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Structural validity and temporal stability of the 13-item sense of coherence scale: Prospective evidence from the population-based HeSSup study

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Abstract

Study objective: To investigate whether the structure of Antonovsky's [*Unraveling the Mystery of Health. How People Manage Stress and Stay Well*. San Francisco: Jossey-Bass, 1987] 13-item Sense of Coherence (SOC) scale remains invariant across time and across age groups and whether any differences in stability of and mean changes in SOC can be seen between young people and individuals aged 30 or above. *Design:* Prospective study with a population-based sample of 18,525 Finns of whom 4,682 were under age 30 and 13,843 over age 30 at both the baseline and 5-year follow-up surveys (the HeSSup study). *Results:* Confirmatory factor analysis supported the correlated 3-factor solution for the SOC scale and its equivalent second-order factor structure at both measurement times and in both age groups. According to Structural Equation Modelling (SEM), SOC was more stable among subjects over 30 years (stability coefficient 0.81) than among younger adults (0.70). The mean level of SOC was higher among subjects over age 30 than subjects under age 30 at both times. The level of SOC increased during the follow-up period in both age groups but to a greater extent among the younger than older age group. *Conclusions:* These data suggest relatively high structural validity and high stability for the 13-item SOC measure and support the notion that SOC becomes more stable following maturation. The 13-item SOC measure seems to provide a psychometrically sound survey instrument for testing Antonovsky's theory on life orientation and health.

Key words: Health, Life orientation, Psychometric properties, Sense of coherence, Stability, Validity

Introduction

The notion that personality and orientation to life may play an important role in health has attracted considerable research interest [1]. While the majority of studies in this field have dealt with type A behavior pattern, hostility and other vulnerability factors [2–4], Antonovsky [1] proposed the concept 'sense of coherence' (SOC) to describe a salutogenic, health-protective life orientation. SOC refers to a global orientation that expresses the extent to which one is confident (1) that the stimuli deriving from one's internal and external environments in the course of living are structured, predictable and explicable; (2) that resources are available to one to meet the demands posed by these stimuli and (3) that these demands are challenges, worthy of investment and engagement. These three orientations, termed comprehensibility, manageability and meaningfulness, which are thought to be separate but highly interrelated, form the main components of SOC. However, only limited empirical evidence is available to support the correlated 3-component structure of SOC in a general population and, although a crucial feature of the definition of SOC is that it represents a stable dispositional orientation after age 30, no previous study has reported the stability of SOC in such a population.

The Orientation to Life Questionnaire, a multiple-choice-type questionnaire to assess SOC [1], exists in two forms: a longer version consisting of 29 items and a shortened 13-item version. Early psychometric studies on SOC-scales used exploratory factor analyses alone which resulted in a one-factor solution for both versions [5–8]. However, in recent years the structure of the SOC-13 scale has been investigated by using confirmatory factor analysis (CFA). This approach offers three advantages over the traditional exploratory techniques. First, CFA makes it possible to test whether a sample data set is consistent with a predefined correlated 3-factor structure. Second, CFA within the Structural Equation Modelling (SEM) framework allows the invariance of the factor structure to be tested across time and across different groups. Third, CFA models tested at different time points can be estimated simultaneously in the same model by SEM, resulting in an error-free stability coefficient for SOC.

Indeed, studies using CFA and SEM have supported the theoretically based correlated 3-factor model (items were assigned to the factors of meaningfulness, comprehensibility and manageability and the factors were allowed to correlate) and its equivalent second-order factor model (the high intercorrelations between the meaningfulness, comprehensibility and manageability factors were explained by a second-order factor) as they have shown a better fit with the data than the one-factor model (all 13 items were assigned to one latent factor) [9–15]. It is important to note, however, that the theoretically based structures of the scale have not been found to be flawless in previous investigations, as two items with different theoretical facets (manageability item number 5 and comprehensibility item number 6) have shown a strong covariance between their error variances, indicating a specific factor characterized by the feeling of "being let down/social disappointment" [9–15]. In longitudinal studies, the theoretically based SOC-structures have been found to be invariant across different measurement times [11–15]. However, all this evidence is limited to relatively small samples of employees [11–15].

