

The synergy between stress and self-compassion in building resilience: A 4-year longitudinal study

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Abstract

This 4-year prospective study investigated the dynamic relationship between stress, self-compassion, and resilience among university students, a population with increasing rates of mental health challenges. Drawing on stress theories, the research explored whether the combination of stress and self-compassion strengthens resilience over time. A sample of 1137 university students (47.6% White, 38% female) completed measures of stress, resilience, and self-compassion annually during the Spring semester across their four undergraduate years. A random intercept cross-lagged panel model with latent interactions was used to test the hypothesized causal relationships. Contrary to the common belief that stress is debilitating, the results revealed a positive association between an increase in stress and a subsequent increase in self-compassion. Moreover, when stress levels increased alongside self-compassion, students demonstrated higher resilience. Notably, an increase in either stress or self-compassion alone did not enhance resilience. These findings highlight the synergetic effect between self-compassion and stress in enhancing resilience; under the right conditions, stress can lead to positive outcomes and increased capacity for coping with future stressors.

KEYWORDS

perceived stress, resilience, RI-CLPM, self-compassion, state, stress inoculation, trait, university students

1 | INTRODUCTION

That which does not kill us makes us stronger.

Friedrich Nietzsche

Psychologists have long been intrigued by how some people attain personal growth and become more resilient after significant stress, despite the well-documented negative effects of stress on health and well-being (DeLongis et al., 1988; O'Connor et al., 2021; Pugliesi, 1999). This phenomenon, known as the “stress paradox,” suggests that stress can sometimes enhance well-being. Although generally unpleasant, stressful events provide an opportunity to practice and build effective responses to manage difficult circumstances. Stress inoculation theory (SIT; Meichenbaum, 2017) posits that growth after stress occurs through the refinement and increased skill at these responses, similar to how the body's immune system becomes stronger after fighting an infection. By navigating challenges, people strengthen their capacity to handle stress and become better prepared for future challenges. In this way, stress leads to greater resilience, defined as an ability to bounce back from negative events (Smith et al., 2008).

For example, couples with good problem-solving skills who experienced a moderate amount of stress during the early months of marriage showed greater future resilience and a better transition to parenthood compared to those who did not experience stress and therefore did not practice these coping skills (Neff & Broadly, 2011). While moderate stress coupled with effective responses can lead to better outcomes (e.g., Crane et al., 2019; Kermott et al., 2019; Park, 2009; Seery et al., 2010), our understanding of the specific responses that facilitate stress-related growth remains limited. Herein we examine how self-compassion, a kind and supportive attitude toward oneself in times of difficulty, may promote stress-related growth.

1.1 | Stress, responses to stress, and outcomes

Three stress-related responses are described in the literature: stress appraisal, stress mindset, and stress management. According to the transactional view of stress, stress appraisal involves people's perception of their ability to cope with a situation deemed stressful if they feel that they do not have adequate resources (Folkman, 1984). For example, imagine a person's car needs major repairs. If they have another car, enough money, or someone to reach out to for help, the situation may be perceived as within their ability to cope, and thus, not stressful; otherwise, the situation could be perceived as highly stressful. This conceptualization of stress as a subjective experience accounts for the wide variation in people's responses to particular situations.

If the person perceives the situation (e.g., their car needing major repairs) as stressful, their beliefs about the nature of stress (i.e., their mindset) may influence outcomes (Crum et al., 2013). In one study, participants watched videos containing either “stress-is-enhancing” or “stress-is-debilitating” messages and reported on their mood and work performance. Those in the stress-is-enhancing condition reported better mood and work performance over time than those in the stress-is-debilitating condition (Crum et al., 2017). A person who finds their car repair situation stressful but views stress as having benefits will have better outcomes than a person who views stress as impairing. Thus, outcomes of experiences seen as stressful are influenced by the interplay between the situation itself and stress mindset.

In addition, how people manage stressful situations—either effectively or ineffectively—can influence outcomes (Carver, 1998; Zimmer-Gembeck & Skinner, 2016). Researchers have categorized and described effective stress management methods in a variety of ways, including use of psychological resources (Hobfoll, 1988), adoption of positive coping techniques (Aldwin et al., 1996; Taylor & Stanton, 2007), the pursuit of meaning-making (Park, 2009), and, when confronted with intense stressors such as trauma, a reevaluation of one's beliefs and

aspirations (Tedeschi & Calhoun, 2004). In the car repair example, a person might use positive reframing, seek support from others, or problem-solve in order to navigate the situation successfully and minimize negative outcomes.

Stress appraisal, stress mindset, and stress management can all influence stress-related outcomes. Stress inoculation theory brings these factors together by suggesting that under the right conditions, stressful situations may not only be endured but also may lead to growth and resiliency as one gains confidence and mastery. Over time, this growth manifests as enhanced social and psychological well-being, such as enhanced social bonds and bolstered psychological resilience (Park & Fenster, 2004). Overall, this work highlights the significance of identifying factors that can alter the outcome of a stressor in a positive direction.

1.2 | Self-compassion: A possible factor leading to increased resilience after stress

One factor that may increase the ability to learn and grow from stress is self-compassion, defined as being supportive of oneself when faced with emotionally challenging situations (Neff, 2023). Self-compassion has been described in a variety of ways, including a “healthy attitude towards oneself” when struggling (Neff, 2003), “a psychologically adaptive mindset” (Neff, Kirkpatrick, et al., 2007, Neff, Rude, et al., 2007), a relatively stable personality trait, and a “mind state” that can be cultivated and induced (Neff, 2023).

