The Long-Term Buffering Effect of Sense of Coherence on Psychopathological Symptoms During the COVID-19 Pandemic:

Findings from a Prospective Observational Study

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Running Title: Buffering Effect of Sense of Coherence

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Keywords: COVID-19, mental health, resilience, rumination, sense of coherence

1 **Abstract**

2 **Background:** The COVID-19 pandemic is a multidimensional long-term stressor. Consequently,
3 research demonstrated a negative impact of COVID-19 on mental health in parts of the general
4 population. However, not all people are affected equally making the identification of resilience
5 factors modulating the pandemic's impact on mental health an important research agenda. One of
6 these factors is sense of coherence (SOC), the key component of the salutogenesis framework.

7 **Objective:** The current study aimed at investigating the long-term relationship between SOC and
8 psychopathology, and the impact of COVID-19-related rumination as its moderator. **Methods:** The
9 prospective observational study assessed psychopathology and SOC before the COVID-19 outbreak in
10 Germany (February 2020) and at six critical time points during the pandemic ($n = 1,479$). Bivariate
11 latent change score models and latent growth mixture modeling were used to analyze changes in
12 psychopathology and SOC along with their interaction and to differentiate trajectories of COVID-19-
13 related rumination. **Results:** A model allowing for unidirectional coupling from SOC to
14 psychopathology demonstrated best fit. In the total sample, psychopathological symptoms increased
15 significantly over time. Previous SOC predicted later changes in psychopathology, whereby a stronger
16 SOC was associated with a decrease in symptoms over time, while a weaker SOC with an increase in
17 symptoms. The same pattern of results was evident in the high-rumination (17.2%) but not in the
18 low-rumination group (82.8%). **Conclusions:** Our findings demonstrate that SOC is an important
19 predictor and modulator of psychopathology during the COVID-19 pandemic, particularly for those
20 respondents that ruminate about the pandemic.

1 Introduction

The coronavirus disease (COVID-19) pandemic has substantially altered the lives of people throughout the world [1]. As of August 2021, the death toll associated with SARS-CoV-2 (severe acute respiratory syndrome coronavirus type 2) stands at 4.3 million [2]. COVID-19-related stress not only resulted from the fear of the virus [3] but also from measures to contain the pandemic. To reduce the spread of the virus, many governments have put in place massive restrictions on public and private life. A large number of countries curbed their economies by repeatedly closing all non-essential businesses, schools, universities, and recreational facilities [4]. Despite governmental aid, many companies had to cut jobs, leaving numerous people exposed to financial hardship [5]. Although physical distancing was held to be one of the most important measures to slow down the spread of SARS-CoV-2, it resulted for some people in harmful social isolation [6]. These factors are among the stressors that accumulated throughout the pandemic and resulted in emotional distress and increased risk for stressor-related mental health problems for many people [7,8].

However, despite fears of a ‘second pandemic’ of mental disorders, a large proportion of the population continues to report good mental health [9], and mental health consequences were found to depend on individual levels of perceived stress [10]. This is in line with earlier theoretical considerations that expected resilience, that is, low levels or absence of psychopathological symptoms, to be the main mental health outcome of the pandemic [11,12]. Building on this outcome-oriented approach to resilience, recent research into resilience conceptualizes resilience as a process of adapting well in the face of significant sources of stress [13,14]. Within this framework, resilience factors (e.g., psychological traits) represent individual resources that protect individuals from potentially aversive effects of stressor exposure. These protective effects are assumed to emerge because resilience factors are associated with adaptive appraisal styles [15,16], and in turn, with more successful coping. Therefore, it is crucial to identify factors that predict changes in mental health, that is, resilience as an outcome during the COVID-19 pandemic.

Sense of coherence (SOC) as the key factor of the salutogenesis framework may be such a resilience factor [17,18]. Due to its interest in health and well-being, the salutogenesis framework

represents a change in perspective as compared to pathogenic models that focus on illness and disease [19]. Such a focus on health has also been reflected in the more recent concept of euthymia [20,21]. SOC represents a global orientation that “expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that one's internal and external environments are predictable and that there is a high probability that things will work out as well as can reasonably be expected” [17]. Within the salutogenesis framework, SOC as a trait-like variable modulates one's position on the continuum between health (*ease*) and *disease*. Individuals with stronger SOC tend to have better health [22,23] and are assumed to cope more successfully. When being exposed to a stressor, those with a stronger SOC may also experience a shift of mental health in the direction of *disease* but are likely to bounce back faster and stronger in the direction of *ease*.