Similar limitations apply to studies examining the rank-order stability of SOC over time. Rank-order stability is typically assessed using test–retest correlations. Test–retest correlations reflect the degree to which the relative ordering of individuals and relative differences between test values is maintained over time. Thus, a high test–retest correlation indicates that (a) individuals' SOC does not change much over time or (b) individuals' SOC changes over time, but in more or less the same way [16, 17]. In a small student sample ($n = 32$) a Pearson test–retest correlation for SOC with a 3-week interval was 0.65 [9] and the corresponding correlation in patient samples ($n < 96$) varied between 0.70 and 0.77 with a 6–12 months interval [18]. Error-free test–retest correlations for SOC (SEM analysis) have also been reported. A one-year follow-up of 219 Finnish employees working in four organizations revealed a relatively high test–retest correlation for SOC (error-free stability coefficient in SEM was 0.72) [13]. Corresponding coefficients have been reported for 771 patients with chronic illness across a 2-year period (0.77) [15], for 615 managers across a 3-year period (0.69) [11], for 577 municipal employees across a 3- to 4-year period (0.82) [19] and for 352 technical designers across a 5-year period (0.66) [12].

According to Antonovsky's [1] theory, SOC develops along with experiences through childhood, adolescence and young adulthood, and could, in favourable circumstances, reach a relatively stable level after age 30. However, only two studies have examined the age-related stability of SOC. A study of 352 technical designers found no differences in the stability of SOC over a 5-year period between younger (25–29 year olds at baseline) and older employees (35–40 years at baseline) [14], and in a study of municipal staff exclusion of employees under age 30 ($n = 23$) had little effect on the stability coefficients [19]. However, small numbers limited the ability to detect significant differences between age groups in these studies.

Rank-order stability is conceptually and statistically distinct from mean-level change [16, 17]. For example, the rank ordering of individuals in a sample could change substantially over time without producing any aggregate increases or decreases in mean levels of SOC (e.g., if the number of people with decreased SOC is offset by the number of people with increased SOC). The mean level of SOC tends to increase over time [12, 20], but no differences in level of increase in SOC have been detected between different age groups in small-scale studies [14].

The Health and Social Support Study (HeSSup) provided us an opportunity to examine the structure and stability of SOC in a very large population-based sample not limited to employees and students. Our study has three specific aims: (1) to test whether the structure of comprehensibility, manageability and meaningfulness fits the data and is replicable across two measurements (time invariance) in a general population; (2) to study whether the structure of the SOC scale remains invariant across age groups (group invariance); and (3) to examine whether SOC remains stable (rank-order stability, mean changes) over time and whether any differences in stability can be seen between young adults (20–24 years old) and adults aged 30 or more.

On the basis of the Antonovsky's [1] theory and prior research, the following hypotheses were formulated:

H1: The 13-item SOC scale comprises three highly interrelated subfactors (meaningfulness, comprehensibility, manageability) and this structure remains the same over time.

H2: The hypothesized structure of the 13-item SOC scale is invariant across different age groups.

H3: The rank-order stability of SOC is relatively high across time and this stability is higher among subjects over 30 years than young adults in their early 20s. The mean level of SOC increases with age.

Method

Sample

This study is part of the Health and Social Support project (HeSSup), a longitudinal cohort study on psychosocial factors and health in the Finnish working-aged population. A random sample (n = 52,739) from the Finnish Population Register Centre, stratified according to gender and four age groups (20–24, 30–34, 40–44 and 50–54 years), were asked to participate in the HeSSup project. A total of 21,101 persons answered the baseline questionnaire. The response rate (40%) was satisfactory if it is taken into account that the respondents were asked to give their consent to the accessing of data from several registers and for follow-up surveys. The follow-up survey was sent 5 years later in 2003, and was answered by 19,675 (80.7%).

