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Research article

The brief COPE-A inventory in Russian for adolescents: Validation and evaluation of psychometric properties

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ABSTRACT

In this paper, the results of a psychometric analysis of a Brief Russian-language version of the COPE-A inventory for adolescents are presented. The inventory was designed for identifying coping strategies used in stressful situations and is comprised of 31 items. The study involved 3530 adolescents aged 13 to 17 years old. Using exploratory factor analysis and confirmatory factor analysis, it was shown that the data correspond to the expected six-factor configuration, but the distribution of items by factors differs from the theoretical structure. To improve the factor structure, two questions were excluded; the final version included 29 items. The resulting inventory's scales turned out to be highly reliable (Cronbach's alpha values range from 0.72 to 0.89). Additionally, the construct validity of the method was assessed. In conclusion, the adapted version of the Brief COPE-A is suitable for use in the adolescent population.

1. Introduction

A number of studies have shown that coping behavior changes during development, and children and adults cope with stress differently [1–4]. At the same time, most research on coping behavior has been carried out on the adult population to understand how people cope with stressful situations in their everyday lives [5]. However, children also encounter stressful situations in their daily lives, such as rejection by peers, educational problems, illness of relatives. The COVID-19 pandemic exacerbated the problems associated with students' mental health, and stress is associated, not only with the risk of illness, but also with a sudden transition to distance learning (which may result in violation of habitual life, social ties, uncertainty). Coping behavior reduces the impact of these stressful situations and is important for the mental development of the child. It is no coincidence that a number of studies on coping strategies in adolescents have been conducted during the pandemic [6–10] since certain coping behavior strategies can act as protective factors in psychological well-being and learning success.

Coping is a conscious or an unconscious strategy used to reduce unpleasant emotions. The theoretical framework of coping, including the strategy of coping with stress, is based on the theory of Lazarus and Folkman, which classifies coping strategies into problem-oriented and emotionally oriented groups [11]. More recent theoretical concepts of coping deal with dispositional coping, which are stable strategies inherent to a particular person in a wide range of life situations, and situational coping, which manifest only

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in specific conditions [12].

A number of questionnaires were developed to assess coping behavior, but the most well-known and frequently used is the "Coping Orientation to Problems Experienced - COPE" scale, as reported by Kato [13]. This inventory measures both dispositional and situational strategies for coping with stress and was developed in 1989 by K S. Carver [14]. The COPE was adapted for more than three dozen countries of the world [15,16], including Russia [17,18].

The inventory is used in a variety of areas including health care - for example, in the study of drug addiction [19], aging [20], breast cancer [21] and spinal cord injury [22], and sports [23–25].

The original COPE inventory included four items for each scale, for a total of 60 items. The COPE inventory measured 15 coping strategies: "Acceptance" - submission to the reality of the situation; "Active coping" - active or direct actions to overcome a stressful situation; "Behavioral disengagement" - refusal to actively cope with stress; "Denial" - refusal to believe in what happened, or an attempt to deny its reality; "Seeking social support for emotional reasons " - seeking empathy and understanding from others; "Humor" - jokes and laughter at the situation; "Seeking social support for instrumental reasons " - seeking advice, help or information from others; "Mental disengagement" - participation in activities aimed at distracting from unpleasant thoughts associated with the problem, for example, dreaming, sleeping; "Planning" - thinking about how to cope with a difficult life situation, developing an action strategy; "Positive reframing and growth" - reassessment of a stressful situation in a positive light; "Turning to Religion" is an appeal to the help of God, faith, religion or meditation; "Restraint coping" - keeping from performing rash actions in response to stress (not present in the Brief COPE); "Alcohol-drug disengagement" ("Substance use") - using alcohol, drugs or medications to take your mind off a stressful situation; "Suppression of competing activities" - the refusal of actions that help solve the problem (absent from a shorter version of the inventory - Brief COPE); "Focus on and venting of emotions " - the expression of negative emotions [14,26].

In health-related situations, to assess coping in patients, or during large-scale studies, it is necessary to reduce the time it takes to complete the questionnaire. For this purpose, the Brief COPE was developed; it includes 13 original scales (with the exception of "restraint coping" and "suppression of competitive activities") and an additional scale of self-blame (criticism of oneself for being responsible for what is happening) [26]. At present, the Brief COPE has been adapted for specific samples: cancer patients, pregnant women, HIV carriers, and internal organ donor candidates [27–33]. Validation and adaptation of the Brief COPE was carried out in many countries of the world: France, Spain, Greece, Australia, New Zealand, Argentina, China, India, Saudi Arabia [29,34–41]. Factor structures of resulting COPE versions are different. As reported by Solberg et al. [16], among studies using the alternative Brief COPE factor models, extracted factors ranged from 2 to 15; the most studies published between 1997 and 2021 analyzed the structure different from the original 14-factor one. Furthermore, Carver and colleagues proposed the factor structure including first-order factors (problem-focused, emotion-focused, disengagement, acceptance), that may be combined in second-order factor [14]. Other authors reported the COPE has three or 5 s-order factors [42–44].

