


## RESEARCH ARTICLE

# Salutary mechanisms in the relationship between stress and health: The mediating and moderating roles of Sense of Coherence—Revised

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## Abstract

While chronic and acute stress are often associated with negative health, the sense of coherence–revised (SOC-R) is proposed to facilitate coping with stress and promote health. However, research is lacking on the specific mechanisms. Therefore, the current study aimed to investigate potential mediating and moderating mechanisms of SOC-R in the relationship between stress and health. Using a cross-sectional design, standardized questionnaires assessed SOC-R, acute (perceived) stress, early-life adversity (ELA; indicator for early-life chronic stress), mental and physical health, and satisfaction with life. Mediation and moderation analyses were conducted with  $N = 531$  Irish adults (mean age: 59.5 years; 58.4% female). Regarding acute (perceived) stress, results showed that SOC-R and its Manageability subscale significantly mediated the association between perceived stress and mental health, and satisfaction with life. SOC-R and its Manageability subscale also significantly moderated the association between perceived stress and mental health. Regarding ELA, the Manageability subscale significantly mediated the association between ELA and mental health, and satisfaction with life; and the Balance subscale significantly mediated the association between ELA and physical health. SOC-R may provide a useful focus for stress-related research, with future longitudinal studies needed to examine SOC-R as a long-term modulating pathway between stress and health.

## KEYWORDS

acute (perceived) stress, early-life chronic stress, physical and mental health, satisfaction with life, sense of coherence-revised

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## 1 | INTRODUCTION

### 1.1 | Chronic and acute stress and the association with health

Growing research interest has focused on the mechanisms underpinning the relationship between stress and health. Health can be understood as a 'state of complete physical, mental and social well-being' (WHO, 2018b, para. 1), incorporating both physical (i.e., proper functioning of the body) and mental health (i.e., good emotional well-being). Both acute and chronic stress have typically been associated with negative health. For instance, acute stress (e.g., being a victim of a violent crime, perceived daily stress) and chronic stress (e.g., long-term unemployment and financial stress, ongoing minority stress) have been associated with an increased risk for mental health disorders, including alcohol use disorder and depressive symptomatology (Cristóbal-Narváez et al., 2020; Keyes et al., 2011). Acute and chronic stress have also been linked to physical health conditions, such as obesity, cardiovascular disease, and type 2 diabetes (Albert et al., 2017; Kivimäki & Kawachi, 2015).

Specific research interest has focused on chronic stress in early life, also termed early-life adversity (ELA). ELA refers to the chronic and often severe forms of stress encountered during childhood or adolescence, including experiences of trauma, abuse, neglect, or maltreatment (Smith & Pollack, 2020). ELA has also been linked to lasting negative effects on health, such as posttraumatic stress disorder and anxiety disorders (Carr et al., 2013; Chaby et al., 2017; Thoma, Bernays, Eising, Maercker, et al., 2021; Thoma, Bernays, Eising, Pfluger, et al., 2021).

In understanding the relationship between stress and health, the traditional pathogenic perspective of stress has often been implemented in health research, that is, focusing on risk factors, disease, and psychopathology (Bauer et al., 2006; Becker et al., 2010). However, in recent decades there has been a shift away from this deficits-based perspective, as studies increasingly demonstrate a vast heterogeneity in the consequences of stress (e.g., Bonanno & Mancini, 2012). A strengths-based approach to stress and its relationship with health can be understood in the application of the salutogenic theory and 'sense of coherence' (SOC).

### 1.2 | The salutogenic theory and SOC

The salutogenic theory focuses on the origin of health and proposes that health should be understood in terms of a continuum of health and disease (Antonovsky, 1990, 1996). SOC is a key component of this theory and is stated to influence an individual's perception and management of stress (Antonovsky, 1987b, 1993). This suggests that stress may not only be detrimental, but may also have the potential to be neutral or even salutary, that is, health-promoting (Vinje et al., 2017). The strength or weakness of an individual's SOC is shaped by overcoming the life experiences and stress encountered into early adulthood, with a strong SOC proposed to facilitate

movement towards health on the health-disease continuum (Antonovsky, 1979, 1987b). Such a conceptualisation of SOC points to a potential mediating role in stress (i.e., difficult life experiences) and health, as well as a potential moderating role regarding the strength of SOC in countering the demands of stress (Antonovsky, 1987a, 1996). Supporting this duality is recent meta-theoretical research on the mediator-moderator distinction, which suggests that when a mediation occurs the change in the mediator can moderate future responses to a predictor (Karazsia & Berlin, 2018). In viewing SOC as a mediator, consideration should be given to type, duration, and severity of stress, which may alter the association with SOC. As a moderator, having a strong (or weak) SOC can have important implications for the association between stress and health (Antonovsky, 1996). To offer empirical support for this salutogenic framework, a SOC scale was developed (Antonovsky, 1987b). While it has been implemented in a variety of populations and languages (see Eriksson & Lindström, 2006); psychometric inconsistencies were often reported (e.g., Drageset & Haugan, 2016; Feldt et al., 2007), and a revised SOC concept and scale was developed.

### 1.3 | Sense of Coherence—Revised

Building on SOC, sense of coherence—revised (SOC-R) defines an individual's ability to perceive life experiences as connected and to balance positive and negative life experiences in order to facilitate good health (Bachem & Maercker, 2018). In its measurement, the SOC-R scale is comprised of three theoretical aspects that focus on the ability to deal with ambiguous life stress. The 'Manageability' aspect refers to dealing with difficult situations; the 'Balance' aspect refers to the balancing of positive and negative life experiences and feelings; and the 'Reflection' aspect refers to the consideration of different perspectives and understanding connections to the wider context (Bachem & Maercker, 2018). Similar to the original SOC, SOC-R can be used as an indicator of stress-related health maintenance. For instance, a recent cross-sectional study investigated SOC-R in a sample of  $N = 102$  rescue workers, a group that frequently encounter acute stress as part of the job (e.g., attacks or injuries to themselves or colleagues, care of severely injured individuals, difficult interactions with relatives of victims; Behnke et al., 2019). Findings showed that higher values of SOC-R were associated with lower levels of posttraumatic stress, depressive, and somatic symptoms (Behnke et al., 2019). However, despite such preliminary research, there is a lack of information on the mechanisms through which SOC-R is associated with stress and health.

### 1.4 | The mediating role of SOC(-R) in stress and health

Much of what is known about the potential mediating role of SOC-R comes from research with the original SOC. For example, one study examined chronic stress in  $N = 870$  adults affected by war-related

events, such as being injured or damage to one's home (Kimhi et al., 2010). Results found that SOC significantly mediated the relationship between chronic stress and anxiety, depression, and somatization symptoms. Another SOC study examined acute stress (i.e., stressful experiences in the form of daily hassles, anxiety, and worry) in  $N = 193$  French adults. Results showed that SOC significantly mediated the relationship between acute stress and satisfaction with life (Gana, 2001). However, regarding SOC-R, only one study to date has examined its mediating role for stress. In a longitudinal study with  $N = 238$  Swiss older adults, SOC-R was shown to significantly mediate the relationships between chronic stress, as well as ELA, and mental health and satisfaction with life (Mc Gee et al., 2018b). While this provides initial evidence of a mediating mechanism, further studies are needed to replicate this.