However, despite a large number of cross-sectional studies [24–26], there is a lack of longitudinal evidence showing that SOC predicts mental health or changes in mental health when individuals are exposed to significant stressors. One study by Engelhardt et al. [27] demonstrated that SOC measured in early pregnancy (pre-stressor) was predictive of posttraumatic stress symptoms and depressive symptoms one month after pregnancy loss (post-stressor). Correspondingly, a study reported SOC to be predictive of depression onset among Japanese workers [28], while another study did not find (post-stressor) SOC to be predictive of posttraumatic stress disorder at one- and three-year follow-up after serious accidental injuries [29]. However, the latter studies did not comprise an assessment of pre-stressor SOC.

As SOC is frequently discussed as a resilience factor [22,30,31], several studies have investigated SOC in the context of the COVID-19 pandemic [32–39]. A recent study showed a robust cross-sectional relationship between SOC and mental health across six countries during the first wave of the pandemic [35]. This finding is supported by a large number of cross-sectional studies conducted during the first wave [32–34,36,37,40] and fewer studies carried out during the second wave [38,39] of the pandemic. Critically, to the best of our knowledge the current study [41] is the first with a pre-outbreak assessment that investigates the longitudinal relationship between SOC and mental health.

Our study was based on a project conducted in February 2020 before the outbreak of the COVID-19 pandemic in Germany that examined the factorial structure of resilience factors. As participants were part of an online panel, we had the opportunity to repeatedly contact them after the outbreak of COVID-19. Thereby, we were able to compare pre-to-post outbreak mental health and examine a potential buffering effect of SOC in different stages of the pandemic. Findings on the pre-to-post outbreak comparison of mental health in this sample were published last year [41]. There was no overall change in psychopathological symptoms from pre-to-post outbreak in the total sample, but we found a significant increase in a subsample reporting high levels of COVID-19 related distress. Significant decreases in symptom levels were evident for a subsample reporting below average COVID-19-related distress. The latter subsample was also characterized by lower levels of psychopathological symptoms, stronger SOC, and better sleep quality. Most importantly, SOC was found to predict pre-to-post outbreak changes in psychopathological symptoms in both subsamples. Stronger SOC was related to smaller changes in psychopathological symptoms (i.e., increases and decreases). Thus, it seems plausible that SOC buffered the impact of COVID-19 as a multidimensional stressor on mental health. However, causal interpretation of these findings is limited as only two time points were assessed, which only captured responses to the first wave of the pandemic ([2]; see Fig. 1). To provide conclusive findings on the long-term relationship between SOC and mental health, it is essential to examine their relationship in the course of the pandemic.

The current study followed the rationale of previous analyses [41] and aimed at extending these findings by examining the relationship between SOC and psychopathological symptoms in the first year post-outbreak based on six critical time points during the pandemic in Germany. Building on meta-analyses on short and long-term mental health consequences of COVID-19 in the general population [8,42], we expected small yet significant increases of psychopathological symptoms over time in the total sample. We had no hypothesis regarding changes in SOC in the total sample, as we did not expect COVID-19 to be perceived as equally stressful among all respondents [43], that is, changes of SOC were expected to vary depending on individual levels of stressor exposure. Therefore, our analyses included COVID-19-related rumination as indicator of subjective stressor

severity [44]. Building on previous research [45] and first studies during the pandemic [46], we assumed that ruminative thoughts occur when stressors are perceived as unsolvable and overpowering, and that the occurrence of rumination is predictive of psychopathological symptoms [47]. Following the rationale that resilience factors are of importance in more stressful situations [15], we assumed SOC to be particularly important in those who experience high levels of COVID-19-related rumination. In line with the results of the first wave of this study [41] and previous findings on the negative impact of stressors on levels of SOC [48–50], we expected SOC to decrease and psychopathological symptoms to increase over time in this group. Moreover, building on our previous findings [41], we expected psychopathological symptoms and sleep problems to be more severe as well as the proportion of respondents above cut-off criteria for psychopathological symptoms to be larger in this group during the pandemic.