A sufficiently large battery of methods is required to conduct large-scale studies of the psychological state of adolescents, which imposes special requirements on the timing of the methods. While the Brief COPE was adapted for adults in many countries, there are few adaptations of it for the adolescent population in the world [45–49]. In Russia, brief versions of the COPE for teenagers have not been developed before. Thus, it became necessary to develop and apply diagnostic tools for coping strategies (coping behavior) in adolescent schoolchildren. The main objective of the current study was to develop a new brief COPE-A version. For this aim second-order factors were considered. The correlation matrix of the scales presented by Rasskazova and colleagues [18] was analyzed and served as the basis for combining the scales in our study. Scales were integrated based on the size of significant correlations. As reported by Solberg [16], this approach for creating a brief version of COPE inventory has been used in a number of studies. This study aims specifically: (1) to develop a new brief COPE version for adolescents, named COPE-A; (2) to evaluate psychometric properties of the brief COPE-A; (3) to assess the factor structure; (3) to analyze new inventory external validity in a sample of Russian adolescents.

The developing of a brief version of COPE-A inventory for adolescents is part of a major study on the emotional state and coping of stress among teens during the COVID-19 pandemic. At the design stage of the study, we encountered the lack of an adequate tool for assessing the coping strategies of adolescents. In adolescence, questionnaires are widely used to study coping strategies, which is due to a sufficient level of development of cognitive and reflective personality components [46]. Available in Russia methods did not meet psychometric requirements or contained a large number of questions, which is not suitable for the online data collection format, most relevant to the general objectives of the study. Thus, the COPE Russian version for adults on a sample of adolescents was adapted in this study. As a result, a new brief COPE-A inventory was developed.

2. Material and methods

2.1. Participants

2.1.1. Data collection procedure

The study involved 4834 schoolchildren aged 13 to 17. The data was collected during the COVID-19 pandemic in 2020 in Russian secondary schools. These participants were part of the study investigating the individual differences in schoolchildren's psychological stress and coping behavior during the COVID-19 pandemic. Before testing, informed consent was obtained from the parents and guardians of adolescents, and consent was obtained from the school administration to conduct testing on school grounds. Due to the restrictions associated with COVID-19, some students were tested at home on an individual basis or during an online lesson. Data collection was carried out on personal computers using the digital psychodiagnostic online platform DigitalPsyTools (https://digitalpsytools.ru/). Schoolchildren were tested using the Coping Orientation to Problems Experienced (COPE) and "Perceived Stress Scale" questionnaires. Information about gender and age was also a part of the test. Students were free to discontinue their

participation in testing at any point in time. The testing procedure for adolescents was approved by the Ethics Committee of the "Psychological Institute of the Russian Academy of Education".

2.1.2. Sampling procedure

Before the main part of the analysis, preliminary data processing and clean-up were carried out. Outlier clean-up was carried out in two stages. During the first stage, "technical" outliers were removed, including observations that could appear as a result of dishonest answers on the inventory. The following four criteria were used to determine the dishonesty of the answers:

1. Similarity of answers. If the same answer was given on all items of the inventory, the observation was removed from the data. Observations that met this criteria were removed from the data prior to any further analysis.
2. Time of completion. If the answer to at least one item of the inventory was given faster than 1.5 s, then the observation was removed from the data.
3. Total time of completion. If the total time for completing the inventory items was less than 400 s, then the observation was removed from the data.
4. Variation in the time of completion. If the standard deviation of the response time distribution was less than 6 s and more than 60, then the observation was removed from the data.

These absolute values were estimated manually, and the left peak of the bimodal distribution was removed for the time of completing the items and the inventory as a whole. For the total time, in addition to the left peak, the tail on the right was also removed. 1100 observations were removed on this step. Number of observations that meet at least one criteria are presented in Table 1.

After removing the observations that corresponded to at least one outlier criterion, an additional evaluation of the Mahalanobis distance on the response time of the respondents was carried out. Observations that fell outside the 0.9 quantile were removed from the data. 204 observations were removed on this step.

The final sample included 3530 adolescents (M = 15.3 years, SD = 1.05 years): 65 adolescents were aged 13, 864 - 14 years old, 1136 - 15 years old, 933 - 16 years old, and 532 - 17 years old. The sample included 1276 boys, 2192 girls and 62 teenagers who chose not to indicate their gender.

