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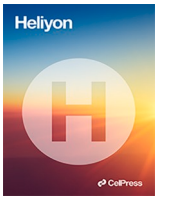

Research article

Assessing the dimensionality of the sense of coherence scale (SOC-L9) using Ghanaian university students: Guarding against the method effect

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ABSTRACT

Background: The dimensionality of the sense of coherence (SOC-L9) scale has been in contention due to the varied factor structure revealed in the literature. In this study, we assessed the dimensionality of the SOC-L9 scale using Ghanaian university students while guarding against the method effect. The study also examined the gender measurement invariance of the scale.

Methods: This research conveniently sampled 1062 students who responded to the SOC-L9 scale with negative items reversed to positive items. A larger proportion of the participants were male students (n = 769, 72.4 %), with 293(27.6 %) being female students. The youngest participant was 18 years old, whereas the oldest was 42 years old. Following all validation studies protocols, four distinct confirmatory factor analysis models were fitted and compared (i.e., unidimensional, three-factor first-order, three-factor second-order and bifactor models).

Results: The initial model comparison revealed that the bifactor CFA model [CFI = 0.958, SRMR = 0.036, AIC = 21231.35, BIC = 21370.45] was superior to the unidimensional [CFI = 0.914, SRMR = 0.046, AIC = 26280.67, BIC = 26414.8] and 3-factor models [CFI = 0.932, SRMR = 0.040, AIC = 26221.67, BIC = 26370.71]. Upon further probing, it was discovered that SOC-L9 functions best as a unidimensional scale for the university student population. Gender measurement invariance was established for configural invariance [CFI = 0.986, SRMR = 0.044], metric invariance [CFI = 0.894, SRMR = 0.051] and scalar invariance [CFI = 0.983, SRMR = 0.047].

Conclusion: The SOC-L9 scale has a nested structure with the various sub-scales interacting to produce a summary total observed score. The structure of the SOC-L9 requires scholars to treat the scale as a unidimensional scale rather than a multidimensional one. This latent structure was found to be consistent with male and female university students.

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1. Introduction

Students' mental health and subjective well-being have been a major concern among positive psychologists, educators, governments and other policymakers [1,2]. This concern arises from the fact that adolescents and young adults in schools and universities worldwide have been found to experience psychological distress (i.e. stress, anxiety, depression, and burnout) [3–6]. For university students, these psychological distress experiences are triggered by academic work, transitional challenges, and social life [7,8]. as well as finding oneself in an emergency situation like the COVID-19 pandemic [3,9]. Edjah et al. [7], for example, reported that university students in Ghana experienced stressors from pressures from studies, a highly competitive academic environment, course overload, meeting deadlines for assignments, and examination pressures. These burdens coupled with institutional challenges such as limited time allocation for lectures, inadequate resources for academic work and infrastructural problems worsen the distress levels of students [3,8,10]. Given the quest for high academic achievement among university students, the high-stakes nature of university examinations and high expectations from parents and families, there is a persistent demand for these students to meet these expectations [10–12], possibly, contributing to high psychological distress levels.

Despite the high level of psychological distress among university students, the use of appropriate coping strategies can reduce students' stress levels and improve their quality of life exerting a positive influence on their health [10,13]. Earlier research works have identified a range of coping strategies including seeking social support from friends, family, peers and loved ones, engaging in activities to distract themselves from the stressors, relying on religious beliefs, values and objects of worship, learning to live with the stressors, and actively working towards overcoming the stressors [14–16]. One of the personal psychological resources or strengths considered to be a useful coping mechanism during arduous situations is the concept of sense of coherence (SOC) [17].

Sense of coherence (SOC), the core construct of the Salutogenetic model, developed by Antonovsky, an Israeli-American sociologist, is a theoretical model that explains successful coping with stressors [17–19]. SOC is considered a health-promoting resource and reflects a person's life orientation which is reflected by their ability to cope with arduous situations [20–22]. Within the Salutogenic theory, SOC expresses the extent to which individuals feel confident that their environment is structured, predictable and explicable; resources are available to meet challenges; and these challenges are worth engaging [17–19]. Generally, the SOC consists of three elements: comprehensibility (the cognitive component - the ability to understand the situation), manageability (the instrumental or behavioural component - the perception of having and controlling resources to cope with the situation), and meaningfulness (the emotional component - the ability to find meaning in the situation) [17–20,23–25]. Together, these three components are highly interrelated, and reflect the interactions of an individual with resources in the environment, jointly playing an essential role in successful coping [17,26,27]. A strong SOC predicts good health, and general psychological well-being [28,29], and acts as a buffer against anxiety, depression and burnout [26,30–33], general psychological distress [34,35], and life satisfaction [33,36].

In an attempt to measure the SOC construct, the Orientation to Life questionnaire was developed by Antonovsky which subsequently had different versions [17–19]. The original version consists of 29 items (SOC-29), while the shorter version comprises 13 items (SOC-13) [17–19]. The SOC scale measures how people manage arduous situations and stay well. Items on the different versions of the SOC scale are designed to measure the aforementioned SOC dimensions (i.e., meaningfulness, manageability, and comprehensibility). Items are scored on 7-point scales. Both the original and short versions have proved highly valid and consistent in several populations [18,37]. The SOC-29 and SOC-13 have also been applied in prospective studies with a duration of up to five years with their functional stability being established [18,38,39]. Given the sound psychometric properties of the SOC scale, the instrument has been translated, validated and calibrated using different samples in over 50 languages across the world [26,28,40]. These validation studies have produced additional versions of the scale (SOC-6, SOC L9, SOC-10, SOC-12) [25,41].