The present study focused on the 18,525 individuals who answered to all the items of the SOC-13 survey at both baseline and follow-up. Previous studies suggest that the respondents recruited at the baseline were reasonably representative of the Finnish population when adjusted for age and sex [21]. As shown in Table 1, any differences in the age and sex distribution between the baseline respondents and the sample used in this study were small. As the present study focused on differences in the stability of SOC between subjects under and over 30 years, we divided the sample into two age groups where the younger age group (n = 4682) represented subjects initially 20–24 years old and older age group (n = 13,843) subjects initially 30–54 years old.

The 13-item SOC scale

The participants completed the 13-item SOC scale [1], which comprises the following items extracted from the 29-item SOC scale:

Table 1. Sex and age distribution among baseline respondents and in the study sample[a]

Baseline characteristic	All respondents at baseline		Study sample[a]	
	N	%	N	%
Sex				
Men	10,608	59.0	7097	61.7
Women	15,249	41.0	11,428	38.3
Age group				
20–24	6895	26.8	4682	25.3
30–34	6119	23.8	4248	22.9
40–44	6222	24.2	4598	24.8
50–54	6530	25.3	4997	27.0

[a]Those with no missing data in sex and age at baseline or any of the SOC items at baseline and follow-up.

Meaningfulness (numbering from the original scale)

(4) "Do you have the feeling that you don't really care about what goes on around you?"
(8) "Until now your life has had ...no clear goals or purpose at all ... vs. ... very clear goals and purpose"
(16) "Doing the things you do every day is ... a source of deep pleasure and satisfaction ... vs. ... a source of pain and boredom"
(28) "How often do you have the feeling that there's little meaning in the things you do in your daily life?"

Comprehensibility

(5) "Has it happened in the past that you were surprised by the behaviour of people whom you thought you knew well?"
(12) "Do you have the feeling that you are in an unfamiliar situation and don't know what to do?"
(19) "Do you have very mixed-up feelings and ideas?"
(21) "Does it happen that you have feelings inside you would rather not feel"
(26) "When something happened, have you generally found that ...you overestimated or underestimated its importance ... vs. ... you saw things in the right proportion?"

Manageability

(6) "Has it happened that people whom you counted on disappointed you?"
(9) "Do you have the feeling that you're being treated unfairly?"
(25) "Many people – even those with a strong character – sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?"
(29) "How often do you have feelings that you are not sure you can keep under control?"

The respondents were asked to select a response on a 7-point semantic differential scale with two opposite anchoring phrases (e.g., 1 = never and 7 = always). After reversing the scores of the five negatively worded items, a total sum score, ranging from 13 (low SOC) to 91 (high SOC), is obtained. At the baseline, the Cronbach's α coefficient for the SOC scale was 0.85 for both age groups. At the second measurement time, the Cronbach's α was 0.85 for the younger adults and 0.86 for the group aged 30 or more.

Statistical analysis

The structure and stability coefficients of SOC were investigated within the SEM framework, using the LISREL 8.54 program [22]. As the variables were ordinal, we used a Weighted Least Square estimation procedure based on covariance and asymptotic covariance matrices calculated by the PRELIS program [23]. The matrices were calculated by setting equal the thresholds for the categorical observed variables. Age group equality in the structure and stability of SOC was analysed by means of a multi-group method.

In the first phase of the analytical procedure, CFA was conducted to determine whether the observed variables (items) of SOC loaded on the latent constructs as hypothesized. The correlated 3-factor structure and its equivalent second-order factor model served as our hypothesized model. In the correlated 3-factor model, the four meaningfulness, five comprehensibility and four manageability items were assigned to their own latent factors which were allowed to correlate. In the second-order factor model, the three estimated correlations among the first-order factors were replaced by a second-order factor (describes total SOC) with three factor loadings, one for each of the three first-order factors (meaningfulness, comprehensibility, manageability). The identifiability of the above-described CFA models was enabled by fixing one indicator per latent factor to a value 1.00. It is notable that the correlated 3-factor model and the second-order factor model are equivalent models in the sense that both models have the same number of independent parameters, the same fitted residuals and the same goodness-of-fit statistics. Therefore, these models fit the given data equally well. To ensure that the hypothesized SOC model was valid, we further estimated a one-factor model of SOC (all 13 items were set to one latent factor) to test the unidimensionality of the scale.