Fig. 1. Course of the COVID-19 pandemic in Germany and assessment periods of the present study.

Data were published by John Hopkins University [2], University of Oxford [51] and was downloaded via Our World in Data [52]. For purpose of visualization, Oxford Stringency Indices were multiplied by 500.

2 Methods and Material

2.1 Study Design and Sample Recruitment

The current study derived from a cross-sectional online study on resilience factors conducted in February 2020. In March 2020, the study team decided to enlarge the scope of the project and to investigate the resilience factor SOC and its association with mental health during the COVID-19 pandemic. Follow-up assessments were conducted in April, August, and November 2020 as well as in January and March 2021 (see Fig. 1). Assessment points were chosen to capture critical points of the course of the pandemic in Germany (see Online Supplementary Material 1 for details). For sample recruitment, we used the WiSo Panel (<https://www.wisopanel.net>; [53]). The panel holds $N = 14,369$ German-speaking adult respondents who live in Germany, Austria, Switzerland, or border regions in neighboring countries. The panel is not representative of the German general population but holds socioeconomically diverse people. Individuals with heterogeneous demographic backgrounds interested in taking part in web-based studies are enrolled in the panel. Of the total panel, $n = 2,007$ had participated in the initial assessment in February 2020. Those were contacted for the follow-up assessments (see Fig. 2 for a study flow chart). For participation in the current study, respondents were offered to be paid 1 EUR per assessment. Data were collected via the online platform SoSci Survey [54] and respondents gave written informed consent according to the Declaration of Helsinki [55] and its latest revisions.

Fig. 2. Study flow chart.

2.2 Measures

Sense of coherence. SOC was assessed using the 9-item German short version (SOC-L9) of the Antonovsky scales [56,57]. SOC-L9 uses a bipolar 7-point scale with a verbal anchor at each pole. Across all time points, SOC showed internal consistency ranging from Cronbach's alpha (α) of 0.89 (2020/03) to 0.92 (2020/08). Temporal stability ranged between $r_{tt} = 0.80$ (2020/02 –2020/08) and $r_{tt} = 0.83$ (2020/02 –2020/03; see Online Supplementary Material 2 for details on retest-reliability).

Psychopathological symptoms. General psychopathological symptom burden was measured using the Mini-Symptom Checklist [58], a brief version of the Brief Symptom Checklist (BSCL; [58]). The 18-item scale is a measure of global psychopathological symptom burden. All items are rated on a 5-point scale, and higher scores indicate more severe psychopathological symptoms. In the current study, internal consistency ranged from 0.95 (2020/02, 2020/04, 2020/08, 2020/11) to 0.96 (2020/03, 2021/01, 2021/03). Temporal stability ranged between $r_{tt} = 0.67$ (2020/02 –2021/03) and $r_{tt} = 0.73$ (2020/02 – 2020/04). To examine the number of respondents with substantial levels of

psychopathological symptoms, we used cut-off scores of 13 and 10 for women and men respectively, which have been used in previous studies [59,60]. Individuals with above cut-off scores show increased psychopathological symptom burden that may – in some but not all cases – reflect symptoms of a mental disorder.

Sleep quality. Sleep quality during the last week was assessed at all post-outbreak assessments using a German version of the Single-Item Sleep Quality Scale [61]. Higher scores on the 11-point scale indicate better sleep quality. Temporal stability ranged between $r_{tt} = 0.56$ (2020/02 – 2020/08, 2020/11) and $r_{tt} = 0.63$ (2020/03 – 2020/04).

COVID-19-related rumination. COVID-19-related rumination was assessed at all post-outbreak assessments using a modified German version of the Perseverative Thinking Questionnaire ([62]; see Online Supplementary Material 1 for items). The 15-item instrument assesses core characteristics of rumination (i.e., repetitiveness, intrusiveness, difficulties to disengage) and was modified to assess COVID-19-related rumination. Each item was rated on a 5-point scale, and higher scores indicated more intense rumination. In the current sample, internal consistency ranged from 0.96 (2020/03) to 0.98 (2020/21). Temporal stability ranged between $r_{tt} = 0.57$ (2020/03 – 2021/03) and $r_{tt} = 0.68$ (2020/03 – 2020/04).