2.2. Instruments

2.2.1. Coping Orientation to Problems Experienced (COPE), 31 items

The development of a brief version of the inventory for adolescent samples was based on the full Russian version of the "Coping Orientation to Problems Experienced - COPE" inventory and involved an analysis of COPE scale reliability, as well as an assessment of the adequacy of the proposed key and the factor structure of the inventory. COPE was translated in Russian by Rasskazova and colleagues [18]; this translation was used in our study. The Russian-translated items are presented in Appendix. Some of them were corrected according to the age of the tested sample, ex. "I turn to school or other substitute activities to take my mind off things" for adolescents instead "I turn to work or other substitute activities to take my mind off things" for adults. The English-translated items are presented from the original full version of the COPE [14] in the Supplementary materials. Possible approaches applied to creating a questionnaire are very diverse among different authors. As reported by Solberg et al. [16], some of the researchers excluded items or subscales to using a dimension reduction technique or modified items or subscales: "19 studies (22%) excluded items or subscales a priori to using a dimension reduction technique while eight studies (9%) modified items or subscales". The alternative approach is reduction of scales. In particular, an approach is used in which the number of all scales is preserved, but at the same time they are reduced to two points. It is assumed that the scores received on two questions per scale reflect the construct that it is supposed to measure, while the questionnaire takes less time of the participant. Considering all scales appears to be an interesting research strategy. However, COPE measures complex psychological constructs, the validity of the results measured in this way may be questionable. Two self-report samples may not be sufficient to measure a latent construct. Otherwise, one item per scale could be limited. From this point of view, in order to adequately measure a latent trait, a psychological construct must be measured in a variety of behaviors. In addition, the developed tool is intended to be used to measure individual differences. Two-item scales have many problems from a psychometric point of view, as they often do not have high reliability. As reported by Yuan et al. [48], two-item subscales version of the Brief COPE

Table 1
Number of observations that meet at least one criteria.

Criteria met	Criteria	Number	Total
1	Identical answers	200	200
	Minimum time	25	
	Total time	61	406
	SD of time	320	
2	Minimum time + Total time	13	
	Total time + SD of time	239	254
	Minimum + SD of time	2	
3	All criteria	240	240
			1100

limited by the low reliability coefficients and unstable factor loadings of some of them. The same arguments are provided by Serrano et al. [50]. It is assumed that the initial measurement has an overestimated reliability. The selection of only the most loaded items into factors after factor analysis does not lead to an increased validity, but to shallow constructs. An example would be the scale “Seeking social support for instrumental reasons” [18], which included similar items: «I talk to someone to find out more about the situation», «I talk to someone who could do something concrete about the problem». Their wording is the same with only minor changes. Reliability is overestimated without examples of other behavior. An alternative way would be to ask the respondent about receiving help from "those close to me”, finding the same response without overestimated item correlations measuring the same behavior. It can be assumed that “Seeking social support for instrumental reasons” would be more diverse in terms of its indicators if it were a latent construct, and not just one of the types of behavior. An approach in which some scales are combined seems to be more promising to provide a new version of COPE with high reliability. Taking into account these arguments, the following shortening strategy for the inventory was used in the current study. First, the scales that showed high correlations were merged into a single scale based on the analysis by E.I. Rasskazova and colleagues [18]. As a result of the merging process, 6 scales in total were formed: Mental disengagement, Active coping (based on Active coping, Planning, Behavioral disengagement of the problem, Denial and Suppression of competing activities), Socio-emotional support (based on Seeking social support for instrumental reasons, Seeking social support for emotional reasons, Focus on and venting of emotions), Turning to religion, Positive coping (based on Positive reframing and growth and Humor) and Acceptance. Additionally, questions from the "Behavioral disengagement " and "Denial” scales of the full version of COPE were included in the Active Coping scale of the brief version as reverse questions. After that, for each new merged scale, items with the highest factor loadings were selected, which cover the coping strategy that the new scale represents the most. The result was a smaller number of scales compared to the full version of the inventory, but each contained 4–5 items. In the teenage version of the inventory, some wording was adjusted (for example, “I turn to school or other substitute activities to take my mind off things” instead of the wording for adults – “I turn to work or other substitute activities to take my mind off things.”). In addition, the scale "Alcohol-drug disengagement” ("Substance use”) was not used. The text of the inventory is presented in the Supplementary files. The scales of the full and brief versions of the inventory and appropriate items are presented in Table 2.

The answers to the questions were given on a Likert scale and presented four options to choose a single answer from: “Usually no, never”, “Rarely”, “Quite often”, and “Yes, often”. They were assigned scores ranging from 1 to 4. Inversion of scores for reverse items was provided: 1 = 4, 2 = 3, 3 = 2, 4 = 1. The results for each scale were calculated as the arithmetic mean of its points.

Table 2
Items of the COPE.