In the second phase of the analyses, we investigated whether the best-fitting structure of SOC was invariant across time (time invariance) and across age (group invariance) and whether the stability coefficient of SOC (i.e., β-path between the latent SOC factors at Time 1 and 2) differed between the age groups. To achieve these objectives, we first estimated a stability model separately for the two age groups studied. In the stability model, the CFA-model of SOC estimated at two time points was connected by using structural equation between the latent factors of SOC. Factorial invariance across time was investigated by comparing the fit of the freely estimated model (i.e., factor loadings and error terms were allowed to vary across measurement times) to the more constrained stability models (i.e., parameter estimates were set equal across time). Similarly, factorial invariance across age groups was investigated by comparing the baseline stability model (the parameter estimates were allowed to be unequal across age groups) to the constrained models (parameter estimates were constrained to be equal across age groups).

When evaluating the fit of the CFA and stability models to the data, we used several types of goodness-of-fit indexes. We used the standard chi-square index of statistical fit that is routinely provided under the maximum likelihood estimation of parameters. However, a well-known disadvantage of the chi-square statistics is its high sensitivity to sample size, as small and, in practice, irrelevant deviations of the empirical data from what is theoretically expected, are detected due to the overwhelming statistical power. We therefore used also other indexes of practical fit, including the root mean square error of approximation (RMSEA) [24], the goodness of fit index (GFI) [25], and Akaike's [26] Information Criterion (AIC). The RMSEA is an absolute index of fit. RMSEA values under 0.05 indicate close fit with the data, values between 0.05 and 0.08 represent reasonable fit, values between 0.08 and 0.10 reflect poor fit, and values greater than 0.10 are unacceptable. The GFI values may range between 0 and 1 and should be greater than 0.90, and preferably greater than 0.95, to consider the fit of a model to data to be acceptable [27]. The AIC measure can be used to compare the goodness-of-fit of the alternative models tested using the same data. The model with the smallest AIC value is considered to be the best model.

When comparing the fit of the stability models with alternative constraints (i.e., tests of factorial invariance across time and across age groups), researchers have usually relied heavily on the change in the chi-square index of statistical fit. A non-significant reduction in chi-square (often identified as $\Delta\chi^2$), relative to change in the number of degrees of freedom (identified as Δdf), indicates that the constrained model is acceptable. If the reduction in chi-square is significant, a freely estimated model is a more adequate model. However, as already stated, the chi-square difference test is sensitive to statistical power in large-scale studies. Thus, to illustrate the effect of excessive statistical power, we evaluated the factorial invariance of the SOC scale by setting the sample size in both age groups to 1000. This sample size was chosen on the basis of the information given by the value of Critical N (CN) produced by LISREL program. In the case of large samples, CN indicates the critical line of sample size where the model would be acceptable. In the present study, the average Critical N in the tested models was 1000.

Finally, the mean level analysis of SOC was conducted using an SPSS 13.0 for Windows software package. A repeated measure of multivariate analyses of variance (MANOVA) was conducted to examine whether there would be any mean changes in SOC between the two measurement times between the two age groups studied. This 2 (group) $\times$ 2 (time) analysis used age as a between-groups variable and time as a repeated measure, enabling the investigation of (a) differences in the mean levels of the SOC between the younger adults and adults aged 30 or more, (b) mean changes in SOC between the measurement times and, (c) the interaction of these effects.

Results

The structure of the 13-item SOC scale

Table 2 summarizes the goodness-of-fit statistics for the tested and compared CFA models of the 13-item SOC scale. The correlated 3-factor structure and its equivalent second-order factor structure showed a better fit with the data than the one-factor model at both measurement times and in both age groups. Our hypothesized model did not, however, provide a superior fit to the data.

