Original Article

Short Form of the Sense of Coherence Scale (SOC-L9) in the US, Germany, and Russia

Psychometric Properties and Cross-Cultural Measurement Invariance Test

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Abstract: Validation of a 9-item version of the Sense of Coherence Scale (SOC-L9) and testing its cross-national measurement invariance and latent mean differences in representative samples from the United States of America (US), Germany, and Russia. The psychometric properties of the SOC-L9 were tested with representative samples aged 18–100 years from the US (N = 2,972), Germany (N = 2,005), and Russia (N = 2,726). Both a model with a general factor and method effect of items with negative wording and a unidimensional model were tested for structure validity. Measurement equivalence and latent mean comparisons were conducted across the samples. The SOC-L9 showed good reliability and validity in all countries. Rather than the unidimensional model, the model with additional method effect showed excellent fit across countries. Cross-national measurement invariance testing found partial strong measurement invariance across the three samples. The latent means of the SOC-L9 in the US sample were higher than those in German and Russian samples. The SOC-L9 has proved to be economic, valid, reliable, and cross-nationally applicable in the US, Germany, and Russia. Meaningful differences across countries were found, suggesting the importance of taking cultural background into account in SOC-related research.

Keywords: sense of coherence, bifactor model, questionnaire validation, cross-national measurement invariance, latent mean comparison, psychometrics

A sense of coherence (SOC) refers to a global orientation that an individual has the feeling of confidence to cope with challenges and stressful situations (Antonovsky, 1987, 1993). More specifically, it contains three components that an individual experiences his or her environment as structured and predictable (comprehensibility), feels that the resources are available when demanded (manageability), and finds meaning in the challenging and stressful situations (meaningfulness) (Antonovsky, 1987, 1993). These three components are highly interrelated and jointly play an essential role in successful coping (Antonovsky, 1987).

It has been repeatedly proven that a strong SOC is directly or indirectly associated with better quality of life (Eriksson & Lindström, 2005), better psychological health than physical health (Eriksson & Lindström, 2006), life satisfaction (Chu, Khan, Jahn, & Kraemer, 2016), and higher level of social support (Wolff & Ratner, 1999). Moreover, a solid body of research has reported strong links between higher SOC and lower levels of mental illness and symptoms, such as depression (e.g., Konttinen, Haukkala, & Uutela, 2008), anxiety (e.g., Hart, Hittner, & Paras, 1991), and stress (e.g., Amirkhan & Greaves, 2003).

The above-mentioned studies involved samples from different subgroups, countries, and cultures worldwide. However, empirical evidence also indicates cultural differences in SOC. For instance, although a strong negative link between SOC and depression was reported in Western societies (e.g., Amirkhan & Greaves, 2003; Konttinen et al., 2008), low SOC scores did not predict depressive symptoms in Kosovan refugees in Sweden (Roth & Ekblad, 2006). Higher SOC scores are associated with higher levels of depression symptoms in Arab Bedouin women in Israel (Daoud, Braun-Lewensohn, Eriksson, & Sagy, 2014). In another study (Lee, Jones, Mineyama, & Zhang, 2002), although the association between SOC and health was positive in all groups, self-identified Chinese and Japanese participants selected the midpoint more frequently on SOC items that involved reporting a positive emotion than American counterparts, indicating a cultural difference in the response pattern. Therefore, it is important to take

culture into account when applying SOC measures in samples with different cultural backgrounds. Participants can vary in their interpretations or understandings of certain words or items or entire scales due to differences in language or in cultural assumptions (Veenhoven, 1996). Therefore, measurement invariance should be tested before comparing sum scores between different national or language groups; a cross-national measurement comparable scale would be useful in this framework.