New scale of the brief COPE	Full COPE scale	Item and its number in the inventory
Mental disengagement	Mental disengagement	**1** I turn to school or other substitute activities to take my mind off things.
	Mental disengagement	**9** I sleep more than usual.
	Mental disengagement	**12** I daydream about things other than this.
	Mental disengagement	**21** I go to movies or watch TV, to think about it less.
Active coping	Supression of competing activities	**2** I concentrate my efforts on doing something about it.
	Denial	**3R** I say to myself "this isn't real."
	Behavioral disengagement	**6R** I just give up trying to reach my goal.
	Active coping	**8** I take additional action to try to get rid of the problem.
	Denial	**10R** I refuse to believe that it has happened.
	Planning	**15** I think about how I might best handle the problem.
	Behavioral disengagement	**17R** I give up the attempt to get what I want (to get this done).
	Planning	**27** I think hard about what steps to take.
	Supression of competing activities	**30** I put aside other activities in order to concentrate on this.
Turning to religion	Turning to religion	**4** I seek God's help.
	Turning to religion	**7** I put my trust in God.
	Turning to religion	**24** I try to find comfort in my religion.
	Turning to religion	**28** I pray more than usual.
Socio-emotional support	Seeking social support for emotional reasons	**5** I discuss my feelings with someone.
	Focus on and venting of emotions	**11** I let my feelings out (for example, I screw and swear).
	Seeking social support for instrumental reasons	**13** I try to get advice from someone about what to do (for example, my parents, friends) about what to do.
	Seeking social support for emotional reasons	**16** I get sympathy and understanding from someone (for example, my parents, friends).
	Focus on and venting of emotions	**23** I get upset, nervous and I'm worried..
	Seeking social support for instrumental reasons	**25** I talk to someone (for example, my relatives, friends) who could do something concrete about the problem.
Positive coping	Positive refraiming and growth	**14** I try to see it in a different light, to make it seem more positive.
	Positive refraiming and growth	**19** I look for something good in what is happening.
	Humor	**20** I make jokes about it.
	Humor	**31** I make fun off the situation.
Acceptance	Acceptance	**18** I get used to the idea that it happened.
	Acceptance	**22** I accept that this has happened and that it can't be changed.
	Acceptance	**26** I learn to live with it.
	Acceptance	**29** I accept that this has happened and that it can't be changed.

The results of this stage of the study made it possible to analyze the reliability of the scales of the inventory, as well as to evaluate the factor structure [51]. Acceptable reliability indicators were found for all scales, except for the indicators of the scales "mental disengagement " and "active coping", which have insufficiently high reliability (Cronbach's $\alpha = 0.59$ and 0.65, respectively). At the same time, using principal component analysis, 6 components were identified that approximately corresponded to the proposed scales of the inventory. However, it was shown that the factor loadings of the items on the Active Coping scale can be attributed to several factors. The results obtained at this stage pointed to the need to confirm the factorial validity of the inventory and look for ways to improve the reliability of the scales, in particular "mental disengagement" and "active coping".

Thus, the goal of the second stage of the study was to find a model that best described the factor structure of the inventory and to create a corresponding key; to assess the reliability of the inventory's scales; and to analyze the external validity of the inventory using correlation with the Perceived Stress Scale, which evaluates similar constructs. The results of the second stage of the study are presented in the corresponding section below.

2.2.2. Perceived Stress Scale (PSS-10)

The Perceived Stress Scale, or PSS for short, was developed to assess the unpredictability, overload and uncontrollability of participants lives under the influence of stressful circumstances. In this study, a version of the inventory was used, which consisted of 10 items validated on the Russian-speaking sample by V. A. Ababkov and colleagues [52]. The inventory consists of two subscales: "Overstrain", which assesses how stressful the events in life over the past month are; "Stress management", which allows one to assess one's own inability to cope with stress; and the "Perceived Stress", general scale which reflects the level of severity of distress in general. This approach showed good reliability on the sample of adolescents aged 13–17 years. Cronbach's alpha indicators were as follows: "Overstrain" scale - $\alpha = 0.82$, "Stress management" scale - $\alpha = 0.77$, "Perceived Stress" - $\alpha = 0.80$.

2.3. Data analysis

Data analysis was carried out using R version 4.1.2 with the "psych" and "stats" packages. The "lavaan" package was used for Confirmatory Factor Analysis (CFA). Exploratory Factor Analysis (EFA) was carried out using principal axis method and Varimax rotation, and the number of components was extracted using parallel analysis. The Varimax rotation was used as the correlation between the factors obtained with Oblimin rotation did not exceed ± 0.32. The Spearman correlation coefficient was used during the correlation analysis, as well as the Games-Howell post hoc test during the comparison of groups by gender.

Previous research on the original version of the COPE questionnaire informed a theoretically expected model for our data. In order to analyze the factor structure of the adapted version of the instrument, we applied confirmatory factor analysis. Model parameters

Table 3
Bootstrapped median factor loadings with the 95% Confidence Intervals from the Exploratory Factor Analysis.