Although there are different modified versions of the SOC scales in use, with different number of questions and varying response options, the SOC-29 and SOC-13 versions have been predominantly adopted in several interdisciplinary research. Alongside the SOC-29 and SOC-13, the shorter SOC-L9 has also been extensively used by researchers in several studies using different populations [42–44]. The SOC-L9 version was developed by Schumacher et al. [41], who extracted nine items from the SOC-29 based on the three components (comprehensibility, manageability, and meaningfulness) and named it the Leipzig Short Scale of SOC (SOC-L9) because it was adapted and utilised in the German language. The SOC-L9 has been widely used and is considered a valid and reliable unidimensional measure of SOC [45,46]. The SOC-L9 has a relatively high internal consistency compared to other short forms of the scale [28].

1.1. The factor structure dilemma of the SOC scale and method effect

Despite the acceptability, utility and widespread use of the SOC scale, scholars have argued that the structure of SOC is complex and inconclusive. Previous research has shown that the SOC seems to be a multidimensional construct with three sub-dimensions [23,40,47,48] rather than unidimensional as proposed by the original author [17–19] and supported by other researchers [23,49–52]. Van Schalkwyk and Rothmann [53], for example, compared the long and short forms of the SOC questionnaire (SOC-29, SOC-11, SOC-6) based on unifactorial and three-factor correlated models. Aside from establishing that the short forms of the scale were superior to the long versions, the authors confirmed a three-factor first-order structure of the scale. Other validation studies have also supported the first-order three-factor structure of different versions of the SOC scale [48,54,55].

Notably, Tušl et al. [56] confirmed that SOC-12 has a three-factor second-order structure which was superior to the unidimensional structure. In a more interesting study by Lajunen [57], a cross-cultural comparison was conducted among Australian, Finnish, and Turkish students based on the factorial structure of Antonovsky's SOC-13 scale. The author found that in all three nations, the SOC scale assumed both the first- and second-order three-factor models compared to the unidimensional structure. Similar to the other

forms of the scale, the SOC-L9 has also been found to demonstrate inconsistent factor structure. Ferguson et al. [58], for example, revealed that the SOC-13 is equivalent to the SOC-L9 assuming both a three-factor model (first-order) and unidimensional structure. A similar observation was made by Kase and Endo [59] confirming adequate equivalence between SOC-29 and SOC-L9 scale forms.

Recently, Lin et al. [60] examined the functional properties of the SOC-L9 scale in the US, Germany and Russia, and found that rather than the unidimensional or three-factor models, the bifactor model with additional method effect (focused on the negatively worded items) showed excellent fit across the countries. A unique strategy used by the authors was that the bifactor entailed a general factor (with all 9 items loading unto) and a method factor (with the 4 negatively worded items loading unto). Although the authors revealed that the SOC-L9 scale comparatively fitted the bifactor model, they were unable to establish the variance contribution of each item to the general factor and the specific factor.

Central to the controversies surrounding the factorial structure of the SOC measure is the issue of method effect, which occurs when an attribute of the measurement process accounts for variations in observed scores that are not due to the construct in question [61]. Based on this understanding, Lin et al. [60] argued that the unidimensional model is not supported for the SOC scale due to the relatively large proportion of reversed items. Other scholars have confirmed this phenomenon indicating that reversed items on a scale usually contribute to the instrument's multidimensionality, often emerging as a method factor in factor analyses [62,63]. Thus,a method factor that is not correlated with the general construct factor may help to maintain the unidimensional structure of the scale [60,64,65].

1.2. Study rationale

Given that the SOC-L9 has been found to have high validity and as well equivalent to other SOC measures (e.g., SOC-13, SOC-29) [41,58–60], its adoption and adaptation are fast growing among scholars in different fields of study across cultures [45,46,66–70]. A key advantage of the SOC-L9 is connected with its briefness which has the potential to lead to negligible fatigue and boredom when administered, thereby increasing the response rate, reliability and validity of the responses [71]. Despite the use and utility of the SOC-L9 scale, there appear to be mixed results about the factor structure of the instrument, with four distinct models identified in earlier validation studies: unidimensional, three-factor first-order, three-factor second-order and bifactor models [58–60]. The implication of the inconclusive factorial structure of the SOC-L9 reflects little or no clarity on whether using a summary global score from the scale offers a greater advantage than using the specific dimensions in analyzing data from the scale – this clarity is not yet documented in previous research. An observation from previous studies appears that whereas some researchers use the composite observed score from the scale for the analyses, others pay much attention to the sub-domains, thereby ignoring the consequences arising from these skewed or biased decisions [46,72].

As earlier highlighted, the inconsistencies in the factor structure of the SOC-L9 scale have been largely attributed to the presence of negatively worded items on the scale [60]. In a recent discourse on this matter, Dodeen [73] discovered that negatively worded items contribute significantly to the determination of the latent structure of a scale and discourage the use of such items. Several scholars who supported Dodeen's [73] position stressed that adding items with negative structure leads to a lack of attention or careless responses, predictable response patterns and difficulty interpreting and understanding the items [74–77]. The current inquiry follows the intense controversies regarding the factor structure and the concerns about the method effect affecting the dimensionality feature of the SOC-L9 scale in previous validation studies. This study attempts to contribute to the factor structure discourse of the SOC-L9 scale by reversing the negative items to positive ones before administration. Afterwards, four models (i.e., unidimensional, three-factor first-order, three-factor second-order and bifactor confirmatory factor analyses) are fitted and compared. While the study provides significant information on an adapted form of the SOC-L9, it also becomes a useful point of departure for further discussions on the method effect and the structure of the SOC measure.

