects of the search for psychological resources to preserve psycho-emotional stability in crisis periods of life is the analysis of the role of the cognitive sphere in the formation and implementation of the individual's resource base. The research analyzes the reflexive mechanisms actualized by the subject in the processes providing different types of activity (Bodrov, 2006; Karpov & Ponomareva, 2000; Kholodnaya, 2019); substantiates the structure and role of metacognitive activity control (Kuhl, 1981, 1983; Bokovikov, 1999). It is noted that developed reflection is a prerequisite for the "rejection" of direct, often impulsive reactions to what is happening (Kholodnaya, 2016, 2019), and a stressful situation creates conditions for the actualization of an action-oriented motivational disposition, if it is expressed in the system of personal qualities of the subject (Kuhl, 1981).

Crisis phenomena is produced by the challenges of an unstable world destructively affect the self-awareness of the person, the design of self-realization spaces by it, the formation of psychological mechanisms for confronting biogenic, technogenic, sociogenic threats. In this regard, the question of the cognitive resources of the subject's

preservation of psychoemotional stability acquires pronounced relevance both in the research and in the practical aspects.

In the study we relied on the theoretical and methodological foundations of resource (Hobfoll, 2002, 2003), subject-resource (Vodopyanova, 2015) approaches, the concept of reflection (Karpov & Ponomarev, 2000) and metacognitive activity control (Kuhl, 1981, 1983), semantic regulation of mental states (Prokhorov, 2009). The indicated theoretical and methodological orientation allows, in the context of our research, to consider cognitive resources as a set of certain aspects of the cognitive sphere, the mobilization of which determines the formation in the mind of the subject of programs and strategies aimed at ensuring personal adaptation in difficult living conditions.

Aim of the study

The current the study's aim is to identify the cognitive resources of a psychoemotional "response" to difficult living conditions.

We tested the following **hypothesis**: in difficult living conditions, cognitive resources affect indicators of psychoemotional stability both in invariant content and specifically for subjects with stable and non-equilibrium states, as well as different types of professional activities.

Methods

The study was conducted in 2020–2021 during the pandemic of the new coronavirus infection Covid-19.

Sample

The total sample consisted of 112 respondents who answered positively during the initial survey to the question: "Is the current period of life or its individual stages difficult for you?". To conduct a comparative analysis, two professional segments were included in the sample:

- 58 people are civil aviation pilots (hereinafter referred to as CA pilots); all respondents are men;
- 54 people – medical workers of hospitals in Moscow and Krasnodar (doctors, nurses; 35 people / 64.8% – women; 19 people / 35.2% – men).

Methodology

Analysis of mental states in difficult living conditions

- The questionnaire "Anxiety and depression" (Ch. Spielberger).

The methodology allows us to determine the level of neuropsychic reaction to the stress of difficult living conditions (Vodopyanova, 2009, 137–138).

Study of cognitive resources

- Test for assessing the motivational orientation of a person (J. Kuhl; adaptation by A. Bokovikov).

The questionnaire of J. Kulya is based on the concept of metacognitive control and is designed to assess the ratio of national (AO) and situational (CO) control modes in situations of success (CSA), failure (CFA) and planning (CPA) activities. The sum of points on each scale (max. the value of 20 points) is a numerical expression of AO and CO-dispositions. An indicator of less than ten is interpreted as a manifestation of the CO mode; more than ten is the AO mode of control (Bokovikov, 1999).

- Questionnaire "Assessment of personality reflexivity" (A. Karpov. In Ponomareva, 2000).

The methodology allows us to establish the features of the respondents' critical assessment of their activities. Four types of reflection of activity are analyzed: communication and interaction with other people (RC); retrospective (RPA); perspective / future (RFA); actual / present (RRA), as well as the general /integral level of reflection (IR) as the sum of indicators for all statements of the questionnaire. Each type of reflection is diagnosed by eight statements evaluated on a 7-point scale (from "absolutely wrong" / 1 point) to "absolutely right" / 7 points). When interpreting the test results, we relied on the standardization data provided by the authors of the methodology (Table 1).

Table 1
Ranges of diagnostic indicators for determining levels of reflection

Types of reflection	Levels		
	Low	Average	High
General reflection (IR)	≥ 80 – 122	123 – 147	148 – 189
Partial reflection	≥ 35	36 – 44	45 – 56

- The methodology of "Multidimensional functional diagnostics of responsibility" (V. Pryadein, 2014).

According to V. P. Pryadein's concept, responsibility should be considered as a personal quality in which operational (naturally defined) and meaningful (lifetime acquired) responsibility are integrated. In the conducted research, the content sphere

was analyzed, which, according to the plan. B. Pryadeina includes three components: motivational; cognitive and productive. Each component includes two scales that allow you to see how socio- or self-centered the analyzed component of responsibility is. The results presented consider a cognitive component that contains two poles: "cognitive meaningfulness" – "cognitive awareness." Cognitive meaningfulness (CM) represents the sociocentric side of responsibility. A person with pronounced cognitive comprehension has the ability to comprehend responsibility holistically, the ability to grasp its core basis; considers responsibility from the standpoint of duty, conscience. Cognitive awareness (CA) refers to the self-centered side of responsibility. It is characterized by a lack of understanding of responsibility, focusing on one sometimes non-specific side of the case. From the point of view of V. Pryadein, responsibility here can be masked by diligence as a personal trait (Pryadein, 2014). The schools of CM and CA include five statements out of 30, representing the diagnosis of a meaningful area of responsibility in the questionnaire. The assessment is based on the use of a 7-point scale, respectively, the maximum score on each scale of the questionnaire is 35 points. The predominance of socio- or self-centered cognitive responsibility is determined by comparing the results of calculating diagnostic indicators.

The methods of parametric (M; SD; t-Student's criterion; r-Pearson's criterion), nonparametric (φ*-Fisher's criterion), multidimensional mathematical statistics (Varimax-rotation; estimation of the uniformity of variance in the data for the analyzed groups of subjects was carried out using Levin's F-criterion) were used in data processing. The standard SPSS-26 package is used for statistical data processing.

Results

Descriptive Statistic

Analysis of anxiety and depression

From the data obtained we can state that despite the positive average values of the coefficients indexing the levels of anxiety and depression in the whole sample there is a significant variance in individual values (Mkt = 4.47 $\pm$ 3.71; Mkd = 3.78 $\pm$ 3.24). Sorting showed that 75.9% of subjects (85 people) respond to difficult living conditions with stable (equilibrium) states do not experience increased anxiety or depression (Mkt = 6.1 $\pm$ 2.00; Mkd = 5.30 $\pm$ 1.69). However, 24.1% of the respondents (27 people) found nonequilibrium states which is reflected in the average values of the coefficients: Mkt = 0.92 $\pm$ 2.56; Mkd = -1.10 $\pm$ 1.77). The comparison shows that at a high level of significance ($p < 0.001$), the indices is determining the degree of stability of emotional states in subgroup n1 are higher than in subgroup n2 (for the state of "anxiety" $t = 13.01$; for the state of "depression" $t = 16.65$).

The obtained result provides a basis for further analysis to differentiate the sample by levels of stability of mental states into two subgroups: n1 (85 people) and n2 (27 people) – Table 2.

Table 2
The results of the analysis of diagnostic data for anxiety and depression

Samples	Anxiety (Mkt)	Depression (Mkd)
N (112 people)	4,47 ± 3,71	3,78 ± 3,24
n_1 (85 people)	6,10 ± 2,00	5,30 ± 1,69
n_2 (27 people))	0,92 ±2 ,56	–1,10 ± 1,77
t (n_1 ⇿ n_2)	*13,01***	*16,65***
	n_1 (85 people)	
pilots- CA (49 people)	6,38 ± 2,46	5,42 ± 2,26
med.workers(36 people)	5,80 ± 1,54	5,28 ± 1,12
t (pilots ⇿ m/w)	*1,52*	*0,16*
men (68 people.)	6,92 ± 1,64	5,90 ± 2,06
women (17 people)	5,18 ± 2,36	4,70 ± 1,32
t (m ⇿ w)	*2,87**	*2,96**
	n_2 (27 people)	
pilots CA (9 people)	0,98 ± 2,68	0,86 ± 1,14
med.workers (18 people)	0,86 ± 2,44	–2,90 ± 2,38
t (pilots ⇿ m/w)	*0,11*	*5,65***
men (9 people)	0,98 ± 2,68	0,86 ± 1,14
women (18 people.)	0,86 ± 2,44	–2,90 ± 2,38
t (m ⇿ w)	*0,11*	*5,65***

Note. *The level of significance of the differences: * p < 0.01; ** p < 0.001. assessment according to the t-Student criterion.*

If we consider the composition of the selected subgroups by leading activity and by gender we note that of the 85 people included in subgroup n1, 57.6% (49 people) are CA pilots, and the remaining 42.4% (36 people) are medical workers. By gender, the n1 subsample included 80.0% (68 people) of men and 20.0% (17 people) of women. Of the

27 people included in subgroup n2, 33.3% (9 people) are respondents representing CA pilots, the remaining 66.7% (18 people) are medical workers. 33.3% (9 people) are men; 66.7% (18 people) are women.

Analysis of the results according to the data of the subsample n1 (stable, equilibrium states)

There are no significant differences in the indices determining the severity of anxiety in comparison with "pilots and medical workers" (at $t = 1.52$ $p > 0.05$). At the same time both indicators exceed the threshold of the boundary of uncertain values and a stable level (5.36): the Mkt for pilots is 6.38 ± 2.46, and for medical workers 5.80 ± 1.54.

A comparison of the indicators of the anxiety index in the female and male parts of the n1 subsample shows that women are characterized by a manifestation of situational anxiety, since the Mkt of women is below the threshold of the boundary of uncertain values and a stable level ($Mk = 5.18 \pm 2.36$). Of the 17 women who made up the n1 subsample, the indicators are in the range of boundary values (from -1.28 to 5.36) 8 people (47.1%) were found. Among men, $Mkt = 6.92 \pm 1.64$, and boundary values were noted in 12 individual indicators (10.5%). These data also determine the reliability of the differences in the indices determining the level of severity of anxiety in comparison with "men and women": at $t = 2.87$, $p < 0.05$.

There are also no significant differences in the indices of depression in comparison with "pilots and medical workers" ($t = 0.16$). However, the indicator in the group of medical workers is at the threshold of the boundary of uncertain values and a stable level: $Mkt = 5.28 \pm 1.12$. The situational manifestation of the state of psychological depression was shown by 8 employees of polyclinics (22.2%), but all indices have a positive value (from 3.18 to 5.04).

A comparison of the depression index in the female and male parts of the n1 subsample shows not only more pronounced stability in men ($Mkd = 5.90 \pm 2.06$ versus 4.70 ± 1.32; $t = 2.96$, $p < 0.05$), but also differences in the ranges of depression intensity. In women, the indicator is in the zone of uncertain values that is depression can manifest itself situationally. A comparison of the proportions of the representation of indicators of uncertain values shows that women have a significantly predominant tendency to situational manifestation of psychological depression (at $f^* = 2.58$, $p \leq 0.003$).

Analysis of the results based on the data of the n2 subsample (unstable, nonequilibrium states)

The sub-sample with unstable mental states (n2) represents less than a quarter of the total sample (27 people; 24.1%). It included 9 CA pilots (men) and 18 medical workers (women).

The level of anxiety both in general and in the subgroups "CA pilots", "medical workers" is represented by average group indicators within the range of intermediate values (from

-1.28 to + 1.28): CA pilots: Mkt = 0.98 ± 2.68; medical workers: Mkt = 0.86 ± 2.44. At the same time there are no statistically significant differences in the indicators (t = 0.11). The marks "often" or "almost always" prevail when answering questions about feeling anxious and worried about someone or something; about sleep disorders; about the appearance of nervousness while waiting.

A comparison by professional subgroups shows that depression is more characteristic of medical workers (Mkd = -2.90 ± 2.38). CA pilots included in the n2 subsample also showed a tendency to psychological depression (Mkd = 0.86 ± 1.14), but at the same time 6 people have index indicators close to the boundary of situationality (1.16 = cd ≤ 1.22). Statistical analysis confirms a higher severity of depression among polyclinic workers (at t = 5.65, p < 0.001).

Analysis of the cognitive sphere of personality with different indicators of psychoemotional stability

The results of diagnostics of the specifics of metacognitive control of activity with different indicators of psycho-emotional stability. In the average indicators of metacognitive control in both compared subgroups, the predominance of the action-oriented mode (AO-mode) is recorded, however, a qualitative analysis reveals a number of specific characteristics of this side of cognitive processes at different levels of psycho-emotional stability (Table 3).

In the group of people with stable conditions (n 1), the emphasis is most pronounced on nationally oriented metacognitive control of failure activity (CFA: M =15.70 = 2.99). This type of control prevails in more than 90.0% of respondents; only 6 people (7.10%) from this sample found a CFA CO-mode in individual indicators.

Table 3

The results of the diagnosis of the motivational orientation of the personality (Kul's test)

Samples	M ± SD	t; p	Control modes (people/ %)		φ*; p
			AO-mode	CO-mode	
control of failure activity (CFA)					
n_1 (85 people)	15,70 ± 2,99		79 / 92,90	6 / 7,10	
		t = 9,54;			φ* = 4,16;
n_2 (27 people)	10,0 ± 2,56	p < 0,001	15 / 55,60	12 / 44,40	p ≤ 0,001

Samples	M ± SD	t; p	Control modes (people/ %)		φ*; p
			AO-mode	CO-mode	
control of success activity (CSA)					
n_1 (85 people)	11,10 ± 2,42	t = 2,53;	61 / 71,80	24 / 28,20	φ*= 0,45;
n_2 (27 people)	12,70 ± 3,07	p < 0,01	18 / 66,70	9 / 33,30	p > 0,05
control of planning activity (CPA)					
n_1 (85 people)	13,10 ± 3,36	t = 2,74;	68 / 80,0	17 / 20,0	φ* = 1,72;
n_2 (27 people)	11,40 ± 2,61	p < 0,01	17 / 63,0	10 / 37,0	p ≤ 0,04

Note. *The indicators that significantly prevail in comparison are highlighted in bold.*

In the subsample of persons with unstable conditions (n2), the AO mode has an advantage in situations of monitoring successful activity (CSA: = 12.70 ± 3.07). However, in individual indicators, the AO orientation of the metacognitive directive in the control of success activity prevails only in 66.7% of respondents (18 people); the remaining 33.3% (9 people) are focused on situational control, without forming a field of cognitive efforts to find ways to overcome the discrepancies between what is and what should be as follows from the content of the relevant statements of the questionnaire.

In general, according to the testing data the motivational activity of the AO mode for all types of cognitive control prevails among people with a stable psycho-emotional sphere, while the proportion of people with pronounced AO motivation according to CFA and CPA is significantly higher than in the sub-sample with non-equilibrium states. In the mean values for all scales in the n1 subsample, only 8.2% of respondents (7 people) found a predominance of situationally oriented metacognitive control, and in the n2 subsample, such a proportion of respondents was 37.0% (10 people): at f* = 3.29, p ≤ 0.001 (Table 3).

Comparisons in groups differentiated by type of activity ("CA pilots ⇹ medical workers") in both samples (n1; n2) do not show significant differences.

Correlation analysis indicates the relationship of indicators of anxiety and depression with the AO mode of cognitive control (Table 4).

High values in the measurements of mental states as indicators of their stability correspond to high values in the measurements of metacognitive control corresponding to the AO-directive of motivation of activity. At the same time, it is noted that the predominance of the CFA CO-mode in 44.4% of respondents of the n2 subgroup was reflected in a negative correlation coefficient (r = -0.277).

Table 4

Correlation matrix (r) of interrelations of indicators of components of metacognitive control and psychoemotional states

Samples	Control of failure activity (CFA)	Control of success activity (CSA)	Control of planning activity (CPA)
n1 (85 people)	0,479***	0,482***	0,627***
n2 (27 people)	-0,277*	0,493**	0,327*

Note: *The level of significance of the differences: * p < 0.05; ** p < 0.01; *** p < 0.001. Assessment by Pearson's r-criterion. For the correlation analysis, the average index of anxiety and depression was calculated: M (kt+kd).*

The results of the diagnosis of the specifics of reflection of activity with different indicators of psychoemotional stability. The indicators of the general level of reflection (IR) in the compared samples differ significantly (Table 5). If in the group of respondents with psychoemotional stability, the average group data is in the range of the average level (M = 123.40 ± 14.00), then in respondents with non-equilibrium states they correspond to the range of the low level: M = 111.30 ± 12.80 (at t = 4.18, p < 0.001).

In sample n1, the emphasis is on two types of reflection: communication (RC: M = 37.40 ± 5.85) and future activity (RFA: M = 37.20 ± 5.78), while the general data on the reflection of actual (real) activity, as well as on RC and RFA, correspond to the indicators of the average level. Data on the reflection of past activities are reduced (M = 33.40 ± 5.25).

Reflection of communication prevails in the n2 sample (RC: M = 34.70 ± 5.15). This is the only indicator whose value is at the upper limit of the low level. The rest are interpreted as indicators of a low level of reflection (Table 5).

An obvious phenomenon is the actual absence of indicators of a high level of reflection for all analyzed species in group n2 and their insignificant representation in group n1. Comparative analysis shows a significant predominance of the severity of the average level of reflection among people with stable conditions, and a low level among subjects with non–equilibrium states (Table 5).