Numerous studies have demonstrated a positive association between self-compassion and well-being, mental health, positive coping, and motivation (for a review, see Neff, 2023) and a negative association with stress and psychological distress (MacBeth & Gumley, 2012; Marsh et al., 2018). Highly self-compassionate people fare better under stressful situations; for example, people high in trait self-compassion were less anxious and less depressed when stressed compared to those who were lower in self-compassion (Lathren et al., 2019; Neff, Kirkpatrick, et al., 2007, Neff, Rude, et al., 2007). In a study conducted over 2 weeks, the effect of perceived stress on negative affect was weaker for those with high baseline trait self-compassion (Krieger et al., 2015), a result replicated over 2 years (Stutts et al., 2018). Self-compassion had a similar role in samples as diverse as nurses (Dev et al., 2020), students dealing with chronic academic stress (Zhang et al., 2016), senior living residents (Smith, 2015), and patients with chronic diseases (Sirois et al., 2015). These results suggest that self-compassion may be useful for managing stress and mitigating its adverse effects in a variety of circumstances.

Although these studies provide insight into how self-compassion relates to resilience in stressful situations, they are primarily cross-sectional and provide limited information about the direction of influence. Furthermore, it remains unclear whether self-compassion can transform stress into personal growth beyond merely mitigating its negative impact. Another complication is that previous research has not distinguished between self-compassion that is relatively stable over time and self-compassion that is more variable and, thus, possibly affected by stress itself.

1.3 | Increased self-compassion as a protective factor

Achieving a broader understanding of the role of self-compassion in contending with stress to build resilience requires considering self-compassion as relatively stable and trait-like while also variable and state-like (Hamaker et al., 2007). Whereas some research views self-compassion as a trait that is only modified through prolonged skill-building interventions, other studies indicate that short-term changes in self-compassion are possible through induction activities such as brief writing tasks (e.g., Odou & Brinker, 2014) or guided meditations (e.g., Breines & Chen, 2012). Importantly, these studies suggest that self-compassion may fluctuate in response to everyday situations.

The distinction between trait and state self-compassion is also important in the context of theories of stress. Although stress theories have emphasized the interplay between stressful situations and adaptive responses (such as mindset and stress management skills), research that captures the dynamic and directional relationships between the two is limited (Infurna & Jayawickreme, 2019). Specifically, few studies have examined whether increases in stress lead to increases in effective responses or factors that subsequently lead to positive stress outcomes.

Based on research indicating that self-compassion can act as a protective mechanism against negative stress outcomes (Lathren et al., 2019; Stutts et al., 2018), we hypothesize that self-compassion may increase in response to stress as a natural defense mechanism, and this increase can enable people to cope more effectively within the current situation while increasing their capacity to deal with future challenges. Although no studies have examined the effects of stress on change of self-compassion, anecdotal evidence from athletes indicates that self-compassion can emerge after failure, boosting morale and persistence (Wilson et al., 2019). Alternatively, increasing stress could lead to decreased self-compassion; under high stress, some individuals may experience heightened self-criticism and feel overwhelmed. This alternative hypothesis is in line with cross-sectional studies showing an inverse relationship between stress and self-compassion (MacBeth & Gumley, 2012; Marsh et al., 2018), particularly among those experiencing chronic, high levels of stress (Vettese et al., 2011).

Using a random intercept cross-lagged panel model (CLPM) over 4 years in a large sample of undergraduates, we sought to confirm research showing that, under certain circumstances, experiencing stress can lead to positive outcomes and stress inoculation. The undergraduate years are a pivotal period in early adulthood, marked by major developmental changes, significant life transitions, and elevated levels of stress (Arnett, 2016). The ability to manage these challenges can have a lasting impact on people's future success (Montgomery & Côté, 2003). During this period, students are also developing important skills that will help them overcome challenges in various aspects of life, including academics and relationship building.

The methodology used in this study advances the literature in several important ways. We explore the possibility that self-compassion is a beneficial response to stress by examining the relationship among self-compassion, stress, and resilience longitudinally in a naturalistic setting. Furthermore, by separating stable (4-year latent mean of self-compassion) from changing (variability in self-compassion that is not explained by the latent mean across time points) effects, we are able to examine nuanced patterns of change and test a causal hypothesis supported by stress inoculation theories— that increases in self-compassion, which we might expect under increasing stress, both precede and contribute to the development of increased resilience.

Specifically, our three hypotheses are:

- (1) In line with extant cross-sectional research, we hypothesize that trait self-compassion will be negatively related with stress and positively related with resilience; trait stress and resilience will be negatively related.
- (2) In line with stress and post-stress growth theories, we hypothesize that within-individual increases in stress will predict later increases in self-compassion across the four time points, while taking into account trait-level between-individual differences. We will also test the competing hypothesis that increasing stress predicts a decrease in self-compassion over time, while taking into account trait-level differences.
- (3) Increasing self-compassion over time coupled with increasing stress over time will predict later increased resilience across all four time points.

2 | METHOD

2.1 | Participants

The data used for the analysis is a subset of the data collected for the Student Resilience and Well-Being Project (Hoyle et al., 2021), a multi-site longitudinal study. We used data from a single site for several reasons: (1) our team

had collected data from this site and had full direct access to these data and (2) this site had the largest and most complete dataset, which was ideal for the statistical analysis techniques used. Participants were full-time, first-year students who were followed through their fourth year of college ($N = 1473$). In this initial sample, 38% of the students identified as female, and 30% as male; the remainder chose not to disclose their gender identity. Racial background was: 47.6% of the students were White, 27.1% were Asian American/Asian, 12.3% were Multi- or Bicultural, 7.4% were African American/Black, and 3.7% were Mexican American/Chicano/Puerto Rican/other Latino.