### 1.5 | The moderating role of SOC(-R) in stress and health

The potential moderating role of SOC has also been investigated, but mainly in studies on the original SOC. For instance, a Canadian study with a nationally representative sample ( $N = 6505$ ) found SOC to act as a significant moderator between chronic stress in the form of stressful life events over the past year (e.g., physical abuse, major financial crisis) and subjective health (Richardson & Ratner, 2005). Building on the SOC evidence, some recent studies have also investigated the moderating role of SOC-R. For example, Mc Gee et al. (2018a) found SOC-R to significantly moderate the relationship between ELA and mental health in  $N = 268$  Swiss older adults. Supporting the assumptions of the salutogenic theory, individuals with a strong SOC-R showed better mental health than those with a weaker SOC-R, even at high levels of ELA (Mc Gee et al., 2018a). In addition, a large-scale study using a representative sample in Germany ( $N = 2373$ ) also found that SOC-R significantly moderated the association between ELA and depression (Thoma et al., 2018). Furthermore, the longitudinal study with  $N = 238$  Swiss older adults examined adult chronic stress, encompassing five domains of chronic stress: chronic worrying, work-related overload, social overload, excessive demands, and lack of social recognition (Mc Gee et al., 2018b). Results showed that the Manageability subscale of SOC-R significantly moderated the relationship between chronic stress and mental health. While these early studies provide initial support for a moderating mechanism of SOC-R, the scope is limited due to the focus on chronic stress.

### 1.6 | Aims of the present study

As shown above, studies have examined SOC(-R) as a mediator (i.e., to explain the relationship in which stress and health are associated), as well as a moderator (i.e., affecting the strength or direction of the association between stress and health). However, the majority of studies on SOC-R have focused on ELA or adult chronic stress in

relation to mediation (e.g., Mc Gee et al., 2018b) or moderation (e.g., Mc Gee et al., 2018a, 2018b; Thoma et al., 2018). In particular, there is a lack of SOC-R research on acute (perceived) stress. Furthermore, the existing studies have largely focused on mental health, with no studies examining physical health, and only limited research on satisfaction with life (e.g., Mc Gee et al., 2018b). Satisfaction with life differs from mental health as it refers to the cognitive component of subjective well-being, in which individuals assess their overall quality of life (Diener et al., 1985). To address these gaps, the current study aimed to examine the potential mediating and moderating mechanisms of SOC-R in the relationship between stress and health and satisfaction with life. It aimed to build on previous studies in Germany and Switzerland (Mc Gee et al., 2018a, 2018b; Thoma et al., 2018), by examining an early-life chronic stress (ELA), as well as acute (perceived) stress, and their associations with SOC-R in a large general population sample in Ireland. It further expands on current research by not only investigating the association with mental health, but also satisfaction with life and physical health.

Drawing on the salutogenic framework and findings from previous studies, the following mediation and moderation hypotheses were tested. First, for mediation: SOC-R is proposed to develop through experiences with difficult life events and stress, and such stress, depending on the type, can also diminish SOC (Antonovsky, 1987a; Bachem & Maercker, 2018). Based on this salutogenic theory, as well as existing mediation studies on ELA and SOC-R (e.g., Mc Gee et al., 2018b); it was hypothesised that SOC-R would act as a significant mediator of the relationship between ELA and health/satisfaction with life. Regarding acute (perceived) stress, research with the original SOC and acute stress (e.g., Gana, 2001) provided the basis for an exploratory mediation hypothesis. It was hypothesised that SOC-R would act as a significant mediator of the relationship between acute (perceived) stress and health/satisfaction with life.

Second, for moderation: Given the existing moderation studies on ELA and SOC-R (e.g., Mc Gee et al., 2018a, Thoma et al., 2018), it was hypothesised that SOC-R would act as a significant moderator of the relationship between ELA and health/satisfaction with life. Regarding acute (perceived) stress, an exploratory moderation hypothesis was investigated. It was hypothesised that SOC-R would act as a significant moderator of the relationship between acute (perceived) stress and health/satisfaction with life. As a strong SOC-R is suggested to have protective effects (Bachem & Maercker, 2018), it was expected that high levels of SOC-R would be associated with better (mental and physical) health and satisfaction with life.

## 2 | METHODS

### 2.1 | Study design

Data for this study were collected using a cross-sectional design, as part of the longitudinal multi-study project 'Differential aging trajectories in high-risk individuals with past experiences of early

adversity'. Data for the current study are derived from a quantitative questionnaire survey conducted in Ireland between June and December 2018, which aimed to examine factors associated with health and healthy ageing in adults with varying experiences of stress in childhood or adolescence. The study was conducted by the University of Zurich, in collaboration with University College Dublin, National College of Ireland, and Ulster University, with the informed consent of all participants in accordance with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of the Faculty of Arts and Social Sciences in the University of Zurich, Switzerland (ID 18.6.1), and the Human Research Ethics Committee—Humanities in University College Dublin, Ireland (ID HS-18-30-Carr).

## 2.2 | Participants and recruitment

Inclusion criteria for all participants were: Irish individuals who were native English speakers and aged 50 years or older. In addition to considerations of empirical research on mediation and moderation analyses, G\*Power software was used in advance to calculate the statistical power analysis and determine a sufficient sample size. In order to detect small to medium effects, a minimum sample size of  $N = 224$  was required, with a significant alpha level of 0.05 and a statistical power ( $1-\beta$ ) of 0.80 (Faul et al., 2007; Fritz & MacKinnon, 2007; Maxwell, 2000). A variety of recruitment methods were used, including online advertisements, newsletters, flyers distributed in public spaces and organisations (such as pharmacies, libraries, adult education centres), Qualtrics survey management software (Qualtrics, 2018), contact points of study collaborators, and radio interviews with the first author.

## 2.3 | Procedure

Individuals could take part in the study by contacting the research team using the email and telephone information provided on the recruitment advertisements. Individuals were screened using the inclusion criteria and eligible participants were provided with the survey package. The questionnaire survey was designed as an online assessment and was also offered in a paper-pencil format. Participants could therefore choose to complete either the online questionnaire survey by following the link or the paper-pencil survey by having the survey package posted to them. In addition, participants could also meet with a member of the research team at the study site (i.e., the university) or at a place of their choosing (e.g., at their homes) to complete the questionnaire survey. The questionnaire survey was programmed online using Unipark software (Unipark & QuestBack, 2020). In both the online and paper-pencil survey, participants were first provided with the study information sheet and then the informed consent form, before completing the questionnaire survey. Following the questionnaire survey, participants were provided with a debriefing sheet containing a summary of the project

and next steps; as well as a contact list of support options, should they be required. The order of the questionnaires in both survey formats were randomised for each participant to avoid sequence and order effects.