Table 5

Descriptive statistics of the results of diagnostic reflection of subjects with non-equilibrium and stable mental states

Samples	M ± SD	Indicators of the proportions (abs. / %) of the severity of reflection levels		
		high	average	low
	reflection on past activities (RPA)			
n_1 (85 people)	33,40 ± 5,25	2 / 2,40	24 / 28,20	59 / 69,40
n_2 (27 people)	30,10 ± 5,21	-	4 / 14,80	23 / 85,20
differences:	t = 2,81 p < 0,05	-	ϕ* = 1,49 p ≤ 0,06	ϕ* = 1,40 p ≤ 0,08
	reflection on real activity (RRA)			
n_1 (85 people)	36,7 ± 5,09	5 / 5,90	38 / 44,70	42 / 49,40
n_2 (27people.)	33,0 ± 5,28	-	8 / 29,60	19 / 70,40
differences	t = 3,19 p < 0,05		ϕ* = 1,42 p ≤ 0,07	ϕ* = 1,96 p ≤ 0,02

	reflection on future activities (RFA)			
n_1 (85 people.)	37,20 ± 5,78	8 / 9,40	36 / 42,40	41 / 48,20
n_2 (27 people)	33,40 ± 5,92	1 / 3,70	6 / 22,20	20 / 74,10
differences:	t = 2,85 p < 0,05	-	ϕ* = 1,98 p ≤ 0,02	ϕ* = 2,43 p ≤ 0,006
	reflection on communication (RC)			
n_1 (85 people)	37,40 ± 5,85	9 / 10,60	45 / 52,90	31 / 36,50
Cn_2 (27 people)	34,70 ± 5,15	-	13 / 48,10	14 / 51,90
differences:	t = 2,33 p < 0,05		ϕ* = 0,43 p > 0,05	ϕ* = 1,41 p ≤ 0,08
	integral index of reflection (IR)			
n_1 (85 people)	123,40 ± 11,16	5 / 5,90	36 / 42,40	44 / 51,80
n_2 (27 people)	111,30 ± 12,80	-	5 / 18,50	22 / 81,50
differences:	t = 4,18 p < 0,001	-	ϕ* = 2,39 p ≤ 0,007	ϕ* = 2,92 p ≤ 0,001

Note. *Indicators that are significantly predominant in comparison are highlighted in bold; indicators in bold italics, the predominance of which is expressed as a trend (0.06 ≤ p ≤ 0.08).*

A comparison of reflection indicators in the subgroups "pilots of CA" – "medical workers" in the samples reveals a predominance of reflection activity of actual (real) activity and the general index of reflection among pilots of CA in the data on the sample with stable mental states ($p < 0.05$). In the environment of persons with non-equilibrium states (n2), CA pilots also have significantly more pronounced reflection of present and future activities, as well as the general level of reflection ($p < 0.05$) (Table 6).

Table 6

Comparison of indicators for measuring reflection of activity in groups differentiated by types of activity

Groups by type of activity	RPA	RRA	RFA	RC	IR
			n_1 (85 people)		
pilots CA	33,90 ± 5,69	37,70 ± 5,38	37,40 ± 6,12	37,50 ± 5,85	128,60 ± 11,83
med. workers	32,80 ± 4,58	35,40 ± 4,37	36,90 ± 5,36	37,40 ± 5,92	120,50 ± 10,47
differences:	t = 1,04 p > 0,05	t = 2,19 p < 0,05	t = 0,37 p > 0,05	-	t = 2,10 p < 0,05
			n_2 (27 people)		
pilots CA	30,60 ± 6,15	33,60 ± 7,42	35,60 ± 3,04	34,40 ± 6,37	118,60 ± 10,94
med. workers	29,90 ± 4,86	32,80 ± 4,07	32,40± 4,73	34,80 ±4,63	110,20 ± 7,51
differences:	t = 0,26 p > 0,05	t = 0,29 p > 0,05	t = 2,10 p < 0,05	t = 0,16 p > 0,05	t = 2,09 p < 0,05

Note. *The indicators that significantly prevail in comparison are highlighted in bold.*

The results of the diagnosis of the cognitive component of the meaningful sphere of responsibility with different indicators of psychoemotional stability. In the group of people with a stable system of psychoemotional "response" to difficult living conditions (n1), the socio-centered type of the cognitive component of responsibility – cognitive meaningfulness (CM) - prevails: M = 26.60 ± 4.89 versus 16.4 ± 4.23 according to the

CA component. In the sample presented by respondents with non-equilibrium states of anxiety and psychological depression, on the contrary, the orientation in the formation of the disposition of responsibility towards the ego–centered aspect - cognitive awareness (CA) is more pronounced: M = 21.10 ± 4.03 versus 19.50 ± 4.02 for the CM component. Statistical analysis shows significant differences in the average group indicators in the surveyed samples for both components of the cognitive component of the meaningful sphere of responsibility ($p < 0.001$) – Table 7.

Table 7

Descriptive statistics of the results of the analysis of the cognitive component of the meaningful sphere of responsibility

	Cognitive meaningfulness (CM)		Cognitive awareness (CA)	
	n_1 (85 people)	n_2 (27 people)	n_1 (85 people)	n_2 (27 people)
M ± SD	26,60 ± 4,89	19,50 ± 4,02	16,40 ± 4,23	21,10 ± 4,03
differences:	t = 7,51; p < 0,001		t = 5,19; p < 0,001	
r:	M (kt + kd) ↔ CM:		M (kt + kd) ↔ CA:	
	r = 0,022	r = 0,500**	r = –0,302*	r = 0,351*

Note. *M (kt + kd) is the average value of anxiety and depression indices; The indicators that significantly prevail in comparison are highlighted in bold; * p < 0.05; ** p < 0.001. Pearson's r-test score.*

A comparative analysis of the data on measuring the cognitive aspect of responsibility in the subgroups "CA pilots" – "medical workers" shows that among people with stable mental states, CA pilots and medical workers have the same pronounced predominance of the CM-component. The picture is different among respondents with non-equilibrium

states. Here, the predominance of the CA component in the data on occupational groups is confirmed, as well as in the n2 sample as a whole, however, in the group of CA pilots, both components are represented by higher average group values ($p < 0.05$) – Table 8.

Table 8

Descriptive statistics of measurements of the cognitive aspect of the meaningful sphere of responsibility in professional groups

	CM		CA	
	Pilots CA	Med. workers	Pilots CA	Med. workers
n_1	26,70 ± 5,06	26,40 ± 4,72	16,10 ± 4,21	16,90 ± 4,28
differences:	t = 0,24; p > 0,05		t = 0,90; p > 0,05	
n_2	22,40 ± 3,40	**18,1 ± 3,54**	23,60 ± 2,35	**19,90 ± 4,19**
differences:	t = 3,12; p < 0,05		t = 2,91; p < 0,05	

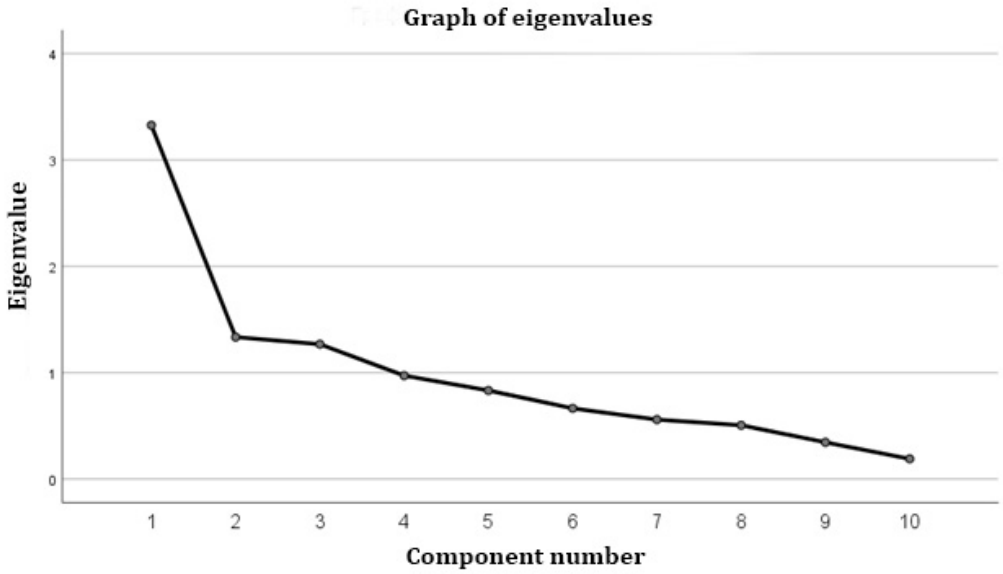
Note. *The indicators that significantly prevail in comparison are highlighted in bold.*

At the final stage of the search for cognitive predictors of a psychoemotional "response" to difficult living conditions, arrays of 10 variables from the compared samples were subjected to factor analysis by the Varimax rotation method. The results of the analysis showed the following.

For subjects with stable conditions, 5 factors were identified, with a total variance of 77.34% (Figure 1; Table 9). As we can see from the configuration of the eigenvalue graph, the first factor has the greatest load (33.26%). Meaningfully, in the first factor, all types of reflection play a leading role, with the predominant value of the integral index of reflection (R = 0.892), which in this sample, as shown above, is expressed mainly at the average level. It is associated with the control of failure activity (R = 0.245) and cognitive comprehension (R = 0.319).

Figure 1

A graph of the eigenvalues of factors identified by a set of variables in a group of respondents with stable psychoemotional states



In the second factor (13.34%), the cognitive component of the meaningful sphere of responsibility plays a formative role (CM: R = 0.830; CA: R = 0.685) with a predominance of the influence of cognitive meaningfulness, which is most pronounced in the diagnostic data in this sample. The CM is in mutual influence with the reflection of past activity (R = 0.285) and the reflection of communication (R = -0.291).

The third factor (12.68%) is influenced by metacognitive control of success activity (R = 0.908). Three types of reflection interact with it: past (R = -0.221); present (R = 0.230) activity and communication (R = 0.222).

The high correlation index in the fourth factor (9.72%) has control over planning activities (R = 0.974). This metacognitive process forms two interactions: with cognitive meaningfulness (R = 0.277) and a negative one with cognitive awareness (R = -0.217).

The fifth factor (8.33%) is formed by metacognitive control of the failure activity (R = 0.851), which is negatively associated with reflection of past activity (R = -0.367) and positively with reflection of future activity (R = 0.250). In addition, there is a tendency for a stable relationship with the reflection of communication (R = 0.208).

Table 9

The matrix of components (factors) in the Varimax rotation data of variables in the sample n1

Rotated matrix of components*					
	components				
	1	2	3	4	5
CFA	,245	,109	-,180	,064	,851
CSA	,050	,068	,908	-,005	-,136
CPA	,004	-,042	,001	**,974**	,049
RPA	,711	,285	-,221	,011	-,367
RRA	,743	,008	–,230	,021	,053
RFA	,781	,066	,131	,037	,250
RC	,688	-,291	,222	,022	,208
IR	**,892**	,114	,100	,005	,155
CM	,319	,830	-,201	,277	,209
CA	-,111	,685	,223	-,217	-,017

The method of factor extraction: the method of principal components.

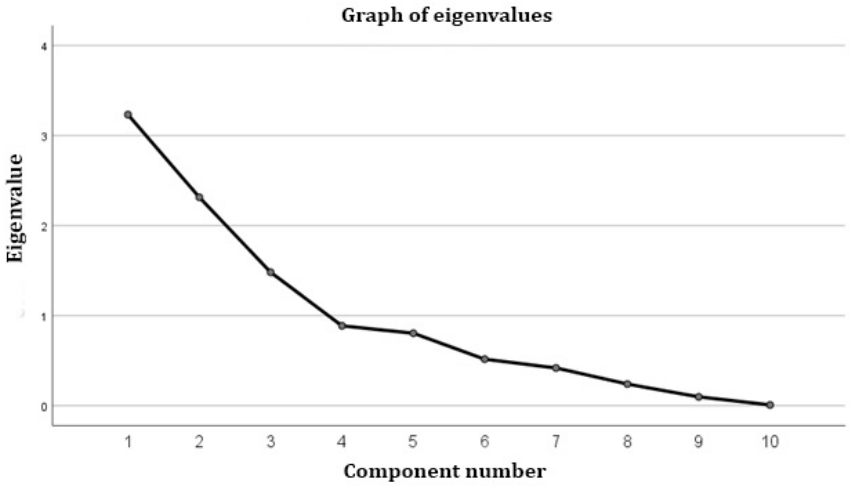
Rotation method: varimax with Kaiser normalization.

* – The rotation converged in 7 iterations.

For subjects with nonequilibrium states, taking into account the smallness of the sample (27 people), 3 factors were identified, with a total variance of 70.30% (Figure 2; Table 10).

Figure 2

A graph of the eigenvalues of factors identified by a set of variables in a group of respondents with non-equilibrium psychoemotional states



The most pronounced factorial effect on the cognitive sphere of a personality with an unbalanced psycho-emotional sphere is exerted by the first factor (32.33%) with a high correlation of general reflection (R = 0.969) and all its components with the control of failure activity (R = 0.419) and cognitive meaningfulness (R = 0.208).

The second factor (23.15%) is formed by a symbiosis of both poles of the cognitive component of responsibility (CM: R = 0.796; CA R = 0.792), "attracting" with a negative correlation control of the activity of failure (R = -0.791), as well as control of the activity of success (R=0.206) and reflection of actual activity (R = 0.285).

In the third factor (14.82%), metacognitive control of planning activities (R = 0.865) is of central importance, closely related to the control of success activities (R = 0.643). They are interconnected with two types of reflection – communication (R = -0.682) and past activity (R = 0.271).

Table 10

The matrix of components (factors) in the Varimax rotation data of variables in the n2 sample

Rotated matrix of components*			
	Components		
	1	2	3
CFA	,419	-,791	-,039
CSA	,088	,206	,643

Rotated matrix of components*			
	Components		
	1	2	3
CPA	,137	,011	,865
RPA	,793	,028	,271
RRA	,806	,285	-,005
RFA	,700	-,164	,033
RC	,514	-,044	-,682
IR	,969	-,059	-,166
CM	,029	,796	,049
CA	,208	,792	,187

The method of factor extraction: the method of principal components.

Rotation method: varimax with Kaiser normalization.

* – The rotation converged in 4 iterations.

Discussion

The analysis of mental states in difficult living conditions, prolonged over a period of more than a year, showed that a significant part of the respondents (75.9%) gives a psychological "response" in the form of stable indicators of anxiety and depression. CA pilots and men are more confident in adapting their emotional sphere to difficult living conditions. The experience of anxiety and psychological depression is especially noted in women and in medical workers. It can be assumed that this phenomenon is the result of activation of the mechanisms of psychological adaptation (Medvedev, 2003). However, in fact, a fourth of the surveyed (24.1%) found non-equilibrium states. Since human adaptation is conditioned by a set of personality properties and qualities, on which the specifics of the mental regulation of the experienced state depend (Bodrov, 2007, p. 50), it is advisable to allocate two groups of subjects according to the criterion of stability of mental states for consistent verification of the empirical hypothesis.

The assumption about the invariant component of cognitive resources influencing the indicators of psychoemotional stability has been confirmed. This is the reflection of activity which plays the most pronounced predictive role in both groups of respondents.

The second part of the hypothesis (about the specifics of the cognitive sphere of subjects with different levels of psycho-emotional stability) was confirmed in the following results of the analysis.

The second part of the hypothesis for people with a stable psycho-emotional sphere, a specific cognitive resource for the formation of a psychological "response" to difficult living conditions, hypotheses (about the specifics of the cognitive sphere of subjects with different levels of psycho-emotional stability) were confirmed in the following results of the analysis:

- a nationally oriented (AO) control mode with a predominance of control over the failure activity (M = 15.70 = 2.99). Such a cognitive position motivates the subject to actively control those aspects of life in which adequate decisions are required with subsequent planning of step-by-step actions, including in the direction of relieving stressful threats (Bokovikov, 1999, 218-219);
- the average level of reflection (M = 123.40 $\pm$ 14.00), with a pronounced emphasis on reflection of communication (M = 37.40 $\pm$ 5.85) and reflection of future activities (M = 37.20 $\pm$ 5.78), which allows you to analyze your own activities and the actions of other people, think about and carefully plan your activities in detail, as well as predict all possible consequences (Karpov, Ponomareva, 2000);
- the predominance of a socio-centered type of cognitive component of responsibility – cognitive meaningfulness (M = 26.60 $\pm$ 4.89), which indicates the ability to comprehensively comprehend responsibility, the ability to grasp its core basis; to consider responsibility from the standpoint of duty, conscience (Pryadein, 2014).

The established relationships are confirmed by the data of factor analysis. The identified factors play the role of psychological resources to ensure psychological adaptation to life in conditions hindered by biogenic threats. According to the leading cognitive mechanism that forms each of the five identified factors, they can be conditionally designated as follows: the factor of reflection of activity (1); the factor of cognitive responsibility (2); the factor of metacognitive control of failure (3); the factor of responsible metacognitive control of planning activities (4); the factor of metacognitive control of the failure of retrospective and prospective activities (5).