The Sense of Coherence Scale is the most common instrument to measure SOC. Antonovsky (1987, 1993) developed a 29-item long version (SOC-29) and a 13-item short version (SOC-13). So far, there are additional versions (SOC-6, SOC-10, SOC-12, etc.) in at least 49 languages across the world (for review, see Eriksson & Lindström, 2006; Eriksson & Mittelmark, 2017). Many of the language versions also vary in length of the scale, thus making it inappropriate to compare the level of SOC cross-nations. Moreover, many of the short versions demonstrated questionable psychometric properties.

Further worth noting is the unclear structure of the SOC scales. Although Antonovsky (1987) suggested the three components of SOC, he also intended that the SOC scales be scored with a single total score and not component scores. Some studies have supported the one-factor solution of SOC scales (e.g., Frenz, Carey, & Jorgensen, 1993), however, several other studies have failed to confirm the unidimensional structure of the SOC-29 or the SOC-13 (e.g., Germano, Misajon, & Cummins, 2001; Sardu et al., 2012). Many studies either adapted different multidimensional solutions (e.g., two-, three-, or five-factor models) or excluded certain items to fit the proposed three-factor model (e.g., Drageset & Haugan, 2015; Eriksson & Lindström, 2005). On the one hand, the various versions indicate cultural differences in SOC measurements (i.e., some items function differently in different cultures). On the other hand, it may be that the unidimensional model is not supported due to the large proportion of reversed items. Multidimensionality of scales is sometimes caused by reversed items, often emerging as a method factor in factor analyses. Two simulation studies have shown that if only 10% of the respondents do not detect an inverse wording of an item, a one-factor solution will not be established even though the construct measured is truly unidimensional (Schmitt & Stuits, 1985; Woods, 2006). Due to the large proportion of negatively worded items in SOC scales (13 out of the 29 items are inverted items) – before concluding multidimensionality of SOC – the effect of a method factor should be considered. Method effects can be seen as a systematic variance that is related to the measurement method instead of the measured latent construct (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). A method factor that is not correlated with the general construct factor may, therefore, help to maintain the unidimensional structure (Rauch, Schweizer, & Moosbrugger, 2007). For this reason, we proposed a bifactor model that may provide an explanation for the various structures found in SOC scales when the one- or three-factor model failed to fit the data.

A 9-item version of SOC scale (the Leipzig Short Scale of SOC, SOC-L9, Schumacher, Wilz, Gunzelmann, & Brähler, 2000) has been widely used as a valid, reliable, unidimensional scale to assess SOC economically. It was revised directly from the original SOC-29, contains items from all three components, and has a relatively high internal consistency compared to other short forms of SOC scales (Eriksson & Mittelmark, 2017). Due to the economical potential of the SOC-L9 in large-scale epidemiological and clinical research, it could be beneficial to validate and test measurement invariance of this short scale across nations.

Taken together, although SOC scales are widely used across the world, there are many modified versions in use, with the number of items ranging from 3 to 12 (Eriksson & Lindström, 2005). This reflects the need for short instruments in health survey applications. The SOC-L9 appears to be a well-established tool among the short forms of SOC (Eriksson & Mittelmark, 2017; Schumacher et al., 2000), however, its use has been limited to the German-speaking population. Thus, it could be beneficial to validate this scale in other than German-speaking samples and to test its invariance across nations. Thus, representative samples from Germany (as a representative of western European countries), the US (as a representative of North American countries), and Russia (as a representative of eastern European countries) were tested in the current study. The US sample was chosen because a short and valid SOC-L9 would be useful in surveys that target English-speaking samples. Furthermore, the US and Germany are similar with respect to several cultural values, such as individualism and equality between people (Hofstede, 2001). Russia, compared to the other two countries, is a more collectivistic society with relatively large discrepancy between the less and more powerful members of the society (Girlando & Eduljee, 2010; Hofstede, 2001) and has undergone a substantial social transformation in the past decades (e.g., Gurina, Frolova, & Degryse, 2011).