## 2.4 | Measures

### 2.4.1 | Socio-demographic information

Collected socio-demographic information included age, gender, relationship status, educational attainment, employment status, income class, and subjective socio-economic status.

### 2.4.2 | Sense of coherence

The SOC-R scale was used to assess the way in which individuals perceive and integrate their life experiences to maintain and develop health (Bachem & Maercker, 2018). The SOC-R scale consists of 13 items rated on a five-point Likert scale. Encompassing the three theoretical dimensions (Manageability, Balance, Reflection), it yields a total SOC-R score, with higher scores indicating higher SOC-R. Previous validation studies have shown a good internal consistency for the SOC-R scale of between  $\alpha = 0.75$  and 0.87 (Bachem & Maercker, 2018; Mc Gee et al., 2018a; Thoma et al., 2018). The Cronbach's alpha in the current study was  $\alpha = 0.74$  for the total SOC-R scale, indicating acceptable internal consistency; with moderate internal consistency for the SOC-R subscales Manageability:  $\alpha = 0.67$  and Balance:  $\alpha = 0.65$ , and excellent internal consistency for the Reflection subscale:  $\alpha = 0.91$ .

### 2.4.3 | Acute (Perceived) stress

The Perceived Stress Scale (PSS) was used to assess the degree to which situations in an individual's life are appraised as stressful (Cohen et al., 1983). The PSS consists of 10 items rated on a five-point Likert scale, with higher scores indicating higher acute (perceived) stress. Validation studies on the PSS have shown a good internal consistency of between  $\alpha = 0.78$  and 0.86 (Cohen et al., 1983; Cohen & Williamson, 1988). The Cronbach's alpha in the current study was  $\alpha = 0.87$ , indicating good internal consistency.

### 2.4.4 | Early-life chronic stress

The Adverse Childhood Experiences—International Questionnaire (ACE-IQ) was used to assess exposure to ELA in childhood and adolescence up until the age of 18 years (WHO, 2011). The ACE-IQ consists of 43 items and measures ELA in the following 13 categories: Emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, violence against household

members, living with household members who were substance abusers, living with household members who were mentally ill or suicidal, living with household members who were imprisoned, having one or no parents/parental separation or divorce, bullying, community violence, and collective violence. Each category is scored as 0 = no or 1 = yes, with 1 = yes being scored when a participant answers in the affirmative (i.e., once, a few times, many times). The final score ranges from 0 to 13, with higher scores indicating higher levels of ELA exposure (WHO, 2018a). Validation of the ACE-IQ is ongoing via implementation in broader health surveys in several countries (WHO, 2018a). However, preliminary validation of the English version of the ACE-IQ has shown good internal consistency of  $\alpha = 0.80$  (Kazeem, 2015). The Cronbach's alpha in the current study was  $\alpha = 0.69$ , indicating acceptable internal consistency.

### 2.4.5 | Mental and physical health

Mental and physical health were assessed using the 36-Item Short Form Health Survey Version 1 (SF-36; Ware & Sherbourne, 1992). The SF-36 consists of 36 items that measure the following eight subscales: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to emotional problems, emotional well-being, social functioning, energy/fatigue, and general health perceptions (Ware & Sherbourne, 1992). Two component summary scores for mental and physical health are calculated from the weighted eight subscale scores, using population-, age-, and gender-specific norms for the means, standard deviations, and factors loadings (Ware et al., 1994). In the current study, population-specific norms from the United Kingdom were used (Jenkinson, 1999; Jenkinson et al., 1993). High internal consistency has been shown for the SF-36, with a Cronbach's alpha of between  $\alpha = 0.76$  and 0.93 across the eight subscales,  $\alpha = 0.91$  for the mental health component summary (MCS), and  $\alpha = 0.92$  for the physical health component summary (PCS) (Jenkinson et al., 1993; Ware et al., 1995). The MCS and PCS subscales were used in the current study. The Cronbach's alpha in the current study was  $\alpha = 0.89$  for the MCS and  $\alpha = 0.88$  for the PCS, indicating good internal consistency.

### 2.4.6 | Satisfaction with life

The Satisfaction with Life Scale (SWLS) was used as an indicator of subjective well-being in relation to overall quality of life and life satisfaction (Diener et al., 1985). The SWLS consists of five items, rated on a seven-point Likert scale, with higher scores indicating higher satisfaction with life. Studies have reported good internal consistency for the SWLS of between  $\alpha = 0.79$  and 0.89 (Diener et al., 1985; Pavot & Diener, 1993). The Cronbach's alpha in the current study was  $\alpha = 0.90$ , indicating excellent internal consistency.

## 2.5 | Data analysis

Statistical analyses were performed using R version 3.6.2. The proportion of missing data was less than 1% and multiple imputation was used to handle missing data (chained random forests method, 5000 trees calculated using the package 'missRanger'). A combined model was examined, which included indicators of ELA (ACE-IQ) and acute (perceived) stress (PSS), SOC-R as a mediator or moderator, mental and physical health (MCS and PCS, respectively), and satisfaction with life (SWLS). As the SOC-R total score was highly correlated with its three subscales ( $r = 0.71$ – $0.86$ ,  $p < 0.001$ ), two combined models were analysed: Model 1 included the SOC-R total score and Model 2 included the three subscales Manageability, Balance, and Reflection. For both the moderation and mediation analyses, the SOC-R total score, SOC-R subscales, and the independent variables (ACE-IQ, PSS) were mean-centred. Regarding the sample size requirements for structural equation modelling, recent simulation studies suggest that with a sample of 460 cases, adequate parameter estimation for multiple model complexities should be achieved (Wolf et al., 2013). Unless otherwise indicated, the alpha level was set to 0.05.

The socio-demographic variables of age, gender, and income were included as covariates in the analyses due to significant correlations with the variables of interest and given their link to a variety of health indicators in the literature. For example, a nationally-representative survey in the United States ( $n = 5692$ ) found that the lifetime prevalence estimates of most mental health disorders varied significantly with age, with women shown to have an increased risk for various mental health disorders in comparison to men (Kessler et al., 2005). Regarding income level, epidemiological research has highlighted the influence of income on physical and mental health (Marmot, 2002). Recent research on adult survivors of ELA ( $N = 257$ ) also found income to mediate the relationship between stress and physical and mental health (Thoma, Bernays, Eising, Maercker, et al., 2021; Thoma, Bernays, Eising, Pfluger, et al., 2021). In addition, survey type (i.e., online or paper-pencil) was also controlled for due to significant differences in study variables between these two groups (see Appendix S1 in the Supporting Information for the group comparison of survey type, and Appendix S2 for results of an additional multi-group analysis).