The inconsistency of the interaction of cognitive resources in the formation of a stable response of the individual to the stressogenicity of difficult living conditions causes the development of non-equilibrium states. This is evidenced by:

- a situationally oriented (SO) mode of control, which, unlike the AO mode, does not form barriers to the appearance of emotional states of anxiety and depression that disorganize human life (Kuhl, 1981; Bokovikov, 1999, 218-219).
- 66.7% of respondents focus on AO-mode of monitoring successful activities. In the context of the concept of semantic regulation of mental states (Prokhorov, 2009), according to which in non-equilibrium states the previous organization of the semantic system and its components - the structure of semantic characteristics - is "shaken," the established phenomenon can be considered as an activation of the rationalization mechanism, giving subjective meaning to the events taking place. The result of this process is a higher indicator of indices of anxiety and depression - with negative values expressed in the rest of the sample to the range of indeterminate values in the indicated 66.7% of subjects;
- predominantly low level of reflection ($M = 111.30 \pm 12.80$), with predominance of communication reflection ($M = 34.70 \pm 5.15$) - cognitive qualities indicating difficulties in understanding the events, their consequences, causes of their actions and actions of other people, impulsiveness in decision-making (Karpov, Ponomareva, 2000). To a certain extent, the low level of activity reflection is obviously compensated by more developed abilities to understand another person (communication reflections), to predict his response to certain stimuli (actions);
- the predominance of an ego-centered type of cognitive component of responsibility – cognitive awareness ($M = 21.10 \pm 4.03$), characterized by a lack of understanding of responsibility, focusing on one, sometimes non-specific side of the matter; possibly, the substitution of responsibility for performance as a personal trait (Pryadein, 2004).

The insufficiency of cognitive resource provision for the formation of psycho-emotional stability in the environment of persons with non-equilibrium states is confirmed by the data of factor analysis. According to the leading cognitive mechanism that forms each of the three identified factors, they can be conditionally designated as follows: the factor of control of the activity of failure and self-centered responsibility

based on reduced abilities of reflection of activity (1); the factor of cognitive responsibility with a predominance of cognitive awareness (2); a factor of metacognitive control of activity planning and its success based on reflection on the retrospective of activity and communication (3).

The study confirmed the final part of the empirical hypothesis which consisted in the assumption of the presence of invariant and specific cognitive resources of psycho-emotional stability for subjects of different types of professional activity.

Equilibrium, stability of mental states of a personality in difficult conditions of life can be provided by the resource role of the formed psychological properties of the higher substructures of personality in the form of resilience, developed sociocentric responsibility, the action orientation of metacognitive control of activity, developed abilities of reflection, as well as a harmonious combination of processes of arbitrary self-regulation.

Invariant resources include the proven absence of differences in the emphasis of metacognitive activity control on action (AO), as well as the predominance of cognitive meaningfulness (CM) as a cognitive aspect of responsibility among CA pilots and medical workers with stable psychoemotional conditions.

How specific resources can be considered:

- for civil aviation pilots, it is an activity of reflection on actual (real) activity and a medium-high general level of reflection; the predominance of meaningfulness in the cognitive aspect of responsibility (regardless of the level of stability of mental states). The presented conclusions are largely consistent with previously published data on the features of the higher substructures of the personality of civil aviation pilots, acting as psychological resources for balance, stability of mental states of the individual in difficult living conditions (Babichkova, 2022).
- for medical workers, it is based on reflection on present and future activities, as well as mainly an average, and in some individual manifestations a low, general level of reflection; orientation to cognitive awareness in the segment of specialists experiencing non–equilibrium states.

Conclusion

The scientific novelty of the study is consisted in the empirical operationalization of the previously introduced concept of "difficult living conditions" through the justification of the resource role of cognitive processes in the formation of a psychoemotional "response" to the stress of the Covid–19 pandemic. It is established that reflection of activity is an invariant predictor of cognitive resources in groups differentiated by the level of psycho-emotional stability. The invariant predictor role in the stability of mental states in professional groups of civil aviation pilots and medical workers of action-oriented metacognitive activity control, as well as cognitive meaningfulness

among CA pilots and medical workers with stable (equilibrium) psychoemotional states is shown.

This study allowed us to determine the factors of cognitive resource provision of stable and non-equilibrium psycho-emotional states which contributes to the verification of concepts of semantic regulation of mental states, metacognitive, resource, subject-resource approaches in modern psychology.

The results obtained correspond in different ways to the results of empirical studies presented in publications. In particular, data on the compensatory role of the AO-mode of control of successful activity under non-equilibrium mental states in stressful living conditions are not presented in the scientific publications of D. Kul and his followers. This can be explained by dynamic processes in the life of modern society, which during the years of experimental research D. Kul (80s of the twentieth century) had no analogues.

A significant result of the study was the identification of intercorrelational relationships between various cognitive mechanisms: metacognitive control, activity reflection, cognitive aspect of the substantive sphere of personal responsibility. These data reflected in the data of factor analysis can serve in the future for experimental research in the field of cognitive psychology.

In general, based on the generalization of the results obtained, it is possible to identify "targets" of psychological impact for the development of counseling programs and psychological support for a person with increased psycho-emotional lability in difficult living conditions.

Limitations

It should be noted that this study has some limitations. First, the empirical sample includes representatives of only two professional groups. In the future, it makes sense to expand the professional composition of the subjects. Secondly, there was a certain imbalance in the composition of participants by gender: the group of pilots is represented only by males, unlike the group of medical workers. This circumstance did not allow us to set the task of determining the gender specificity of cognitive resources of psychoemotional stability of a person in difficult living conditions. We assume that these limitations will be overcome at the next stages of the ongoing research.

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Bela Aslanovna Yasko – the concept of research and its theoretical justification, methodological justification of empirical search, writing the text of the section "Introduction", scientific editing of the texts of the sections "Results"; "Discussion"; critical revision of the content of the article.

Ekaterina Sergeevna Babichkova – select and conduct of psychodiagnostic procedures, presentation of primary statistics. Mathematical and statistical processing; writing sections "Results", "Abstract"; design of the general text of the article; work with sources.

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Psychological indicators of subjectivity of life position

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Abstract

Introduction. The relevance of the issues of constructing a person's life path is conditioned by intensive modern transformations and the need to function in conditions of uncertainty, innovation, risks, multitasking and time deficit. The focus of the present study is the identification of psychological indicators of the subjectivity of life position in youth (chronotopic, metacognitive and reflexive). **Methods.** The diagnostic study was conducted with the participation of girls and young men studying undergraduate programmes at the Orenburg State Pedagogical University (n = 217, age of the subjects 19-24 years old). The psychodiagnostic complex consisted of standardised methods of diagnostics of life position, temporality, psychological boundaries, metacognitive processes and self-constructs: "Personal Life Position Questionnaire (PLQ)", "Temporal Modalities of Life Existence", "Psychological Boundary Diagnostic Methodology", "Analyticity-Holistic Scale", "Self-Efficacy Scale", "Tolerance-Intolerance to Uncertainty Questionnaire", "Related Self-Concept", "Collective and Independent Self-Concept". **Results.** The results of the conducted research fix the connection of subjectivity of the life position with the balance of modal evaluations, rationalisation of time periods of life realization, giving and taking in functions of psychological boundaries, tolerance to uncertainty, self-efficacy, independent self-concept. **Discussion.** Psychological indicators of the subjectivity of the position in youth are a holistic and authentic perception of the present, a meaningful attitude to time, its perception as a resource for achieving goals and realising life tasks. The balanced information-energy exchange between the external and internal spaces of the personality, provided by the intensity and vigour of the passing functions of psychological boundaries (taking in and giving away), is significant for the formation of the subjectivity of the life position. The importance of intrasubjective

self-constructs in the formation of the subject's position in adolescence is proved. The analysis of significant links between the subjectivity of the position and metacognitive processes – self-efficacy, tolerance to uncertainty – is presented. In adolescence, the identified indicators reveal the potential of personality in the independent choice of goals and strategies for their achievement, building an authentic life line on the basis of an active, responsible and conscious attitude to their own lives, constructive creative self-realisation and self-development.

Keywords

subjectivity, adolescence, life position, temporality, psychological boundaries, independent self-concept, chronotopic foundations, metacognitive processes

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Introduction

Modern reality, which synthesises transitivity, virtuality, temporal mobility into a single context, actualises the need for permanent change and renewal of personality for effective problem solving, realisation of creative potential and harmonious living. The ability and readiness of the individual to function in the format of multitasking, uncertainty, innovation and risk is rapidly increasing. Under these conditions, the problems of personality subjectivity in relation to their own life and development, their self-determination in the conditions of imposed socio-cultural standards of success and efficiency, deficit of external and internal resources become extremely important. In this regard, it is necessary to comprehend the issues of subjectivity of life position in adolescence, to identify psychological indicators mediating this process.

Purpose of the study

The aim of the study is to identify psychological indicators of subjectivity of life position in adolescence. Achievement of the goal involves scientific and theoretical analysis of the problem of personality's life position and its subjectivity, as well as a diagnostic study of the stated phenomenon. The **object of the** study is the life position of a person, the **subject** of the study is psychological components of the subjectivity of the life position in adolescence.

The extensive interdisciplinary research space of the considered problem of the life position of the individual allows to designate it as a complex, integrative, systemic and dynamic phenomenon, which:

- connects personality and social reality – objective and subjective aspects of personality, external and internal life space (Leontiev, 2019, p. 95).
- accumulates the individual's life experience and opens new life perspectives, potentials of future achievements and results (Abulkhanova, Berezina, 2001);
- defines a way of personal movement based on prolongation, positive inertia, and resilience (Maslow, 1970);
- integrates dynamically developing relations of personality to the surrounding reality, others and oneself and realises these relations in activity (Markin, 2005);
- unites the past, present and future of the personality into a continuous and unified line of the life path; provides the possibility of continuous changes of the personality through the integration of fundamental and emergent personal constructs - dynamics and statics, process and result (Fominyh, 2022a).

D. A. Leontiev (2019) notes as important components of the life position the individual's separation of himself from the flow of life, ability to manage and arbitrarily influence life, to implement conceived projects and goals, as well as to coordinate the perception of himself and his own life. Life position acts as a component of the highest level of personality disposition and an aspect of its psychological maturity. These aspects are realised in the parameters of awareness, activity and harmony, laying the foundations for constructive, progressive and proactive life transformations or their inversion. Living according to imposed socio-cultural templates and standards is a common variant of life position, leading to destructiveness, regression and passivity. It can be concluded that the system-forming elements of life position are intertwined in the context of personality subjectivity.

Subjectivity as a characteristic of development and life reflects the ability to build a unique life trajectory in accordance with personally significant criteria, as well as to creatively transform personal life space on the basis of independent, responsible and free choice, vision of opportunities and alternatives (Podolsky, Idobaeva, 2019). Subjectivity is revealed through the concept of activity, that is, the ability to manage one's life, consciously design and implement plans and goals, realise potential, and transform the life path (Abulkhanova, 2005; Antsyferova, 2000; Grishina, 2009). The criteria of activity are the balance of autonomy and inclusion in the social context, the ability to overcome dependence on external and internal circumstances, independence of decisions (Leontiev, Shilmanskaya, 2019).

Methods

Sample

The study involved 217 subjects aged 19–24 years old (80% of the subjects were girls) studying undergraduate programmes at the Orenburg State Pedagogical University. The sample is homogeneous in terms of professional employment and marital status.

Methodology

The basis for the diagnostic study of the subjectivity of the life position was the method "Personal Life Position Questionnaire (PLQ)" (Leontiev, Shilmanskaya, 2019), within which the activity is considered in a similar meaningful context.

The study of chronotopic bases of the life position was carried out on the basis of the methods "Temporal modalities of life fulfilment" (Bredun, Shcheglova, Smeshko, Shmer, 2021), "Methods of diagnostics of psychological boundary" (Levy, 2013a).

In the study of the specificity of metacognitive processes of the subjects were used "Analyticity-Cholisticity Scale" (Apanovich, Znakov, Alexandrov, 2017), "Self-Efficacy Scale" (Schwarzer, Yerusalem, Romek, 1996), "Tolerance-Intolerance to Uncertainty Questionnaire" (Kornilova, Chumakova, 2014).

Reflexive elements of personality, combining inter- and intrasubjective aspects of self-concept, were diagnosed using the techniques "Related Self-Concept" (Dorosheva, Knyazev, Kornienko, 2016) and "Collective and Independent Self-Concept" (Dorosheva et al., 2016).

Mathematical and statistical processing of the results included the calculation of Pearson's (C) and Chuprov's (T) coefficient of mutual conjugation, which allows to establish the degree of closeness of the relationship between the studied features.

Results

Based on the methodology "Personal Life Position Questionnaire (PLQ)" (Leontiev et al., 2016), we obtained relatively high indicators of life position activity in young men and girls (62% of respondents – high level of activity, 30% – medium, 8% – low levels), revealing the ability of personality to manage and arbitrarily influence their own lives. Psychological indicators of subjectivity in adolescence were identified on the basis of statistical analysis of the links between high indicators of life position activity and chronotopic, metacognitive and reflexive aspects of personality.

Chronotopic bases are the point of intersection of temporal and spatial dimensions of personality's life, in this regard, they are considered through the correlation of temporal moduses of personality reflected in temporal characteristics, as well as through interaction with external and internal reality regulated by psychological boundaries (Table 1).

The results of the conducted research fix the connection of the subjectivity of the life position of the subjects with the balance of modal evaluations (C = 0.254; T = 0.324) and the rationalisation of the time periods of life (C = 0.249; T = 0.289). A strong correlation was established for these indicators. The balance of modal evaluations reflects the integrity and authenticity of the perception of the present. Rationalisation of life-exercise periods provides a meaningful attitude to time, distribution of time resources taking into account actual goals and tasks (Bredun, Shcheglova, Smeshko, Schmer, 2021).

Table 1

Indices of the coefficient of mutual conjugation between life position activity and chronotopic bases in adolescence (C; T; p ≤0.05)

Chronotopical foundations	Activity
Emotional fixation on events	C = 0.117; T = 0.137
Rationalisation of time periods of life existence	C = 0.249; T = 0.289
Balance of modal scores	C = 0.254; T = 0.324
Non-permissive boundary	C = 0.116; T = 0.121
Permeable boundary	C = 0.131; T = 0.146
Retractable boundary	C = 0.243; T = 0.288
Reciprocating boundary	C = 0.307; T = 0.331
Containment boundary	C = 0.265; T = 0.298
Calm-neutral border	C = 0.128; T = 0.162

Note. *Statistically significant figures are highlighted in the table.*

Psychological boundaries carry out regulation and control of interaction, as well as protection of personal space. In the conducted research, a strong correlation between the activity of the life position and the intensity and vigour of the passing functions of boundaries - the taking in (C = 0.243; T = 0.288) and giving back (C = 0.307; T = 0.331) – which provide exchange processes between the external and internal spaces of the personality: they pass the necessary information and energy from the external space and allow the expression of internal impulses (Levy, 2013b). Most likely, the revealed connection is an important condition for constructive interaction with social space. The strengthening of the indicators of the permeability functions of the boundaries runs parallel to the tension of the restraining function (C = 0.265; T = 0.298), which containers the internal energy subjectively significant for the individual. In general, openness to the new and expression of authentic impulses are the basis for building a subjective life line.

Because metacognitive processes encompass an individual's abilities to assess and apply his or her own resources, we included analyticity-holistic cognitions, assessment of perceptions under uncertainty, and analyses of self-efficacy in the focus of the study (Table 2).

Table 2

Indices of the coefficient of mutual correlation between life stance activity and metacognitive processes in adolescence (C; T; p ≤0.05)

Metacognitive foundations	Activity
Focus of attention	C = 0.123; T = 0.156
Causal attribution	C = 0.123; T = 0.145
Tolerance for contradictions	C = 0.121; T = 0.156
Perception of change	C = 0.102; T = 0.149
Tolerance for uncertainty	C = 0.439; T = 0.533
Intolerance to uncertainty	C = 0.123; T = 0.165
Interpersonal intolerance to uncertainty	C = 0.125; T = 0.141
Self-efficacy	C = 0.353; T = 0.443

Note. *Statistically significant indicators are highlighted in the table.*

The general results of the "Analytic-Cholistic Scale" (Apanovich, Znakov, Alexandrov, 2017) indicate the predominance of the holistic pole in the subjects. At the same time, statistically significant relationships between the activity and analytic-cholistic poles of the studied parameters (focus of attention, causal attribution, tolerance to contradictions and perception of changes) were not revealed. The mentioned emphasises the fact proved in science about the necessity of harmonious correlation of contextual and dispositional explanation of events and changes (Brushlinsky, 2006). Within the framework of the study of metacognitive processes of young men and girls, strong links were established between the activity of life position and tolerance to uncertainty (C = 0.439; T = 0.533), self-efficacy (C = 0.353; T = 0.443), as important elements of personality potential assessment.

The study of reflexive elements of personality, including inter- and intrapersonal aspects of self-concept, was chosen as another angle of the scientific and empirical search for the foundations of subjectivity of life position in adolescence (Table 3).

Table 3

Indices of the coefficient of mutual conjugation between life position activity and reflexive elements of personality in adolescence (C; T; p ≤0.05)

Reflexive elements of personality	Activity
Interpersonal	
Related self-concept	C = 0.145; T = 0.187
Interdependent self-concept	C = 0.137; T = 0.178
Intrapersonal	
Independent self-concept	C = 0.346; T = 0.395

Note. *Statistically significant indicators are highlighted in the table.*

The subject status of the personality in adolescence correlates with high indicators of independent self-concept (C = 0.346; T = 0.395), for which a strong correlation was recorded. Self-perception, the attitude of the individual to himself in this case does not depend on the social context in which he is included, but is determined by personal results and achievements. Autonomy, independence from others, the ability to resist social pressure and the opinion of others are prioritised for a person.

Thus, psychological indicators of subjectivity of life position in youth are based on chronotopic, metacognitive and reflexive elements of personality. The data obtained in the study fix the significance of temporality, psychological boundaries, tolerance to uncertainty, self-efficacy and independent self-concept in building a subjective life position.

Discussion

Subjectivity in this study is considered from the position of activity and initiative in relation to the processes of life fulfilment (Leontiev, 2003). Activity is the basis for building interaction with the surrounding world on the basis of subjectively significant reference points, meanings and values, implementation of autonomous and flexible behavioural strategies, creative transformation of life space. The opposite pole of this component covers passive rigid adaptation strategies, dependence on the assessment and opinion of others, deficit of internal resources of life transformations.