In sum, the current study firstly aimed to test the psychometric properties and to standardize the SOC-L9 in representative samples from the United States of America (US), Germany, and Russia. Regarding the structure factors of the SOC-L9, a unidimensional model, a three-factor model, and a bifactor model with a method factor (for the four reversed items) were tested and compared. To test construct validity, the correlations between the SOC-L9 and other related constructs (depression, anxiety, stress, positive mental health, life satisfaction, and social support)

were examined. The SOC-L9 was expected to be positively associated with all positive mental health measures and negatively associated with all negative measures. Norms of the SOC-L9 were presented for each of the countries. Secondly, a cross-national measurement invariance test was applied to determine the degree of invariance of the measurement across nations and to rule out potential bias. Together with latent mean comparison (Byrne & Van de Vijver, 2010), differences in test parameters across cultures were examined.

Methods

Participants and Data Collection

Participants were recruited as part of a large-scale, cross-national, longitudinal investigation on protective and risk factors in mental health. The project was approved by the Ethics Committee of the Faculty of Psychology. Participants all gave informed consent.

Representativeness for adult populations in Germany, Russia, and the US was based on the register-assisted census data. Systematized sampling procedures were applied considering the distribution of age, gender, and education. Data of representative samples from the three countries were collected by an independent institute for opinion and social research. Participants were recruited via telephone. Each session took less than an hour. Data collection took place between November 2012 and January 2013 for the German sample, July and December 2013 for the sample in the US, and between December 2013 and February 2014 for the Russian sample. In total, 8,102 participants (2,010 from Germany, 3,020 from Russia, and 3,072 from the US) participated in the survey.

Questionnaires

English and German versions of all questionnaires and Russian versions of most scales had been previously validated. All the scales listed below apart from the SOC-L9 have been tested for measurement equivalence and established at least partial strong invariance across cultures (Bieda et al., 2017; Scholten, Velten, Bieda, Zhang, & Margraf, 2017).

Sense of Coherence Scale (SOC-L9)

The 9-item version of SOC scale (Schumacher et al., 2000) utilizes a 7-point Likert scale with two anchoring verbal responses. Item 2, Item 3, Item 5, and Item 8 are scored reversely; therefore, a higher score indicates a stronger sense of coherence.

Positive Mental Health Scale (PMH)

Positive aspects of emotional well-being and health were assessed by the 9-item PMH (Lukat, Margraf, Lutz, van der Veld, & Becker, 2016). Respondents rate the items on a 4-point Likert scale ranging from 0 (= *do not agree*) to 3 (= *agree*). A higher total score indicates better emotional well-being. In the US sample, Cronbach's α was .92; in the German sample, .89; and in the Russian sample, .85.

Satisfaction With Life Scale (SWLS)

The 5-item SWLS measures global life satisfaction (Diener, Emmons, Larsen, & Griffin, 1985). Participants rate each item from 1 (= *strongly disagree*) to 7 (= *strongly agree*). A higher score suggests higher life satisfaction. Cronbach's α was .84 in the US sample, .85 in the German sample, and .88 in the Russian sample.

The Brief Form of Perceived Social Support Questionnaire (F-SozU K-6)

In the F-SozU K-6 (Kliem et al., 2015; Lin, Hirschfeld, & Margraf, 2019), items are rated on a 5-point Likert scale ranging from 1 (= *not true*) to 5 (= *true*). A higher score indicates a higher level of perceived social support. In the current study, the internal consistency was .89 in the US sample, .79 in the German sample, and .78 in the Russian sample.

Depression, Anxiety, and Stress Scale (DASS-21)

Symptoms of depression, anxiety, and stress (seven items for each) over the past week were assessed by a 21-item version of the DASS (Henry & Crawford, 2005). Participants rate their agreement on a 4-point Likert scale from 0 (= *did not apply to me at all*) to 3 (= *applied to me very much or most of the time*). A higher average score on each subscale indicates more severe symptoms within that category. Overall Cronbach's α was .94 in the US sample and .93 in the German and Russian samples.