### 2.5.1 | Mediation analysis

To examine the potential mediating role of SOC-R (and its three subscales), bivariate correlations were first calculated using Pearson's correlations to examine relationships between study variables following established recommendations for testing mediation effects; with indirect (*ab*) effects estimated by applying the bootstrapping method with 10,000 resamples (Preacher & Hayes, 2004; Zhao et al., 2010). Bootstrapped standard errors were computed as these are more accurate when data deviates from normality, that is, altered kurtosis or skewness (Wright & Herrington, 2011). Thus, a series of indirect effects were tested in a combined model (i.e.,

Model 1 with SOC-R total and Model 2 with the three SOC-R subscales) by applying a structural equation modelling framework (package 'lavaan'). Confidence intervals for indirect effects were calculated by using the bias-corrected percentile method, with regular confidence intervals computed for direct effects.

## 2.5.2 | Moderation analysis

To examine the potential moderating role of SOC-R (and its three subscales), a multivariate regression analysis was first applied within the combined model (i.e., Model 1 with SOC-R total and Model 2 with the three SOC-R subscales) to test for significance of interaction effects. In the post-hoc analyses, the  $p$ -values were corrected by applying the Bonferroni correction method to account for the family-wise error rate, which lead to a test criterion of  $p = 0.008$ . When the interaction estimates were significant, the interaction was further examined using simple slopes analyses and the Johnson–Neyman procedure to identify the specific regions of significance along the continuous moderator.

## 3 | RESULTS

### 3.1 | Sample characteristics

The sample included a total of 531 participants, consisting of 310 females (58.4%) and 221 males (41.6%), with a mean age of 59.53 years ( $SD = 7.14$ , age range = 50–86 years). See Table 1 for a summary of the sample characteristics. The majority of the participants were married (63.5%,  $n = 337$ ), with 13.9% ( $n = 74$ ) separated or divorced, and 13.6% ( $n = 72$ ) single. Regarding highest level of education, 45.2% ( $n = 240$ ) indicated having obtained a university level education, and 31.5% ( $n = 167$ ) obtained a secondary school level of education. Concerning employment status, 49.3% ( $n = 262$ ) of the participants were employed, with 26.7% ( $n = 142$ ) retired, and 21.3% ( $n = 113$ ) unemployed. Regarding household income per year, the majority of the participants were in the categories €10,000–€30,000 (34.1%,  $n = 181$ ) and €30,000–€50,000 (28.6%,  $n = 152$ ). Subjective socio-economic status was assessed on a scale from 0 to 10, with the mean socio-economic status around the midpoint ( $M = 5.65$ ,  $SD = 1.70$ ). Regarding the experienced stress, on average, participants reported low-medium levels of ELA ( $M = 5.26$ ,  $SD = 1.41$ ; possible range: 0–13), and moderate levels of acute (perceived) stress ( $M = 16.00$ ,  $SD = 7.04$ ; possible range: 0–40).

### 3.2 | Mediation analysis

Mediation analyses were examined within the combined models (i.e., Model 1 with SOC-R total, Model 2 with the three SOC-R subscales), which included acute (perceived) stress, ELA, physical and mental health, and satisfaction with life. See Appendix S3 in the in the

Supporting Information for bivariate correlations. See Table 2 for the parameter estimates of the direct and indirect effects for the mediation analyses.

#### 3.2.1 | Acute (Perceived) stress—SOC-R as a mediator

The SOC-R total score and the Manageability and Reflection subscales were examined as potential mediators based on their significant bivariate correlations with acute (perceived) stress (SOC-R total score:  $r = -0.30$ ,  $p < 0.001$ ; Manageability:  $r = -0.49$ ,  $p < 0.001$ ; Reflection:  $r = -0.32$ ,  $p < 0.001$ ); with mental health (SOC-R total:  $r = 0.26$ ,  $p < 0.001$ ; Manageability:  $r = 0.44$ ,  $p < 0.001$ ; Reflection:  $r = 0.26$ ,  $p < 0.001$ ) and with satisfaction with life (SOC-R total:  $r = 0.24$ ,  $p < 0.001$ ; Manageability:  $r = 0.36$ ,  $p < 0.001$ ; Reflection:  $r = 0.24$ ,  $p < 0.001$ ); as well as the significant associations between perceived stress and mental health ( $r = -0.73$ ,  $p < 0.001$ ), and satisfaction with life ( $r = -0.55$ ,  $p < 0.001$ ).

Regarding mental health, a significant indirect effect was shown for both the SOC-R total score ( $b = -0.16$ , 95% BCCI [−0.237, −0.089],  $p < 0.001$ ), as well as the Manageability subscale ( $b = -0.47$ , 95% BCCI [−0.598, −0.349],  $p < 0.001$ ), while the direct effect remained significant ( $b = -1.03$ , 95% CI [−1.145, −0.929],  $p < 0.001$ ). This indicates a partial mediation and suggests that SOC-R total, as well as the Manageability subscale, significantly mediates the relationship between perceived stress and mental health. See Figure 1a,b for the mediation model with mental health.

As there were no significant associations between SOC-R total (or any of the three SOC-R subscales) and physical health, SOC-R and its subscales were not further examined as potential mediators of the relationship between perceived stress and physical health.

Regarding satisfaction with life, a significant indirect effect was shown for both the SOC-R total score ( $b = 0.10$ , 95% BCCI [−0.150, −0.054],  $p < 0.001$ ), as well as the Manageability subscale ( $b = -0.23$ , 95% BCCI [−0.308, −0.156],  $p < 0.001$ ), while the direct effect remained significant ( $b = -0.51$ , 95% CI [−0.581, −0.420],  $p < 0.001$ ). This indicates a partial mediation and suggests that SOC-R total, as well as the Manageability subscale, significantly mediates the relationship between perceived stress and satisfaction with life. See Figure 2a,b for the mediation model with satisfaction with life.

#### 3.2.2 | Early-life chronic stress—SOC-R as a mediator

The SOC-R subscales Manageability and Balance were examined as potential mediators based on their significant bivariate correlations with ELA (Manageability:  $r = -0.11$ ,  $p < 0.001$ ; Balance:  $r = 0.21$ ,  $p < 0.001$ ); with mental health (Manageability:  $r = 0.44$ ,  $p < 0.001$ ), with physical health (Balance:  $r = -0.13$ ,  $p = 0.041$ ), and with satisfaction with life (Manageability:  $r = 0.36$ ,  $p < 0.001$ ); as well as the significant associations between ELA and mental health ( $r = -0.38$ ,

TABLE 1 Sample characteristics

Sample characteristics	(N = 531)					
	Total		Male		Female	
	M	SD	M	SD	M	SD
Age (years; age range = 50–86; n = 530)	59.53	7.14	60.61	6.95	58.76	7.18
Subjective socio-economic status (range = 1–10; n = 517)	5.65	1.70	5.62	1.66	5.67	1.73
	N	(%)	n	(%)	n	(%)
Sex	-	-	221	41.6	310	58.4
Marital status						
Single, never married	72	13.6	30	13.6	42	13.6
In a relationship	18	3.4	6	2.7	12	3.9
Married	337	63.5	154	69.7	183	59.0
Separated/Divorced	74	13.9	25	11.3	49	15.8
Widowed	30	5.6	6	2.7	24	7.7
Education						
No formal education	4	0.8	3	1.4	1	0.3
Primary school	18	3.4	7	3.2	11	3.5
Secondary/High school	167	31.5	87	39.4	80	25.8
Post-secondary training	54	10.2	18	8.1	36	11.6
Professional qualification	32	6.0	16	7.2	16	5.2
University	240	45.2	86	38.9	154	49.7
Other	16	3	4	1.8	12	3.9
Employment status						
Employed	262	49.3	104	47.1	158	51.0
Unemployed	113	21.3	40	18.1	73	23.5
Retired	142	26.7	73	33.0	69	22.3
Other	14	2.6	4	1.8	10	3.2
Income (Euro; n = 528)						
Under 10,000	46	8.7	21	9.5	25	8.1
10,000–30,000	181	34.1	71	32.1	110	35.5
30,000–50,000	152	28.6	59	26.7	93	30.0
50,000–80,000	79	14.9	35	15.8	44	14.2
80,000–100,000	32	6.0	13	5.9	19	6.1
100,000 and over	38	7.2	21	9.5	17	5.5

Abbreviations: M, mean; SD, standard deviation.