The acceleration of life processes in modern socio-cultural space rapidly changes the priority goals and values of the individual, divides the chronotope into unrelated short-term fragments, and blocks the stable identification of the individual (Emelin, Tkhostov, 2015). The chronotopic orientation of a personality's life is reflected in the originality of the temporal structure (Bredun, Balanev, Vaulina, Krasnoryadtseva, Shcheglova, 2020). An important aspect of a personality's life fulfilment is its temporal perception, which includes subjective balance in the ratio of past experience, present resources and future prospects. These processes are necessary for the reorganisation of interconnected relations between the personality and the environment in conditions of continuous change (Bredun, Shcheglova, Smeshko, Schmer, 2021).

The results of the study confirmed the connection of subjective aspects of the subjects' life position with temporal perception, in particular, a holistic and authentic perception of the present, a meaningful attitude to time, and its perception as an obligatory resource for achieving goals and realising life tasks (Fominyh, 2022b). The psychological boundaries of personality take part in these processes. The subjectivity of the position of young men and girls is associated with the intensity and vigour of the permeability functions of psychological boundaries – absorbing and giving, which allow to ensure the balance between the external and internal spaces of the personality.

Metacognitive processes are the basis for perception and comprehension of the surrounding reality and life situations. Cognitive assessment of what is happening on the basis of the system of formed relations determines the choice of strategies of response and personal behaviour. In modern conditions associated with uncertainty, continuous challenges and changes, time deficits, the implementation of subjective strategies is associated with a certain measure of complementarity, balance in inclusion in the social context and autonomy, independence, i.e. analyticity and holistic (Znakov, 2013; Nisbett, Peng, Choi & Norenzayan, 2001; Markus & Kitayama, 1991; Matsumoto & Yoo, 2006). In the sample we studied, no statistically significant relationships were obtained for these indicators, which confirms the significance of the trade-off / flexible variation of analyticity-cholisticity in the perception and interpretation of events and phenomena of the real world. In the study we obtained pronounced indicators of holisticness in the sample population, indicating the significance of social elements in the processes of mentalisation in the adolescent period, but significant links with activity were not confirmed. The result is obvious, given the age of the subjects, the importance of the social context in the organisation of life processes, the accumulation of experience, the formation of a system of professional and personal ties necessary for the effective functioning of the personality. The relevance of the holistic-analytical balance is also determined by important conditions of personogenesis of the subjective life position in adolescence: separation processes, overcoming dependence on family and significant relatives, confronting imposed life patterns and success criteria, setting meaningful life tasks and accepting personal responsibility for the chosen decisions.

The indicators of self-efficacy – the cognitive basis of activity organisation, which includes subjective ideas of an individual about potential possibilities of achieving life goals

and transformations – turned out to be significant for the subjectivity of a person's life position. It is self-efficacy that determines the choice of the scale and complexity of tasks, the forecasting of options for the development of events, and the development of a behavioural line (Bandura, 1977; Jerusalem, 1992; Stajkovic & Luthans, 1998; Loschakova, 2015).

The position of the subject of life and development, the author's attitude to one's life is connected with the specificity of reflexive elements of personality. Domestic and foreign studies use a number of related terms to characterise them: self-constructs, self-concept, sensations of the Self, self-consciousness, identity, etc. (Rogers, 1961; Erikson, 1968; Hartmann, 1971; Kohut, 1971; James, 1890; Freud, 1991; Burns, 2003; Shapoval, Fominyh, 2018; Harris, 2019; Abdurasulov, Nazirli, 2020, etc.). For the subjective status of personality in the adolescent period, intrasubjective self-constructs including autonomy, independence, self-sufficiency as a key context of functioning turned out to be significant. In addition, concentration on individual motives, goals, needs, authenticity of self-realisation, self-expression, and the tendency of out-of-context explanation of social reality are characteristic. At this age, the emphasis on internal attributes is the basis for choosing life guidelines and strategies, independent construction and implementation of life project, in spite of significant intersubjective relations, transmitted and imposed socio-cultural stereotypes, economic and other factors.

Conclusion

The subjectivity of the position is a key characteristic of personal development and life, determining the construction of a unique life trajectory in accordance with personally significant criteria, as well as the creative transformation of life space on the basis of independent, responsible and free choice. Adolescence is a period of intensification of the processes of building life plans and projects, associated with the formation of subjective personal qualities. Psychological indicators of subjectivity of life position in youth are based on chronotopic, metacognitive and reflexive elements of personality, which together reveal the inner potential in building an authentic life line on the basis of a conscious, valuable and active attitude to one's own life, constructive creative self-realisation and self-actualisation. The results of the conducted research allowed us to establish that the subjectivity of life position in adolescence is expressed in the following psychological indicators:

- holistic and authentic perception of the present time, meaningful and valuable attitude to time, perception of it as a resource for achieving goals and realising life tasks;
- balanced information-energy exchange between the external and internal spaces of the personality on the basis of coordinated work of the absorbing and giving functions of psychological boundaries;
- independent self-concept with a prioritisation of autonomy, independence, self-sufficiency and internal attributes of personal and social functioning;

- self-efficacy, tolerance to uncertainty, which ensure the scale and complexity of the chosen tasks, forecasting of options for the development of events, development of the optimal behavioural line, internal stability of the personality in relation to emerging threats and obstacles.

In general, the identified chronotopic, metacognitive and reflexive indicators of the subjectivity of life position expand the possibilities of psychological and pedagogical support of young men and girls at the stage of life self-determination. The identified indicators can be used as vectors and guidelines for individual diagnostic and advisory, psycho-educational, and training work, implemented by psychological services of educational organisations and youth support centres. The results presented in the study do not claim to be exhaustive coverage of the problem; therefore, they can be continued in interdisciplinary scientific contexts.

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Psychological Prerequisites for Precarious Employment

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Abstract

Introduction. The study was carried out at the intersection of two research fields – precarious employment psychology and employability. The aim of this study is to identify the psychological characteristics of individuals engaged in precarious employment. **Methods.** The study population comprised 748 subjects (mean age = 31.03 years, min – 20 years, max – 45 years), of whom 48.13 % were men and 63.5 % had higher education. The study used the following diagnostic tools: (a) the Employment Precarity Index, (b) the Forced Employment scale, (c) the Perception of Barriers to Career Development scale, (d) the Attitudes Toward the Speed of Social Processes inventory, (e) the Involvement in Information and Communication Technologies in Work Activities questionnaire, (f) the Personal Flexibility at the Labor Sphere scale, and (g) the Vocational Identity scale. **Results.** All psychological prerequisites examined in the study (attitude toward the speed of social processes, involvement in information and communication technologies, personal flexibility, vocational identity) were closely related to the level of employment precarity and psychological well-being related to labor and profession. The use of the method of correlation pleiades made it possible to isolate the most significant psychological characteristics that correlate with precarity and psychological well-being – vocational identity and personal flexibility. The lower their scores, the more individuals feel the forced nature of their employment and barriers to career development, the higher the likelihood of their precarious status in the labor market. A comparison of employees engaged and not engaged in precarious employment showed that representatives of the first group have lower awareness of social acceleration and higher rejection of it; they are significantly less involved in information and communication technologies and have significantly lower scores in labor sphere flexibility and vocational identity.

Groups of employees differ in terms of their financial status, education, and experience of unemployment. **Discussion.** The results obtained are of theoretical and practical importance. The scope of psychological characteristics of individuals is expanded, helping them overcome uncertainties in the labor market and thus improve the quality of employment.

Keywords

precarious employment, precarity index, psychological well-being, vocational identity, personal flexibility, quality of employment

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Introduction

This study was conducted at the intersection of two relatively recent fields of research. One of them focuses on the study of precarious employment. This concept captures the current and expected instability of various aspects of labor relations. Signs of precarity include casual or short-term employment, low or unstable income, unpredictable work schedule, forced part-time employment, limited labor and social rights, lack of on-the-job training opportunities, etc. Such employment can cause threats to individuals' social integration and psychological well-being (Toshchenko, 2018, 2021; Sizova, Leonova, & Henze, 2017; Benach et al., 2014; Lewchuk, 2017).

A previous review of psychological studies of precarious employment (Diomin, 2021) enables us to make some generalizations. First, uncertainty in the labor market is seen as a background and factor in the activity of human labor and as a projection of global instability. Secondly, most studies document a reduction in psychological well-being in precarious employment conditions, which can be interpreted as a problem in adapting to new employment phenomena. Thirdly, although the number of people involved in precarious employment is increasing, the psychological prerequisites and mechanisms for adapting to unstable employment forms are not yet sufficiently studied.

Another direction focuses on the study of employability. The concept has no clear definition, and its content has changed in recent decades, depending on the context of

its use and the theoretical position of scientists (Thijssen, Van der Heijden & Rocco, 2008). In the 2000s and 2010s several employment models have been proposed.

One of the first widely discussed models in the framework of the *dispositional* approach is a combination of professional identity, adaptability, human (education) and social capital (Fugate, Kinicki & Ashforth, 2004). According to the authors, employability is an active form of labor adaptation that enables employees to identify and realize career opportunities and facilitates the movement between employment within and between organizations. Although employment ability does not guarantee actual employment, it increases the likelihood of obtaining employment and improves its quality (Fugate, Kinicki & Ashforth, 2004).

In a subsequent paper, Fugate & Kinicki (2008) clearly highlighted their commitment to the dispositional approach, considering it the best in uncertainty and frequent changes in the labor market. Five components of the dispositional structure of employability have been identified, including psychological stability (optimism), career motivation, proactivity in labor and career (according to the content of the corresponding scale, this is preoccupation with labor and career) were added to identity and adaptability (renamed as openness to change) (Fugate & Kinicki, 2008).

Several models of employability are implemented in the context of *resource* approach. Van der Heijde & Van der Heijden competence model (2006) is based on the fact that competence is a valuable resource for an organization and ensures productivity and competitiveness. In addition to professional knowledge (experience, competence), the structure of employability includes foresight and optimization (focus on professional self-development and increasing competitiveness), personal flexibility, corporate identity, balance (finding a compromise between career and personal life, between the interests of the employer and individual interests) (Van der Heijde & Van der Heijden, 2006).

Forrier et al. (2015) proposed a procedural model implying that employment change increases *movement capital* – an analogue of the dispositional model of Fugate et al., represents a complex of human strengths that helps solve career problems. Movement capital enhances the perceived employment opportunity, which in turn encourages further job-to-job transitions. As a result, a dynamic chain is created linking the main aspects of employability (Forrier, Verbruggen & De Cuyper, 2015). A. Forrier turns to L. Hobbfall's theory of resource conservation and points out that people with lower employability are more likely to find work in the secondary labor market, which may have a negative impact on future employment opportunities, as negative employment has a negative social and psychological impact on people (Forrier, De Cuyper & Akkermans, 2018).

When studying graduate employability, they actively use the concept of identity (Tomlinson, 2012). M. Tomlinson proposed the combination of identity and personal capital, and identified five capitals (human, social, cultural, identity-related, and psychological) (Tomlinson, 2017). The idea was productive and in particular enabled researchers to describe the structure of graduates' career readiness (Wallis, 2021).

One of the most important unresolved problems in employability research is individuals' adaptation to unstable and precarious employment (Forrier, De Cuyper & Akkermans, 2018; Green et al., 2013). According to recent publications, attention should be paid to socially and psychologically vulnerable groups of population, and to the psychological well-being of people with different levels and structures of employability. Until now, research has been conducted in well-educated groups from developed economies (Akkermans & Kubasch, 2017; Forrier, De Cuyper & Akkermans, 2018).

Consequently, there is a lack of knowledge of psychological factors and mechanisms to be included in precarious employment studies. Precarious employment is also understudied in employability studies.

Research purpose

Based on the analysis conducted, the purpose of the study was to identify the psychological characteristics of individuals engaged in precarious employment. We believe that, on the one hand, the composition of these characteristics should take into account the progress of employment research, such as professional identity, and that they should correspond to the characteristics of the employment institution in today's socio-historical conditions, such as the variability of the labor market (corresponds to personal flexibility), rapidity of employment processes (Rosa, 2003; Ulferts, Korunka, & Kubicek, 2013; corresponds to the attitude to the speed of social processes), and saturation of employment with information and communication technologies (corresponds to involvement in information and communication technologies). In the conceptual framework of the study, we also included indicators of psychological well-being related to profession and labor, believing that this is important not only for identifying the characteristics of individuals' inclusion in precarious employment, but also for understanding and assessing the quality of employment in the labor market (Kuchenkova, 2019, 2022; Sizova, Leonova, & Henze, 2017; Benach et al., 2014).

Research hypotheses

First, we assume that employment precarity and individuals' psychological well-being related to profession and labor are closely related to the attitude toward the speed of social processes, involvement in information and communication technologies (hereinafter referred to as ICT), personal flexibility, and vocational identity.

Secondly, it is expected that workers engaged in precarious employment and those who are not engaged may differ from each other in terms of the severity of these characteristics.

Methods

Sample

The sample comprised of 748 subjects (mean age = 31.03 years, min – 20, max – 45), of whom 48.13 % were men and 51.87 % were women; 63.5 % had higher education; 37.3 % were in regular full-time employment; for 20.86 %, the contract (agreement) had a fixed end date in 1-3 years; 20.72 % were in temporary employment lasting less than one year; 21.12 % were in casual short-term employment. The median value of the financial status of the families of respondents was 4 points on a 6-point scale.

Diagnostic tools

Employment precarity was assessed using the Employment Precarity Index, a scale containing 13 items and measuring a set of actual and expected characteristics of individuals' employment which include:

- duration of the employment relationship (varying from regular employment to casual short-term employment)
- unstable wages
- unpredictability of work schedule
- forced part-time employment
- difficulties in individual labor and social rights
- imbalance of power interpersonal relations
- lack of on-the-job training opportunities

To obtain a total precarity score, the scores for all items were summed up. The scale has undergone psychometric validation (Diomin, 2022). The higher the scale score, the higher the level of precarity.

Forced employment is one of the aspects of individuals' psychological well-being related to profession and labor. We used the force scale from the Psychological Structure of Employment Questionnaire (A. N. Diomin, D. Yu. Pivkin, 2014) which contained four items, each requiring an answer from 1 to 7 points. Items have two poles (for example: "This job matches my dreams" – "This job is very different from what I dreamed about"). The mean score on the scale was calculated.

Perception of barriers to career development is another aspect of individuals' psychological well-being related to profession and labor. J. Holland, D. Daiger, P. Power considered it in the My Vocational Situation instrument as an important addition to vocational identity. The corresponding scale was modified into Russian (Diomin, Sedykh, & Sedykh, 2017). Each item required an answer from 1 to 4 points; the mean score on the scale was calculated.

The Attitude Toward the Speed of Social Processes questionnaire includes two scales – awareness of social acceleration (cognitive component – 3 items) and rejection of social acceleration (affective component – 6 items). Responses range from 1 (strongly disagree) to 5 (strongly agree). The mean score for each scale was calculated (Diomin, Stepanova, 2023).

The Involvement in Information and Communication Technologies in Work Activities questionnaire includes 16 items that form the affective and motivational component of involvement (experience of positive emotions, interest, pleasure when using ICT), the operational component (consistency, active use of ICT in professional activity), preoccupation (focus on the technological environment, immersion in it when using ICT). Each item on the questionnaire must be rated from 1 (completely disagree) to 5 (completely agree). The total engagement score was calculated as the average of the sum of all scores (Diomin & Zykova, 2023).

Personal flexibility at the labor sphere was measured using the Personal Flexibility scale (Van der Heijde, Van der Heijden, 2006), a modified Russian-language version (Diomin & Kireeva, 2022). The scale includes six items, which are rated on a 5-point rating scale from 1 (strongly disagree) to 5 (strongly agree); the mean score on the scale was calculated.

Vocational identity was measured using a modified Russian-language version of the scale from the My Vocational Situation instrument. According to J. Holland, vocational identity refers to the clarity and stability of individual goals and self-perception related to career. Items are rated on a 4-point rating scale from 1 to 4; the mean score on the scale was found.

The following question was also used, "Have you ever had periods (a month or more) without work? (1 – no, I haven't; 2 – yes, I have (write down how many such periods there have been)). The answer indicates the experience of unemployment, which correlates with the experience of precarious employment and may have adverse long-term effects on individuals (Diomin, 2022; Sizova, Leonova, & Henze, 2017; Giudici & Morselli, 2019).

Statistical methods

When analyzing the data, we used correlation analysis (Spearman's ρ; method of correlation pleiades); Mann-Whitney U-test and Fisher's φ-test for comparative data analysis.

Results

Table 1 shows the results of a correlation analysis of the psychological and social characteristics of the surveyed workers. All psychological characteristics included in the study (attitude toward the speed of social processes, involvement in information and communication technologies, personal flexibility, vocational identity) are closely related

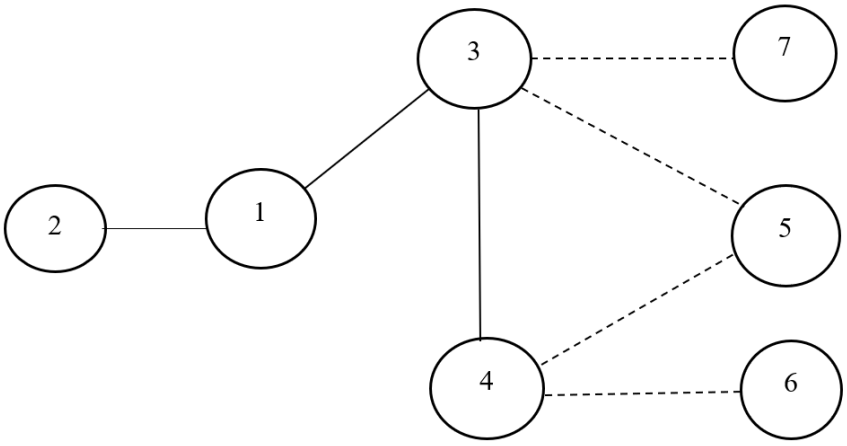
to the level of employment precarity and psychological well-being related to profession and labor.