The variables of interest were measured soon after Spring Break across 4 years (2015–2018). For the current analysis, participants whose responses were missing for all three measures of perceived stress, self-compassion, and resilience ($n = 332$) were excluded from the analysis, resulting in 1137 participants in the final sample.

2.2 | Missing data and power analysis

As is common in longitudinal data, there were substantial missing data throughout the study: 70%, 69%, 68%, and 34% were missing at the end of each year compared to the enrolled participants at the baseline. As a result of an effort to minimize the high missing rates, the final year's participation almost doubled that of the previous years. Two hundred sixty-one participants (18%) provided data at all time points, 502 (34%) provided data at the last time point only, and 336 (23%) did not provide data after baseline. We assumed that the non-responses were missing at random. A Fully Bayesian method (Ibrahim et al., 2005), a Bayesian analog of the full-information maximum likelihood estimator (FIML), was used to account for missing data. Our power analysis suggests that our RICLPM requires a sample size of 770–1093 to detect a cross lagged effects of 0.25 with 70% power with 70% missing values; for 80% power, the corresponding sample size is 977–1390. See Supporting Information S1: Section S1 for details.

2.3 | Measures

2.3.1 | Perceived stress

The 10-item Perceived Stress Scale (Cohen & Williamson, 1988) was used to measure the degree to which participants evaluated their life as upsetting and out of control during the past month. A sample item is: "In the last month, how often have you been upset because of something that happened unexpectedly?" Participants answered the questions using a 0 (*Never*) to 4 (*Very Often*) scale. A total score was calculated by reverse-scoring the positively worded items and computing a mean score. Omega coefficients ranged from 0.89 to 0.91 across the four timepoints.

2.3.2 | Self-compassion

The 12-item Brief Self-Compassion Scale was used (Raes et al., 2011). Responses to each item used a 5-point scale ranging from 1 (*Almost Never*) to 5 (*Almost Always*). A sample item is: "When I'm going through a very hard time, I give myself the caring and tenderness I need." A total score was calculated by reverse-scoring the negatively worded items and computing a mean score. Omega coefficients ranged from 0.88 to 0.91.

2.3.3 | Resilience

The six-item Brief Resilience Scale (Smith et al., 2008) measures resilience as the ability to bounce back and recover from stress. A sample item is "It does not take me long to recover from a stressful event." The response scale

ranged from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). A score was calculated by reverse-scoring the negatively worded items and computing a mean score. Omega coefficients ranged from 0.90 to 0.93. The descriptive statistics, intra-class correlations, and bivariate correlations of the variables across four-time points are reported in the results section.

2.4 | Statistical methods

A random intercept cross-lagged panel model (RI-CLPM; Hamaker et al., 2015) with latent interactions was specified to test the hypothesized causal relationship between perceived stress, self-compassion, and resilience. The CLPM allows researchers to disentangle the time-lagged effect and cross-sectional correlations. The time-lagged effect is decomposed into the carry-over effect and the cross-lagged effect. The carry-over effect, which is often called the autoregressive (AR) effect, refers to the effect of the past state of the variable. On the other hand, the cross-lagged (CL) effect refers to the effect of the other variables of the previous time point. To illustrate, the cross-lagged model can estimate $A_{t-1} \rightarrow A_t$ and $B_{t-1} \rightarrow B_t$ for AR effects and $A_{t-1} \rightarrow B_t$ and $B_{t-1} \rightarrow A_t$ for CL effects simultaneously. This approach allows the identification of the direction and the strength of the hypothesized causal associations. RI-CLPM (Hamaker et al., 2015; Mulder & Hamaker, 2021) is an extension of the traditional CLPM model. One limitation of the classic CLPM is that it does not distinguish between-individual and within-individual effects. The RI-CLPM allows an examination of within-individual changes (state) controlling for between-individual differences (trait). The model can be further extended to include latent interaction effects (Ozkok et al., 2022).

The current analysis examined the within-level interaction effects to identify the dynamic synergetic effect of self-compassion and stress on resilience, apart from trait-level effects. The within-level interaction effect is understood as the moderating influence of a state variable on either the AR or CL effect. For example, as stress levels rise, an increase in self-compassion at the previous time point may result in heightened resilience at the next time point. To illustrate, for each outcome $Y = S, C, R$ and time $t = 2, 3, 4$, the outcome at time t for subject $i = 1, 2, \dots, N$ is modeled as

$$Y_{i,t} = \alpha_t^Y + \zeta_i^Y + \sum_{A=S,C,R} \beta_A^Y A_{B,i} + u_{i,t}^Y + \sum_{A=S,C,R} \gamma_A^Y A_{W,i,t-1} + \sum_{(A,D)=(S,C),(C,R),(R,S)} \gamma_{AD}^Y A_{W,i,t-1} D_{W,i,t-1} + \epsilon_{i,t},$$

where S is stress, C is self-compassion, R is resilience, $A_{B,i}$ denotes the subject- i -specific trait latent variable, $A_{W,i,t}$ is the subject- i -specific latent variable for time t , ζ_i^Y and $u_{i,t}^Y$ are the trait and time t error of outcome Y for subject i , respectively, and α_t^Y , β_A^Y , γ_A^Y , and γ_{AD}^Y are the intercept for time t and outcome Y , main effects associated with the trait variable A on Y , main effects associated with the state latent variable A on Y , and the interaction effects of A and D on Y , respectively. The model is partially stationary in the sense that the main and interaction effects (β_A^Y , γ_A^Y , δ_{AD}^Y) are constant over time but that it allows the intercept to be time-varying for flexibility. This two-way interaction model can be rewritten in an expanded form as below (also see Figure 1):