$p < 0.001$ ), physical health ( $r = -0.25$ ,  $p < 0.001$ ), and satisfaction with life ( $r = -0.27$ ,  $p < 0.001$ ).

Regarding mental health, a significant indirect effect was shown for the Manageability subscale ( $b = 0.42$ , 95% BCCI [0.230, 0.634],  $p = 0.026$ ), while the direct effect remained significant ( $b = -0.82$ , 95% CI [-1.362, -0.259],  $p = 0.003$ ). This indicates a partial mediation and suggests that the Manageability subscale significantly mediates the relationship between ELA and mental health. See Figure 3a for the mediation model with mental health.

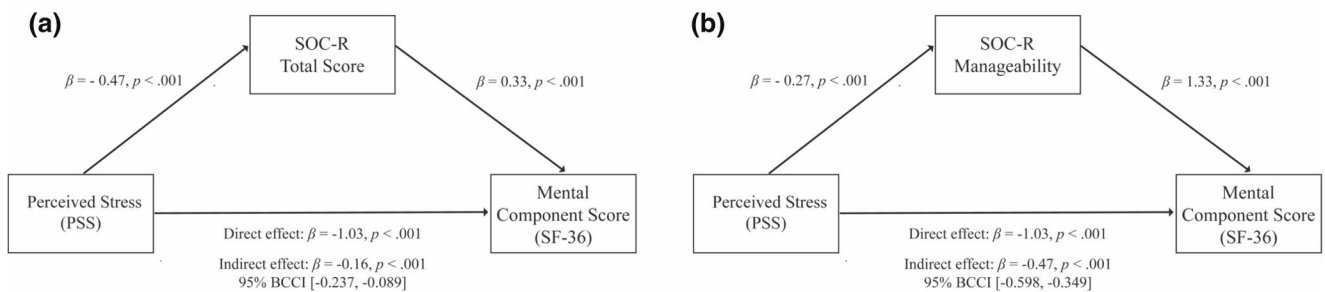
Regarding satisfaction with life, a significant indirect effect was also shown for the Manageability subscale ( $b = 0.20$ , 95% BCCI [0.026, 0.397],  $p = 0.030$ ), while the direct effect was no longer significant ( $b = -0.36$ , 95% CI [-0.800, 0.122],  $p = 0.123$ ). This indicates that the Manageability subscale significantly mediates the relationship between ELA and satisfaction with life. See Figure 3b for the mediation model with satisfaction with life.

Regarding physical health, a significant indirect effect was shown for the Balance subscale ( $b = -0.28$ , 95% BCCI [-0.557, -0.101],

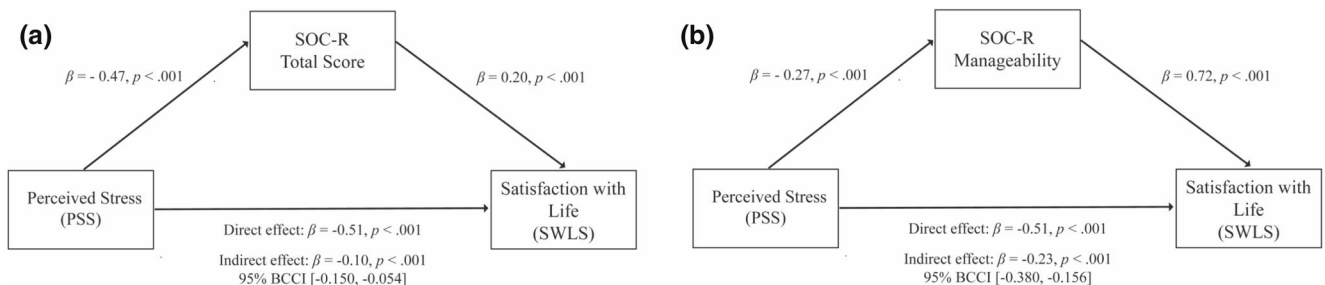
**TABLE 2** Direct and indirect effects for the mediation analyses

	<i>b</i>	SE	Z	<i>P</i>	95% BCCI/CI
<b>Acute (perceived) stress (PSS)</b>					
PSS → SOC-R Total → MCS	-0.16	0.03	-4.17	**	[-0.237, -0.089]
PSS → SOC-R manageability → MCS	-0.47	0.06	-7.28	**	[-0.598, -0.349]
PSS → SOC-R reflection → MCS	0.02	0.03	0.66	0.513	[-0.056, 0.088]
PSS → MCS	-1.03	0.05	-19.41	**	[-1.145, -0.929]
PSS → SOC-R Total → SWLS	-0.10	0.02	-4.10	**	[-0.150, -0.054]
PSS → SOC-R manageability → SWLS	-0.23	0.03	-5.92	**	[-0.308, -0.156]
PSS → SOC-R reflection → SWLS	-0.01	0.02	-0.25	0.802	[-0.055, 0.036]
PSS → SWLS	-0.51	0.04	-12.33	**	[-0.581, -0.420]
PSS → PCS	-0.25	0.07	-3.42	0.001*	[-0.403, -0.108]
<b>Early-life chronic stress (ACE-IQ)</b>					
ACE-IQ → SOC-R manageability → MCS	0.42	0.18	2.23	0.026*	[0.044, 0.773]
ACE-IQ → MCS	-0.82	0.28	-2.93	0.003*	[-1.362, -0.259]
ACE-IQ → SOC-R balance → PCS	-0.28	0.10	-2.52	0.012*	[-0.557, -0.101]
ACE-IQ → PCS	-1.45	0.35	-4.13	**	[-2.152, -0.769]
ACE-IQ → SOC-R manageability → SWLS	0.20	0.09	2.18	0.030*	[0.026, 0.397]
ACE-IQ → SWLS	-0.36	0.23	-1.54	0.123	[-0.800, 0.122]

Abbreviations: 95% BCCI, bias-corrected bootstrapped confidence interval reported for indirect effects; 95% CI, confidence interval reported for direct effects; ACE-IQ, Adverse Childhood Experiences—International Questionnaire; *b*, estimate; MCS, Mental health Component Summary; PCS, Physical health Component Summary; PSS, Perceived Stress Scale; SE, robust standard error; SOC-R, Sense of Coherence—Revised; SWLS, Satisfaction With Life Scale; Z, z-value.  
\* = *p* < 0.05; \*\* = *p* < 0.001.