This research also extends the cultural perspective of the SOC-L9 use and utility by validating the measure in a seemingly different culture. Previous validation studies were conducted in largely individualist cultural settings (i.e., Germany, Russia and the USA). It is important to emphasize that SOC is a cultural concept and thus, the variabilities about how individuals react, explain, perceive and adjust to arduous situations might differ from one culture to another [16,78,79]. Scholars have also established that people in a homogeneous society with deeply rooted historical and stable religious values are more likely to interpret the world as stable, predictable and cohesive [17,78]. Unlike the individualist culture that solely depends on independence and self-sufficiency, in a collectivist cultural setting like Ghana, individuals' orientation towards life is determined by the extent to which their immediate/extended community is consistent, manageable and meaningful [80]. Therefore, these individuals in the collectivist culture draw on a larger domain of protective resources when they find themselves in arduous situations [81]. Interestingly, the interplay of culture and SOC development is intertwined with gender; whereas some studies have found no gender difference [82,83], others have identified females as having stronger SOC [57] and vice versa (i.e., males having stronger SOC) [84]. These variations in understanding and perceiving the SOC concept could contribute to the inconsistent factor structure of the SOC scale. Relatedly, the mixed findings on gender and SOC development could also contribute to the differential functioning of the SOC-L9 scale.

Establishing the functionality of the SOC-L9 within African culture, thus, provides an insight into the cultural and social dynamics regarding the scale usage, thereby offering useful information on the practical applicability and utility of the measure, including the validity threats of using the measure in arduous situations and settings [85–87]. Accordingly, validating the SOC-L9 scale in the African context (Ghana in focus) could be beneficial because participants can vary in their interpretations or understandings of certain words or items or entire scales due to differences in language or cultural assumptions. Adapting and validating the SOC-L9 in Ghana could provide useful information to guide the utility of the scale for assessing personal health capacity during arduous situations among students in universities and the general population.

The overarching aim of this research is to assess the dimensionality feature of the SOC-L9 scale across a sample of university students in a largely collectivist cultural setting. First, the study tested the factorial structure of the modified SOC-L9 scale by fitting different competing models (i.e., unidimensional, three-factor first-order, three-factor second-order and bifactor models). Second, the research also examined the gender measurement invariance of the SOC-L9 to determine whether the measure has an adequate structure that does not lead to gender differential functionality and utility.

2. Materials and Methods

2.1. Study design

The study was carried out within the validation study framework which served as a design. This research design permitted the use of distinct phases of planning, adapting the SOC-L9 scale, sample determination, and assessment of statistical indicators for judging the adequacy of models [88]. We acknowledge that although some previous validation studies have adopted the descriptive survey design [89–91], a recent body of literature has confirmed validation study as a design due to its scientifically recognized principles that do not align with descriptive research survey design [92]. In view of that, recent validation studies have been found to have applied this research design [93–95].

2.2. Participants characteristics

Originally, 1440 students were estimated to participate in the study based on Mundfrom et al.'s [96] recommendations using the ratio of the variables to the factors, the number of factors of the original scale, and a non-response consideration. Out of the estimated sample, 282 respondents refused to take part whereas 96 others failed to complete the survey, resulting in a final sample of 1062 university students. The study conveniently recruited these students from a university in Ghana. The students were recruited from the various lecture halls such that those who were willing and ready to participate in the study were allowed to do so. A larger proportion of the participants were male students (n = 769, 72.4 %), with 293(27.6 %) being female students. The youngest participant was 18 years old, whereas the oldest was 42 years old. The mean age of the participants was 28 years (SD = 5.53). The university students were selected for this validation study because they have been identified as experiencing high psychological distress (i.e., stress, anxiety, depression), hence, their personal psychological resources like SOC during an arduous situation are critical for quality mental health and subjective well-being [28,97–99].

2.3. Instrumentation

The study used the Leipzig Short Scale (SOC-L9) of Antonovsky's Sense of Coherence Scale (SOC-29). The SOC-L9 is a nine-item version of SOC-29, with two anchoring verbal responses, developed by Schumacher et al. [41] using a sample of the German population. The SOC-L9 is conceptualized as a scale having items from the three dimensions: comprehensibility, manageability, and meaningfulness. The comprehensibility dimension had two items (Item 1 and Item 4), the manageability domain comprised three items (Item 5, Item 7 and Item 8) and the meaningfulness sub-scale had four items (Item 2, Item 3, Item 6 and Item 9). The response options were on a seven-point Likert-type scale. The scale's total score ranges from 9 to 63 where higher summed scores indicate higher SOC. The SOC-L9 is a reliable, valid, and economic measurement as demonstrated in previous studies [25,26,28,41], The scale has been validated by other researchers [59,60] and used in some survey studies [70]. We adapted the instrument to align it to the purpose of the study by reversing the four negatively worded items (i.e., Item 2, Item 3, Item 5 and Item 8). Reversing the items meant that the position of the two anchored verbal responses was changed to sound positive, and not rewording these items as in changing their wording.