$$Y_{i,t} = \alpha_t^Y + \zeta_i^Y + \beta_S^Y S_{B,i} + \beta_C^Y C_{B,i} + \beta_R^Y R_{B,i} + u_{i,t}^Y + \gamma_S^Y S_{W,i,t-1} + \gamma_C^Y C_{W,i,t-1} + \gamma_R^Y R_{W,i,t-1} + \gamma_{SC}^Y S_{W,i,t-1} C_{W,i,t-1} + \gamma_{CR}^Y C_{W,i,t-1} R_{W,i,t-1} + \gamma_{RS}^Y R_{W,i,t-1} S_{W,i,t-1} + \epsilon_{i,t}$$

We used a Bayesian estimation framework, which concurrently models random effects and accounts for missing data (Daniels & Hogan, 2008; Ibrahim et al., 2005) and has both computational (Asparouhov & Muthén, 2010) and finite-sample statistical (Asparouhov & Muthén, 2021) advantages—smaller bias—over its frequentist counterpart. The uniform distribution, one of the most often used non-informative prior, was used for the priors. Gibbs sampling

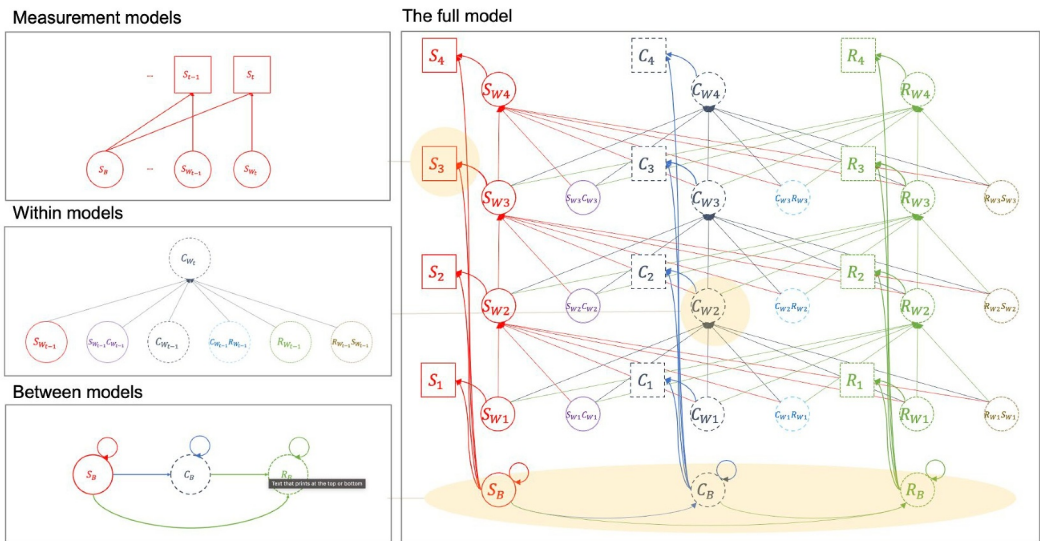


FIGURE 1 Conceptual model. S_t , Stress level at time t ; C_t , Self-compassion at time t ; R_t , Resilience at time $t = 1-4$; Subscripts B , Time-invariant latent variables; Subscripts Wt , Time- t latent variables; $A_{Wt}D_{Wt}$, Interaction of time- t latent variables A and D .

was used for the Markov Chain Monte Carlo algorithm. The Proportional Scale Reduction factor < 1.1 was set as the convergence criterion, which took 113,000 iterations. Mplus 8.3 was used for the analysis.

3 | RESULTS

The means, standard deviations, and bivariate correlations of the measurements at each time point are summarized in Table 1. The ICCs for self-compassion, stress, and resilience were 0.633, 0.629, and 0.483, respectively, implying that the within-subject variation of each measure over time is moderately stable compared to the between-individual variability. The distribution of each measure at each time point is given as a histogram in Figure S1; although the Shapiro-Wilk test statistics suggest that the measurements deviated from the normal distribution, the distributions were reasonably concentrated around the mean, and our inference based on the central limit theorem is valid given the large sample size and boundedness of the measurements (i.e., bounded variance). The main results are summarized in Figure 2 and Table 2.

3.1 | Hypothesis 1: Trait self-compassion, trait stress, and trait resilience

The between effect refers to between-individual trait relationships. The trait outcome model tested the hypothesis that self-compassion will be positively related to resilience and negatively related to stress, and that stress and 4-year resilience will be negatively related.

The trait model was developed with stress and self-compassion as predictors and resilience as an outcome. Self-compassion was predicted by stress. The results showed that the trait-like stress significantly negatively predicted self-compassion, $\beta = -0.887$, $SE = 0.073$, 95% CI $[-1.057, -0.767]$, $p < 0.001$. Perceived stress was also significantly negatively related to resilience, $\beta = -0.762$, $SE = 0.325$, 95% CI $[-1.578, -0.425]$, $p = 0.002$. However, self-compassion was not significantly related to resilience, $\beta = 0.275$, $SE = 0.281$, 95% CI $[-0.411, 0.583]$, $p = 0.11$.