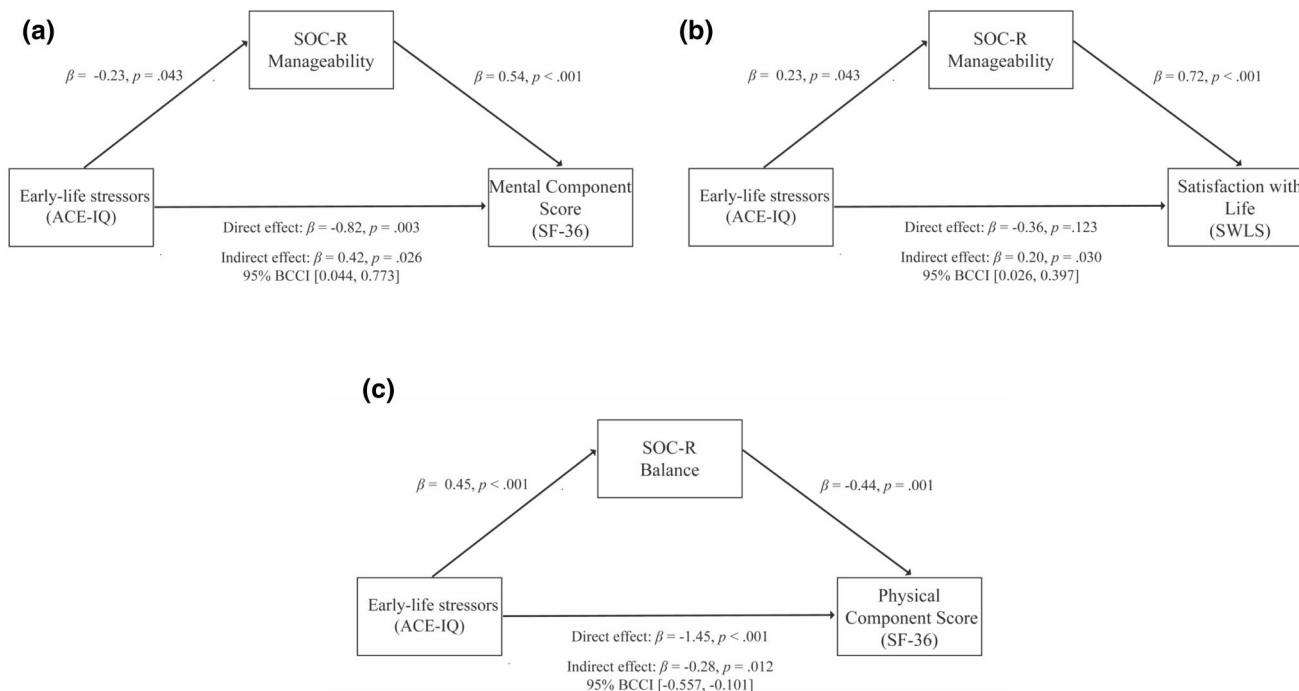


**FIGURE 1** Mediation models of the relationship between acute (perceived) stress (PSS) and mental health (MCS), significantly mediated by sense of coherence—revised (SOC-R) total (panel A) and SOC-R manageability (panel B)



**FIGURE 2** Mediation models of the relationship between acute (perceived) stress (PSS) and satisfaction with life (SWLS), significantly mediated by sense of coherence—revised (SOC-R) total (panel A) and SOC-R manageability (panel B)





**FIGURE 3** Mediation models of the relationship between early-life chronic stress (ACE-IQ) and mental health (MCS; panel A), and satisfaction with life (SWLS; panel B), significantly mediated by sense of coherence–revised (SOC-R) manageability; and the relationship between early-life chronic stress (ACE-IQ) and physical health (PCS; panel C), significantly mediated by SOC-R balance

$p = 0.012$ ), while the direct effect remained significant ( $b = -1.45$ , 95% CI [-2.152, -0.769],  $p < 0.001$ ). This indicates a partial mediation and suggests that the Balance subscale significantly mediates the relationship between ELA and mental health. See Figure 3c for the mediation model with physical health.

### 3.3 | Moderation analysis

Two multivariate regression models were first conducted to test for significance of interaction effects. These two combined models (i.e., Model 1 with SOC-R total, and Model 2 with the three SOC-R subscales) included acute (perceived) stress, ELA, physical and mental health, and satisfaction with life. When a significant interaction effect was observed across the multiple multivariate test statistics (i.e., Pillai's trace, Wilk's lambda, Hotelling's trace statistic, Roy's largest root), post-hoc regression analyses were conducted to examine the interaction effects in more detail. Pillai's trace is reported below, as the results for the other multivariate test statistics were highly consistent. Regarding ELA, no significant interaction effects were observed in the multivariate test statistics for SOC-R ( $V = 0.000$ ,  $p = 0.975$ ) or its three subscales (Manageability:  $V = 0.001$ ,  $p = 0.926$ ; Balance:  $V = 0.002$ ,  $p = 0.625$ ; Reflection:  $V = 0.001$ ,  $p = 0.877$ ), nor in an additional robust regression analysis (see Appendix S4 in the Supporting Information for results of a robust regression analysis). Thus, only the moderation analyses with acute (perceived) stress are presented in the following section.

#### 3.3.1 | Acute (Perceived) stress–SOC-R as a moderator

Based on the significant multivariate test statistics, SOC-R total ( $V = 0.01$ ,  $p = 0.048$ ) and the Manageability subscale ( $V = 0.018$ ,  $p = 0.023$ ) were further examined as potential moderators of the relationship between acute (perceived) stress and (mental and physical) health, as well as satisfaction with life.

Regarding SOC-R total, post-hoc regression analyses showed a significant interaction effect for mental health ( $b = 0.01$ , 95% CI [0.012, 0.023],  $p = 0.007$ ), indicating that SOC-R total significantly moderated the relationship between perceived stress and mental health. Simple slopes analysis revealed significant negative relationships between perceived stress and mental health at low ( $b = -1.21$ ,  $SE = 0.07$ ,  $p < 0.001$ ), mean ( $b = -1.10$ ,  $SE = 0.05$ ,  $p < 0.001$ ), and high ( $b = -0.99$ ,  $SE = 0.07$ ,  $p < 0.001$ ) levels of SOC-R total. High and low levels refer to one standard deviation above and below the mean. The decrease in effect (i.e.,  $b$ -values) indicated a buffering effect of SOC-R, suggesting that participants with high SOC-R total showed better mental health compared to those with low SOC-R total (i.e., high SOC-R total was associated with a weaker relationship between perceived stress and mental health). Similarly, the Johnson-Neyman procedure also showed that as SOC-R total increased, the strength of the relationship between perceived stress and mental health decreased (lower bound:  $b = -1.65$ ,  $SE = 0.24$ ,  $p < 0.001$ ; upper bound:  $b = -0.99$ ,  $SE = 0.06$ ,  $p < 0.001$ ). Inspection of the interaction plot also showed that after a certain level of perceived stress, and particularly at higher levels, a buffering effect was observed in which

participants with higher SOC-R showed better mental health scores in comparison to those with low and mean levels of SOC-R (see Figure 4a for the graph of the significant interaction effects). No significant interaction effects were observed for physical health ( $b = 0.002$ , 95% CI [0.012, 0.017],  $p = 0.735$ ) or satisfaction with life ( $b = 0.007$ , 95% CI [0.001, 0.015],  $p = 0.092$ ).