Table 2. Goodness-of-fit statistics for the alternative CFA models of the SOC-13

	Subjects initially between 20 and 24 years (N = 4682)		Subjects initially between 30 and 54 years (N = 13,843)	
	Time 1	Time 2	Time 1	Time 2
Correlated 3-factor model/second-order factor model	$\chi^2(62) = 972.63$, $p < 0.001$ RMSEA = 0.056 GFI = 0.99 AIC = 1030.63	$\chi^2(62) = 1219.70$, $p < 0.001$ RMSEA = 0.063 GFI = 0.98 AIC = 1277.70	$\chi^2(62) = 3285.90$, $p < 0.001$ RMSEA = 0.061 GFI = 0.98 AIC = 3343.90	$\chi^2(62) = 3164.45$, $p < 0.001$ RMSEA = 0.066 GFI = 0.98 AIC = 3222.45
Modified correlated 3-factor model/ second-order factor model[a]	$\chi^2(61) = 619.24$, $p < 0.001$ RMSEA = 0.044 GFI = 0.99 AIC = 679.24	$\chi^2(61) = 793.81$, $p < 0.001$ RMSEA = 0.051 GFI = 0.99 AIC = 853.81	$\chi^2(61) = 2020.17$, $p < 0.001$ RMSEA = 0.048 GFI = 0.99 AIC = 2080.17	$\chi^2(61) = 1987.89$, $p < 0.001$ RMSEA = 0.048 GFI = 0.99 AIC = 2047.89
One-factor model	$\chi^2(65) = 1358.92$, $p < 0.001$ RMSEA = 0.065 GFI = 0.98 AIC = 1410.92	$\chi^2(65) = 1709.77$, $p < 0.001$ RMSEA = 0.074 GFI = 0.98 AIC = 1761.77	$\chi^2(65) = 4376.50$, $p < 0.001$ RMSEA = 0.069 GFI = 0.98 AIC = 4428.50	$\chi^2(65) = 4286.83$, $p < 0.001$ RMSEA = 0.069 GFI = 0.98 AIC = 4338.83

[a]Error covariance between the items 5 (comprehensibility item) and 6 (manageability item) estimated in the model.

We therefore modified it on the basis of the information given by the modification indices. On the basis of this information, we allowed the errors of comprehensibility item 5 and manageability item 6 to correlate, which led to a substantial improvement in the fit for the hypothesized model. This modified model was chosen for our subsequent analysis of the stability of SOC. As the correlations between the meaningfulness, comprehensibility and manageability factors turned out to be very high at both measurement times and in both age groups (varied between 0.76 and 1.00), we decided to choose the modified second-order factor model of SOC for our subsequent stability models.

The factorial invariance and rank-order stability of SOC

We next moved from the CFA models to the stability models in order to test the factorial invariance of the SOC scale across time in both age groups. Table 3 reports the results for the tested models with alternative constraints. It should be noted that, on the basis of the modification indices one significant autocovariance between the items 8 and one significant residual autocovariance between meaningfulness factors were estimated in all stability models (non-significant error covariances were not included in the model). As shown in Table 3, the chi-square difference test rejected the constrained models as compared to a freely estimated model when the estimation was based on the original sample sizes. The detailed analysis of the factor loadings showed, however, that the deviation in magnitude of the factor loadings across time were very minor (0.00–0.03) and thus of little relevance. To avoid the overwhelming statistical power caused by original sample size in the chi-square difference test, we evaluated the factorial invariance across time by setting the sample size to 1000. On the basis of this smaller sample size, the chi-square difference test supported the fully constrained model where the factor loadings and error variances were set to be invariant across time. Thus, the fully constrained model was chosen as the baseline model for our subsequent analyses of factorial invariance across the two age groups.

The results of the chi-square difference tests for factorial invariance across the two age groups are reported in Table 4. As the results of chi-square difference tests based on the original and on the smaller (n = 1000) sample sizes show, the baseline stability model of SOC (Model A; factor loadings and error variances were allowed to vary across age groups) displayed better goodness of fit than the model with equality constraints in the factor