TABLE 1 Descriptive statistics and correlations of stress, self-compassion, and resilience across four time points.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Perceived stress at year 4	1.85	0.71											
2. Perceived stress at year 3	1.80	0.72	0.51**										
			[0.42, 0.59]										
3. Perceived stress at year 2	1.77	0.75	0.40**	0.54**									
			[0.31, 0.49]	[0.46, 0.61]									
4. Perceived stress at year 1	1.68	0.72	0.42**	0.54**	0.54**								
			[0.33, 0.51]	[0.46, 0.61]	[0.46, 0.61]								
5. Self-compassion at year 4	3.05	0.66	-0.63**	-0.49**	-0.34**	-0.30**							
			[-0.68, -0.56]	[-0.57, -0.40]	[-0.44, -0.25]	[-0.39, -0.20]							
6. Self-compassion at year 3	3.02	0.68	-0.43**	-0.59**	-0.39**	-0.40**	0.67**						
			[-0.52, -0.34]	[-0.65, -0.53]	[-0.47, -0.30]	[-0.48, -0.31]	[0.61, 0.73]						
7. Self-compassion at year 2	3.06	0.71	-0.44**	-0.51**	-0.64**	-0.42**	0.61**	0.69**					
			[-0.53, -0.35]	[-0.59, -0.43]	[-0.69, -0.58]	[-0.50, -0.33]	[0.53, 0.67]	[0.64, 0.74]					
8. Self-compassion at year 1	3.08	0.70	-0.42**	-0.44**	-0.41**	-0.54**	0.60**	0.68**	0.69**				
			[-0.50, -0.33]	[-0.52, -0.35]	[-0.49, -0.32]	[-0.58, -0.49]	[0.52, 0.66]	[0.62, 0.73]	[0.63, 0.74]				
9. Resilience at year 4	3.51	0.80	-0.60**	-0.40**	-0.34**	-0.31**	0.59**	0.46**	0.46**	0.44**			
			[-0.66, -0.54]	[-0.49, -0.30]	[-0.44, -0.25]	[-0.41, -0.21]	[0.53, 0.65]	[0.37, 0.54]	[0.37, 0.54]	[0.35, 0.52]			
10. Resilience at year 3	3.55	0.79	-0.44**	-0.60**	-0.41**	-0.39**	0.47**	0.58**	0.52**	0.47**	0.63**		
			[-0.52, -0.35]	[-0.66, -0.54]	[-0.49, -0.32]	[-0.47, -0.30]	[0.38, 0.55]	[0.52, 0.64]	[0.44, 0.59]	[0.38, 0.54]	[0.55, 0.69]		
11. Resilience at year 2	3.58	0.81	-0.43**	-0.41**	-0.56**	-0.42**	0.42**	0.42**	0.57**	0.47**	0.63**	0.63**	
			[-0.51, -0.33]	[-0.49, -0.32]	[-0.62, -0.50]	[-0.50, -0.34]	[0.33, 0.51]	[0.33, 0.50]	[0.51, 0.63]	[0.39, 0.54]	[0.56, 0.69]	[0.56, 0.69]	
12. Resilience at year 1	3.53	0.79	-0.47**	-0.43**	-0.50**	-0.54**	0.49**	0.51**	0.56**	0.57**	0.60**	0.67**	0.70**
			[-0.55, -0.39]	[-0.51, -0.35]	[-0.57, -0.42]	[-0.58, -0.49]	[0.41, 0.57]	[0.43, 0.58]	[0.48, 0.62]	[0.52, 0.61]	[0.52, 0.66]	[0.61, 0.72]	[0.64, 0.74]

Note: M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation.

* Indicates $p < 0.05$. ** indicates $p < 0.01$.

3.2 | Hypothesis 2: State self-compassion increases after an increase in stress

Next, a time-varying outcome model was examined to evaluate the effect of the changes over time. To comprehensively consider all possible bidirectional effects and test the competing hypothesis that stress may decrease self-compassion, each of the three variables—perceived stress, self-compassion, and resilience—served as both