2.4. Data collection procedure

Prior to the data collection, ethical protocols were followed. The Institutional Research Board (IRB) of the University of Education, Winneba approved the research with the reference number DAA/P.1/Vol.1/39. After the approval, the various Heads of Department and Dean of Student Affairs at the selected university were contacted for their consent and official letters were sent to them for approval of the data collection. Before the data collection, the study rationale was well explained to the participants. Accordingly, written informed consent forms were given to all participants. Also, all participants were taken through the survey instrument to foster understanding and clarity. Furthermore, participants were informed that their participation in the study was voluntary and that they could withdraw at any time. Again, there was an assurance of keeping their data safe and anonymous, with information gathered only meant for research purposes. First to fourth-year regular students were eligible to participate in the study. Students on distance and sandwich programmes were excluded from the study. To collect the data, we recruited and trained research assistants. All the assistants had prior experience in data collection and were trained on how to administer the scale. During this training, the items and response options were carefully discussed. The survey instruments were given to the participants immediately before lectures to respond to the survey items within approximately 15 minutes with the help of the research assistants. The data collection commenced from February to March 2022 (2 months). Before this phase, participants were contacted for their availability and willingness to participate in the study. The data collection took place at the university's main south and north campuses.

2.5. Statistical analyses

Descriptive statistics (i.e., mean, standard deviation, skewness and kurtosis) of the items were computed. This exercise was done after the data were screened and cleaned to remove all errors that might have occurred at the data management and entry stage. All the analyses were performed with the JASP computer software, specifically utilizing the Lavaan function to conduct the structural equation modelling analysis. Using the minimum likelihood estimator, the full information maximum likelihood (FIML) strategy was used to handle missing data. Four confirmatory factor analysis (CFA) models were fitted, namely, unidimensional CFA, three-factor first-order multidimensional CFA, three-factor second-order multidimensional CFA, and bifactor CFA models.

The models were assessed using the Root Mean Square Error of Approximation (RMSEA, < 0.10), Comparative Fit Index (CFI, > 0.90), Standardized Root Mean Square Residual (SRMR, < 0.080) [100], Akaike information criterion (AIC) and Bayesian information criterion (BIC) (lower values are preferred) indicators. Other indicators computed include Explained Common Variance (ECV), Construct Replicability (H), Factor Determinacy (FD), Absolute Relative Parameter Bias (ARPB), Percent of Uncontaminated Correlations (PUC), Relative Omega, OmegaG/OmegaS (Omega total for the general factor and specific factors), OmegaH/OmegaHS (Hierarchical Omega for general factor and subscales). Regarding the Omega estimates, domains with high values (usually above 0.80) are preferred [101]. A similar interpretation was used for the ECV, PUC, *H*, and FD values, both for the general factor and the specific factors [102–104]. The ARPB values are expected to be less than 15 % (i.e., 0.15) for the model to be considered adequate [105].

3. Results

3.1. Descriptive statistics

The descriptive statistics (i.e., mean, standard deviation, skewness, kurtosis, and minimum and maximum values) of the items were computed.

As presented in Table 1, the mean values ranged from 1.921 to 2.679. The sub-domain comprehensibility sub-domain reported the highest mean value ($M = 2.310$, $SD = 0.223$) followed by the meaningfulness dimension ($M = 2.337$, $SD = 0.111$) and manageability domain ($M = 2.162$, $SD = 0.516$). The skewness and kurtosis values were acceptable and thus, the item response distributions were considered normal.

3.2. Model comparisons

We compared four CFA models: unidimensional CFA, three-factor first-order CFA, three-factor second-order CFA and Bifactor CFA models. The unidimensional CFA reflects a model where all the items load onto a single construct, that is SOC (Fig. 1A). Additionally, the bifactor model fitted in this research comprised of first, a general SOC factor, where all the nine items load onto and secondly, the three uncorrelated specific factors where the items load onto their specific assigned factor (Fig. 1B). For the three-factor first-order CFA, it reflects a measurement specification where specific items are assigned to their respective confirmed three factors (i.e., the three domains) such that the factors are correlated (Fig. 1C). The three-factor second-order CFA model has a nesting structure where specific items load onto their respective factors (i.e., the three domains) and the factors in turn also load onto a general SOC factor (Fig. 1D). The statistical model fit indices are compared using six indicators (see Table 2 and Fig. 1).

Comparing the indicators from the models, it was found that whereas some indices were adequate and acceptable, others were not. For example, the RMSEA indicators were quite high and very close to the < 0.10 criteria for all the models. Despite this observation, the CFI and SRMR indicators met the < 0.08 cut-off for all the indicators. Overall, the bifactor model [CFI = 0.958, SRMR = 0.036, AIC = 21231.35, BIC = 21370.45] appeared to be superior to the unidimensional [CFI = 0.914, SRMR = 0.046, AIC = 26280.67, BIC = 26414.8] and 3-factor CFA models [CFI = 0.932, SRMR = 0.040, AIC = 26221.67, BIC = 26370.71].

Table 1
Mean, standard deviation, skewness and kurtosis of the SOC-L9 items.