Table 3. Time invariance tests for the stability model of SOC

Alternative stability models (second-order factor model)	Subjects initially between 20–24 years (n = 4,682)						Subjects initially between 30–54 years (n = 13,843)					
	χ^2	df	$\Delta\chi^2(\Delta df)$	RMSEA	GFI	AIC	χ^2	df	$\Delta\chi^2(\Delta df)$	RMSEA	GFI	AIC
1. Freely estimated model[c]	3265.67[a]	290		0.047	0.98	3387.67	9256.35[a]	290		0.047	0.98	9378.35
	696.95[b]	290					668.05[b]	290				
2. Partially constrained model[d]	3301.90[a]	302	2. vs. 1[a]	0.046	0.98	3399.90	9391.24[a]	302	2. vs. 1[a]	0.047	0.98	9489.24
			36.23 (12), $p < 0.001$						134.89 (12), $p < 0.001$			
	704.68[b]	302	2. vs. 1[b]				677.78[b]	302	2. vs. 1[b]			
			27.73 (12), $p < 0.05$						9.73 (12), $p < 0.05$			
3. Fully constrained model[e]	3375.86[a]	312	3. vs. 2[a]	0.046	0.98	3453.86	9601.04[a]	312	3. vs. 2[a]	0.046	0.98	9679.04
			73.96 (10), $p < 0.05$						209.80 (10), $p < 0.05$			
	720.46[b]	312	3. vs. 2[b]				692.92[b]	312	3. vs. 2[b]			
			15.78 (10), $p < 0.05$						15.14 (10), $p < 0.05$			

[a]Chi-square difference test based on original sample size.
[b]Chi-square difference test based on sample size set to be 1000.
[c]Factor loadings, β-paths from second-order factor to first-order factors and error variances estimated freely across time.
[d]Factor loadings and β-paths from second-order factor to first-order factors set to be equal across time, error variances estimated freely.
[e]Factors loadings, β-paths from second-order factor to first-order factors and error variances set to be equal across time.

loadings (Model B). A closer examination revealed four factor loadings which varied substantially across groups (items 6, 8, 12, 25). We therefore estimated a model where these four loadings were estimated freely across groups while other loadings were constrained to be equal (Model C). Model C was supported by the chi-square difference test as compared to the baseline model. Finally, to investigate the significance of the difference in the stability coefficient of SOC (i.e., β-path between second-order SOC factors) between the age groups, we estimated a Model D in which the stability coefficient of SOC was estimated as equal across groups while the other constraints were identical to those used in Model C. However, this model was not supported by the chi-square difference test, and consequently, Model C was considered the best model of our analyses. Model C with a completely standardized solution is shown graphically in Figure 1.

As Figure 1 shows, the stability of SOC differed between the two age groups. The stability coefficient for young adults was 0.70 and for adults over 30 years 0.81. The squared multiple correlations (R^2) for the structural equation were 0.49 for young adults and 0.66 for older adults, indicating that the proportion of variance in the SOC factor at the second measurement time as predicted by the SOC factor at the first measurement time was 49% and 66%, respectively. The factor loadings of the single items of the 13-item SOC scale were in general high, ranging from 0.44 to 0.86. The comprehensibility item number 26 showed the lowest factor loading on its latent factor at both measurement times (0.44 at Time 1, 0.46 at Time 2).

Mean changes in SOC

Finally, we examined the mean changes in SOC by using composite variables of the total 13-item SOC score. At the first measurement time, the mean level of SOC was 61.6 (SD = 11.3) for the younger age group and 65.2 (SD = 11.3) for the older age group. Five years later, the means were 64.4 (SD = 11.4) and 66.6 (SD = 11.3), respectively. In both age groups, the increase in SOC over time was significant (time effect $p < .000$). Compared with the younger adults, the older adults reported significantly higher SOC at both measurement

Table 4. Group invariance tests for the stability model of SOC

Multi-group comparison	Goodness-of-fit statistics					
	χ^2	df	$\Delta\chi^2(\Delta df)$	RMSEA	GFI	AIC
Baseline model A[c]	12,976.91[a]	624		0.046	0.98	13,132.91
	1413.39[b]	624				
Constrained model B[d]	13,356.39[a]	636	B vs. A[a] 379.48 (12), $p < 0.001$	0.046	0.98	13,488.39
	1467.69[b]	636	B vs. A[b] 54.30 (12) , $p < 0.001$			
Constrained model C[e]	13,006.30[a]	632	C vs. A[a] 29.39 (8), $p < 0.001$	0.046	0.98	13,146.30
	1417.58[b]	632	C vs. A[b] 4.19 (8), $p < 0.05$			
Constrained model D[f]	13,103.42[a]	633	D vs. C[a] 97.12 (1), $p < 0.001$	0.046	0.98	13,241.42
	1432.66[b]	633	D vs. C[b] 19.27 (1) , $p < 0.001$			