2.3 Data Analyses

Analyses were conducted using *RStudio* [63], the *lavaan* package [64], the *lcs*m package [65], and the *RBtest* package [66]. Latent growth mixture modeling (LGMM) was performed using *MPlus* [67]. Comparisons with the German general population were based on data from Census 2011 [68] and were performed using one-sample *t*-tests and χ^2 tests. Patterns of missing data (i.e., missing completely at random, missing at random, not missing at random) were investigated using a regression-based approach [69]. To analyze latent changes in psychopathological symptoms and SOC as well as the ability of SOC to predict changes in psychopathological symptoms and vice versa, we applied bivariate latent change score (BLCS) models [70,71]. To ensure sound parameter estimates, respondents that participated in fewer than two assessments of SOC and psychopathological

symptoms were excluded from analyses. Models were estimated using full information maximum likelihood (FIML) and maximum likelihood estimations with robust standard errors and scaled test statistics (MLR) to account for non-normal distributed data [72]. Model fit was assessed using the comparative fit index (CFI) and Tucker-Lewis index (TLI; acceptable fit: 0.95–0.97; good fit: ≥ 0.97) and the standardized root-mean-square residual (SRMR; acceptable fit: 0.05–0.10, good fit: ≤ 0.05 ; [73]). To compare nested models, we used $\Delta\chi^2$ difference tests to examine improvement of model fit. The equations proposed by Jajodia [74] were used to illustrate coupling effects from SOC to psychopathological symptoms. To identify different trajectories of COVID-19-related rumination, we used unconditional LGMM with FIML to handle missing data. Respondents who participated in fewer than two assessments of COVID-19-related rumination were excluded from these analyses. Criteria for model selection followed guidelines for LGMM [75], and the best fitted model was selected through multiple criteria. These were reduction in Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC), sample-size adjusted Bayesian Information Criterion (SSBI), and entropy. Significance of fit differences was indicated by the Vuong-Lo-Mendell-Rubin Likelihood test (VRLT) and the Lo-Mendell-Rubin Adjusted LRT test (LRT). Subgroup analyses used the results from LGMM and were performed by means of multigroup models.

3 Results

3.1 Sample Characteristics

The mean age of respondents who were included in the analyses ($n = 1,479$) was 55.3 years ($SD = 13.34$; range: 20–95 years) at baseline. A total of 52.8% were women. The large majority lived in Germany (96.3%), 2.2% in Austria, 1.1% in Switzerland, and 0.4% in other countries (e.g., French-German border area). The current sample did not differ in gender from the general population, $p = 0.052$, but respondents were significantly older, $t(1478) = 11.86$, $p < 0.001$ ¹. Moreover, compared

¹ Comparability is limited as no precise average age of the adult German general population is available. Public statistics collapse people older than 85 years, i.e., average age of the German general population may be higher than assumed for the current study ($M = 51.09$).

with the Census data² the current sample was more educated: 0.3% versus 7.6% had not (yet) graduated from school, 31.4% versus 55.7% reported ten years of formal education, 20.3% versus 32.5% in the Census sample completed their A-level. Moreover, compared to 17.6% in the general population, 32.7% have a university degree, and 2.9% versus 1.2% hold a doctoral degree. The regression-based test (RBtest) showed that missing data for all variables included in the following analyses was at least missing at random allowing for the use of FIML. Missing data ranged between 0% at the pre-outbreak assessment (2020/02) and 33% (2020/11).

3.2 Dropout Analyses

Respondents who were excluded from analysis were younger, $t(2005) = -6.15, p < 0.001, d = -0.31$, more likely to be male, $\chi^2(1) = 18.49, p < 0.001, \text{Cramer's } V = 0.10$, but did not differ in educational level, $p = 0.642, r_{rb} = -0.01$, from included respondents. They reported lower levels of SOC, $t(2005) = 2.66, p = 0.008, d = 0.14$, but did not differ in psychopathological symptoms at pre-outbreak assessment, $t(2005) = -1.54, p = 0.123, d = 0.08$. The comparison between those who were included and excluded from the analyses on COVID-19-related rumination revealed the same pattern of results: Excluded respondents were significantly younger, $t(1477) = -5.42, p < 0.001, d = -0.64$, more likely to be male, $\chi^2(1) = 9.22, p = 0.002, \text{Cramer's } V = 0.08$, but equally educated, $p = 0.106, r_{rb} = -0.11$. They reported significantly lower levels of SOC, $t(1434) = -2.33, p = 0.020, d = 0.28$, but comparable levels of psychopathological symptoms, $t(1433) = 1.60, p = 0.110, d = -0.19$, at pre-outbreak assessment.