Item No	Factor 1 [95%CI]	Factor2 [95%CI]	Factor 3 [95%CI]	Factor 4 [95%CI]	Factor 5 [95%CI]	Factor 6 [95%CI]
18				0.498 [0.494,0.501]		0.274 [0.273,0.276]
22				0.694 [0.692,0.697]		
26				0.667 [0.664,0.669]		
29				0.748 [0.745,0.75]		
10R			0.525 [0.524,0.526]			
15						0.66 [0.659,0.662]
17R			0.375 [0.373,0.376]			
2						0.593 [0.591,0.594]
27						0.654 [0.653,0.656]
30						0.416 [0.414,0.418]
3R			0.41 [0.408,0.412]			
6R			0.308 [0.306,0.309]			
8						0.674 [0.673,0.675]
11			0.579 [0.577,0.58]			
13	0.714 [0.708,0.717]					
16	0.625 [0.62,0.629]		0.257 [0.256,0.258]			
23			0.592 [0.591,0.594]			
25	0.663 [0.657,0.666]					
5	0.565 [0.559,0.57]					
14	0.282 [0.278,0.284]				0.409 [0.407,0.41]	0.342 [0.34,0.344]
19					0.527 [0.525,0.528]	0.272 [0.27,0.274]
20					0.735 [0.734,0.736]	
31					0.712 [0.71,0.713]	
24		0.743 [0.742,0.744]				
28		0.785 [0.785,0.786]				
4		0.846 [0.845,0.846]				
7		0.826 [0.8260.827]				
1			0.271 [0.269,0.273]			
12			0.492 [0.491,0.494]			
21			0.355 [0.354,0.356]			
9			0.472 [0.47,0.473]			

were estimated with the mean and variance adjusted weighted least squares method (WLSMV) [53], which has demonstrated good performance on categorical variables with few categories in sample sizes over 200 [54]. Correlation of the error terms was not included into the model. During the model fitting, the following criteria of model fitness were chosen [55–57]: the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Standardized Root Mean Squared (SRMR), Root Mean Square Error of Approximation (RMSEA). The values corresponding to better models were accepted: a CFI of >0.90 and TLI scores that approach as the value of 1; SRMR of <0.08; RMSEA of <0.08 [55–57].

Cronbach's alpha coefficient, widely used in psychological research, was chosen as an indicator of reliability. A value of Cronbach's alpha greater than 0.7 indicated sufficient reliability of the scale [58].

In order to prevent overfitting of our EFA and CFA models and reliability estimation, bootstrap was used. Procedure was as follows: on each step, the sample was randomly divided into three equal subsamples. The first subsample was then used for reliability estimation, the second - for EFA and the third - for CFA. Cronbach's Alpha coefficients for each scale, EFA loadings, CFA fit measures and loadings were then extracted and saved into the corresponding vectors. The resampling and analysis were performed 1000 times with resulting 1000 values for each Cronbach's Alpha coefficient, EFA and CFA loading and CFA fit measure. In this article we report median value and 95% Confidence interval for each value.

3. Results

Initially, an Exploratory Factor Analysis was conducted to determine the structure of the COPE inventory. The final factor configuration, described by six components, is presented in Table 3. Communality with confident intervals from the bootstrapped Exploratory Factor Analysis is presented in Appendix 1.

The search for the best factor structure of the inventory included a step-by-step removal of items. Two criteria for the items removing were taken into account. 1. The threshold less than 0.3 was not overcome on any of the scales. 2. Factor loadings among several factors after the factor analysis procedure using EFA were presented at the same time. Item 1 ("I turn to school or other substitute activities to take my mind off things") had a load less than 0.3, so it was deleted. Item 14 ("I try to see it in a different light, to make it seem more positive") had similar loads on two factors (5 and 6). It was impossible to make an unambiguous decision about which factor it belongs to, so these items were removed. The standardized factor loadings obtained during the confirmatory factor analysis after the removal of "poorly performing" items are presented below in Table 4. Items 1 and 14 of the inventory acted as "poorly performing" questions and were excluded. Thus, item on the "Positive reframing and personal growth" scale of the full version of the inventory "I am looking for something good in what happened") was excluded, as was one item on the "Mental disengagement" scale ("I turn to school or other substitute activities to take my mind off things").

The characteristics of the model of the obtained factor structure (without excluded items) are presented in Table 5. The values presented in the table indicate that the new model (excluding items 1 and 14) has a good fit, which indicates its high quality.

Table 4
Bootstrapped median factor loadings with the 95% Confidence Intervals from the Confirmatory factor analysis.