S/N	Items		Mean	SD	Skewness	Kurtosis
SC1	Manageable	Unmanageable	1.921	0.680	0.889	1.506
SC2	Meaningful[a]	Meaningless	2.492	0.170	0.223	−0.065
SC3	Structured[a]	Unstructured	1.779	0.467	0.216	1.479
SC4	Easy to influence	Impossible To Influence	2.402	0.919	0.304	0.516
SC5	Significant[a]	Insignificant	2.434	0.966	0.310	0.450
SC6	Clear	Unclear	2.399	0.747	0.378	1.030
SC7	Controllable	Uncontrollable	2.359	0.658	0.188	0.600
SC8	Rewarding[a]	Unrewarding	2.502	0.220	−0.401	−1.301
SC9	Predictable	Unpredictable	2.679	0.888	0.963	−0.170
Factors						
Manageability			2.162	0.223	−0.548	0.848
Meaningfulness			2.337	0.111	0.843	0.685
Comprehensibility			2.432	0.516	−0.053	−0.198
Overall/Total SOC			2.310	0.761	−0.129	0.051

[a] Reversed items.

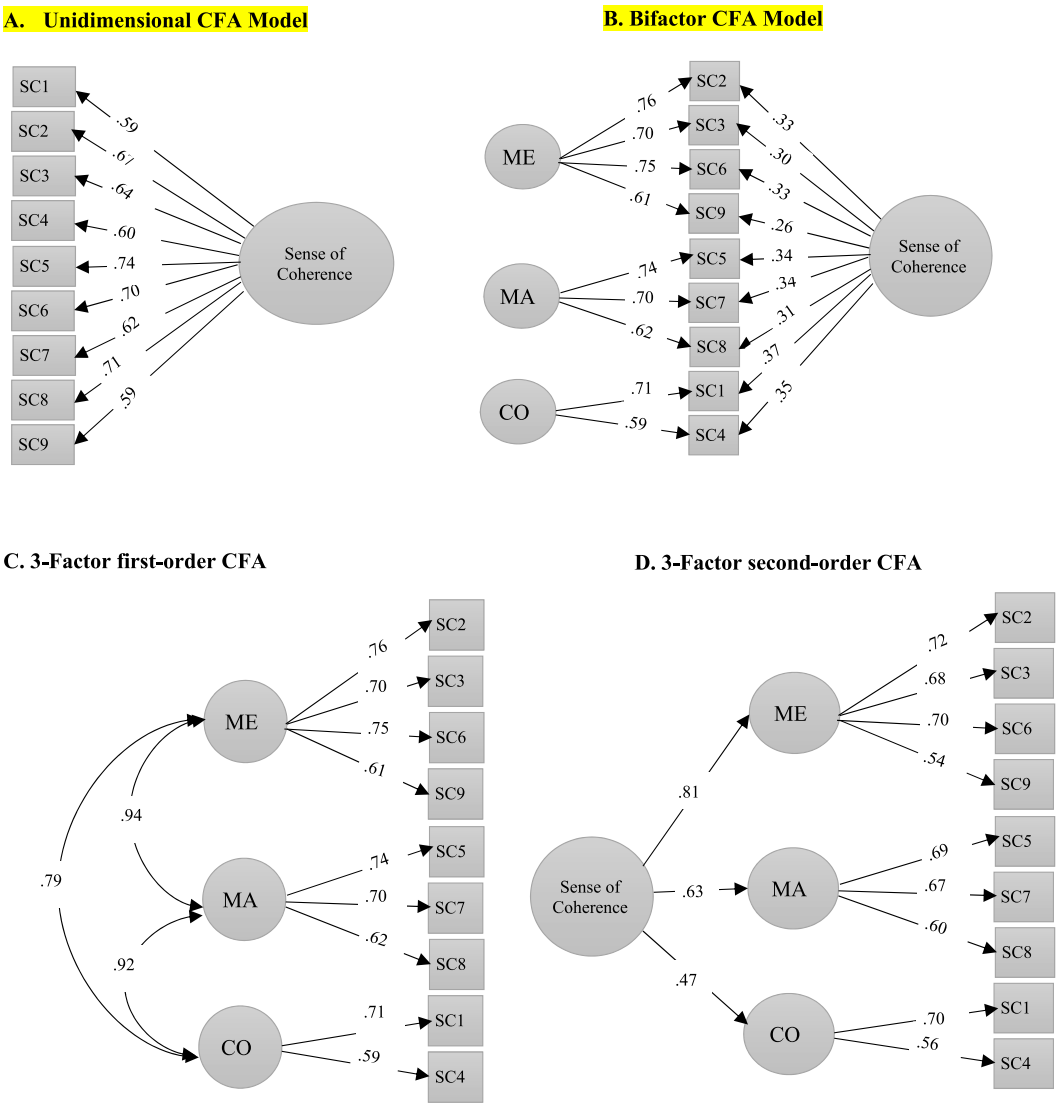


Fig. 1. A–D: Measurement models for the SOC-L9 four competing Models
ME- meaningfulness, MA- manageability, CO - comprehensibility.

Table 2
Model Fit Indicators for Unidimensional CFA, three-factor CFA, three-factor second-order CFA and Bifactor CFA.

Models	X^2/df	RMSEA [90%CI]	CFI	SRMR	AIC	BIC
Unidimensional CFA	330.74/27[a]	0.103 [0.093, 0.113]	0.914	0.046	26280.67	26414.81
3-factor CFA	265.73/24[a]	0.097 [0.087, 0.108]	0.932	0.040	26221.67	26370.71
Second-order 3-factor CFA	769.67/28[a]	0.188 [0.177, 0.199]	0.674	0.119	52293.40	52353.02
Bifactor CFA	229.412/26[a]	0.066 [0.059, 0. 86]	0.958	0.036	21231.35	21370.45

[a] The Chi-square difference test showed statistically significant differences.