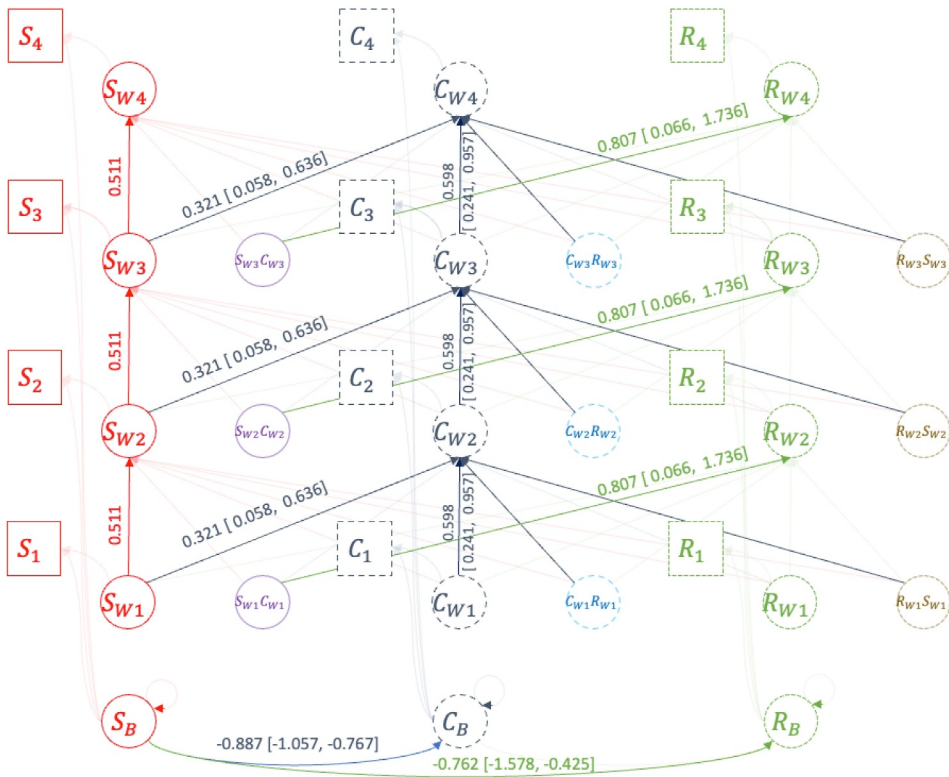


FIGURE 2 The estimated model. S_t , Stress level at time t ; C_t , Self-compassion at time t ; R_t , Resilience at time $t = 1-4$; Subscripts B , Time-invariant latent variables; Subscripts Wt , Time- t latent variables; $A_{Wt}D_{Wt}$, Interaction of time- t latent variables A and D . The paths with statistically significant coefficients are shown as solid lines with the coefficients on them. Each within-model coefficient shares the same value along the vertical line (i.e., different time points), and is only displayed once for the sake of simplicity.

predictors and outcomes. All possible cross-lagged (CL) and autoregressive effects (AR) were included to disentangle the carry-over effect of a variable from its previous time point from the influences of other variables. Finally, the model included all potential two-way interactions between stress, self-compassion, and resilience to thoroughly capture the dynamic interplay among the three variables.

3.2.1 | Perceived stress

The AR effect was significant in predicting perceived stress, $\beta = 0.51$, $SE = 0.19$, 95% CI [0.080, 0.830], $p = 0.018$, indicating a significant carry-over effect of stress from the previous time point to the next. However, none of the CL effects were significant. Resilience and self-compassion at the previous time point did not significantly predict perceived stress at the next time point. None of the interaction effects from the previous time point significantly predicted stress.

3.2.2 | Self-compassion

Self-compassion showed significant AR and CL effects. An increase in self-compassion at the previous time point was significantly related to higher self-compassion at the next time point (AR), $\beta = 0.60$, $SE = 0.19$, 95% CI [0.241,

TABLE 2 The within-level interaction model.

Outcome	Predictor	Two-way within-level interaction model
Time-invariant outcome model		
R_t	S_t	-0.762 [-1.578, -0.425] *
	C_t	0.275 [-0.411, 0.583]
C_t	S_t	-0.887 [-1.057, -0.767] *
Time-varying outcome model		
Outcomes: Stress		
S_{Wt}	$S_{W,t-1}$	0.511 [0.080, 0.830] *
	$R_{W,t-1}$	0.151 [-0.241, 0.515]
	$C_{W,t-1}$	0.277 [-0.145, 0.639]
	$S_{W,t-1}R_{W,t-1}$	-0.049 [-1.044, 0.874]
	$C_{W,t-1}R_{W,t-1}$	0.336 [-0.461, 1.668]
	$C_{W,t-1}S_{W,t-1}$	0.227 [-0.656, 1.055]
Outcomes: Self-compassion		
C_{Wt}	$C_{W,t-1}$	0.598 [0.241, 0.957] *
	$R_{W,t-1}$	0.075 [-0.212, 0.387]
	$S_{W,t-1}$	0.321 [0.058, 0.636] *
	$S_{W,t-1}R_{W,t-1}$	-0.908 [-1.831, 0.299]
	$C_{W,t-1}R_{W,t-1}$	-1.191 [-2.170, 0.471]
	$C_{W,t-1}S_{W,t-1}$	-0.430 [-1.193, 0.525]
Outcomes: Resilience		
R_{Wt}	$R_{W,t-1}$	0.065 [-0.309, 0.503]
	$S_{W,t-1}$	0.074 [-0.248, 0.387]
	$C_{W,t-1}$	0.169 [-0.132, 0.627]
	$S_{W,t-1}R_{W,t-1}$	-0.624 [-1.486, 0.230]
	$C_{W,t-1}R_{W,t-1}$	0.335 [-0.498, 1.202]
	$C_{W,t-1}S_{W,t-1}$	0.807 [0.066, 1.736] *

Note: S_t , Stress level at time t ; C_t , Self-compassion at time t ; R_t , Resilience at time $t = 1-4$. Parameter estimates and 95% confidence interval estimates for the main effect model and the two-way interaction model. $t = 2, 3, 4$.

* $p < 0.05$.

0.957], $p < 0.001$. This finding suggests a significant carry-over effect of self-compassion from one time point to the next. Resilience at the previous time point did not predict self-compassion at the later time point, $\beta = 0.08$, $SE = 0.15$, 95% CI [-0.212, 0.387], $p = 0.29$ (CL). In line with our hypothesis, an increase in perceived stress significantly positively predicted self-compassion at the later time point (CL), $\beta = 0.32$, $SE = 0.15$, 95% CI [0.006, 0.636], $p = 0.008$. These findings support the hypothesis that stress increases rather than diminishes self-compassion. None of the interaction effects were significant.

3.3 | Hypotheses 3: The positive interaction effect of stress and self-compassion on resilience

3.3.1 | Resilience

None of the AR and CL effects were significant for resilience. Instead, supporting Hypothesis 3, the interaction between perceived stress and self-compassion ($C_{W,t-1}S_{W,t-1}$) was significant, $\beta = 0.81$, $SE = 0.42$, 95% CI [0.066, 1.736], $p = 0.017$ (Figure 3). An increase in stress, only when coupled with an increase in self-compassion from the previous time point, was linked to an increase in resilience at the next time point. Meanwhile, increases in stress or self-compassion alone were not linked to subsequent increases in resilience. This result is in line with the hypothesis that self-compassion coupled with stress leads to more positive outcomes.