Item No	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
18				0.711 [0.71,0.712]		
22				0.731 [0.73,0.732]		
26				0.794 [0.793,0.795]		
29				0.821 [0.82,0.822]		
10R			0.639 [0.638,0.64]			
15						0.818 [0.817,0.819]
17R			0.404 [0.403,0.406]			
2						0.583 [0.582,0.584]
27						0.815 [0.814,0.816]
30						0.596 [0.594,0.597]
3R			0.53 [0.529,0.532]			
6R			0.165 [0.163,0.168]			
8						0.674 [0.673,0.675]
11			0.595 [0.594,0.596]			
13	0.837 [0.837,0.838]					
16	0.76 [0.76,0.762]					
23			0.629 [0.628,0.63]			
25	0.802 [0.801,0.803]					
5	0.69 [0.689,0.691]					
9					0.828 [0.827,0.83]	
20					0.684 [0.682,0.685]	
31					0.726 [0.725,0.728]	
24		0.853 [0.852,0.854]				
28		0.886 [0.886,0.887]				
4		0.935 [0.935,0.935]				
7		0.916 [0.915,0.916]				
12			0.6485 [0.647,0.65]			
21			0.532 [0.53,0.533]			
9			0.471 [0.47,0.473]			

Thus, based on the results obtained, 6 scales (and their corresponding items - see Table 6) were determined, which together, constitute a revised version of the Brief COPE-A inventory for adolescents: Turning to religion, Avoidance, Problem-focused coping, Socio-emotional support, Acceptance, Humor. The final version included 29 questions (items 1 and 14 were excluded). Items 3, 6, 10, and 17 were included in the "Avoidance" scale but as regular (non-reverse) questions.

Table 7 presents descriptive statistics and reliability scores of the resulting inventory scales. The obtained values allow one to conclude that the new inventory scales demonstrate high reliability (Cronbach's α medians for all scales exceeds 0.7).

Analysis of gender differences was also carried out. One way ANOVA was calculated with Post Hoc test for both genders. Table 8 presents descriptive statistics of performance on the inventory for both boys and girls on all scales, as well as a comparison of the means with the level of significance. Statistically significant differences at level of 0.01 were found between girls and boys in scales "Socio-emotional support", "Turning to religion", "Avoidance" and "Acceptance". Girls scored higher on these scales than boys.

3.1. Assessment of the construct validity of the COPE-A inventory

One of the special cases of external validity is construct validity, which involves evaluating the theoretical construct with an established approach. To assess the construct validity of the inventory, the approach chosen was one that was already tested and based on sound theory. Using this logic, the Perceived Stress Scale (PSS) was used to test the construct validity of COPE-A. The results of the analysis of the relationships between the COPE-A and PSS (perceived stress score) scales are presented in Table 9.

During the course of the analysis, both low (starting from 0.05) and high (up to 0.55) significant correlation scores were obtained for scales of the two questionnaires. The "Overstrain" scale, which assesses how stressful life events were during the last month, turned out to be negatively related to the "Problem-focused coping" scale ($p > 0.05$) and positively related to all other coping scales ($p < 0.001$), except "Humor", with which there were no reliable correlations. The "Stress management" scale, which reflects the inability to cope with stress, was positively related to scales, such as "Turning to religion" and "Avoidance" at a significance level of 0.001 and negatively related to all other scales (p from 0.01 to 0.001). The "Perceived Stress", which reflects the level of severity of distress, was generally negatively related to the "Problem-focused coping" scale ($p < 0.001$) and to the use of the "Humor" ($p > 0.05$) as a way to reduce stress. At the same time, positive correlations were obtained with "Turning to religion" and "Socio-emotional support" and "Avoidance" at a significance level of $p < 0.001$. At the same time, no correlations were found between the general scale of perceived stress and acceptance.

4. Discussion

During the course of this study, a model was proposed that best describes the factor structure of the inventory and includes the following six scales: "Turning to religion" (4 items), "Avoidance" (9 items), "Problem-focused coping" (5 items), "Socio-emotional support" (4 items), "Acceptance" (4 items), and "Humor" (3 items). Two items were excluded from the resulting factor structure so that the final brief version of the COPE-A for adolescents included 29 items. The factor structure was obtained using empirical data of the Russian adolescent population and was altered relative to the theoretically assumed one. Confirmatory factor analysis showed high fit indices of the proposed model. After that, the scales (factors) are considered in terms of their items belonging to the full version of the COPE-A and the theoretically proposed factor structure of the brief version. The "Turning to religion" and "Acceptance" scales remained unchanged compared to the assumed theoretical structure and included four items each. The "Problem-focused coping" scale included items demonstrating the use of coping strategies, such as "planning", "suppression of competing activities", and "active coping", as described by the full version of the COPE. The theoretical assumptions about the inclusion of the reverse items from the "Behavioral avoidance of the problem" and "Denial" scales of the full version of COPE into the "Problem-focused coping" factor were not confirmed: these items showed large loads on the factor, which were labeled "Avoidance". They were included in the new factor reverse. The "Socio-emotional support" scale did not confirm the theoretical assumptions; it only included items that belonged to the "Seeking social support for emotional reasons" and "Seeking social support for instrumental reasons" scales in the full version of the COPE. The assumed relatedness to these scales of the items of "Focus on and venting of emotions" was not confirmed; instead, they showed the maximum factor loadings on another factor, "Avoidance". Items from the "Focus on and venting of emotions" scale belong to another factor corresponding to the idea of the existence of coping that deals with problem solving, which may include the search for social support, which are more effective in controlled situations, as well coping that deals with emotions, which are more effective in uncontrollable situations [11,59]. "Mental disengagement", a scale that was supposed to be separate, has lost its independent meaning, and its items are also included in the "Avoidance" factor; one of them - "I turn to school or other substitute activities to take my mind off things"- was excluded from the factor structure. The identification of the "Avoidance" factor in the structure of the model on our empirical data is consistent with the results of previous studies on the shortening of the COPE, in which the "Avoidant Coping" factor is