3.3. Additional indicators after model comparison

Further investigations were carried out to confirm the factor structure of the scale relative to the dimensionality of the SOC scale. We conducted the analysis at three different levels: the factor level, model level and item level (see Table 3 and Fig. 2).

For purposes of clarity, the ECV describes the degree of common variances explained by the general factor or the specific factor. OmegaG and OmegaS parameters reflect the reliability of the multidimensional composite. All items are considered for the estimation of the OmegaG whereas only the items loading onto the specific domains are considered for the estimation OmegaS for each dimension.

While the OmegaH explains the proportion of systematic variance in unit-weighted composite scores explained by the variations on the general factor, the OmegaHS parameter reflects the percentage of systematic variance of a sub-dimension score after variances explained by the general factor have been partitioned out. The H parameter is an index of replicability of the construct (e.g., SOC), which reflects the association between a factor and an optimally weighted item total. The FD index describes the relationship between the factors and factor scores.

The results showed that about 83.6 % of the common variances were explained by the general factor, SOC (see Table 3). The three dimensions (i.e., meaningfulness, manageability and comprehensibility) attained weak explained common variance ranging between 15.6 % and 19 %. Comparing the omega estimates across the general factor and the specific factors also confirmed that the general SOC factor explained greater variances based on all the sources of variance. The *H*-index for the general factors also supported the observation that the nine items accurately represented the general SOC factor better than their respective specific factors. The resulting pattern is also confirmed by the factor determinacy values (see Table 3). At the model level, an average relative parameter bias value of 10.6 % is deemed acceptable and poses no threat to the specified model.

At the item level, three indicators were used to analyze the output – IECV, RPB and ARPB. The IECV index reflects the degree to which the responses to an item are explained by the variability on the general SOC, serving as a proxy for judging the unidimensionality of the items. The RPB is the ratio of the (a) difference between an item's loading in the unidimensional structure and the general factor loading and (b) the general factor loading in the bifactor model.

Fig. 2 shows relevant indicators which provide information on whether specific items lend themselves more to a unidimensional model than a multidimensional one. The rule of thumb is that if a greater percentage of the items are more aligned to a unidimensional model, then the scale should be considered as such and vice versa. The results showed that all the explained common variance values were greater than 0.80 indicating that the items essentially reflected a unidimensional set that converged to explain the content of the general SOC factor (see IECV values in Fig. 2). The relative parameter bias and the absolute relative parameter bias estimates for the majority of the items showed adequate fit. Out of 9 items, 8 of them (88.9 %) had RPB and ARPB values less than 0.15.

3.3.1. Gender measurement invariance for the bifactor model

The study also examined whether there is a differential functioning of the SOC scale for male and female university students. The latent structure of the SOC scale for male university students was similar to the factor structure of their female counterparts (i.e., configural invariance was confirmed, CFI = 0.986, SRMR = 0.044). Also, the item variance contributions to their associated factors were similar for both male and female university students (i.e., metric invariance was assumed, CFI = 0.894, SRMR = 0.051). Additionally, the item intercepts were similar across the SOC scale functioning for both male and female respondents (i.e., scalar invariance was established, CFI = 0.983, SRMR = 0.047) (see Table 4).

4. Discussion

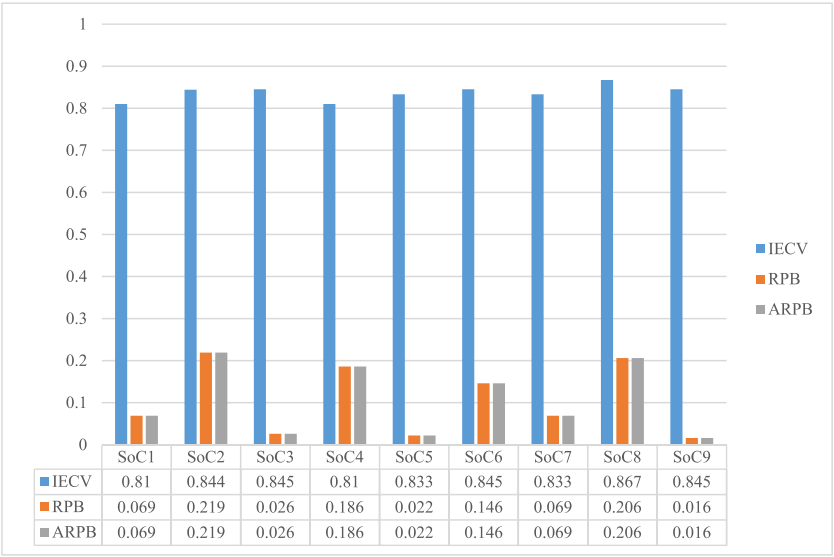
Given the controversies in the literature regarding the structure and dimensionality of the SOC scale [17–19,23,40,47,48], we cross-examined the dimensionality of an adapted SOC-L9 scale guarding against the method effect. Four distinct competing models (i.e., unidimensional CFA, three-factor first-order CFA, three-factor second-order CFA and bifactor CFA) were first compared to understand the latent structure of the scale, followed by whether a global score or dimension-specific scores from the scale should be used for analysis. Gender measurement invariance was also tested. The findings showed that the SOC-L9 scale assumed a bifactor model structure when compared with the unidimensional and three-factor CFA models. This finding suggests that the short version of the SoC scale has a nesting structure which reflects items contributing distinct variances in two ways: (a) a general factor, SOC, which directly loads onto the manifest variables and (b) three uncorrelated sub-dimensions (i.e., meaningfulness, comprehensibility, and manageability) which load onto the same manifest variables with the model. While not many studies have been documented regarding the calibration of the SOC-L9 scale, the findings from a few studies [59,60] appear to reflect key ideas from this research. Whereas Lin et al. [60] found the SOC-L9 scale to have a more general structure, Kase and Endo [59] revealed a unidimensional model of the scale.

