The Effects of Stress Beliefs on Daily Affective Stress Responses

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Abstract

Background: Negative beliefs about the effects of stress have been associated with poorer health and increased mortality. However, evidence on the psychological mechanisms linking stress beliefs to health is scarce, especially regarding real-life stress. **Purpose:** The aim of the current study was to investigate the effects of stress beliefs on affect in the daily stress process in a population prone to health-impairing effects of stress: university students. **Methods:** Using daily diaries, 98 university students reported on daily perceived social and work-related stressors as well as positive and negative affect for ten consecutive days. Stress beliefs, depressive and anxiety symptoms, neuroticism and demographic variables were assessed prior to the daily diary phase. **Results:** Hierarchical linear models revealed a significant cross-level interaction between negative stress beliefs and the association of daily social stressors with negative affect ($B = 0.24$; 99%-CI = 0.08 to 0.41, $p < .001$). When experiencing social stress, participants who held high negative stress beliefs had higher daily negative affect (simple slope = 4.09; $p < .001$); however, for participants who held low negative stress beliefs the association between daily social stress and daily negative affect was considerably smaller (simple slope = 2.12; $p < .001$). Moreover, individuals believing stress to be controllable showed higher positive affect throughout the ten-day daily diary phase. **Conclusions:** Negative stress beliefs were found to moderate the affective response to daily real-life stressors. Given the established relationship between affect and health, this study provides initial evidence of psychological mechanisms linking stress beliefs to health.

Keywords: stress beliefs; stress mindset; stress reappraisal; stress; affect; daily diary

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Stress is an evolutionary survival mechanism designed to facilitate coping with situational demands [1]. It occurs if a situation is perceived as threatening or challenging and as exceeding one's personal resources [2]. This triggers a cascade of psychological (cognitive, behavioral and emotional) and biological (e.g. activation of the sympathetic nervous system [SNS] and the hypothalamic-pituitary-adrenal axis [HPA]) stress responses. While primarily adaptive in nature, chronic stress can have detrimental effects on health [3]. A huge body of literature documents the pathogenetic role of stress in a broad range of diseases [4–6], resulting in a predominantly negative connotation of stress in the scientific literature and in public perception [7–9].

This is concerning given that recent studies show that negative beliefs about stress can be harmful to health per se. In a representative population sample, individuals reporting high stress levels showed increased mortality at eight-year follow-up only if they perceived stress to be bad for one's health as opposed to those with high stress but without negative perceptions of stress [9]. Similarly, negative beliefs about stress predicted heightened incidence of myocardial infarction or heart disease-related deaths at 18-year follow-up in the Whitehall-II cohort of British civil servants [10].

Recent research has begun to explore the effects of stress beliefs on both a situational and a more generalized level. Jamieson and Crum [11] distinguish between situational stress reappraisal (i.e. the acute stress response is either appraised to be a helpful resource or as posing additional demands) and stress mindset, comprising subjective beliefs about the nature of stress on a general level (i.e. stress is enhancing vs. stress is debilitating). Similarly, the cognitive model of stress responses by Power and Dalgleish [12], which was further elaborated by Daniels, Harris, and Briner [13] to incorporate goal progress and coping variables, outlines two pathways of information processing regarding how stress beliefs might influence affect in response to a stressor: Controlled processing primarily involves conscious

appraisal of whether a situational stressor is believed to hinder goal progress. Automatic processing, by contrast, primarily involves beliefs about the effects of stressors in general. In specific situations automatic processing is hypothesized to trigger stress beliefs via implicit associative learning mechanisms. Both situational and generalized stress beliefs have been linked to health- and performance-related outcomes. Positive stress reappraisal has been linked to increased academic and social-evaluative performance, reduced performance anxiety [14–17], and a healthier physiological stress response [18–21].

Generalized stress beliefs have mainly been studied using two psychometrically evaluated self-report questionnaires: The Stress Mindset Measure (SMM) by Crum et al. [22] uses a unidimensional, bipolar scale to assess whether individuals generally believe stress to be enhancing or debilitating. Previous research found that positive stress mindsets were associated with reduced distress in response to adverse life events in adolescents throughout one school year [23], with lower perceived stress, favorable well-being and better academic performance in undergraduate university students [24], and with increased vigor and task performance as well as decreased anxiety and depression in employees [22,25]. More recently, the Beliefs About Stress Scale (BASS) [26] was developed to assess stress beliefs using a multidimensional approach, i.e. beliefs about negative effects of stress, beliefs about positive effects of stress, and beliefs about whether the effects of stress can be controlled by one's own actions. The construct validity of the three distinct scales was supported by both exploratory and confirmatory factor analyses in separate samples. Moreover, there is initial evidence to support the reliability and discriminant and predictive validity [26]. The BASS was found to predict health outcomes in university students, an important risk population for the health-debilitating effects of stress [27,28]. Controlling for general strain, physical and mental health status, neuroticism, optimism, and somatosensory amplification, it was found that negative stress beliefs at baseline predicted higher somatic complaints and higher perceived stress in university students during end-of-term exams 6-8 weeks later [26,29]. In

conclusion, accumulating evidence suggests that both situation-specific and generalized stress beliefs might be a promising new construct in explaining and possibly influencing short- and long-term health.