Table 5
Median with the 95% Confidence Intervals of the Confirmatory Factor Analysis fit measures.

Model	CFI	TLI	RMSEA	SRMR	$\chi 2$
Median	0.912	0.901	0.074	0.073	2712.692
95% CI Lower	0.912	0.901	0.074	0.073	2705.618
95% CI Upper	0.912	0.902	0.074	0.073	2719.505

Table 6
Scales of the revised Brief COPE-A inventory.

	Socio-emotional support	Turning to religion	Avoidance	Acceptance	Humor	Problem-focused coping
Item number						
	13	4	11	29	19	8
	25	7	23	22	20	2
	16	24	10	26	31	27
	5	28	12	18		15
			9			30
			3			
			17			
			21			

Table 7
Descriptive statistics and reliability scores for the resulting COPE-A.

	Socio-emotional support	Turning to religion	Avoidance	Acceptance	Humor	Problem-focused coping
Number of items	4	4	9	4	3	5
Mean	2.50	1.72	2.04	2.62	2.36	2.84
Standard deviation	0.731	0.747	0.470	0.668	0.714	0.576
Median	2.50	1.50	2.00	2.75	2.33	2.80
Cronbach's α median [95% CI]	0.817 [0.816,0.818]	0.890 [0.889,0.890]	0.719 [0.718,0.720]	0.802 [0.801,0.803]	0.716 [0.715,0.717]	0.776 [0.775,0.777]

Table 8
Descriptive statistics and gender difference for the resulting COPE-A.

Scale	Boys (n = 1276)		Girls (n = 2192)		Comparison of means	p
	M	SD	M	SD		
Socio-emotional support	2.34	0.698	2.60	0.733	−0.262	<0.001
Turning to religion	1.59	0.688	1.79	0.770	−0.201	<0.001
Avoidance	1.95	0.468	2.09	0.463	−0.143	<0.001
Acceptance	2.55	0.699	2.67	0.646	−0.118	<0.001
Humor	2.37	0.739	2.36	0.700	−0.001	<0.714
Problem-focused coping	2.84	0.605	2.84	0.560	0.005	0.785

Table 9
Correlation scores for the COPE-A and PSS scales.

	1	2	3	4	5	6	7	8	9
1. Overstrain	–								
2. Stress management	0.38***	–							
3. Percieved stress	0.81***	0.83***	–						
4. Socio-emotional support	0.20***	−0.05*	0.08***	–					
5. Turning to religion	0.18***	0.07**	0.16***	0.21***	–				
6. Avoidance	0.55***	0.33***	0.51***	0.32***	0.26***	–			
7. Acceptance	0.11***	−0.10***	0.00	0.25***	0.06**	0.21***	–		
8. Humor	−0.02	−0.16***	−0.10***	0.22***	0.06**	0.17***	0.28***	–	
9. Problem-focused coping	−0.04	−0.35***	−0.24***	0.33***	0.05*	0.01	0.35***	0.27***	–

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

singled out as a second-order factor [60–62]. One of two items from the "Positive reframing and personal growth" scale of the full version of COPE ("I try to see it in a different light, to make it seem more positive"), which were theoretically merged with the "Humor" scale in the general factor "Positive coping", was excluded from the factor structure describing coping strategies in adolescents. Previously, researchers made the assumption that "Positive Reframing" may be dispositional rather than situational coping [18]; that is, it may indicate personal coping mechanisms. The exclusion of this subscale item may indicate that this construct is not yet sufficiently formed in adolescence.

During the course of the analysis, the reliability of the inventory scales was assessed, which resulted in high reliability, confirmed by Cronbach's alpha values of 0.7 and higher.