Essentially, the findings of this research support the use of a summary global observed score from the scale for decision-making in terms of statistical analysis. This notion has been reiterated by several scholars who validated the short versions of the SOC scales [23,55,59,106] for several reasons, including high covariances among the three sub-dimensions of the scale (i.e., meaningfulness, comprehensibility, and manageability) and low-reliability estimates for these sub-dimensions. A more noticeable reason in literature accounting for the multidimensional nature of the SOC-L9 scale is the relatively high number of negatively worded items (about 33 %).

Table 3
Bifactor model indicators for the general factor SOC and the sub-domains of SOC.

Indices	General factor	Meaningfulness	Manageability	Comprehensibility
ECV	0.836	0.156	0.156	0.190
OmegaG/OmegaS	0.936	0.854	0.872	0.807
OmegaH/OmegaHS	0.877	0.133	0.136	0.153
Relative Omega	0.936	0.156	0.156	0.190
H	0.916	0.291	0.267	0.228
FD	0.939	0.582	0.587	0.588

Percent of Uncontaminated Correlation = 0.722; Average Relative Parameter Bias = 0.106.



	SoC1	SoC2	SoC3	SoC4	SoC5	SoC6	SoC7	SoC8	SoC9
IECV	0.81	0.844	0.845	0.81	0.833	0.845	0.833	0.867	0.845
RPB	0.069	0.219	0.026	0.186	0.022	0.146	0.069	0.206	0.016
ARPB	0.069	0.219	0.026	0.186	0.022	0.146	0.069	0.206	0.016

Fig. 2. Item level Indicators
IECV- item-level explained common variance; RPB – relative parameter bias; ARPB - absolute relative parameter bias.

Table 4
Gender measurement invariance indices.

Indices	Configural	Metric	Scalar
CFI	0.986	0.984	0.983
TLI	0.959	0.976	0.983
GFI	0.997	0.996	0.998
RMSEA	0.094	0.072	0.061
SRMR	0.044	0.051	0.047

Simulation studies have also confirmed that reversed items have higher chances of causing multidimensionality during scale development and validation, especially when about 10 percent or more do not detect the negative item wording [107,108].

Regarding the SOC-L9, Lin et al. [60] investigated the effect of the negatively worded items by including a method factor in their bifactor model. Lin and associates confirmed that the multidimensional structure of the SOC-L9 is attributed to the use of reverse items. The findings of this study also supported the observation of Lin et al. [60], although a different but similar approach was adopted. We reversed the items before administrating the scale; yet, a bifactor model was confirmed with further analysis indicating that the items contributed significantly to the general factor compared to the specific factors (i.e., the three dimensions). Consistent with the views from earlier studies [59,60], our findings have demonstrated that reporting separate scores for each dimension does not provide any substantial advantage over the use of a composite score. This notion supports the use of a composite score if a more valid and accurate description of the participants' SOC levels is warranted.

The findings provide a much broader and more complex conceptualization of the SOC concept in university students. A hierarchical structure of SOC operationalization was found indicating the extent to which SOC indicators explain the degree of shared variances to their respective factors (i.e., manageability, meaningfulness and comprehensibility) after accounting for the general SOC. It is clear that after accounting for the general SOC, the specific items did not significantly contribute to explaining the three domains of SOC - manageability, meaningfulness and comprehensibility. Given this understanding, SOC is viewed by university students as a more general construct with a multidimensional structure where the observable indicators better explain the global SOC concept than using the three specific SOC domains. It is not surprising that several scholars stressed that comprehensibility (the cognitive component - the ability to understand the situation), manageability (the instrumental or behavioural component - the perception of having and controlling resources to cope with the situation), and meaningfulness (the emotional component - the ability to find meaning in the situation) domains of SOC are highly interactive and interrelated, producing a robust coping capacity when individuals find themselves in arduous situations [17,26,27]. This highly interactive nature of the various components of SOC has also been demonstrated in the observed pieces of behaviours that characterize the construct. For example, a student who finds arduous life events as controllable is likely to perceive the situation as easy to influence and meaningful. Although these behaviours as classified under different domains of SOC, they provide much more information to the general SOC variable than to their specific domains.