4 | DISCUSSION

This study examined the dynamic relationships between stress, self-compassion, and resilience among university students across 4 years. By using the RI-CLPM model, we isolated the influences of within-individual changes in these factors from between individual differences. Our focus was on discerning how changes in stress, self-compassion, and resilience at one time point influenced both their own trajectory and those of the other variables at subsequent time points. Among all directionalities examined, we were particularly interested in understanding the effects of changes in students' stress and self-compassion on their ensuing resilience. A key merit of RI-CLPM with interaction effects lies in its comprehensiveness; every variable is scrutinized both as a predictor and an outcome across all intervals. This ensures an exhaustive exploration of the multifaceted and bidirectional nature of psychological processes. Additionally, the interaction effects allowed us to examine the interactive roles of stress and self-compassion in fostering long-term resilience.

Our first hypothesis was partially supported. Self-compassion was significantly related to lower stress in the trait outcome model. This finding is consistent with mostly cross-sectional literature showing that people higher in trait self-compassion report lower stress (Bluth et al., 2018; MacBeth & Gumley, 2012; Marsh et al., 2018; Shebuski et al., 2020). Likewise, when examining bivariate correlations, self-compassion and resilience were positively linked (Table 1). Contrary to our initial hypothesis, the previously observed positive correlation between trait self-compassion and trait resilience did not hold when analyzed using RI-CLPM methodology. This deviation from our expectations could be attributed to notable distinctions between RI-CLPM and prior studies that found a significant correlation (e.g., Bluth et al., 2018; Simmons et al., 2023). While bivariate correlations solely focus on the association between self-compassion and resilience, the RI-CLPM considers the bidirectional interplay among stress, self-compassion, and resilience over time. Furthermore, by encompassing all two-way interactions, it captures the intricate dynamics among these variables comprehensively. We believe this model is more realistic and better reflects the complicated and nuanced nature of these variables in real life. The implication of this finding is that it is the *change* in self-compassion that occurs under stressful circumstances, rather than the stable tendencies to be self-compassionate, that is the significant factor in predicting future resilience (see Hypothesis 3). Future research should continue to unravel distinct contributions of trait and state self-compassion.

Our second hypothesis was confirmed. An increase in stress led to an increase in self-compassion across all years. Although cross-sectional research shows that stress and adversity are negatively related to self-compassion (e.g., Barlow et al., 2017; Vettese et al., 2011), this longitudinal perspective shows self-compassion as a changing process over time. Given that self-compassion has been described as a supportive attitude toward oneself in the context of difficulties (Neff, 2023), it makes sense that self-compassion may increase following a moderate amount of stress as a way to care for oneself and make decisions about how to address the challenge. Thus, our findings offer a nuanced understanding of the dynamic relationship between stress exposure and self-compassion. The

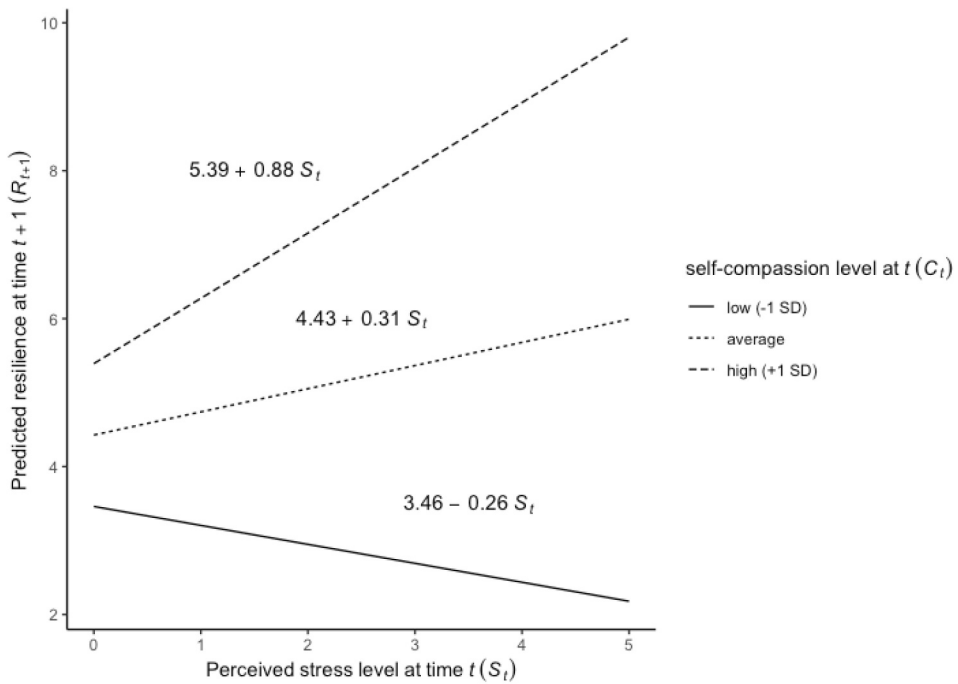


FIGURE 3 Interaction effect of stress and self-compassion on future resilience. S_t , Stress level at time t ; C_t , Self-compassion at time t ; R_t , Resilience at time $t = 1-4$.

findings did not support the alternative hypothesis that increasing stress leads to a decrease in self-compassion. Future research should consider whether the presence of certain moderators (e.g., childhood maltreatment, marginalized identities, mental health challenges) coupled with rising stress leads to feelings of inadequacy, shame, and self-criticism (i.e., decreasing self-compassion).