Data Analyses

Descriptive analyses (e.g., mean (*M*) and standard deviation (*SD*), skewness and kurtosis values), Cronbach's α, and correlations between SOC-L9 and other positive mental health measures (PMHS, SWLS, RE, and F-SozU K-6) as well as correlations between SOC-L9 and some negative mental health measures (DASS) were conducted via SPSS (version 18.0, IBM Inc, 2009).

All confirmatory factor analyses (CFAs) were conducted with the software program R and its package Lavaan (version 6.12) with robust maximum likelihood estimation. Two models were tested within each sample for the structure of SOC-L9: (1) a unidimensional model where all nine items loaded to one factor; (2) a three-factor model that contains a comprehensibility factor (Items 1 and 4),

a manageability factor (Items 5, 7, and 8), and a meaningfulness factor (Items 2, 3, 6, and 9) that inter-correlated with each other; and (3) a bifactor model that contains a general factor (where all nine items were loaded to) and a method factor (where the four items with negative wording were loaded to). The correlation between the general factor and method factor was constrained to zero. For model fit evaluation, root mean square error of approximation (RMSEA) values $\leq$ .06, standardized root mean square residual (SRMR) values $\leq$ .08, and the comparative fit index (CFI) values $\geq$ .95 were interpreted as evidence for a well-fitting model (Hu & Bentler, 1999).

Furthermore, a measurement invariance test was conducted across the three samples. As recommended by Vandenberg and Lance (2000), first, a multigroup CFA without equality constraints was conducted to test for configural invariance. A good model fit of the model indicated that the factor structures were the same across groups. Then, weak invariance (metric invariance) was tested as all factor loadings were constrained to be equal across groups. If weak invariance was supported, a strong invariance (scalar invariance) test was conducted by additionally constraining the intercepts of the items across groups. A ΔCFI $\leq$ .01 was used to determine whether the decrease in fit between the latter model and the previous model was substantial (Cheung & Rensvold, 2002). In case full invariance could not be established, partial invariance was examined by freely estimating the factor loading/intercept of the variant item accordingly (Byrne, Shavelson, & Muthén, 1989). In case strong or partial strong invariance was established, latent means were compared (Milfont & Fischer, 2010).

Results

Sample Characteristics

After excluding cases with duplicate answers (3 in Germany and 34 in the US) and missing values of the SOC-L9 (2 in Germany, 86 in the US, and 294 in Russia), the total number of valid cases reported in Table 1 was used for analyses. Demographic information of all samples is presented in Table 1.

Item Characteristics

Item characteristics of the SOC-L9, the *mean (M), standard deviation (SD),* and *skewness* and *kurtosis values* of each item for the representative samples of Germany, Russia, and the US are described in Table 2. Skewness and kurtosis values in all samples indicated acceptable normal univariate distribution. SOC-L9 total scores ranged from 9 to 63 in the Russian sample; from 11 to 63 in the US sample; and from 15 to 63 in the German sample.

Table 1. Demographic characteristics

	Germany	Russia	US
Total *N* (% in the original sample)	2,005 (99.8)	2,726 (90.2)	2,952 (96.1)
Gender, *N* (%)			
Female	1,180 (58.9)	1,467 (53.8)	1,730 (41.4)
Male	825 (41.4)	1,259 (46.2)	1,222 (58.6)
Age			
Mean (*SD*)	51.96 (17.36)	42.06 (16.70)	54.84 (17.44)
Range	18–92	18–100	18–99
Married/have steady partner, *N* (%)	1,022 (76.1)	1,639 (60.1)	1,604 (54.3)
Years of education[a], *N* (%)			
Did not graduate high school	413 (20.6)	94 (3.4)	281 (9.5)
High school graduated	1,132 (56.4)	1,393 (51.1)	1,021 (34.6)
Higher education	439 (21.9)	1,239 (45.5)	1,333 (45.2)
Employment status			
Full-/part-time working	1,123 (56.0)	1,468 (53.6)	N/A
Current student	100 (5.0)	195 (7.2)	N/A
Unemployed	74 (3.7)	223 (8.2)	N/A
Homemaker[b]	50 (2.5)	231 (8.5)	N/A
Retired/disability	630 (31.4)	587 (21.5)	N/A