Regarding the Manageability subscale, post-hoc regression analyses showed a significant interaction effect for mental health ( $b = 0.04$ , 95% CI [0.021, 0.063],  $p < 0.001$ ), indicating that the Manageability subscale significantly moderated the relationship between perceived stress and mental health. As was observed for the SOC-R total score, the simple slopes analysis revealed significant negative relationships between perceived stress and mental health at low ( $b = -1.17$ ,  $SE = 0.07$ ,  $p < 0.001$ ), mean ( $b = -1.03$ ,  $SE = 0.05$ ,  $p < 0.001$ ), and high ( $b = -0.88$ ,  $SE = 0.07$ ,  $p < 0.001$ ) levels of Manageability. The Johnson–Neyman procedure also showed that as Manageability increased, the strength of the relationship between perceived stress and mental health decreased (lower bound:  $b = -1.71$ ,  $SE = 0.19$ ,  $p < 0.001$ ; upper bound:  $b = -0.87$ ,  $SE = 0.07$ ,  $p < 0.001$ ). Inspection of the interaction plot supported this buffering effect, showing that after a certain level of perceived stress, and particularly at higher levels, participants with higher SOC-R showed better mental health scores in comparison to those with low and mean levels of SOC-R (see Figure 4b for the graph of the significant interaction effects). No significant interaction effects were observed for physical health ( $b = 0.02$ , 95% CI [0.003, 0.058],  $p = 0.081$ ) or satisfaction with life ( $b = 0.01$ , 95% CI [0.007, 0.027],  $p = 0.261$ ).

## 4 | DISCUSSION

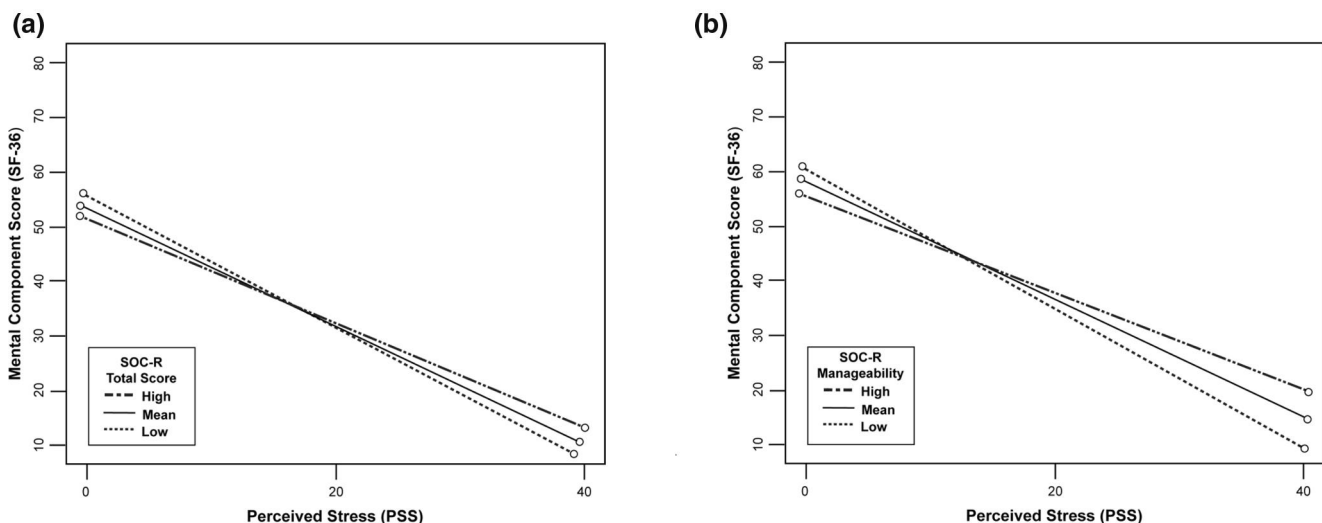
The current study aimed to assess the mediating and moderating mechanisms of SOC-R in the relationship between stress and health. Regarding acute (perceived) stress, SOC-R and its Manageability

subscale were significant mediators for mental health, as well as satisfaction with life. In addition, SOC-R and its Manageability subscale were also significant moderators of the relationship between acute (perceived) stress and mental health. Regarding ELA, the Manageability subscale was a significant mediator for mental health, as well as satisfaction with life; and the Balance subscale was a significant mediator for physical health. The findings will be discussed in detail below, first for acute (perceived) stress, and then for ELA.

### 4.1 | SOC-R and acute (perceived) stress

The current study expanded on previous research by including an indicator of acute (perceived) stress. In support of the hypothesis, SOC-R and its Manageability subscale were found to significantly mediate the relationship between perceived stress and mental health, as well as satisfaction with life. While this is the first study to examine an acute (perceived) stress with SOC-R, the findings are in line with research on the original SOC and mental health. For example, a recent large-scale study with  $N = 2907$  older stroke patients found SOC to be a significant mediator of the relationship between acute (perceived) stress (also measured with the PSS) and depressive symptoms (Guo et al., 2018). In addition, while previous studies have shown SOC-R to mediate the relationship between chronic stress and satisfaction with life (e.g., Mc Gee et al., 2018b), the present study is the first to demonstrate this mediation with satisfaction with life for acute (perceived) stress. While these initial findings appear promising, further longitudinal research is required to examine the mediation of acute stress experiences in more detail.

Regarding moderation, in support of the hypothesis, SOC-R and its Manageability subscale were observed to be significant moderators of the relationship between perceived stress and mental health. While this is a new finding for acute (perceived) stress, the results are in line with previous chronic stress research, which found that



**FIGURE 4** Significant interaction between acute (perceived) stress (PSS) and mental health (MCS) at different levels of the moderator sense of coherence—revised (SOC-R) total (panel A), and SOC-R manageability (panel B). High and low levels refer to one standard deviation above and below the mean of the moderator

SOC-R and Manageability acted as moderators in the relationship between chronic stress and mental health (Mc Gee et al., 2018b). Furthermore, when examining the subscale level in the current study, Manageability emerged as both a significant mediator and moderator of the relationship between acute (perceived) stress and mental health. Defined as the 'ability to come to terms with difficult situations' (Bachem & Maercker, 2018, p. 210); the Manageability component of SOC-R may be most relevant in the association with stress and mental health, in comparison to balance or reflection. However, this is mainly conjecture at this early stage and substantial (longitudinal) evidence is needed to further examine the component level of SOC-R.