In psychology, different methods of analyzing correlation matrices are used, including the method of correlation pleiades (Sukhodolsky, 1972), the method of determining the indices of structural organization (Karpov & Karpov, 2018), and the sum of correlation coefficients (Tolochek, 2023), in which importance is attached to the number of identified close correlations.

It is logical to consider this parameter as a sign of the structure-forming status of a variable and as a prologue for a deeper interpretation of the results.

The table does not include age, gender, marital status; they have only 1 to 3 significant relationships with other variables. The largest number of connections have the precarity index, forced employment, perception of barriers to development, financial situation, involvement in ICT, vocational identity, level of education (significant connections from 11 to 9 with an average value of 9). Since correlations of different error levels are presented in the matrix (from $p = 0.05$ to $p = 0.0000$), following the method of correlation pleiades differentiation (Sukhodolsky, 1972), we identified variables with the closest relationships for this sample size ($p \geq 0.362$). Figure 1 shows the corresponding correlation pleiades.

Figure 1
Correlation pleiades differentiation (contains the closest relationships between variables)



Note: *1 – precarity index; 2 – type of contract (duration of employment relations in which casual employment has the maximum score); 3 – forced employment; 4 – barriers to development; 5 – vocational identity; 6 – flexibility of the individual at the labor sphere; 7 – family financial status. A solid line refers to a positive dependence; a dotted line refers to a negative dependence.*

Table 1
Correlations of employee psychological and social characteristics

№	*Employee characteristics*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	Precarity index	1.0	0.60**	0.25**	0.40**	0.31**	-0.10*	0.12**	-0.17**	-0.19**	-0.30**	-0.23**	-0.35**
2	Type of contract		1.0	0.15**	0.14**	0.12**	-0.04	-0.03	-0.09*	-0.05	-0.06	-0.10**	-0.15**
3	Experience of unemployment			1.0	0.18**	0.10**	0.05	0.01	-0.01	-0.03	-0.13**	-0.13**	-0.11**
4	Forced employment				1.0	0.41**	-0.13**	0.13**	-0.26**	-0.26**	-0.46**	-0.18**	-0.37**
5	Perception of barriers to development					1.0	-0.10*	0.22**	-0.16**	-0.36**	-0.67**	-0.14**	-0.32**
6	Awareness of acceleration						1.0	-0.05	0.19**	0.23**	0.04	0.04	0.14**
7	Rejection of acceleration							1.0	-0.15**	-0.21**	-0.23**	-0.07*	-0.07*
8	Involvement in ICT								1.0	0.17**	0.12**	0.16**	0.15**
9	Flexibility at the labor sphere									1.0	0.32**	0.04	0.18**
10	Vocational identity										1.0	0.17**	0.30**
11	Education											1.0	0.27**
12	Family financial status												1.0

Note: ** – 0.05; ** – 0.01.*

The composition of the pleiade reproduces the following main blocks of variables: characteristics of labor relations (general precarity, type of contract); psychological well-being related to profession and labor; prerequisites for engagement in precarious/non-precarious employment (vocational identity, personal flexibility at the labor sphere, financial status).

In the next stage of analysis, polar groups were identified based on precarity and psychological well-being. To do this, we first transformed the raw scores into standard scores and assigned z-scores to them, which made it possible to identify the following scoring ranges: 'low', 'below average', 'average', 'above average', and 'high'. Given the quantitative composition of the groups obtained, we decided to combine the 'low' and 'below average', and 'above average' and 'high' ranges.

As a result, two pairs of 'ideal' polar groups were formed. The first group included those with a high level of precarity and, at the same time, a high level of forced employment (42 subjects); they opposed a group with a low level of precarity and a low level of forced employment (19 subjects). The second pair included people with a high level of precarity and a high level of perception of barriers to development (n = 54); they contrasted with a low level of precarity and a low level of perception of barriers to development (n = 21). We consciously formed two pairs of groups because we used two indicators of psychological well-being. Their combination made the analysis excessive.

Tables 2 and 3 present the results of comparing polar groups using the Mann-Whitney U-test.

Table 2

Comparison of a group with a high level of precarity and a high level of forced employment with a group with a low level of precarity and a low level of forced employment (Me)

Employee characteristics	High level of precarity, high level of forced employment (n = 42)	Low level of precarity, low level of forced employment (n = 19)	U	p-value
Awareness of social acceleration	3.33	4.33	258.5	0.028
Rejection of social acceleration	3.33	2.67	210.0	0.003

Employee characteristics	High level of precarity, high level of forced employment (n = 42)	Low level of precarity, low level of forced employment (n = 19)	U	p-value
Flexibility at the labor sphere	3.25	4.0	146.5	0.000
Vocational identity	2.5	3.64	58.0	0.000
Involvement in ICT (total score)	2.73	4.01	140.5	0.000
Financial status	4.0	5.0	107.0	0.000

In addition, the proportion of subjects with higher education is very different – 43 % of respondents with high precarity, 89 % of respondents with low precarity (Fisher's φ criteria used, p = 0.001) and 71 % of respondents with unemployment experience (Fusher criteria used, p = 0.0001).

Table 3

Comparison of a group with a high level of precarity and a high level of perception of barriers to development with a group with a low level of precarity and a low level of perception of barriers to development (Me)

Employee characteristics	High level of precarity, high level of perception of barriers to development (n =54)	Low level of precarity, low level of perception of barriers to development (n =21)	U	p-value
Awareness of social acceleration	3.67	4.33	327.0	0.004
Rejection of social acceleration	3.33	2.33	244.0	0.000
Flexibility at the labor sphere	3.5	4.33	249.0	0.000
Vocational identity	2.21	3.71	10.0	0.000
Involvement in ICT (total score)	2.84	4.0	303.5	0.002
Financial status	4.0	5.0	135.5	0.000

Both groups differ greatly in the proportion of subjects with higher education - 37 % for those with a high level of precarity versus 76 % for those with a low level of precarity (using the Fisher's φ criterion, p = 0.002), as well as in the proportion of subjects with experience of unemployment (74 % vs. 19 %; using φ-Fischer's criterion, p = 0.0001).

Employees engaged and not engaged in precarious employment differ in all psychological characteristics and indicators of financial status, education, and unemployment experience.

Discussion

The results presented in tables 1-3 and Figure 1 confirm the hypothesis. Precarious employment, psychological well-being of individuals and psychological characteristics arising from the analysis as prerequisites for employment constitute a complex of closely related phenomena; precarious and non-precarious employees differ significantly in psychological characteristics.

Let's consider some aspects of the results obtained.

Getting into the number of structure-forming variables of ICT involvement and professional identity is very remarkable. In the first case, the spread of ICT in the labor market, which facilitates and accelerates the solution of many professional tasks, is a competitive factor that increases prospects for professional development and reduces uncertainty in the labor market, increases the level of adaptation and increases the capital of labor mobility (Forrier, Verbruggen & De Cuyper, 2015). In this context, it is natural that involvement in ICT negatively correlates with the Precarity Index, the perception of barriers to development and the experience of forced employment.

The structure-forming status of identity corresponds to its role in regulating behavior in various spheres of life, including the labor market. Professional identity is one of the two psychological prerequisites of precarious/non–precarious employment that have entered the correlation pleiade. It is closely related to indicators of psychological well-being rather than to the Precarity Index. This is consistent with the results of an earlier study that professional identity has a greater predictive validity in terms of psychological well-being than in terms of employment status and behavioral characteristics (Diomin, Sedykh, & Sedykh, 2017).

Reardon & Lenz, discussing the scientific heritage of J. Holland, pointed out that professional identity helps make the right decisions in situations of uncertainty (Reardon & Lenz, 1999). The results of the study can supplement this conclusion. The reverse relationship between vocational identity and uncertainty of employment is realized taking into account the current psychological well-being related to profession and labor. It is not a coincidence that both variables (forced employment and the perception of barriers to development) are cores in the correlation pleiades.

This addition supports the authors' position, who consider it important to take into account the psychological well-being of a person when investigating precarious employment (Kuchenkova, 2019, 2022; Sizova, Leonova, & Henze, 2017; Toshchenko, 2021, 2022; Benach et al., 2014).

The existence of vocational identity and personality flexibility in the core correlation pleiade confirms not only the content of the employability model (Fugate, Kinicki & Ashforth, 2004; Fugate & Kinicki, 2008), but also considerations regarding the effectiveness of combining identity with the willingness to respond to changes in employment and profession (Wallis, 2021).

The 'identity – flexibility' link is a strong dispositional construction, which can have a direct or indirect influence on individual activity related to employment.

The results of the comparison analysis of the polar groups confirmed the results of the correlation analysis; they clearly demonstrated the differences between the employees engaged and those not engaged in precarious employment. These differences relate not only to vocational identity and personal flexibility, but also to the speed gaps (acceptance-rejection of social acceleration) and the digital gaps (different levels of involvement in ICT).

On the basis of the results of the study, we consider it desirable to work with a more comprehensive understanding of employment quality. Initially, many authors considered it through the prism of the presence/absence of status-related and behavioral signs of precarious employment (Holman & McClelland, 2011; Van Aerden, Moors, Levecque & Vanroelen, 2015). A more complex structure includes a combination of status-related and behavioral characteristics and their cognitive assessments that are implemented to predict employment in the coming months or years (Diomin, 2022; Lewchuk, 2017). The first and second components are symmetrical, closely related to each other and are embodied, in particular, in the Precarity Index scale. Taking into account the correlation dependencies, an additional component of employment quality can be added to the two components of employment quality – affective employment assessments (psychological well-being related to profession and labor). Although this component is more mobile and autonomous, it also plays an important role in complementing and concretizing the first two components. This understanding of the quality of employment strengthens the importance of the dispositional construct of 'vocational identity/personal flexibility at the labor sphere for regulating individual behavior in the labor market.

Comparing table 2 and table 3 and the content of the correlation pleiade enables us to draw a methodological conclusion that the two indicators of psychological well-being related to profession and labor (forced employment and the perception of barriers to development) can be exchanged and used separately. It depends on the tasks that are being fulfilled.

In general, the results of the study show specific psychological characteristics that are very likely to be accompanied by changes in the quality of employment of a person.

In dealing with psychological variables, we should not forget the social characteristics of employees that affect their employment. We are talking mainly about family financial status and education level (both variables are structure-forming; financial status is also a part of the core correlation pleiade).

Conclusion

The research hypotheses were confirmed. All psychological characteristics (attitude toward the speed of social processes, involvement in information and communication technologies, personal flexibility, vocational identity) are closely related to: a) the level of employment precarity and b) psychological well-being related to profession and labor.

The use of the method of correlation pleiades enabled us to identify the most important psychological characteristics combined with psychological well-being and employment precarity. This is vocational identity and personal flexibility at the labor sphere. The lower their indicators, the more individuals feel the forced nature of employment and barriers to career development, the greater their precarity in the labor market.

The use of the polar group method enabled us to compare the psychological characteristics of employees engaged in precarious employment and those not engaged in precarious employment. The first have a lower sense of social acceleration and a higher rejection of it. They are significantly less involved in information and communication technologies, have less flexibility at the labor sphere and have a blurred professional identity.

The results obtained are new and of theoretical and practical importance. First, ideas about the psychological conditions of precarious employment (in addition to its effects) are developing. Secondly, the scope of an individual's psychological characteristics is expanding, helping to overcome uncertainty in the labor market and thus improve the quality of employment. This is important for recruitment policies, staff development and advice for people seeking or changing jobs.

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Perception of Time and Situation of Uncertainty by Students with Different Strategies of Informational Behavior

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Abstract

Introduction. The high level of uncertainty in modern life makes young people turn to the virtual environment. Modern students are active users of Internet content and demonstrate different strategies of informational behavior of a normative and risky nature. Our research is devoted to studying the relationships between time orientations, information behavior strategies and indicators of tolerance to uncertainty among university students. **Methods.** The study involved 192 students of the humanities faculties, aged from 18 to 29 years, with an average age of 20 years; 160 girls and 32 boys. Methods used: "Strategies of Information Behavior" SIP (Abakumova et al.), questionnaire "Involvement in the Internet Environment" (Grishina, Zvezdina), D. McLane's Tolerance of Uncertainty Scale, "Time Perspective Questionnaire" by F. Zimbardo. Spearman's r-rank correlation coefficient was applied. **Results.** The sample of students shows a relative balance in the expression of time perspectives. Students with a positive past orientation are more tolerant of uncertainty; normative strategies of information behavior dominate in them. Students with a negative past orientation showed an avoidance of uncertainty and a preference for monosyllabicity. Students with a negative past orientation more often resort to risky behavior and seek satisfaction of their needs in non-normative ways in the Internet environment. The respondents' perception of their present as fatal showed their great vulnerability to risks, inability to control their lives and be tolerant of uncertainty. **Discussion.** Positive past orientation and hedonic present orientation are positively associated with preferences for uncertainty and novelty and normative information behavior strategies. Negative past experience reduces the level of tolerance to uncertainty and is associated with risky strategies of informational behavior, which can act as a coping strategy for unconstructive problem solving.

Keywords

informational behavior strategies, informational behavior, tolerance to uncertainty, time orientation, negative past, positive past, fatalistic present, hedonistic present.

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Introduction

Modern young people at the stage of professional and life self-determination are facing the challenge of growing global risks, digital transformations of the economy. On the one hand, a person faces the uncertainty of the current socio-cultural situation, the impossibility of predicting the future, and on the other hand, high rates of digitalization, flows of multidirectional content. These factors inevitably influence the lbeliefs, strategies and life orientations of the individual. In modern psychology, tolerance to uncertainty is studied in connection with various psychological characteristics, from life orientations, psychological endurance and well-being to creativity (Oral & Karakurt, 2022; Andronnikova, 2021; Geçgin & Sahranç, 2017; Lee, 2019; Nishikawa, Fracalanza, Rector , & Laposa, 2022; Bratukhin, Bratukhin, 2024; Researchers consider the time perspective both from its influence on the cognitive and behavioral sphere of the individual, as well as its dynamic nature and the factors that determine its development (Zimbardo, Boyd, 2010; Baird, Webb, Sirois & Gibson-Miller, 2021; Syrtsova et al. , 2007; Mello, Barber, Vasilenko, Chandler & Howell, 2022; Yanitsky, Sery, Goloshapova, 2012; Personal information behavior has also been the focus of researchers in the last decade (Smirnov, 2021); Luchinkina et al., 2022; Yudeeva, 2022; Ionova, Pyataeva, 2021; Kozlova, Sushkov, 2014; Grishina et al., 2022). However, the description of the relationship between all characteristics: tolerance to uncertainty, time perspective and information behavior of an individual is not sufficiently presented in modern research.

Thus, there is great scientific interest in studying the nature and characteristics of the relationship between tolerance to uncertainty, time perspective and information behavior of the individual.

Aim of the research

The purpose of the study is to study empirically students' attitudes toward time in connection with informational behavior strategies and tolerance for uncertainty.

Based on the purpose of the study, the following hypotheses were put forward:

- there may be positive connections between normative models of information behavior of students, time orientations and indicators of tolerance to uncertainty;
- risky models of students' information behavior may be associated with students' negative past and fatalistic present.

When choosing the object of study, we proceeded from the fact that students, for the most part, are active users of Internet content and using their example we can trace various models of informational behavior. The modern Internet environment provides the user with a large number of pro-social resources, but this environment is risky, carrying unverified, sometimes offensive and provocative information, calls for illegal and destructive activities. Taking this situation into account, in the author's methodology aimed at studying models of information behavior, we focused on vectors of behavior based on normativity (prosociality) and deviance (riskogenicity).

Materials and methods

Sample characteristics

An empirical study was conducted on the basis of the Don State Technical University with students of the Faculty of Humanities (full-time and part-time department). The study involved 192 students, aged 18 to 29 years, the average age was 20 years.

Research methods

In accordance with the purpose of the work, the following research methods were selected:

- "Strategies of informational behavior" SIP (Abakumova I.V., Romek V.G., Kolenova A.S., Grishina A.V., Zvezdina G.P.);
- Questionnaire for studying the involvement in the Internet environment (Grishina A.V., Zvezdina G.P.).
- Uncertainty Tolerance Scale (D. McLane);
- Zimbardo Time Perspective Inventory (abbr. ZTPI).

The authors approach is based on the study of models of informational behavior using the author's technique "Strategies of informational behavior" SIP (Abakumova I.V., Romek V.G., Kolenova A.S., Grishina A.V., Zvezdina G.P.). The technique allows determining the severity of a particular strategy of informational behavior, based on the motivational orientation.

Based on the motives of informational behavior, we divided all the strategies we have identified into normative and risky ones. Normative strategies include:

- Internet for killing time;
- Internet for information search;
- Internet to tell others about yourself;
- Internet for shopping;
- Internet as a motivating force.

Risky strategies include:

- Internet as an access to alternative information (oppositional views);
- Internet for participation in communities (extremism, destructive tendencies);
- Internet for spying on others in social networks;
- Internet for the realization of sexual needs;
- Internet for expressing ideas (manifestations of nationalism).