Notes. All reported data are unweighted. The total *N* refers to the cases that had valid answers to all nine items of the SOC-L9. *SD* = standard deviation; N/A = questions were not asked, thus have no data here. [a]High school referred to all level of secondary schools; higher education included college, university, masters, and doctorate. [b]Homemaker included people who were busy with household, on maternity leave, or leave to care for child(ren).

Table 2. Means (*M*s), standard deviations (*SD*s), skewness (*S*), kurtosis (*K*), Cronbach's α if item deleted (α′), and standardized factor loadings of general factor (λg) and method factor (λm) of the SOC-L9 in German, American, and Russian representative samples

	US (*N* = 2,952)								Germany (*N* = 2,005)							Russia (*N* = 2,726)						
Item	*M*	*SD*	*S*	*K*	r_{tt}	α′	λg	λm	*M*	*SD*	*S*	*K*	α′	λg	λm	*M*	*SD*	*S*	*K*	α′	λg	λm
1	5.90	1.88	−1.65	1.38	.41	.74	.51		5.81	1.56	−1.42	1.31	.76	.55		5.78	1.82	−1.39	0.77	.66	.42	
2	2.09	1.85	1.64	1.36	.41	.74	.33	.48	2.53	1.57	1.09	0.53	.75	.48	.41	2.69	2.07	0.92	−0.52	.64	.33	.44
3	2.41	1.76	1.24	0.62	.52	.73	.45	.58	2.63	1.35	0.97	0.97	.75	.50	.48	2.54	1.76	0.94	−0.07	.64	.31	.48
4	5.50	2.03	−1.13	−0.13	.40	.75	.53		5.53	1.66	−1.04	0.10	.76	.54		5.03	2.18	−0.66	−1.02	.67	.40	
5	2.18	1.80	1.56	1.30	.50	.73	.47	.39	2.27	1.49	1.39	1.46	.76	.47	.35	2.37	1.99	1.28	0.27	.64	.31	.42
6	6.06	1.63	−1.98	3.07	.41	.74	.49		5.94	1.39	−1.59	2.22	.76	.49		5.91	1.80	−1.60	1.13	.65	.42	
7	5.69	1.74	−1.34	0.84	.53	.73	.67		5.21	1.65	−0.84	−0.09	.75	.60		5.70	1.76	−1.29	0.64	.64	.58	
8	2.24	1.69	1.45	1.16	.43	.74	.41	.35	2.58	1.31	0.92	0.77	.76	.37	.29	2.62	1.75	0.89	−0.12	.65	.29	.40
9	5.49	2.07	−1.45	−0.07	.37	.75	.45		5.43	1.59	−0.97	0.14	.77	.57		5.31	2.03	−0.91	−0.51	.64	.53	
Sum	51.72	9.66	−1.17	0.87					49.91	8.17	−0.75	0.67				49.52	9.05	−0.62	0.28			

Note. When calculating α' and factor loadings, Items 2, 3, 5, and 8 were calculating reversely.

Internal Consistency

Internal consistency of the SOC-L9 was .78 (Germany), .76 (US), and .67 (Russia). Cronbach's α – when deleting a given item – is also displayed in Table 2, indicating that deleting any item would reduce Cronbach's α.

Confirmative Factor Analyses

Results of the CFA tests are displayed in Table 3. The unidimensional model revealed poor model fit for all data. The model fit indexes of the three-factor models appeared acceptable; however, the correlation between the manageability factor and the meaningfulness factor was greater than 1.0 in all samples. Therefore, we rejected the three-factor model. Meanwhile, adding a method factor to the general factor of all items resulted in excellent model fit according to the conventional criteria CFI, RMSEA, and SRMR in all samples, supporting a bifactor model with method effect structure for the SOC-L9. With this result, a sum score of all nine items (four items were reversed scored) is valid for further analysis.