[a]Chi-square difference test based on original sample size.
[b]Chi-square difference test based on sample size set to 1000.
[c]All parameters estimated freely across age groups (the model is fully constrained across time).
[d]Only factor loadings estimated as equal across age groups (the model is fully constrained across time).
[e]Four factor loadings (items 6, 8, 12, 25) estimated as unequal, other factors loadings estimated as equal (the model is fully constrained across time).
[f]In addition to constraints estimated in model C, also stability coefficient of SOC estimated as equal across groups (the model is fully constrained across time).

times (group effect $p < .000$). However, a significant interaction effect was also found: mean level of SOC increased more strongly in the younger than older adults ($p < .000$).

Discussion

Evidence from a large population-based cohort suggests high structural validity and high temporal

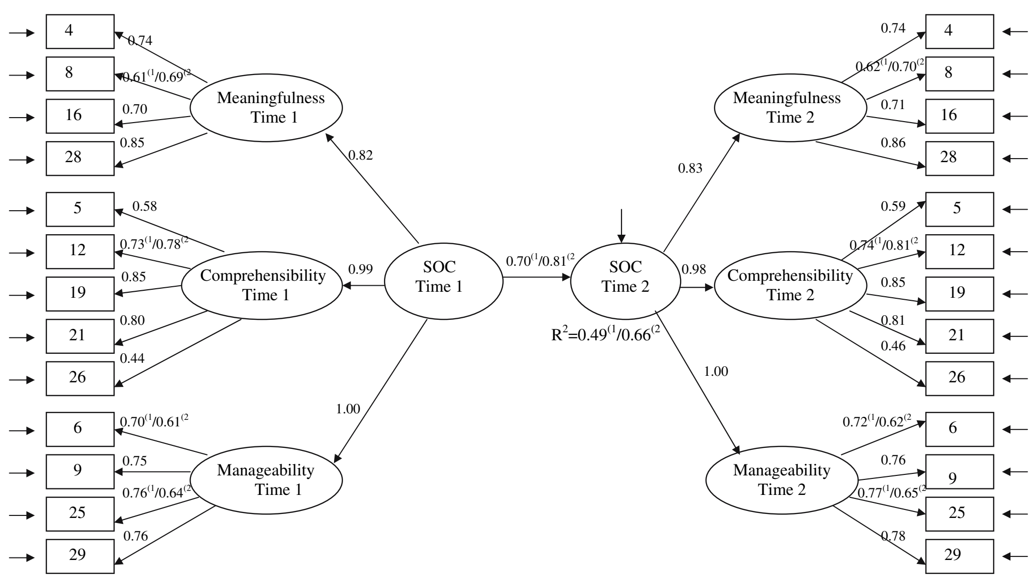

Figure 1. Standardized solution for the final stability model of SOC [1) estimate for young adults, 2) estimate for adults over 30 years].

stability for the 13-item SOC scale. Our findings are also consistent with the notion that SOC may be more stable among people over 30 than among younger adults. The use of a very large sample, a longitudinal data design with a 5-year follow-up, and sophisticated statistical methodology are the particular strengths of this study. The methodological choices enabled testing of a theoretically predefined factor structure, its invariance across time and across age groups and, in addition, estimation of the error-free stability coefficients of SOC for the two age groups defined based on Antonovsky's theory.