3.3 Model Selection

The model selection process is in Table 1. Compared to a model without coupling effects between SOC and psychopathological symptoms only a model allowing for unidirectional coupling from SOC to psychopathological symptoms (see Fig. 3) significantly improved model fit, $\Delta\chi^2(1) =$

² Census data contains individuals aged 15 and older and is not entirely comparable to the current sample.

78.70, $p < 0.001$. By contrast, a model allowing for bidirectional coupling did not improve model fit compared to both unidirectional models, $\Delta\chi^2(1) = 1.76$, $p = 0.185$.

Table 1. Fit statistics for all models and model comparison

		#pa	$(\Delta)\chi^2$	p	CFI	TLI	SRMR	AIC	BIC
Model 1	No coupling between SOC and psychopathological symptoms	98	117.95	0.083	0.992	0.992	0.022	108868	108979
Model 2	Unidirectional coupling from psychopathological symptoms to SOC	97	115.18	0.100	0.992	0.993	0.025	108861	108978
Model 1 vs. Model 2	$df = 1$		1.99	0.159					
Model 3	Unidirectional coupling from SOC to psychopathological symptoms	97	112.39	0.136	0.992	0.993	0.023	108860	108977
Model 1 vs. Model 3	$df = 1$		78.70	< 0.001					
Model 4	Bidirectional coupling between SOC and psychopathological symptoms	96	110.07	0.155	0.992	0.993	0.024	108855	108976
Model 3 vs. Model 4	$df = 1$		1.76	0.185					
Model 5	Multigroup model (model 3)	194	281.44	< 0.001	0.984	0.985	0.034	104899	105130
Model 3 vs. Model 4	$df = 97$		193.9	< 0.001					

Note. AIC: Akaike Information Criterion, BIC: Bayesian information criterion, CFI: Comparative Fit Index, #pa: number of parameters, df: degrees of freedom, SRMR: Standardized Root-Mean-Square Residual, TLI = Tucker-Lewis Index.

Fig. 3. Schematic illustration of the final model (see Online Supplemental Material 1 for the full model including manifest variables).

3.4 Unidirectional Coupling from SOC to Psychopathological Symptoms

In the total sample, there was a constant increase in SOC, $\alpha = 15.05$, $p < 0.001$, and psychopathological symptoms, $\alpha = 36.01$, $p < 0.001$, along with a proportional change of SOC, $\beta = -0.32$, $p < 0.001$, and psychopathological symptoms, $\beta = -0.82$, $p < 0.001$. Higher levels of SOC were related to larger constant changes in SOC, and higher symptom levels were associated with larger constant changes in psychopathological symptoms. Constant changes in SOC and psychopathological symptoms were not significantly related. Previous SOC levels predicted later changes in psychopathological symptoms, $\gamma_{SOC \rightarrow PS} = -0.29$, $p = 0.048$. Stronger SOC was related to smaller changes in psychopathological symptoms. Building on the equations proposed by Jajodia [74] this translates to the following estimations: For individuals with relatively low levels of SOC (-1 SD) and average levels of pre-outbreak psychopathological symptoms, one would expect psychopathological symptoms to increase by 3.04 from pre-pandemic assessment (2020/02) to post-outbreak

assessment (2020/03), while for those with relatively strong SOC (+ 1 *SD*), one would expect a symptom decrease of -2.93.