Regarding gender differences, it was shown that girls had significantly higher scores on the "Turning to religion", "Socio-emotional support", "Avoidance" and "Acceptance" scales. As shown by Compas et al. [63], studies of gender differences in adolescents have

mixed results. At the same time, the results obtained in our study correlate with the previously results. Thus, it is noted that girls are more likely to seek social support, while boys use avoidance [64]. Also, as it was shown in other study by Eschenbeck [65] adolescents from 7 to 16 years old, girls are more likely to seek social support and solve problems, while boys tend to use avoidant coping strategies. At the same time, in our study, it was found that girls have higher scores on the Avoidance scale than boys, which is consistent with another study by Griffith and colleagues [66]. The authors also emphasize the importance of assessing the stressor itself, with which it is necessary to cope, i.e., the importance of the situational aspect in assessing coping strategies.

Analysis of the external validity of the inventory using correlation with the PSS questionnaire scales, which evaluates similar constructs, showed significant correlations from 0.05 to 0.55 at a significance level of 0.05 to 0.001. The most similar scale of the PSS - "Stress management", which assesses the inability to cope with negative factors - turned out to be negatively associated with scores on the "Problem-focused coping", "Socio-emotional support", "Acceptance" and "Humor" scales. In addition, this scale has positive correlations with the "Turning to religion" and "Avoidance" scales. In general, the obtained correlations provide evidence of the relatedness of the studied constructs. Similar correlations were obtained in a study by Serrano [50] on a sample of adolescents aged 14–18 years old. The level of correlations in their study for individual scales in different models ranged from 0.09 to 0.36. The results are also consistent with earlier data from a number of studies indicating that the use of coping strategies is associated with lower levels of stress [67,68]. Additionally, earlier in a study of a sample of students, a positive correlation of the total PSS score ($p < 0.001$) with maladaptive coping strategies was shown [69]. Based on the correlations obtained, the Brief COPE-A showed good construct validity. The overall level of perceived stress and overstrain was associated with the use of maladaptive coping strategies, which indicates good construct validity and is consistent with previous results.

4.1. Limitations and future direction

The present research has the main limitation related to the ecological validity. The used inventory version was developed based on the adult questionnaire. One of the possible mechanisms to improve the ecological validity of the study is to develop a version of the inventory specifically for adolescents. However, the proposed in the current study version of the questionnaire demonstrated appropriate psychometric properties and validity. The important aim of the future research is to consider the factor structure of the Brief COPE-A in terms of situational and dispositional copings, including item response theory application. Part of the coping strategies is assumed to be situational (in particular, "socio-emotional support"), at the same time another part is thought to be dispositional ("humor"). To test this assumption the future research may be conducted with supplementary data about life situation of the adolescents including information about their stress factors. The possibility of such analysis is provided by the data collected in the same adolescents sample.

5. Conclusion

This study assessed psychometric properties and validated the Brief COPE-A on a Russian-speaking sample of adolescents. As a result of exploratory factor analysis and confirmatory factor analysis, 2 items of the inventory were excluded, which led to an improved factor structure with six highly reliable scales that allow for the measurement of coping strategies, such as "problem-focused coping", "avoidance", "socio-emotional support", "acceptance", "turning to religion", and "humor". The resulting updated inventory is suitable for use in the adolescent population. Further direction of research might have to do with studying situational and personal coping strategies in adolescents that are developed during different stages of maturation.

Author contribution statement

Marakshina Julia; Malykh Artem: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Vasin Georgy: Analyzed and interpreted the data; Wrote the paper.

Ismatullina Victoria: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Lobaskova Marina: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Adamovich Timofey: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Malykh Sergey: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no competing interests.

Appendix 1

Table:Communality with Confident intervals from the bootstrapped Exploratory Factor Analysis

Item No	Communality	95% CI	
		Lower	Upper
18	0.3925	0.391	0.394
22	0.537	0.535	0.538
26	0.538	0.536	0.539
29	0.63	0.628	0.631
10R	0.353	0.352	0.354
15	0.562	0.561	0.563
17R	0.182	0.18	0.183
2	0.381	0.38	0.383
27	0.528	0.526	0.529
30	0.269	0.267	0.27
3R	0.221	0.219	0.222
6R	0.216	0.214	0.217
8	0.486	0.484	0.487
11	0.349	0.347	0.35
13	0.651	0.65	0.652
16	0.523	0.522	0.525
23	0.399	0.397	0.4
25	0.568	0.566	0.57
5	0.417	0.415	0.419
14	0.425	0.424	0.427
19	0.467	0.466	0.469
20	0.573	0.571	0.574
31	0.5355	0.534	0.537
24	0.58	0.579	0.582
28	0.646	0.645	0.647
4	0.753	0.752	0.754
7	0.711	0.71	0.712
1	0.117	0.116	0.118
12	0.314	0.313	0.315
21	0.242	0.241	0.243
9	0.257	0.256	0.258

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e13242.

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