Criteria Validity

Table 4 presents the means and *SD*s of all relative scales and correlation results between the SOC-L9 and the other measurements. The SOC-L9 was negatively and strongly associated with stress, anxiety, and depression symptoms and positively linked to all positive mental health measurements, suggesting that in the three countries, having higher SOC indicates higher satisfaction of life and higher positive mental health level. Normative data of age (10-year period per group) and gender for all the general populations are provided in Electronic Supplementary Material 1 (ESM 1).

Cross-National Measurement Invariance Test

Table 3 demonstrates the multigroup CFA model test (based on the bifactor model) results. Full configural invariance and weak invariance were established, suggesting that all countries had identical structures of the SOC-L9 and equivalent contribution of each item to the core construct. Full strong invariance was not supported, but a partial strong invariance was established after allowing free estimation of the intercept of Item 4 and Item 7, indicating that the item intercept is variant across groups.

Latent Mean Comparisons

Latent mean comparisons were conducted for the SOC-L9. Results indicated that the US sample (as reference group) had significantly higher latent means on the SOC and the method factor than the German ($z_{SOC} = -0.132$, $p < .0001$; $z_{Method} = -0.194$, $p < .0001$) and Russian samples ($z_{SOC} = -0.199$, $p < .0001$; $z_{Method} = -0.176$, $p < .0001$; Figures 1 and 2). To compare the Russian and German groups, the latter was used as the reference group. Results indicated that the Russian sample ($z_{SOC} = -0.069$, $p = .051$; $z_{Method} = .018$, $p = .639$) did not differ significantly from the German group.

Discussion

The current study validated the SOC-L9 and tested its measurement invariance in the general population samples from Germany, Russia, and the US. The overall good to modest psychometric properties supported the SOC-L9 as a short, valid, and reliable tool for SOC measurement in

Table 3. Confirmative factor analyses (CFAs) results of all samples

Model	χ^2/df	RMSEA [90% CI]	CFI	SRMR	ΔCFI
Single group CFA – Unidimensional model[a]					
Germany	267.92/27	.067 [.061, .073]	.890	.045	
Russia	355.89/27	.067 [.071, .072]	.825	.090	
US	385.08/27	.067 [.062, .072]	.873	.048	
Single group CFA – three factor model[b]					
Germany[c]	216.11/24	.063 [.056, .071]	.943	.036	
Russia[c]	384.22/24	.074 [.068, .081]	.859	.046	
US[c]	440.86/24	.077 [.071, .083]	.908	.044	
[1]Single group CFA – Bifactor model[d]					
Germany	149.36/23	.052 [.046, .059]	.942	.034	
Russia	105.3/23	.036 [.030, .043]	.956	.028	
US	80.57/23	.029 [.023, .035]	.980	.021	
Measurement invariance test based on the bifactor model					
Configural invariance	334.10/69	.039 [.035, .042]	.962	.027	
Weak invariance	396.63/91	.036 [.033, .039]	.956	.034	.006
Strong invariance	681.64/105	.046 [.043, .049]	.917	.042	.039
Partial strong (τ7 free)	582.45/103	.043 [.040, .046]	.931	.039	.025
Partial strong (τ4, τ7 free)	476.22/101	.038 [.035, .041]	.946	.036	.010

Notes. CFI = comparative fit index; 90% CI = 90% confidence interval; τ4 = intercept of Item 4; τ7 = intercept of Item 7; RMSEA = root mean square error of analysis; SRMR = standardized root mean square residual. All χ^2 tests and $\Delta\chi^2$ were significant, $p < .001$. [a]In the unidimensional model: all items loaded to one factor. [b]In the three factor model, comprehensibility factor included Items 1 and 4, manageability factor included Items 5, 7, and 8, and meaningfulness factor included Items 2, 3, 6, and 9. The three factors were inter-correlated. [c]The correlations between the manageability and the meaningfulness factor are greater than 1.0. [d]In the bifactor factor model: all items loaded on a general factor, while Item 2, Item 3, Item 5, and Item 8 also loaded on a method factor.