3.5 Trajectories of COVID-19-Related Rumination

Using LGMM we identified two trajectories of COVID-19-related rumination across six waves: A smaller group ($n = 254$), the high-rumination group, showed consistently high levels of COVID-19-related rumination and a larger group, the low-rumination group, showed consistently low levels of COVID-19-related rumination ($n = 1149$; for details on the LGMM results, see Online Supplementary Material 1). There were no differences between the groups with respect to age, $t(1401) = 1.71$, $p = 0.088$, $d = 0.12$, gender, $\chi^2(1) = 0.52$, $p = 0.470$, *Cramer's V* = 0.02, and educational level, $p = 0.366$, $r_{rb} = 0.06$. However, the high-rumination group displayed higher levels of psychopathological symptoms, $F(1, 647) = 275.43$, $p < 0.001$, $\eta_p = 0.17$, lower sleep quality, $F(1, 654) = 17.91$, $p < 0.001$, $\eta_p = 0.02$, and weaker SOC, $F(1, 656) = 66.48$, $p < 0.001$, $\eta_p = 0.08$, than the low-rumination group. As can be seen in Table 2, the proportion of participants with above cut-off psychopathological symptoms scores differed between the high- and the low-rumination group ranging from 24.4% (2020/11) to 27.0% (2021/01) in the low-rumination group, and from 53.9% (2020/02) to 59.8% (2020/11) in the high-rumination group, $\chi^2(1) \geq 101.97$, $p < 0.001$.

1 **Table 2.** Psychopathological symptoms by COVID-19-related rumination group

	Assessment period						
	2020/02	2020/03	2020/04	2020/08–09	2020/11	2021/01	2021/03
Low rumination (<i>n</i>)	1149	1122	998	927	821	902	859
<i>n</i> of respondents above cut-off	239	224	189	173	142	186	159
% respondents above cut-off	20.8	20.0	18.9	18.7	17.3	20.6	18.5
High rumination (<i>n</i>)	254	245	226	201	164	204	175
<i>n</i> of respondents above cut-off	137	140	135	111	98	113	96
% respondents above cut-off	53.9	57.1	59.7	55.2	59.8	55.4	54.9
Total sample (<i>n</i>)	1403	1367	1224	1128	985	1106	1034
<i>n</i> of respondents above cut-off	376	364	324	284	240	299	255
% respondents above cut-off	26.8	26.6	26.5	25.2	24.4	27.0	24.7

2 *Note.* Cut-off scores: 10 (men), 13 (women).

3

4 **3.6 COVID-19-Related Rumination as Moderator**

5 To examine the impact of COVID-19-related rumination on the relationship between SOC and
6 psychopathological symptoms, we compared the BLCS model between high and low rumination
7 groups (see Online Supplementary Material 1 for a schematic illustration). The multigroup model
8 improved model fit significantly, $\Delta\chi^2(97) = 193.9, p < 0.001$. In the low-rumination group SOC
9 constantly increased over time, $\alpha = 16.74, p < 0.001$, and SOC changes depended on previous levels
10 of SOC, $\beta = -0.34, p < 0.001$, while psychopathological symptoms did not show constant or
11 proportional changes, $p \geq 0.537$. In this group there was no coupling between SOC and
12 psychopathological symptoms, $\gamma_{SOC \rightarrow PS} = -0.17, p = 0.593$. In the high-rumination group, there was no
13 constant or proportional change in SOC over time, $p \geq 0.214$. However, psychopathological
14 symptoms increased constantly over time, $\alpha = 81.21, p = 0.001$, and changes depended on previous
15 symptom levels, $\beta = -1.00, p < 0.001$. In both groups, constant changes in SOC and
16 psychopathological symptoms were not significantly related. In contrast to the low-rumination
17 group, changes in psychopathological symptoms were predicted by previous SOC strength, $\gamma_{SOC \rightarrow PS} = -$

1.09, $p = 0.011$, in the high-rumination group, that is, stronger SOC was related to smaller changes in psychopathological symptoms. In this group, one would expect a symptom increase of 10.02 from first to second assessment for individuals with low levels of SOC ($-1\ SD$) and average psychopathological symptom burden at pre-outbreak assessment (2020/02), while symptoms would be expected to decrease by 9.70 for individuals with high levels of SOC ($+1\ SD$).