Finally, as hypothesized, an increase in stress coupled with an increase in self-compassion between two-time points was associated with an increase in resilience at the next time point. This finding is directly in line with stress inoculation theory, suggesting that university students who are more self-compassionate when faced with stress are more likely to gain resiliency from the experience, increasing their ability to bounce back from future encounters with hardship (e.g., Seery, 2011). Facing challenges from a kind, supportive stance may facilitate positive emotions in the midst of the situation, improve one's sense of mastery and self-efficacy at managing hardships, and thus cause one to feel more equipped to manage future problems. Interestingly, neither the change in self-compassion nor stress alone predicted subsequent resilience. This finding may also support the importance of inoculation, underscoring the value of confronting and surmounting stress with adaptive response in building resilience.

Future work could examine the mechanisms by which self-compassion leads to resilience through the lens of the stress response. For example, self-compassion is linked to the physiological state of safety and connection (Kirschner et al., 2019) and lower physiologic threat reactions when experiencing a lab-induced stressor (Breines et al., 2015). From this calm and soothed state, people might be more likely to perceive a specific stressor as manageable or surmountable as opposed to threatening and overwhelming. In support of this possibility, self-compassion has been linked to lower perceived stress reactivity (including one's thoughts and feelings in response to stress) in various contexts, including work overload, social conflict, and failure (Helminen et al., 2021). Similarly, people high in self-compassion are less likely to have negative thoughts in response to a recent difficult event (Leary et al., 2007). These aspects of self-compassion may foster stress inoculation, resulting in a more positive response to stress.

Self-compassion may also promote an adaptive mindset about stress itself, particularly given it includes recognition that difficulties and mistakes are understandable and connect us with others. In fact, studies with both students and older adults show that self-compassion is associated with a “stress-is-enhancing” mindset (Miyagawa et al., 2020; Neff et al., 2005). For example, Miyagawa et al. (2020) found that students' trait self-compassion is linked to the belief that failure can lead to important learning opportunities, thus conceptualizing stress as having beneficial consequences.

Third, a recent meta-analysis has summarized research linking self-compassion to a wide variety of adaptive ways of coping with and managing stress (Ewert et al., 2021). This study concluded that people high in self-compassion are more likely to use both problem-focused coping (e.g., planning, active coping, seeking instrumental support) and emotional approach coping (e.g., acceptance, positive reframing), while less likely to use maladaptive coping (e.g., denial, rumination, behavioral disengagement). These findings make sense in that one would expect a self-compassionate attitude would help people see their difficulties with a balanced, connected, and supportive perspective, allowing them to take active measures to cope with stressful situations rather than disengage or escape from the difficulty. Use of adaptive stress coping mechanisms are another way self-compassion may promote post-stress resilience.

In addition to highlighting the benefits of self-compassion for undergraduates, these results suggest that avoiding or minimizing stressors may have an unforeseen negative consequence, depriving people of the opportunity to learn how to care for themselves effectively and build resilience. From this standpoint, avoiding stress and emotional discomfort may ultimately not be in students' best interests (Celniker et al., 2022).

Regarding the limitations of this study, participants were undergraduate students in a highly selective university, which may limit the generalizability of the results. Future research should investigate this effect in more diverse samples that include young adults from various socioeconomic and demographic backgrounds. Evidence suggests, for example, that both self-compassion and stressors/coping strategies may vary by socioeconomic status, race, and culture (Vigna et al., 2018). Future longitudinal research could explore whether trajectories differ by demographics or other social determinants of well-being.

There are also time and measurement limitations in this study. Although the study was designed to capture the long-term changes over time, the 1-year interval between time points may be too long to fully capture the impact of state stress, self-compassion, and resilience. Indeed, many fluctuations in stress, self-compassion, and resilience may occur in that large time frame, so future work should capture changes in all three variables with more frequent assessments, perhaps using ecological momentary assessment. In addition, trait measures of all variables were used; it is unclear how the findings might be different if state measurement scales were used. Of note, subsequent to data collection for this study, a state self-compassion scale was developed (Neff et al., 2021). This scale could be used in future study designs to confirm these relationships using a different methodological approach.

Despite these limitations, the study provides a dynamic view of changes over the long-term. Likely, highly impactful stressful experiences will involve longer-term changes to these variables. Given that few studies have explored growth after stress longitudinally on a large scale and over a significant time period (Infurna & Jayawickreme, 2019), the current study addresses a gap in the literature.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest regarding the publication of this article. This statement is made in the interest of full disclosure and to ensure the integrity of our research.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Karen Bluth, PhD, is an Associate Professor in the Department of Psychiatry at University of North Carolina-Chapel Hill, where she investigates the relationships between self-compassion and mental health, particularly among adolescents. She is the developer of several programs that focus on cultivating self-compassion, such as Mindful Self-Compassion for Teens. Dr. Bluth is also the author of several books on self-compassion, including *The Self-Compassion Workbook for Teens*.

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Mark Leary, PhD, is an Emeritus Professor of Psychology and Neuroscience at Duke University. Throughout his distinguished career, he has extensively studied motivation, emotion, self-awareness, social relationships, and psychological well-being. His research has significantly contributed to understanding how these factors influence human behavior and mental health.

Rick Hoyle, PhD, is a Professor of Psychology and Neuroscience at Duke University. His scholarly work is dedicated to understanding how adolescents and young adults navigate their goal-directed behaviors via self-regulatory processes. Dr. Hoyle's approach to self-regulation is comprehensive, considering the distinct and combined effects of personality traits, various environments such as home and school settings, cognitive and emotional aspects, as well as social dynamics, on the multifaceted aspects of goal pursuit.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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