Table 4. Means (*M*) and standard deviations (*SD*) of all validation measures and correlations (*r*) between SOC-L9 and all validation measures

	Germany (*N* = 1,834)			Russia (*N* = 226)			US (*N* = 2,773)		
Scales	*M*	*SD*	*r*	*M*	*SD*	*r*	*M*	*SD*	*r*
Stress	4.87	4.67	−.48***	5.39	4.59	−.40***	6.23	4.82	−.48***
Anxiety	2.04	3.20	−.46***	3.10	3.75	−.36***	4.29	4.53	−.46***
Depression	2.42	3.54	−.57***	3.76	3.87	−.46***	4.06	4.87	−.56***
PMH	21.92	4.75	.64***	21.09	5.17	.51***	23.12	5.08	.55***
SWLS	27.14	5.74	.60***	23.61	6.65	.48***	27.03	6.59	.57***
F-SozU K-6	27.41	3.50	.33***	25.78	4.62	.37***	25.34	5.38	.43***

Note. F-SozU K-6 = Brief Form of Perceived Social Support Questionnaire; PMH = Positive Mental Health Scale; SOC-L9 = Sense of Coherence Scale (9-item version); Stress/Anxiety/Depression = the Stress/Anxiety/Depression subscale of the Depression, Anxiety, and Stress Scale; SWLS = Satisfaction with Life Scale. ***$p < .001$.

these countries. Moreover, the scores of the SOC-L9 were significantly associated with all the positive and negative mental health measures tested. In line with many earlier studies, SOC seems to be a health-promoting resource that impedes mental illness (e.g., Amirkhan & Greaves, 2003; Konttinen et al., 2008; Wolff & Ratner, 1999) and develops a positive subjective state of health (e.g., Chu et al., 2016; Eriksson & Lindström, 2006).

Results from the CFAs confirmed the structure problems frequently encountered with SOC scales (e.g., Eriksson & Lindström, 2006; Larsson & Kallenberg, 1999), that is, not supporting a simple one-factor or three-factor structure. In the present study, support for the statistically more satisfactory bifactor model including a method factor was found. SOC scales often contain a large proportion of reversed items, which may be one reason for the contradictory results in previous studies (e.g., Germano et al., 2001; Sardu et al., 2012). By adding a method factor into the SOC-L9, the general factor of SOC was supported in all our samples. The bifactor model has seldom been tested in other SOC scales; thus, we do not know whether the reversed items could be the reason that other studies had failed to confirm the unidimensional structure or three-component models. We suggest future studies to consider and test the bifactor model, before using the EFA to develop new multifactor models or to remove items (e.g.,

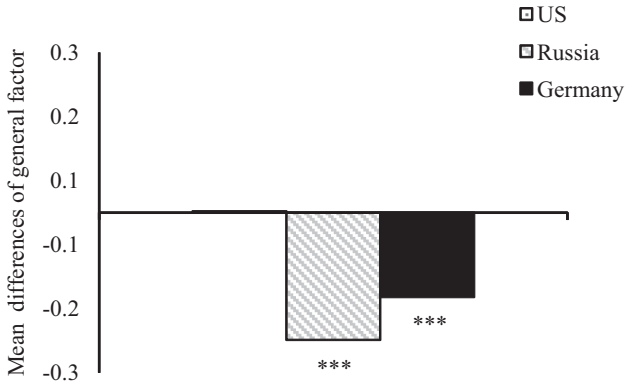

Figure 1. Latent mean differences of the general SOC factor across nations with the US group as the reference group (held at zero). ***p < .0001.