4 Discussion

In this one-year prospective observational study, we found a small yet significant increase of psychopathological symptoms in the general population. However, our multigroup model revealed that mental health consequences of the pandemic were heterogeneous: The majority of the sample (82.8%) did not experience significant changes in psychopathological symptom levels, while symptom increases were pronounced in a subgroup of respondents experiencing high levels of COVID-19-related rumination (17.2% of the total sample). In the total sample and in the high-rumination group, previous SOC significantly predicted changes in psychopathological symptoms at subsequent assessments. Those with stronger SOC at previous assessment were more likely to experience a decrease in symptoms, while those with weaker SOC were at higher risk for an increase in symptoms. Thus, our findings support a buffering effect of SOC, thereby corroborating our previous findings from the analysis of the first wave [41].

Our results in the total sample are in line with previous studies on long-term mental health consequences of COVID-19 [42,76] that show a small yet significant increase in psychopathological symptoms in the general population. However, by showing that 82.8% of the sample did experience no changes in psychopathological symptoms, our study also supports the notion that the main psychological outcome of COVID-19 is resilience [11]. At the same time, our results also show that there is a vulnerable subgroup – characterized by higher levels of COVID-19-related rumination and psychopathological symptoms and lower levels of SOC – that is at risk for clinically meaningful symptoms. These results are accordant with previous research demonstrating that high levels of rumination represent a particularly important transdiagnostic risk factor for the onset of depression

1 and anxiety symptoms in the context of stressful events [77]. Correspondingly, $\geq 53.9\%$ of the
2 respondents in the high-rumination group showed above cut-off psychopathological symptom
3 burden (compared to $\leq 20.8\%$ in the low-rumination group). However, we did not find a constant
4 increase of these shares over time – however shares peaked at the end of the first wave (2020/04)
5 and when case number started to increase massively during the second wave (2020/11).

6 Beyond insights on the impact of COVID-19 on mental health the present study is, to the best of
7 our knowledge, the first to investigate the relationship between SOC and psychopathological
8 symptoms throughout exposure to a multidimensional long-term stressor. Further, in contrast to
9 previous longitudinal studies on SOC that used regression-based analyses and investigated less
10 complex stressors (e.g., work stress) [27–29], we examined the association between SOC and
11 psychopathological symptoms by means of BLSC modeling, allowing to analyze the complex interplay
12 between SOC and mental health. Among the different models examined in the current study, the
13 model allowing for unidirectional coupling from previous SOC to later psychopathological symptoms
14 showed the best model fit. In this model, previous SOC significantly predicted later changes in
15 psychopathology symptoms. Thereby, SOC is the leading indicator of change in this relationship. This
16 finding does not only corroborate earlier evidence identifying SOC as a predictor of (changes in)
17 mental health [27,78], but it further points out that SOC has predictive value over a longer period of
18 time. Thereby, our results challenge previous conceptual criticism of SOC as to being merely an
19 inverse measure of psychopathological symptoms [79,80]. Interestingly, SOC's predictive value was
20 particularly pronounced in a group showing high COVID-19-related rumination, higher levels of
21 psychopathological symptoms, lower sleep quality, and weaker SOC. This may suggest that, in line
22 with the salutogenic framework [17,18], SOC has its strongest impact on mental health when
23 individuals are exposed to stressors. According to the more recent Positive Appraisal Style Theory of
24 Resilience (PASTOR, [15]), resilience factors come into play when aversive situations are strong
25 enough to automatically trigger negative appraisal. In such situations stronger SOC may be
26 associated with more positive reappraisal of the situation. However, future studies will have to

investigate SOC in the context of appraisal styles to further examine a potential causal link between SOC and psychopathological symptoms along with potential mediators.

Interestingly, we found SOC to increase over time in the total sample. This was even more pronounced in the low-rumination subgroup. Thereby, our findings challenge the notion of SOC being a trait-like variable [17,18,81] by showing substantial changes in level of SOC (without any intervention) over a relatively short period of 13 months (along with high rank stability, $r_{tt} \geq 0.82$). Increases in SOC in the total sample and the low-rumination group may reflect stressor-related personal growth that has also been described in other samples during the COVID-19 pandemic [82,83]. Future studies will have to examine if these experiences reflect real or illusory growth and in how far they are associated with changes in SOC [84].