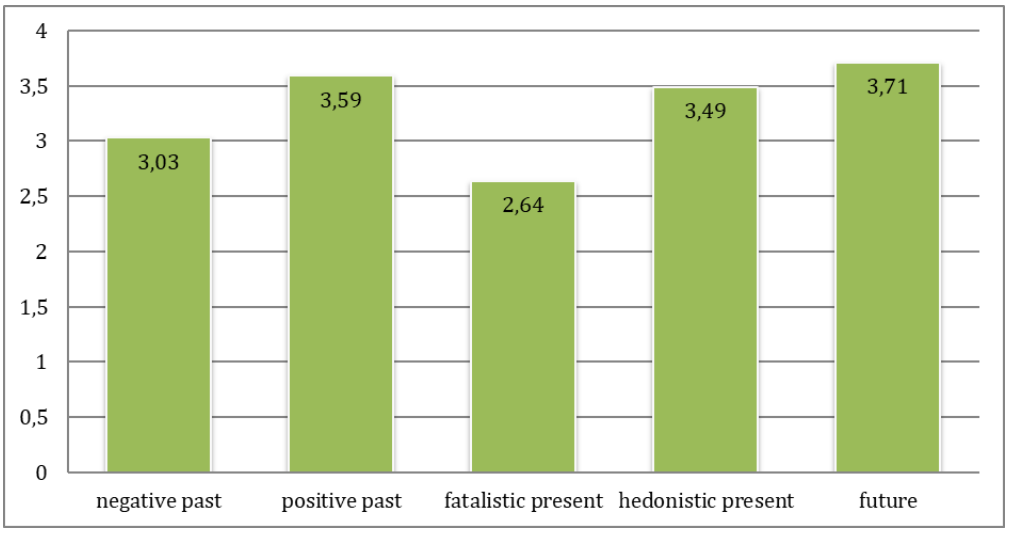
Each strategy is distinguished by a certain direction of behavior and a complex of different motives of behavior. (Grishina, et al., 2022).

Results

The study of the system of students' attitudes to time showed that the severity of time orientations is within the average values (Figure 1).

Figure 1

The severity of time perpectives among students (in points)



Students fairly evenly assess their past, present and future. The fatalistic present is less pronounced, which indicates that students rely more on themselves, their own strengths, and not on fate. Orientation to oneself and one's capabilities speaks of a realistic assessment of external and internal resources when making vital decisions.

The realism of the behavior of the respondents is also evidenced by the severity of the hedonistic present, the value of which is slightly below the average value. Orientation to the future suggests that students build goals and see the prospect of their lives.

Thus, the obtained results indicate a balanced (harmonious) system of attitude to time. Recognizing the positive and negative experiences of the past, students live in the present and plan their future.

In modern conditions, students live in a mixed reality, the use of electronic means has become a vital necessity today. Using digital devices, students use different strategies of information behavior.

We have studied the relationship between time orientations, strategies of informational behavior of students and indicators of tolerance to uncertainty.

The study of the relationship between time orientations and motivational strategies of students' informational behavior made it possible to identify the specifics of the manifestations of normative and risky informational behavior, attitudes towards the new and uncertainty among students with different time orientations (Table 1).

Table 1

Results of the correlation analysis between the time orientation "negative past", strategies of informational behavior and indicators of tolerance for uncertainty

Variables	Correlation coefficient (Rs)	p-value
negative past & uncertainty preference	-0,38	0,01
negative past & novelty attitude	-0,33	0,01
negative past & uncertainty tolerance	-0,51	0,01
negative past & attitude towards uncertainty	-0,41	0,01
negative past & Internet as an access to alternative information	0,27	0,01
negative past & Internet to participate in communities	0,21	0,05
negative past & Internet for the realization of sexual needs	0,21	0,05

According to the position of F. Zimbardo, the negative past reflects a general pessimistic, negative attitude or attitude with an admixture of disgust towards the past. The study of correlations between the negative past and informational behavior strategies showed that this time orientation is associated only with risky informational behavior strategies; no statistically significant relationships were found with normative strategies.

The negative past has direct weak links with such risky information behavior strategies as - "Internet as an access to alternative information" ($r=0.27$, $p < .01$), "Internet to participate in communities" ($r=0.21$, $p < .05$), "Internet for the realization of sexual needs" ($r=0.21$, $p < .05$). The obtained results may indicate that the traumatized past encourages respondents to risky behavior, to seek satisfaction of their needs in non-normative ways. Perhaps a negative reconstruction of past events through participation in online communities, the search for alternative, not always verified information acts as a defense mechanism against the negative, traumatic influence of the past.

Traumatization of past experience is reflected in the acceptance of the new and uncertain. Moderate inverse relationships were found between the negative past and uncertainty tolerance scales - preference for uncertainty ($r=-0.38$, at $p < .01$), attitude towards novelty ($r=-0.33$, at $p < .01$), tolerance for uncertainty ($r= - 0.51$, at $p < .01$), attitude to uncertainty ($r=- 0.41$, at $p < .01$). Respondents with a negative attitude towards their past prefer a stricter regulation of their lives, a complete understanding of what is happening. It is difficult for them to navigate in a new situation, situations of uncertainty and unpredictability are perceived by them as unfamiliar, complex and additionally traumatize them.

Let's analyze the relationship between the positive past and the studied parameters (Table 2).

Table 2

The results of the correlation analysis between the time orientation "positive past", informational behavior strategies and scales of tolerance for uncertainty

Variables	Correlation coefficient (Rs)	p-value
positive past & preference for uncertainty	0,26	0,01
positive past & attitude towards novelty	0,32	0,01
positive past & tolerance to uncertainty	0,34	0,01

Variables	Correlation coefficient (Rs)	p-value
positive past & attitude towards uncertainty	0,26	0,01
positive background & attitude towards challenging tasks	0,29	0,01
positive past & Internet as a motivating force	0,21	0,05

Acceptance of one's own past experience correlates with only one strategy of informational behavior - "Internet as a motivating force" (r= 0.21, p < .05). A positive past acts as a kind of life support for the respondents and acceptance of the present and future. A positive past has direct moderate connections with all uncertainty tolerance scales. A positive attitude towards one's past also contributes to a positive attitude towards uncertain situations. Students who perceive their past positively are more likely to perceive themselves as a subject of their own actions and control their own lives, they are more optimistic about their own successes and failures, and more likely to expect success in the future. They easily accept complex tasks (0. r=29, at p < .01) and are optimistic about the challenges of the time, seeing them as new opportunities (r=0.32, at p < .01).

The study of the links between strategies of informational behavior, scales of tolerance to uncertainty and orientation to the fatalistic present showed that there are direct and reverse weak links (Table 3).

Table 3

Results of the correlation analysis between the time orientation "fatalistic present", strategies of informational behavior and scales of tolerance to uncertainty

Variables	Correlation coefficient (Rs)	p-value
fatalistic present & uncertainty tolerance	-0,26	0,01
fatalistic present & attitude towards complex tasks	-0,22	0,05

Variables	Correlation coefficient (Rs)	p-value
fatalistic present & internet as an access to alternative information	0,21	0,01
fatalistic present & Internet to participate in communities	0,21	0,01

The fatalism of the present is manifested in the fact that a person considers his life as completely dependent on external circumstances, on the will of fate, and does not see the possibility of managing it. The connection between the fatalistic present and risky strategies of information behavior - "Internet as an access to alternative information" ($r=0.21$, $p < .05$), "Internet for participation in communities" ($r=0.21$, $p < .05$) indicates that a person who is insecure about his present doubts all the time and seeks support in communities that give illusory support and instill some confidence that you are not alone in his thoughts and doubts. Access to alternative information gives the user a sense of acceptability for diversity and variation in how reality can still be viewed.

The feedback between the fatalistic present and uncertainty tolerance ($r= -0.26$, at $p < .01$) suggests that a person who attaches great importance to the will of fate and external circumstances, a dogmatic person, hardly survives new and unpredictable situations, hardly adapts to changes , which can lead to a decrease in adaptation.

Feedback with the “attitude to complex tasks” scale ($r= -0.22$, at $p < .05$) confirms the conclusion that a person with a pronounced fatalism of the present strives for simplicity, algorithmization, clarity both in business and in relationships. Such a person demonstrates helplessness and tries to find support outside, exposing himself to additional risks.

The largest number of connections was obtained in the study of the hedonic present (Table 4).

Table 4

Results of the correlation analysis between the time orientation "hedonistic present", informational behavior strategies and scales of tolerance for uncertainty

Variables	Correlation coefficient (Rs)	p-value
hedonistic present & uncertainty preference	0,41	0,01
hedonistic present & attitude to novelty	0,47	0,01
hedonistic present & Internet to tell others about yourself	0,47	0,01
hedonistic present & Internet for shopping	0,35	0,01
hedonistic present & Internet for "killing time"	-0,24	0,01
hedonistic present & Internet as a motivating force	0,40	0,01
hedonistic present & Internet for spying on others in social networks	0,32	0,01
hedonistic present & Internet for the realization of sexual needs	0,21	0,05
hedonistic present & Internet for expressing religious ideas	0,22	0,05

The hedonistic present reflects the focus on the "here and now", on getting pleasure, as evidenced by correlations. A direct moderate relationship was found between the hedonistic present and informational behavior strategies - Internet to tell others about yourself (0. r=0.47, p < .01), Internet for shopping (r=0.35, for p < .01), Internet as a motivating force (r=0.40, p < .01). The focus on oneself and one's actual needs is also manifested in the Internet environment. Representing and presenting themselves in the Internet space, respondents experience pleasure, amuse their pride and reinforce their self-esteem. When shopping on Internet sites, they also satisfy their hedonistic consumer needs. The example of others acts as a motivating force for them, carries them away to new adventures and pleasures.

An interesting result was obtained by revealing the correlation between the Internet strategy for "killing time" and the hedonic present (r=-0.24, at p < .01). Students focused on getting pleasure from life today do not want to waste their time on empty wandering around the Internet and wasting personal time. Their behavior on the Internet is more purposeful and objectified.

The presence of direct links between the hedonistic present and risky strategies of informational behavior - Internet for spying on others (r=0.32, p < .01), Internet for the realization of sexual needs (r=0.21, for p < .05), Internet for expressing religious ideas (r=0.22, at p < .05), also indicates their hedonistic orientation, the orientation of getting pleasure "here and now".

Orientation to hedonism, often takes the person away from the need to think about the future and their future prospects, their behavior is characterized by the fact that they are focused on the present and they have no concern for the future.

The relationship of present hedonistic with uncertainty preference and attitudes toward novelty suggests that the uncertainty associated with risking the unknown attracts pleasure-oriented individuals.

The study of the relationship between future orientation and information behavior strategies showed that there were direct weak links with normative strategies – "Internet as information search" (r=0.21, p < .05) and "Internet as a motivating force" (r=0.23, at p < .05) (Table 5).

Table 5

The results of the correlation analysis between the time orientation "future", information behavior strategies and indicators of tolerance for uncertainty

Variables	Correlation coefficient (Rs)	p-value
future & uncertainty preference	-0.32	0.01

Variables	Correlation coefficient (Rs)	p-value
future & internet for information search	0.21	0.05
future & internet as a motivating force	0.23	0.05

Students focused on the future, on achieving their plans and prospects actively use the Internet to search for information to solve issues of study, project implementation and research activities. An example of successful people presented in the Internet space acts as a kind of guideline for them, which they can rely on when designing their future.

An inverse relationship was established between future orientation and uncertainty preference ($r= -0.32$, $p < .01$). The more respondents prefer uncertainty, the less they are able to imagine their future. Perhaps the expectation of constant novelty, changes in situations do not allow them to determine long-term plans, see their prospects. The preference for uncertainty is associated with the hedonistic present, the respondents' acceptance of risk and unpredictability increase emotional arousal. The subsequent release brings pleasure to the respondents and fills their life with content and meanings.

Discussion

In recent years, research has been actively conducted on the attitude of the individual to the situation of uncertainty. So, Oral M., Karakurt N. (2022) state that psychological endurance is negatively correlated with tolerance for uncertainty. Thus, the greater the resistance to difficult life situations a person has, the lower the tolerance for uncertainty, the more expressed the desire for anticipation of the future, greater concretization; Andronnikova O.A. (2021) describes the relationship between uncertainty tolerance and endurance among adolescents ("Risk Taking" ($r = 0.75$), "Control" ($r = 0.71$), "Involvement" ($r = 0.65$), "Resilience" ($r = 0.65$)); Geçgin & Sahranç (2017)). study the relationship of intolerance to uncertainty and psychological well-being; Lee (2019) analyzes the effect of resilience on uncertainty intolerance in medical students; Nishikawa, Fracalanza, Rector, & Laposa (2022) determine that uncertainty intolerance significantly influences the association between social interaction anxiety and negative interpretations of positive events; Sokolova (2015) notes that tolerance to uncertainty and tolerance of ambivalence

may indicate the achievement of individual maturity, constancy and integrity of "Self", capable of coping with anxieties. Bratukhin E., Bratukhin A. (2024) analyze the perception of time in individuals with a predominance of tolerance or intolerance to uncertainty. They note that in subjects with a predominance of tolerance to uncertainty, situations of the past and future are perceived as dynamic, significant, filled with personal meaning and positive emotional experiences. Panova, V.S. (2021) analyzes the relationship between tolerance for uncertainty, meaningful life and value orientations; Kondrashikhina O. A., Tikhomirova I. A. (2020) study the verbal and non-verbal creativity and uncertainty tolerance of psychology students.

Our results are partially consistent with the results of researchers: a positive past and hedonic present have positive relationships with tolerance for uncertainty, and future orientation has a negative relationship with preference for uncertainty.Time perspective is considered one of the most powerful influences on human behavior (C.Peng et al, 2021). There was a number of studies analyzing how time perspective links to psychological and behavioral pecularities of a person, determines his values and aims.

Zimbardo P., Boyd J.(2010) note that time perspectives have a strong influence on the cognitive and behavioral sphere of the individual. Baird, H. M., Webb, T. L., Sirois, F. M., & Gibson-Miller, J. (2021) found that future time perspective is associated with self-regulation skills and influences.

Researchers point to the dynamic nature of time perspectives. Syrtsova A., et al. (2007) studied the age dynamics of the time perspective, the features of the personality's time perspective at different ages (from older adolescence to late adulthood), gender differences in the manifestation of the personality's time perspective at different ages, factors influencing the formation of the dominant time perspective. Mello, Barber, Vasilenko, Chandler & Howell (2022) concluded from their research that attitudes toward time perspective change with age: adolescents and young adults think more often about the future , but the older a person gets, the more he turns to the present. The authors also note that people with low self-esteem have a greater emphasis on the past than others, while high self-esteem is characteristic of people who highlight the present and future as the most important. Time perspectives can change over the course of a lifetime, influenced by career, economic and political instability, substance use, traumatic events, or personal successes and failures.

The formation of time perspectives is influenced by many factors, some of which are related to the process of socialization (cultural values and the predominant religious orientation, type and breadth of education, socio-economic status and family patterns). Chronotopic characteristics of the students' world image are reflected in the studies of Yanitsky M. S., Sery A. V., Balabashchuk R. O. (2019). Analyzing the value-semantic

orientation and socio-cultural determinants of the image of the future of student youth scientists conclude that two-thirds of the representatives of student youth reveal a formed value-semantic orientation of the image of the desired future, the nature of which is determined by belonging to a particular socio-cultural environment. The semantic regulation and temporal organization of the life path of a modern personality was studied by Goloshapova E.S.(2012). Features of the perception of life prospects in a difficult life situation were investigated by Timofeeva, T.S., Belikova A.V., 2021.

Researchers believe that temporal orientation, attitudes and experiences can be considered as stable personality traits (Zimbardo P.G., Boyd J., 1999). Temporal prospects are considered as an expression of one's own system of personal meanings, which allows one to create a coordinated system of coordinates for the life of a person at a particular age (level of education, marital status, etc.). Russian scientists Bastrakova, Mukhlynina, Sharov (2020) are attempting to describe the features of modeling life prospects by the digital generation; Zhemchugova (2020) presents time perspective as a factor in a person's basic beliefs.

Stolarski et al. (2020) analized the construct of time perspective (TP) and its connection with a number of psychological phenomena, including well-being, mental health, personality, cognitive functioning, self-control, interpersonal relations, as well as biological features and demographic variables. Sobol, Przepiórka, Meisner & Kuppens, (2021) studied the effect of fatalistic time perspective on self-esteem in extraverts and introverts. It was shown that introverts after the induction of fatalistic time perspective had higher self-esteem than introverts after neutral induction.

Russian scientists such as Bastrakova, Mukhlynina, Sharov (2020) are attempting to describe the features of modeling life prospects by the digital generation; Zhemchugova (2020) presents time perspective as a factor in a person's basic beliefs.

The connection between time perception and risky behaviour was studied (Sekścińska, Rudzinska-Wojciechowska & Maison, 2018) in the context of risky financial choices. Authors showed that chronic Future and Present Hedonistic TPs are the most important in the context of risky financial choices. Higher Future TP is related to a propensity to invest and make safe investment choices. Higher Present Hedonistic TP is related to a low propensity to invest and risky investment. These values correlate favorably with their colleges from University of Warshaw Łukasz Jochemczyk, et al, and futhersupport the idea that risk-taking can be linked to stable personality traits, such as impulsivity and extraversion. So, they propose that time perspective is another personal characteristic that affects risk taking. Specifically, authors hypothesized that a habitual focus on the hedonic aspects of the present would be associated with greater risk-taking propensity

in a variety of domains (e.g., health, investments, ethics). It means that individuals who are focused on the hedonistic aspects of the present appeared to be more interested in risk-taking than are those whose do not focus on this perspective. (L. Jochemczyk, 2017) This matches well with our findings about the correlation of hedonistic present and risky behavior online.