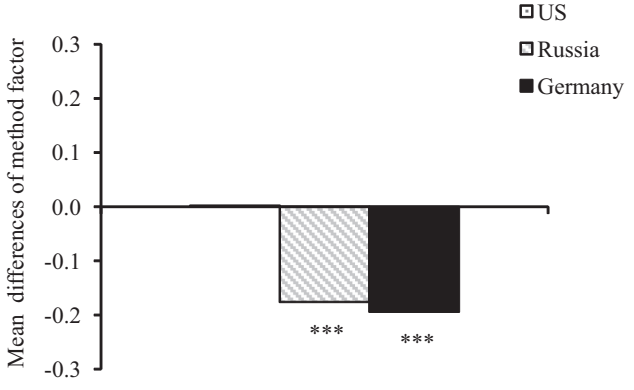

Figure 2. Latent mean differences of the method factor across nations with the US group as the reference group (held at zero). ***p < .0001.

Drageset & Haugan, 2015). If this is indeed a common problem in the SOC scales, an adaption of the SOC scales (e.g., rewording of reversed items) would be necessary.

Measurement equivalence tests found partial strong measurement equivalence across all three countries, suggesting that a similar latent factor with the same meaning was presented in the three countries. It appears that adults in the US, Germany, and Russia conceptualize SOC similarly. However, the intercept of Item 4 ("Do you have very mixed-up feelings and ideas") and Item 7 ("Many people – even those with a strong character – sometimes feel like losers in certain situations") was not equivalent across countries. For equal latent factor scores, Russians were more likely to report mixed-up feelings/ideas than Germans and Americans, while Germans reported more frequently feeling like a loser than Russians and Americans. It may reflect real differences among countries, or rather, this bias could be based on cultural differences (i.e., participants have different understanding or interpretation of these items). For instance, Russia has been undergoing substantial sociopolitical, economic, religious, and demographic transition (e.g., Gurina et al., 2011); thus, this could be a reason why Russians have more mixed feelings about life when facing such changes. It may also be that in Germany, people are more negative-orientated (e.g., "die deutsche Angst"); thus, they might be more open to admit feeling defeated, while in the other two nations, people are more hesitant to acknowledge feelings of being a loser. Future research could conduct focus group interviews for a further and deeper understanding of the biases reported here.

The latent mean comparisons showed that the US population had a significantly higher latent mean of the SOC-L9 than the German and Russian samples. Since the effects were small and our test samples were large, these differences should be interpreted cautiously. For instance, the higher SOC level in the US sample may be simply due to the fact that the SOC scales were originally developed in the US. Germany and Russia may have different exhibitions or understandings of how to better cope with hard events in life, which are not included in the current form of SOC-L9. Nevertheless, the SOC-L9 has proven to be invariant across nations and can be used for an unbiased measurement of sense of coherence.

There are limitations that should be taken into account. First, the internal consistency in the Russian sample was low. The reason for the low internal consistency based on inter-item correlations can lie in the translation, but also in content issues. However, based on the results in Table 2, none of the current items should be deleted. Also, the cross-national differences revealed by the latent mean comparisons were valid. Second, the causes for nonequivalence are still not completely clear, and the interpretation of the cross-national differences can only be hypothesized. Third, all results are based on only three countries under study; additional research is needed to evaluate measurement equivalence of the SOC-L9 in other countries.

In sum, the SOC-L9 has proved to be economical, valid, reliable, feasible, and cross-nationally applicable in the US, Germany, and Russia. Cross-national measurement invariance testing demonstrated partial strong measurement equivalence. Latent mean comparisons indicated that people in the US generally have higher SOC than people in the other two countries.

Electronic Supplementary Materials

The electronic supplementary material is available with the online version of the article at https://doi.org/10.1027/1015-5759/a000561

ESM 1. Norms of the SOC-L9 in the three countries

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