CFA provided support for the hypothesized structure of the 13-item SOC-scale, which includes the components of comprehensibility, manageability and meaningfulness. Although the correlated 3-factor model and its statistically equivalent second-order factor model did not provide a faultless approximation with the data, they were nevertheless superior compared to a unidimensional structure of the scale. The weakness of the hypothesized structure of the SOC scale seems to lie in one error covariance between comprehensibility item 5 ("Has it happened in the past that you were surprised by the behavior of people whom you thought you knew well?") and manageability item 6 ("Has it happened that people whom you counted on disappointed you?"). Thus, the scale would appear to include an additional specific factor characterized by the feeling of being let down/social disappointment. This finding resembles previous findings in smaller populations [9–13] and indicates that these particular items share a common variance that their own factors do not explain.

From a practical perspective, the high correlations between the three SOC factors, and in particular between the factors of comprehensibility and manageability, limit their use as separate SOC indicators. This observation was seen in the second-order factor structure as high factor loadings on the second-order factor from the comprehensibility and manageability factors, i.e., it can be concluded that these two factors measure similar aspects. The same finding has also been detected in previous studies [9–15, 19]. We therefore recommend that, when utilizing the SOC-13 scale in empirical research as a sum variable, all the factors might more usefully be merged. We further recommend that when utilizing the SOC-13 scale in CFA and SEM models, a second-order factor model with three first-order factors (meaningfulness, comprehensibility, manageability) is the most appropriate way to characterize SOC, as was seen in the present study.

A further important observation regarding the structure of the 13-item SOC scale is that the factor loadings and error variances were identical across time, i.e., the structure of the scale remained the same over time. The scale did not fully meet the criteria of factorial invariance across age groups as four factor loadings were found to vary across the two groups. However, the other factor loadings (including β-paths from the second-order SOC factor to the first-order factors of meaningfulness, comprehensibility and manageability) were invariant between the age groups and, consequently, it can be concluded that the group invariance was relatively high. In previous investigations with smaller and more homogeneous samples, both time and group invariance criteria have been supported [12, 14]. It is likely that the large and more heterogeneous sample used in the present study in part explains the variation in the four factor loadings between the age groups.

Regarding the stability of SOC, a remarkable finding was that the stability of SOC increased with advancing age, as suggested by Antonovsky [1]. The stability coefficient for the younger adults (age 20–24 at the baseline) was 0.70 and for the older adults (age 30–54 at the baseline) 0.81. Thus, our results provided strong support for Antonovsky's [1] hypothesis that SOC becomes more stable following maturation. The age-difference found in the present study was not in line with the earlier results observed among Finnish technical designers [14]. The weakness of that study was, however, that all the designers, including those in the younger age group, were age 30 or more at the second measurement time.

Our finding that mean level of SOC increased over time is in line with those of earlier studies [12, 14, 20]. At the first measurement time, mean level of SOC was 61.6 (SD = 11.3) among young adults in their early 20's and 65.2 (SD = 11.3) among adults over age 30. At the second measurement time, the corresponding means were 64.4 (SD = 11.4) and 66.6 (SD = 11.3). This observed increase in SOC was very similar to that detected among Finnish technical designers (n = 352) over a 5-year follow-up [14]. At the first measurement time, among young designers (under age 30) the mean level of SOC was 61.7 (SD = 12.4) and among older designers (over age 30) 61.0 (SD = 11.8). Five years later the corresponding means were 65.3 (SD = 11.2) and 65.7 (SD = 10.8). However, contrary to the present findings, significant age differences among the designers were not detected, which may stem from the smaller age-difference between these age groups compared to those of the present study.

At least two limitations should be mentioned. First, the response rate in the first survey was modest and may limit the generalizability of our findings to the general population in Finland. Previous attrition analyses of the HeSSup study suggest that the main reasons for non-response may be the predisposing sociodemographic and behavioural factors, the length and sensitive nature of the questionnaire, and suspicion of the written consent and of a connection being made between the individual and the registers mentioned on the consent form [21]. It seems unlikely that such factors would seriously bias observations regarding the structure and stability of SOC. Second, as the present study was based on a Finnish sample, further research is needed to confirm that the present findings are generalizable to populations in other countries and cultures.

In conclusion, the relatively high structural validity and high stability observed suggest that the 13-item SOC scale provides a solid foundation for future large-scale research on the health effect of SOC as indicated by Antonovsky's life orientation theory.

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