The accelerated pace of digitalization has stimulated greater research activity in the study of individual informational behavior. Thus, Smirnov (2021) considers digitalization as a factor in the formation of deviant illegal behavior among students; Luchinkina et al. (2022) analyze the gender characteristics of media consumption by modern youth; Yudeeva (2022) describes the features of motivation for destructive communicative behavior of adolescents on social networks; Ionova, Pyataeva (2021) study the personal characteristics of students prone to Internet addictive behavior; Kozlova and Sushkov (2014) studied the relationship between virtual identity and the user's emotional orientation; psychological predictors of risky information behavior among student youth were reviewed by Grishina and others (2022).

Our findings are also in good agreemnt with results of Luca Chittaro, Andrea Vianello (2013): Past Negative and Present Fatalistic temporal frames are predictors of problematic Internet use.

As hypothesized, our experiment demonstrates that time perspective can be considered as one of psychological predictors of risky behavior.

Conclusion

Our study was devoted to the students' attitudes to time in connection with information behavior strategies and tolerance to uncertainty. Based on the empirical study, the following conclusions were drawn:

- The sample of students who took part in the study demonstrated a fairly balanced system of attitudes towards time - past, present and future;
- Negative past has direct links with risky information strategies and feedbacks with indicators of tolerance for uncertainty, which indicates that situations of uncertainty are more difficult for people with traumatic past experience and they more often resort to risky behavior in the Internet environment, compensating for their experiences and traumas;
- Positive past has direct links with the normative strategy "Internet as a motivating force" and acts as a predictor of tolerance to uncertainty, acceptance of new and complex situations;
- Fatalistic present has direct links with risky information strategies and reverse

with indicators of tolerance to uncertainty, belief in fate and fatalism make a person vulnerable to risks, deprives him of control over his own life and makes him less tolerant to uncertainty and complex ambiguous tasks;

- The obtained results confirm the hypothesis that risky models of information behavior of students can be associated with a negative past and a fatalistic present among students;
- Hedonistic present has direct links with both normative and risky strategies of informational behavior, with a preference for uncertainty and an attitude towards novelty. A hedonistic orientation shows that students are willing to take pleasure in a variety of ways, including taking risks from the unknown and the uncertain;
- Orientation to the future has direct links with the normative strategies of informational behavior aimed at searching for information and using others as motivational guides and feedback with a preference for uncertainty.
- The results obtained indicate that the first hypothesis was partially confirmed.

The evidence from this study suggests that the current situation of uncertainty, a high rate of change requires a quick response, focus on the "here and now", risk, so it is more in line with the "hedonic present" time perspective and makes it difficult to predict the future, especially in the long term. The present findings might be used in preventive and psycho-corrective work with student youth on the development of pre-adaptive abilities, readiness to accept the new and uncertainty, on forecasting of models for the implementation of the future.

Limitations of the study

Limitations may include the following circumstances: 1) we conducted research on a student sample; 2) we did not take into account the gender characteristics of the respondents. It is obvious that informational consumption (in particular, preferred strategies of informational behavior) among representatives of different generations and among men and women may differ for various reasons.

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Author Contribution

Galina Pavlovna Zvezdina – concept and design of the study, selection of diagnostic techniques, data collection.

Natalya Evgenievna Komerova – analysis of literature on the research topic, preparation of sections "introduction" and "discussion of results".

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Personality Destructions in the Professional Sphere: Subjective Control as a Factor of Their Overcoming

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Abstract

The introduction presents the substantiation of the relevance of the study of subjective factors of personality destructiveness and emotional exhaustion in the professional space in the conditions of uncertainty. The results of analyzing the research of internal predictors that cause the emergence of destructive transformations and emotional exhaustion of personality in the situation of modern risks are presented. The aspects of negative influence of complex and entropic professional environment on personality adaptation and psychological well-being are described. The barriers of successful adaptation of personality to new requirements with different level of subjective control are shown. The substantive characteristic of psychological effects of the influence of professional socialization on the psychological well-being of the personality or the formation of destructions is given. The novelty of the study lies in the identification and description of subjective control as a factor of effective overcoming of personality destructions in the professional sphere of different orientation. The Results section shows the specificity of the pattern of manifestation of indicators of the formation of components of subjective control of personality in representatives of technical and pedagogical professions. The analysis of the results of the empirical study of the components of the subjective control system as a factor in the prevention of personality destructions in the process of immersion in the profession is described. The Discussion presents a description and interpretation of the results of the empirical study of manifestation of subjective control components and their relationship with the probability of destructive transformations

and emotional exhaustion in persons with different professional orientation. The data of the empirical study show the presence of risks of emotional exhaustion and destructive transformations of personality in the situation of deficits and risks of subjective control. The resource possibilities of subjective control in the prevention of destructive personal transformations under the influence of immersion in the profession are shown for the first time. The Conclusion shows the clustering of psychological factors related to the peculiarities of the system of subjective control, influencing the emergence of emotional exhaustion of personality in the conditions of modern risks of uncertainty. The idea that the effectiveness of psychological assistance programs in overcoming the state of emotional exhaustion and destruction in the professional sphere is determined by the level of mobilization of subjective control resources to achieve success and psychological well-being is emphasized.

Keywords

subjective control, personality, professional deformation, destructions, responsibility, controllability of life, transformations

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Introduction

Today, a person who is developing, self-efficient, promising, and capable of pre-adaptation is in demand. In this regard, it is interesting to study possible predictors of regression and stagnation of personality development, mechanisms of their action and ways to overcome them. Professional activity occupies a significant place in the life of a modern person and represents the leading form of the subject's activity, so the formation of personality here is the most intensive. Professional formation, being built into the system of life priorities, goals and values, influences all spheres of the subject's life activity, setting new "tasks for meaning", endowing activity with a special prognostic meaning, setting the meaning matrix of building productive motivational intents of the personality (Abakumova, 2019; Maunz, Glaser, 2024). In modern conditions of increased mobility and global challenges (e.g., special working conditions during the COVID-19 pandemic) (Toscano, Bigliardi, Polevaya, Kamneva, Zappalà, 2022) the success and psychological preservation of the subject of professional activity is associated with the ability to maximize the use of their potential, initiating developmental formats and stimulating the formation of the ability

to pre-adaptation (Asmolov, Shekhter, Chernorizov, 2017). Especially the success of personality socialization in the professional sphere is associated with the improvement of the system of subjective control that contributes to the implementation of life plans. As a result of immersion in the space of professional life, over time there are transformations of personal life attitudes, attitudes to oneself, others and the world. At the same time, these transformations can be both constructive and destructive, which is determined by a complex of individual-psychological predictors.

Productivity of adaptation is determined, according to our hypothesis, by the level of development and integration of the system of subjective control of personality, Subjective control of personality consists of 3 blocks (Shcherbakova, 2020):

1. The strategic block is formed by values, meanings, meaning-life orientations of the individual, which become the subjective basis of transformations and set the strategy of movement. The role of this block of activity control increases in the situation of modern risks and the need to build sustainable economic and social systems.
2. The tactical block is based on the professional and social competence of the individual and promotes effective coping in complex and problematic situations.
3. The operational block is based on the subject's autopsychological competence and allows to manage psychological and emotional states.

Deficits of development of subjective control system can contribute to destructive character of personality changes in the context of profession. At the same time, as emotional exhaustion is formed, strategic, tactical and operational control mismatch occurs. This leads to the fact that declarations of personality cannot be realized in practice and its self-efficacy decreases, pre-adaptation becomes more difficult. From the point of view of modern psychology, personality development acts as a unified system of progressive and regressive transformations, but their ratio in the process of life and professional path is constantly changing.

Personality destructions in the professional sphere provoke rapid fatigue and depletion of personal resource (Hu, Zhang, Zhai, Wang, Gan, Wang, Wang, Wang, Yi, 2024), change of the established structure of activity and communication, which negatively affects not only productivity and interaction with colleagues (Slowiak, Jay, 2023), but also has a wider range of influence on different spheres of human activity and psychological well-being (Povarenkov, 2021; Rodina, 2019).

Destructions that arise in the process of long-term performance of the same professional activity are a consequence of insufficiently formed ability to personal growth, reflect deficits of creativity, autopsychological competence and transformative activity, insufficient understanding of motivational intention. In the conditions of modern risks, a personality oriented to personal growth, possessing skills of self-transformative activity and self-control, having a clear idea of the meaningful purpose of the undertaken efforts for the future, has more chances to preserve his psychological well-being and

performance. Personal values, clear goals, expressed subjective position, personal resistance to entropy and multifactor stress as attributes of modern life become a kind of psychological buffer, mitigating destructive influences in a situation of uncertainty (Salikhova, 2020, Soloviev, 2019) .

Professional being is an integral part of beingness of a modern person and, accordingly, success, demand and preservation of personality as a professional are significant factors in maintaining high self-esteem and psychological well-being. Professional activity, in general, has a positive impact on the subject, facilitating development and providing a platform for the realization of their potential. At the same time, in conditions of uncertainty, multifactor stress, a person faces unfavorable conditions of activity realization, high tension, abrupt changes in requirements, overloads, which makes special demands on personality stability, ability to choose constructive coping strategies. Otherwise, deformations, psychosomatic disorders, various developmental disorders, intrapersonal crises, self-esteem and self-relationship problems may occur. The problem of constructiveness or destructiveness of personal transformations in professional life is directly related to the psychological safety of personality and the ability to survive in a situation of uncertainty and multitasking (Karpova, Drynkina, 2022; Solovyova, 2020). In this regard, researchers now pay special attention to the factors of psychological self-regulation in the workplace (Barabamshchikova, Kuznetsova, 2022).

Destructive disorders in emotional exhaustion in professional activity are manifested in the fact that some links in the structure of individual activity fall out of the field of subjective control of a person, due to the rapid onset of fatigue and overstrain of the subject, he misses the opportunity to maximally realize the acquired skills and abilities. In the situation of emotional exhaustion the personality has a decrease in the function of self-control, forecasting and goal-setting, which prevents the build-up of self-actualization in the time perspective. The study of destructive deformations expressed in the syndrome of emotional exhaustion in the context of the modern situation of the subject's professional activity realization is important (Shekhovtsova, 2020). Destructive transformations of personality trigger psychological defenses, minimize subjective involvement in activity, which in certain circumstances leads to a decrease in performance, professional mistakes and extreme situations. Non-constructive transformations of personality in the process of realization of professional activity lead to the fact that it ceases to meet the modern standard of a specialist and turns out to be unclaimed. In empirical studies of modern psychologists it is shown that the predictors of professional deformation can be associated with the contradiction between objective and subjective goals of activity, personal meaning and significance of what is happening (Alessandri, Perinelli, 2018). Here, the developed strategic control allows harmonizing the situation at the semantic level, setting new vectors of development, progressive transformation, and the operational one makes it possible to preserve emotional stability and emotional self-efficacy, allowing to resist emotional exhaustion

Psychologists classify professional deformations, distinguishing their different types: semantic, motivational, cognitive, personal and conative. Today, emotional exhaustion in psychology is considered as an independent phenomenon, the result of the negative impact of the profession on the personality. Emotional exhaustion can cause regression of self-realization in the professional space, significantly reduce the status of psychological well-being of the individual, negatively affect its effectiveness. The phenomenon of exhaustion can transform professional self-concept and the image of the subject's future, provoking personality destructions and becoming a significant obstacle on the way to success. Therefore, it is of great importance to develop autopsychological competence, the ability to take care of one's psychological well-being, to support the development of personal characteristics that reduce the likelihood of emotional exhaustion (Pacheco, 2020).

Personality destructions in professional activity are expressed in the violation of goal-setting, problems with reflection of the situation, deficits of planning and forecasting, lack of control and regulation, moreover, professionally significant qualities can be significantly distorted. The expressed system of subjective control of the personality is associated with the predisposition of the subject to attribute responsibility for the results of activity to himself, to consider himself the master of his life, imagining that life can be manageable if one shows adequate self-control (Shcherbakova, 2019). The resource of the system of subjective control as a factor of effective overcoming personality destructions in the professional sphere is associated, first of all, with the fact that internality correlates with the ability to make decisions independently, purposefulness, ability to help and support oneself.

The purpose of the present study was to investigate the expression of components of the subjective control system in persons with different professional orientation and differences in the expression of emotional exhaustion indicators.

Methods

The study involved teachers and representatives of technical specialties, total sample size 354 people. The sample included respondents with emotional exhaustion indicators higher than average values. The idea of the sample formation was to be able to compare the studied variables in representatives of professional orientations that are far enough from each other (Shinkarenko, 2012).

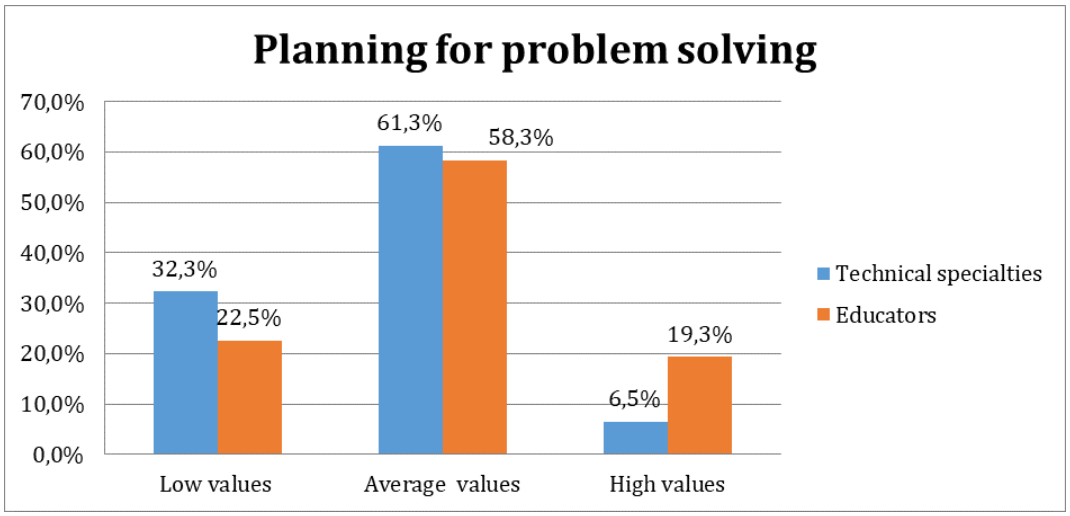
The following methods were used in the research: Diagnostics of professional exhaustion by K. Maslach, S. Jackson (adaptation of I. E. Vorobyanova (2008)); Coping Strategies questionnaire by R. Lazarus (adaptation of WCQ methodology) (Kryukova, Kuftyak, 2007); Meaning-Life Orientations test by D. A. Leontiev. This toolkit allows us to get an idea of the expression of certain components of the system of subjective control of personality. The indicators of certain scales were chosen as indicators: "problem-solving planning", "self-control", "acceptance of responsibility" from questionnaire "Coping

Strategies" by R. Lazarus (adaptation of WCQ methodology); "locus of control I-I (I am the master of life)", "locus of control I-life (controllability of life)" from the methodology "Meaning-Life Orientations" by D. A. Leontiev. These scales provide necessary information about the expression of components of the system of subjective control of personality.

Results

As a result of the conducted empirical study, interesting data were obtained. In the process of diagnostics using the questionnaire "Coping Strategies" by R. Lazarus (adaptation of WCQ methodology), the levels of expression of the indicator "problem-solving planning" were revealed (Fig. 1).

Figure 1
Expression of problem-solving planning skills among educators and technicians

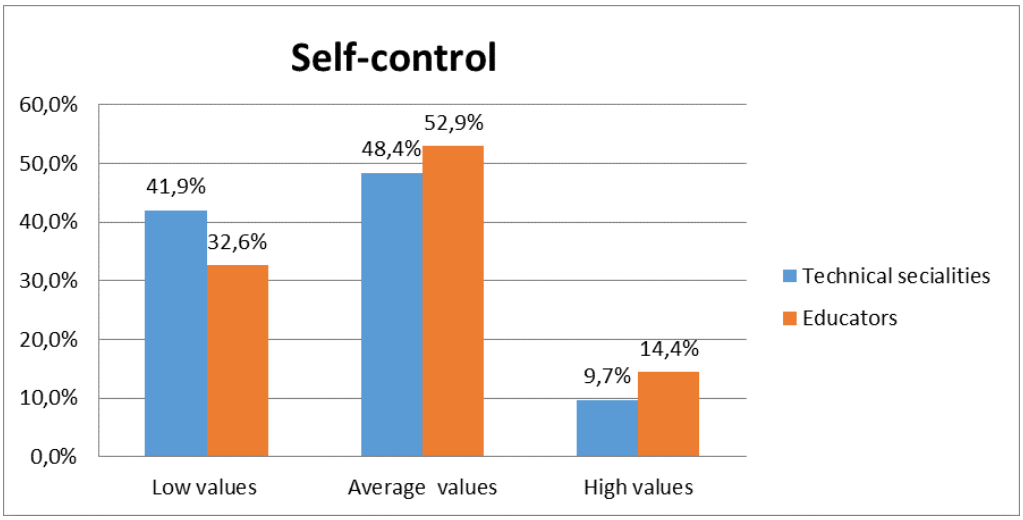


From the obtained data we can conclude that the majority of respondents of both groups (61% and 58%) have average values of expressiveness of the ability to plan problem solving. The majority of teachers and technical specialists, in general, know how to solve tasks in crisis situations and plan the process of finding a way out. At the same time, the respondents of the "Teachers" group have fewer low values (22%), while the technical specialists have 32%, and a higher percentage of high values 19% vs. 6%. The analysis of diagnostic data allows us to see the risks associated with the greater expression of low values of skills to plan problem solving in situations of difficulty.