The findings also account for a cultural perspective of the study in terms of the latent structure and dimensionality of the SOC-L9 scale. We add that culture shapes stress experiences, stress evaluation and stress coping [17,78]. Ghanaian university students find themselves deeply engrained in collectivist culture and this is believed to have shaped their conceptualization of the SOC concept, as

found in this research. With higher levels of interdependence and communal shared values, individuals in the collectivist culture develop their SOC based on resources within their community or environment, including the home, church, workplace, and general surroundings [80]. Thus, the ability of university students to understand and find meaning in arduous situations, as well as their held perceptions about having and controlling resources could be largely explained by the school values, school support systems (i.e., counselling services), peer support, parent's socio-economic status, family values, etc. These strong social ties and dependence on group or communal support, are likely to result in a stronger interaction between the observed proxies of behaviours which constitute SOC. In other words, students who find themselves in an arduous situation (e.g., failed exams) will find meaning in the situation only when the situation is well understood by the students (e.g, failing exams does not mean dismissal) and perceive that they possess and control resources needed to cope with the arduous situation (e.g., paying re-sit/referral fees, ability to obtain resources which would help them to re-learn) [26]. This could explain why the SOC was conceptualized as a more general construct than a multi-dimensional one.

After establishing that the SOC-L9 supported the bifactor model, gender invariance was conducted based on this model. The findings confirmed that there was no differential functioning of the SOC-L9 scale based on gender. Statedly differently, the SOC-L9 scale functioned similarly for male and female university students suggesting that the instrument can be used for any gender respondent without bias. Despite previous empirical research demonstrating variations in SOC levels for male and female participants [57,84], it appears that these observed differences in SOC are not attributed to the scale functioning. This similar scale functioning finding is expected for two reasons. First, when individuals find themselves within the same cultural boundaries and therefore draw on similar resistance resources and support to deal with arduous situations, they might demonstrate similar levels of coping in terms of emotional, behavioural and cognitive capabilities [81]. This observation is likely to be more predominant in university students, especially when these individuals are confined within a similar environment and operating with similar values, codes, ethics, regulations, support systems and orientation. Secondly, the age distribution of the university students was within a range of 18–42 years which reflects a period where SOC is still developing [29]. With the majority of the university students in this research aged 28 years, it is expected that their SOC will be relatively stable [109], leading to the observed similarity in the SOC behaviours demonstrated by both the male and female students and subsequently, the SOC scale working in the same way.

4.1. Practical implications

The current findings of the study have implications for researchers, counsellors, psychologists, and other relevant users of the scale. First, the various dimensions of the SOC construct (i.e., cognitive, affective and behavioural components), as identified in seminal studies, seem to interact and function together [17–20,23–25]. Therefore, making it difficult for separate domains to stand alone, thereby a total observed score from the items reflecting a more comprehensive understanding of the SOC construct. Remarkably, any attempt to use the scale in separate dimensions is likely to result in construct underrepresentation for some subscales. Users of the scale need to focus on using a total observed score. Secondly, the reverse items on the SOC-L9 should be revised before administering to guard against the method effect, particularly for scholars who wish to continue the calibration of the instrument. It is suggested that retaining the reverse items on the SOC-L9 should be done sparingly and the total observed scores of participants reported for analysis.

4.2. Strengths and limitations

The strength of this research lies in the approach and statistical strategy adopted for the investigation. First, reversing the wording of the items administered offers a benchmark for significant comparison with previous studies which did otherwise. This strategy offers a bit of clarity and insight into the effect of reversed items in determining the structure of the scale. Conducting the traditional bifactor CFA has offered better information on how much variances each of the 9 items contribute to the general SOC factor as well as their specific sub-scales. It is not surprising that the bifactor model has been identified as a powerful approach to the evaluation of the multidimensionality assumptions, in a way that reflects contemporary theoretical viewpoints of the latent structure of interest [94,110].

Although the study findings provide a point of departure for further discussions on how method effect contributes to the dimensionality discourse of the SOC scale, this insight is not entirely conclusive. This research did not test the original 9-item SOC scale with the reversed items and the revised version of the present study. The study, therefore, recommends that future studies should compare the reversed version and the non-reversed form of the SOC-L9 using two different but similar samples and compare the results, thereof. This call is necessary for providing greater clarity to the dimensionality inconsistencies observed in previous studies and to also understand the role of the method effect. Furthermore, the study was conducted using 1062 students in a university in Ghana and therefore, the findings may not be generalizable enough beyond that university [71]. Further, the use of a convenient sample may also result in biased findings coming from either a homogeneous student sample or a heterogeneous one. For instance, the greater proportion of male participants in this study could be explained by the use of a convenient sample. These limitations should be considered in future research.

5. Conclusion

The SOC-L9 scale has a nested structure with the various sub-scales interacting to produce a summary total observed score. The structure of the SOC-L9 requires scholars to treat the scale as a unidimensional scale rather than a multidimensional one. This latent structure was found to be consistent with male and female university students, indicating an equivalent functionality of the SOC-L9

scale. However, the observed structure of the scale is partly attributed to the adaptation that was made by reversing the negatively worded items. At least, the study opens up the long-standing discussion about the role of method effect on the dimensionality of the SOC-L9 scale. Consequently, further studies are welcomed to provide additional insight into the structure and dimensionality of the SOC-L9 scale while guarding against the method effect using different designs.

Data availability statement

Anonymized data is available upon reasonable request through the corresponding author.

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Ethical approval and consent to participate

The study was approved by the Institutional Review Board of the University of Education, Winneba, Ghana with reference number DAA/P.1/Vol.1/39. All standard procedures were adhered to in line with the 6th edition of the Declaration of Helsinki. Written informed consent was also obtained from all study participants before data collection.

CRediT authorship contribution statement

Frank Quansah: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Edmond Kwesi Agormedah:** Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation. **Medina Srem-Sai:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation. **John Elvis Hagan Jr:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Thomas Schack:** Writing – review & editing, Visualization, Validation, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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