Importantly, SOC's instability may not only indicate a theoretical inconsistency within the salutogenesis framework but it may also represent an opportunity for clinical intervention. Given that previous findings show that SOC can be modified by interventions [78,85,86], and our results that underline SOC's predictive validity for mental health changes, it seems worthwhile to include SOC in resilience interventions. Resilience can be learned [9,12], and SOC may represent a component that should be targeted more often by resilience trainings that were found to have positive effects in different populations [30,87]. Previous evaluations of SOC-targeting interventions in single studies have yielded promising results but often use unspecific interventions [88]³ and study designs that do not allow for strong conclusions (e.g., non-randomized trials, single-arm trials) [89,90]. Future studies should therefore investigate the efficacy of SOC-targeting interventions according to recent suggestions for study designs in resilience research [91]. Given that a stronger SOC is also predictive of more stable mental health in our study, prevention programs could be useful to buffer adverse effects of future life stressors on mental health [92].

³ For example, Tan et al. [88] investigate a health promotion intervention based on the salutogenesis framework focusing on internal and external resources, motivation, personal responsibilities, physical activity, and social and environmental impact on health behaviors. However, the intervention does neither comprise specific SOC-strengthening elements nor address SOC components (i.e., comprehensibility, manageability, and meaningfulness).

1 It is important to consider the limitations of the current study: First, the study used a
2 nonrepresentative sample recruited via an online panel (WiSo panel; [53]) and was observational.
3 Therefore, we cannot exclude that changes in mental health found in the present study were not
4 related to the COVID-19 pandemic, but reflected spontaneous fluctuations over time or (less well
5 evidenced) over seasons [93–95], as we do not have a long-term pre-pandemic assessment of the
6 sample. Moreover, a substantial number of respondents dropped out during the study or did not
7 participate in all assessments ($n = 658$ completed all assessments). However, missing data was at
8 least random, and we aimed to account for potential biases by dropout analyses. Second, we did not
9 assess individual stressor exposure, as this was not possible due to the dynamic course of the
10 pandemic that did not allow for a complex assessment of individual COVID-19-related distress (i.e., as
11 governmental policy and measures to contain the pandemic changed dynamically, also stressor
12 assessment would have changed between assessments, which is not ideal for longitudinal data
13 analyses). We accounted for this lack of precise stressor assessment by including COVID-19-related
14 rumination as an indicator of perceived stress levels and stressor quality in our analyses. However,
15 future studies should include more elaborated stressor assessments [96].

16 Despite these limitations, the current study improves our understanding of the interaction
17 between the resilience factor SOC and mental health during the COVID-19 pandemic. In line with
18 previous research, we found a small, yet significant increase of psychopathological symptoms in the
19 total sample and identified a subgroup of respondents (17.2%) characterized by high COVID-19-
20 related rumination, high levels of psychopathological symptoms and weaker SOC that is particularly
21 burdened by the pandemic. In this subgroup, and in the total sample, previous levels of SOC were
22 predictive of later changes in psychopathological symptoms. A stronger SOC was associated with
23 smaller changes and a greater chance to experience symptom decreases over time. This predictive
24 value hopefully inspires further research into mechanisms linking SOC and psychopathological
25 symptoms (e.g., appraisal styles) and into interventions fostering SOC, and in turn, resilience.

1 Statements

2 Statement of Ethics

3 The study was conducted in accordance with the ethical standards of the ethics committee of
4 Saarland University and the 1964 Helsinki Declaration and its later amendments or comparable
5 ethical standards. According to the ethics committee of Saarland University, the study was exempt
6 from ethical approval.

8 Disclosure Statement

9 This article received no support from any funding agency, commercial business, or not-for-profit
10 institution. In the last 3 years, the authors have had no commercial conflicts of interest.

12 Funding Sources

13 None.

15 Author Contributions

16 SKS: conceptualization (lead), formal analysis (lead), methodology (lead), writing – original draft
17 preparation; MRS: conceptualization (supporting), methodology, writing – review and editing (equal);
18 MK: formal analysis (supporting), methodology (supporting), visualization, writing – review and
19 editing (equal); ASG: data curation, project administration, resources (lead), supervision (supporting),
20 writing – review and editing (equal); TM: conceptualization (supporting), resources (supporting),
21 supervision (lead), writing – review and editing (equal).

23 Data Availability Statement

24 The data that support the findings of this study are available on request from the corresponding
25 author, TM. The data are not publicly available due to information that could compromise the
26 privacy of research participants.

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