The data on the scale "Self-control" show that half of respondents of both groups have moderately expressed self-control and this is a resource position. At the same time, the representatives of technical specialties (41,9 %) have low values and only 9%

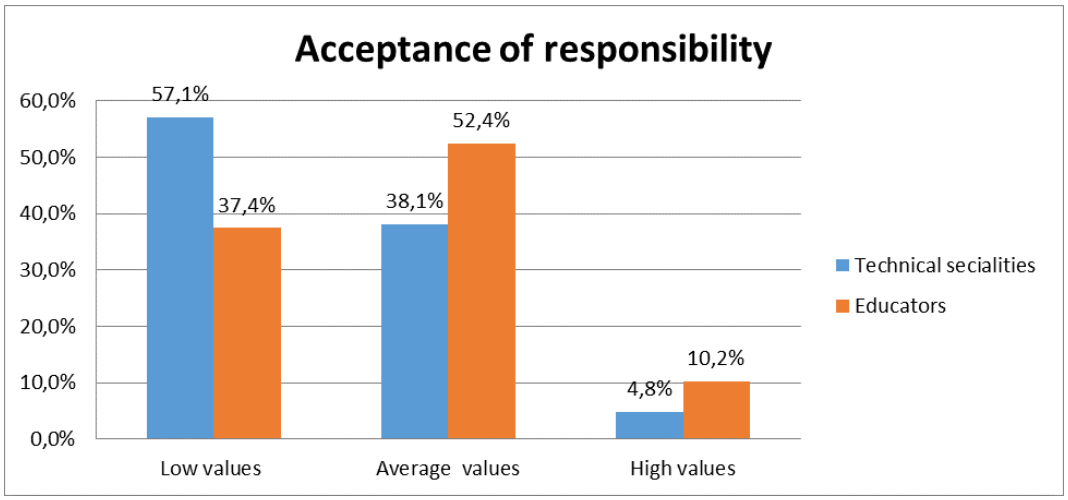
demonstrated high self-control, here there is a risk of emotional exhaustion associated with the deficit of self-control (Fig. 2).

Figure 2
Expression of self-control indicators in teachers and technicians



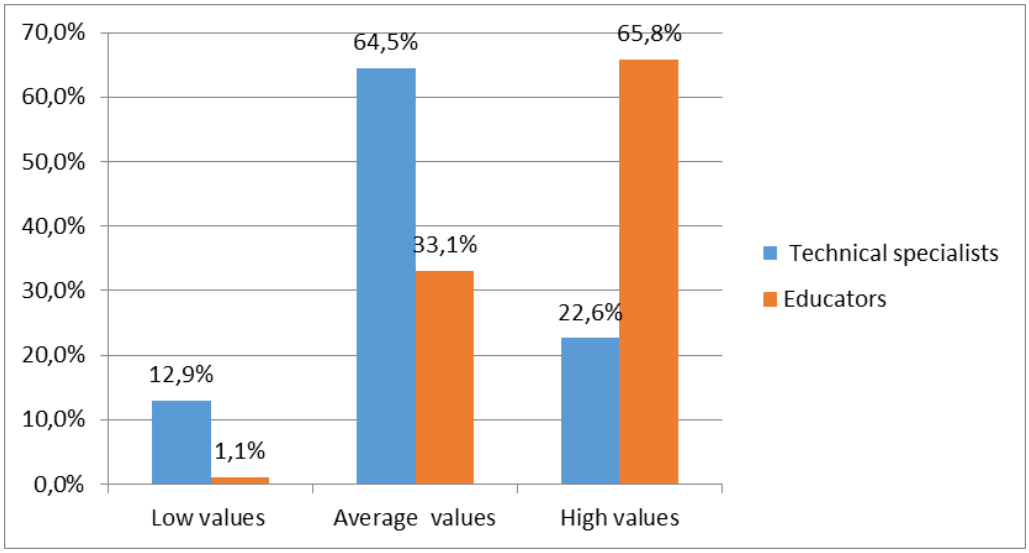
The data on the scale "Acceptance of responsibility" (Fig. 3) show that teachers have a higher degree of readiness to accept responsibility compared to technical professionals. Obviously, this is due to the peculiarities of the professional profile: teachers are more often faced with the professional situation of the need to make decisions, while technical professionals are forced to follow the technology and act according to the algorithm.

Figure 3
Indicators of readiness to accept responsibility in educators and technicians



As a result of the study using the test of meaning-life orientations (MLO) by D. A. Leontiev, diagnostic data were obtained regarding locus of control I - I and locus of control I - life, reflecting the subject's ideas about the possibility of being the master of his life and managing it in the conditions of modern risks. Comparative data on the indicated indicators are reflected graphically in Figures 4 and 5.

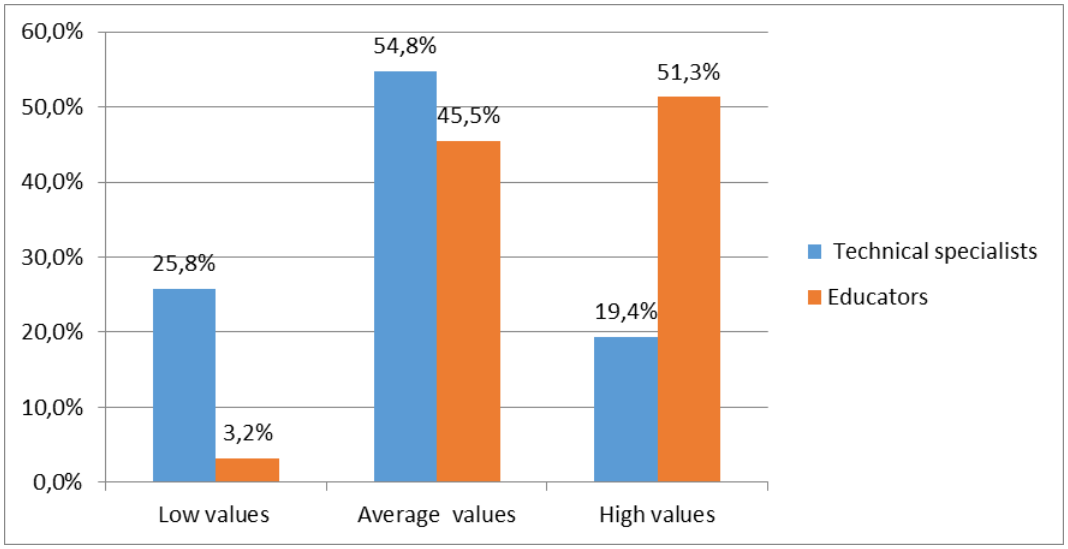
Figure 4
Indicators of locus of control I - I (I am the master of life) in teachers and technical specialists



The data indicate that more than half of the respondents of both groups believe that they can realize all their plans, as it depends on their own efforts, an insignificant part of 12% and 1% – prefer to rely on fate and specific circumstances. At the same time, the position of teachers is somewhat biased and reflects rather a declaration and desire to be the master of life than the real state of affairs. This is obviously due to the peculiarity of the pedagogical profession, where the professional, realizing the educational function, asserts the idea of the need to be an independent subject and master of life. Mythologized idea of the ability to hypercontrol can be a risk in terms of the development of professional destruction of the teacher's personality.

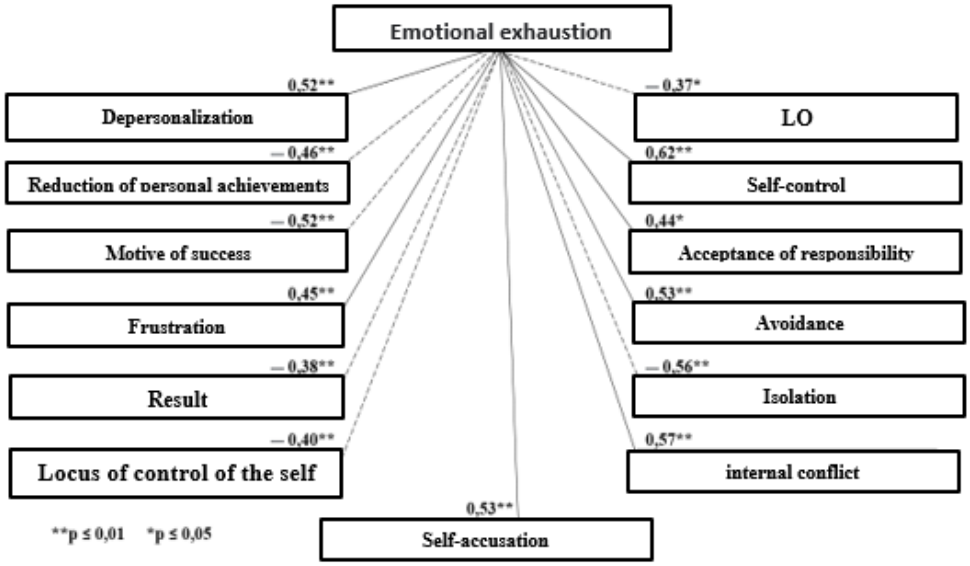
The picture of life manageability indicators (Fig. 5) looks more realistic in the group of specialists of technical profile: 25% – low level, 54.8% – medium and high in 19.4%. of respondents. The group of "Educators" showed higher results: 51.3% - high level and 45.5% – medium level. Thus, they believe that everything that happens to them depends on their competence, abilities, purposefulness, is determined by their desire and activity. In a situation when overestimated expectations regarding the manageability of life are not justified, intra-personal conflict and destructive transformations of personality can develop.

Figure 5
Indicators of locus of control self - life (controllability of life) in teachers and technical specialists



Correlations between the scale "Emotional exhaustion" and scales of emotional exhaustion, LOT, coping strategies and motivation to achieve success/failure, frustration in professional's technical profile (Fig. 6).

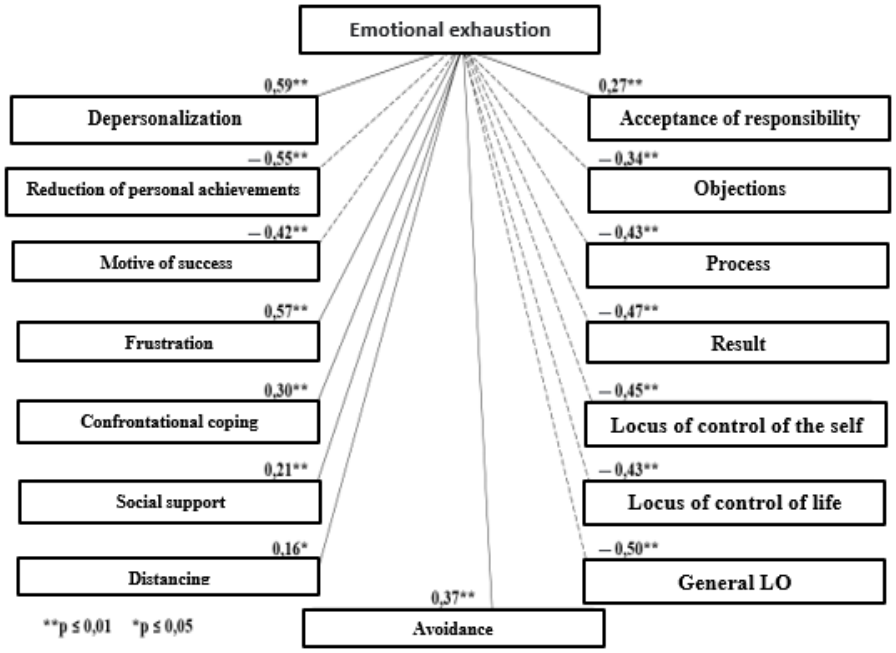
Figure 6
Correlations between indicators of emotional exhaustion and control in technical specialists



As the analysis of correlations has shown, emotional exhaustion has significant direct correlations with self-accusation, internal conflict, avoidance and depersonalization; at the same time, there is a significant direct correlation with self-control (0.62) and a moderate direct correlation with acceptance of responsibility. This picture reflects the peculiarities of the state of personality in the situation of exhaustion: at the value of preserving one's status there is a mythologization of the ability of self-control and a desire to rigidly control or mask one's emotional experiences. Against the background of avoidance and frustration respondents showing the presence of emotional exhaustion demonstrate an inverse correlation between emotional exhaustion and achievement motive, as well as locus of control of the self, which reflects the projections of exhaustion state in technical specialists.

Correlations between the scale "Emotional exhaustion" and scales of emotional exhaustion, LOT, coping strategies and motivation to achieve success/failure, frustration in the group of teachers are presented in Fig. 7.

Figure 7
Correlations between indicators of emotional exhaustion and control in educators.



The analysis of correlations of emotional exhaustion in the group of teachers shows that this indicator has significant direct correlations with depersonalization, frustration, insignificant – with avoidance, confrontation and acceptance of responsibility. At the same time, there is an inverse correlation at the significance level between the reduction of personal achievements and the meaningfulness of life and a less significant inverse

correlation emotional exhaustion – locus of control of the self; locus of control of life. Thus, against the background of frustration and depersonalization, a teacher in the state of emotional exhaustion loses to a certain extent a sense of control over his internal and external manifestations and life in general.

Discussion

The analysis of the obtained empirical data allows us to see the differences in the development of components of subjective control in persons of different professional orientation. It is interesting that the highest indicators of expression of components of the subjective control system are found in representatives of the pedagogical profession, in which a specialist can make decisions independently and performs work that requires endurance and patience, the ability to control oneself (Holmström, Tuominen, Laasanen, Veermans, 2023). Lower indicators are found in representatives of technical professions that require high qualification, the need to act within the framework of certain professional regulations and technical assignments, which provides insufficient opportunities to demonstrate independence in the management of the production process.

Understanding and systematization of resources and risks associated with the peculiarities of the development of the system of subjective control as a factor of effective overcoming personality destructions in the professional sphere allows us to identify the focuses of psychological support of the subject of activity aimed at the formation of his psychological safety in conditions of increased stressogenicity of the environment (Trofimova, Kuzmina, 2022).

Resources of subjective control in the prevention of emotional exhaustion and other personality destructions are acceptance of responsibility and the ability to control one's activity in difficult situations, optimizing efforts to achieve the result, which allows to be more successful and psychologically well.

Risks associated with the peculiarities of the individual system of subjective control include the following items:

- deficits in self-control;
- doubts about the self-efficacy of the self as a subject of responsibility and regulation of activity;
- The mythologizing of one's own ability to control life.

A subject with insufficiently high subjective control cannot directly relate his/her behavior to life events and feels that he/she is not in control of his/her life. At the same time, the relationship between locus of control and goal setting in professional activity can be quite ambiguous. In their study E. A. Pronenko, D. V. Vashumirskaya found that no significant correlations were found between locus of control and the characteristics of achieving professional goals. However, among those who set themselves goals for the workday shift the level of internality turned out to be higher, which may indicate some

tendency: people with internal locus of control are more inclined to set goals for the workday (Pronenko, Vashumirskaya, 2023).

The success of professional socialization of subjects with different orientation in the situation of modern risks can be significantly influenced by the level of productive activity and unfavorable emotional background of activity. Therefore, it is important to model the implementation of complex psychological assistance focused on stimulating the development of self-control and self-regulation, the formation of motivational intension of successful pre-adaptation, the formation of attitudes of success, the development of skills of self-initiation of positive emotions (Bogdan, Masilova, 2022).

Expansion of the resource of subjective control and integration of its strategic, tactical and operational levels is essential for increasing the effectiveness of prevention of destructive transformations of personality. In modern conditions the role of appropriate programs of psychological support of constructive socialization of personality in the space of professional life of the subject increases. This is associated, first of all, with the need to develop personal stability, antifragility and stable subjective picture of the world as opposed to external uncertainty (Ukraintseva, 2021). The content of such programs involves working with the subject's personal meaning and motivational intents as components of strategic subjective control. development of professional skills of self-control and skills to optimize the course of functional and psychoemotional states. Individual and group work in this direction allows to increase personal resistance to destruction and allows to reduce the influence of stress factors in the situation of modern risks. The resource of subjective control in relation to the prevention and correction of personality destructions is associated with the fact that this psychological new formation allows to feel oneself the master of the situation, capable of managing the situation, thereby reducing the stress associated with the increasing demands of multitasking activity.

Conclusion

Thus, the results of the study allow us to conclude about the significance of the relationship "quality of subjective control - severity of personality destructiveness". This relationship is two-sided: on the one hand, at the stage of personality destructions in professional activity the ability to adequately use the possibilities of subjective control in a situation decreases; on the other hand, the deficits of subjective control make the personality more vulnerable to destructive external influences and stress.

There are differences in the expression of components of the subjective control system in specialists of different professional orientation, demonstrating the presence of emotional exhaustion: teachers and workers of the technical sphere. Obviously, it is connected with the peculiarities of the professional activity model and requirements to the format of its subject's activity.

Optimization of autopsychological activity of the subject, formation of supersituational forms of control and regulation, development of the system of subjective control,

integration and harmonization of its components can be singled out as productive directions of overcoming professional destructions of personality.

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Author Contribution

Tatiana Nikolaevna Scherbakova – conceptualization, methodology, project administration, final approval of the article version for publication.

Tatiana Vladimirovna Stashkova – conducting the research, data analysis, description of the results obtained and statistical processing of data.

Sergey Nikolayevich Ryagin – interpretation of results, statistical processing of results, formulation of conclusions of the study.

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Conflict of Interest Information

The authors declare that there is no conflict of interest.