The exploratory hypothesis for acute stress was not supported with regard to physical health. However, the lack of a mediating or moderating role of SOC-R for physical health may be expected from studies with the original SOC. For instance, a review on physical health research found only a few modest or non-significant associations between SOC and physical health (Flensburg-Madsen et al., 2005). In addition, a systematic review of SOC and health measures found that the physical component scale of the SF-36 (the measure of physical health in the current study) showed weaker associations with SOC than the mental component scale (Eriksson & Lindström, 2006). As a next step, it may be useful to examine additional indicators of physical health (e.g., objective health status, functionality measures, medication lists, physician or hospital attendance) to overcome potential measurement issues.

## 4.2 | SOC-R and early-life chronic stress—ELA

Regarding mediation, in support of the hypothesis, the subscale Manageability was shown to significantly mediate the relationship between ELA and mental health, as well as satisfaction with life. This is consistent with previous research in a Swiss sample ( $N = 268$ ), which found SOC-R total to mediate the relationship between ELA (in the form of neglect) and mental health, as well as satisfaction with life (Mc Gee et al., 2018b). However, a novel finding of the current study was the significant mediation by the subscale Balance in the relationship between ELA and physical health. The Balance subscale refers to the ability to balance positive and negative life experiences and feelings (Bachem & Maercker, 2018). It may be that the Balance component of SOC-R is most relevant for ELA, in comparison to manageability or reflection. For instance, it may represent a form of emotion regulation involved in the relationship between ELA and physical health. For example, in a recent study of  $N = 290$  women enrolled in a clinical trial, emotion regulation was observed to mediate the association between ELA and physical health (Cloitre et al., 2019). However, given that the current cross-sectional study is the first finding of its kind on SOC-R (Balance) and physical health, definitive statements cannot be made and further prospective studies are warranted.

Regarding moderation for ELA, the hypothesis was not supported, as SOC-R did not significantly moderate the relationship

between ELA and physical or mental health, nor satisfaction with life. This contrasts with previous studies in Germany (Thoma et al., 2018) and Switzerland (Mc Gee et al., 2018a) which both found SOC-R to significantly moderate the relationship between ELA (emotional neglect) and mental health. The lack of a significant moderation in the current study may be due to the differences in the ELA measure, as emotional neglect was incorporated into the overall ELA indicator in the current study (WHO, 2018a). Such an encompassing total score may mask the more nuanced effects of the specific types of ELA. It may therefore help for future studies to examine different ELA types, as well as total ELA exposure.

Another explanation for the lack of a significant moderation may be the comparatively low levels of ELA observed in the current study, which may be somewhat accounted for by the characteristics of the selective sample. For instance, recent research by Lewer et al. (2020) examined ELA rates using ecological data at the local authority level in England. Results showed that high rates of ELA were associated with child poverty and deprivation, areas of high population density, and regions with high rates of social problems (e.g., unemployment, drug- and alcohol-related deaths). In the current study, the socio-demographics depict a sample with the majority reporting a high level of education, in employment, in a mid-level income class, with average subjective socio-economic status (see Table 1 for socio-demographics). Given these characteristics, and in light of the findings of Lewer et al. (2020), it could be expected that the current sample would report lower rates of ELA exposure. However, as this was not the focus of the present study this explanation is only speculative, but future studies examining ELA may benefit from consideration of such socio-ecological factors.

## 4.3 | Limitations and future research directions

Some limitations must be considered with respect to the findings of the current study. A main limitation of this study is the cross-sectional design, which does not allow for any causal inferences to be made. For example, a potential alternative explanation of the findings may be that individuals with health problems also have lower levels of SOC-R and perceive more stress as a result of their health problems. Therefore, future replication of this study is needed, using prospective designs and repeated measurements (Geyer, 1997). In addition, regarding the reliability of the SOC-R subscales, the Manageability and Balance subscales showed only moderate internal consistency, as indexed by Cronbach's alpha. While the number of items or the dimensionality of a scale can affect the magnitude of Cronbach's alpha, lower values can potentially limit the reliability and also the validity of a scale (Tavakol & Dennick, 2011). Therefore, the results of the regression analyses should be interpreted with care in regard to the Manageability and Balance subscales. Further research is needed to examine the psychometric properties, specifically the reliability and validity, of the SOC-R scale and its subscales in greater detail. Furthermore, regarding the relatively low ELA scores discussed above, the opt-in method of participation may have led to a

self-selection bias (e.g., participants with ELA experiences choosing not to participate), potentially further contributing to the low ELA scores. A potential bias may also be seen in the highly educated sample in the current study (e.g., 45.2% with a university level education). In comparison, the most recent census of the Irish population stated that only 18.9% of those aged 65 years or older had obtained a third level education, that is, higher qualification (Central Statistics Office, 2016). In addition, the interactive data provided for the 2016 census on age and education allowed for a comparison of the age group 50–84 years, which most closely fit with that of the current study (Central Statistics Office, 2020). Results showed that only 21.91% of this age group had obtained a third level education. Although a wide variety of recruitment methods were employed in the current study, it may be that individuals with a university education have greater exposure to or are more familiar with research studies and are therefore more likely to participate. Thus, the findings may not be entirely representative of this age group and future studies should aim to replicate this study with a more diverse range of educational levels.

## 5 | CONCLUSION

The findings of the current study can add tentative support to the limited research on the associations between SOC-R, stress, and health. In particular, two novel findings emerged: the mediating and moderating role of SOC-R in relation to acute (perceived) stress; as well as the mediating role of the SOC-R Balance subscale in the relationship between ELA and physical health. To build on these preliminary findings and provide substantial information on the mechanisms of SOC-R, longitudinal data is required. For example, a study by Grevenstein et al. (2016) examined the original SOC in a sample of  $N = 318$  adolescents in Germany. Using a 9-year prospective, longitudinal design the results were able to identify SOC as a significant long-term predictor of substance use frequency and mental health (Grevenstein et al., 2016). Going forward, such longitudinal research could provide the stronger evidence needed to identify SOC-R as a long-term modulating pathway between stress and health. In conclusion, the findings of the current study identified potential roles of SOC-R in the relationship between stress and health, suggesting that SOC-R may provide a useful focus for further stress-related research.

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## CONFLICT OF INTEREST

No conflict of interest was reported by the authors.

## ETHICS STATEMENT

The study was conducted by the University of Zurich, in collaboration with University College Dublin, National College of Ireland, and Ulster University, with the informed consent of all participants in accordance with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of the Faculty of Arts and Social Sciences in the University of Zurich, Switzerland (ID 18.6.1), and the Human Research Ethics Committee—Humanities in University College Dublin, Ireland (ID HS-18-30-Carr).

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Open Science Framework (OSF) at <http://doi.org/10.17605/OSF.IO/AEPMN>, identifier: DOI 10.17605/OSF.IO/AEPMN.

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