To that aim, it is crucial to understand the mechanisms by which stress beliefs affect health. Based on initial evidence, recent reviews by Jamieson et al. [21,30] and Jamieson and Crum et al. [11] have outlined mechanisms linking stress beliefs to performance, well-being and health. Drawing on the biopsychosocial model of threat and challenge [31], positive stress beliefs are hypothesized to foster approach-motivated challenge stress responses (as opposed to avoidance-motivated threat stress responses), which lead to a downstream modulation of adaptive psychological and physiological mechanisms. At the physiological level, this relates to adaptive activation of physiological resources during stress encounters and quicker recovery following a stressor [21], thereby facilitating situational performance and reducing overall allostatic load [3]. This is supported by several experimental studies using laboratory stressors (Trier Social Stress Test; TSST [32]). For instance, participants instructed to view their stress response as enhancing showed a healthier cardiac stress response [18,19], higher anabolic hormone increases [33], increased SNS activation [20] during stress and a quicker recovery of heart rate and blood pressure following a stressor [34]. However, a recent meta-analysis indicated that the manipulation of stress beliefs appears to be more consistently associated with psychological variables such as stress and affect than with physiological variables [35].

On a psychological level, Jamieson and Crum [11,21,22,30] identify changes in affect due to stress beliefs as one of the proximal variables that might influence performance, well-being and long-term health outcomes. Similarly, according to Daniels, Harris and Briner [13], both controlled and automatic processing of stress appraisal influence the affective stress response. Given that affect has been associated with mental and physical health via multiple links, such as altering physiological functioning, influencing coping, health behavior and

information processing, and affecting individuals' psychosocial resources [36–42], such pathways might explain the health consequences of stress beliefs. Recent studies have already provided initial evidence to support the influence of stress beliefs on the affective stress response. In a study by Crum and colleagues [33], participants who were experimentally manipulated to view stress as enhancing prior to undergoing the TSST showed increased positive affect in response to the stressor, whereas participants who were manipulated to view stress as debilitating showed decreased positive affect. Similar studies reported that instructions of positive stress reappraisal were associated with higher positive affect [16] or reduced observer-rated negative affect [20] in response to a laboratory stressor. Beyond laboratory studies, only a small number of studies have provided evidence for potential psychological mechanisms underlying the effects of stress beliefs on health: In three daily diary studies, Harris and Daniels [43–45] found that employees' situational beliefs about the adverse impact of work stressors were associated with poorer daily affect. However, while these studies assessed beliefs about stress and affect concurrently, only one daily diary study to date has provided evidence of the temporal priority of stress beliefs. Daniels et al. [46] found that more generalized negative beliefs about work stressors, as assessed before experience sampling, predicted poorer affect in response to work stressors throughout a five-day daily diary assessment.

In conclusion, there is growing evidence from both large general population samples and experimental studies that negative beliefs about stress lead to detrimental health outcomes, and may therefore represent a new target for psychological interventions aiming to prevent negative effects of stress on health. In order to design focused interventions, it is necessary to understand the psychological mechanisms which translate stress beliefs into negative health outcomes. Initial evidence suggests that the affective stress response might play an important role in such a pathway. However, as previous daily diary studies focused on work-related stress, there is an evidence gap regarding the role of stress beliefs when

experiencing real life social stress. Furthermore, apart from experimental studies, evidence on the effect and temporal priority of stress beliefs on affect remains limited. An examination of the relationship between stress beliefs and established health mediators such as positive and negative affect, as it unfolds in real life, is warranted to gain more evidence on the ecological validity on this new construct. Therefore, the aim of the current study was to investigate the effects of stress beliefs on psychological variables of the daily stress process in a risk population for health-diminishing effects of stress: university students. Based on initial evidence (see above) from the literature [21,22,30,45], it was expected that individuals with negative stress beliefs would show increased negative and decreased positive affect while under stress.

A daily diary approach was chosen since it offers several advantages over other non-experimental study designs [47,48]. For example, data can be assessed in the context of and in temporal proximity to occurring events, thereby reducing retrospective self-report bias while simultaneously increasing ecological validity. Moreover, as stress and affect can vary over short periods of time, daily diary assessment is more suitable to capture short-term changes in stress and affect than conventional repeated measures designs. Furthermore, multiple assessments over time allow for the distinction of between-person and within-person effects. Hence, it is possible to investigate the extent to which a person's affect varies in response to different events over time, in addition to correlating baseline levels of affect across individuals.

Method

Procedure

University students were invited to participate in a ten-day, online daily diary study about stress perception via e-mail lists or online forums of several universities in Germany, Austria and Switzerland. Participation was voluntary and the only inclusion criteria were

being a university student and providing written informed consent. As compensation for their efforts, participants had the chance to win gift certificates. Participants underwent an online baseline assessment 1-10 days before the daily diary phase. During the daily diary assessment period of ten days, participants were asked to provide answers on the online daily diary questionnaire every day. Emails with the link to the online daily diary questionnaire were sent every evening at 6 p.m. To avoid confounding with events on the following day, answers on the daily diary questionnaire for the respective day were only admissible until 2 a.m. on the following day. To match repeated assessments, participants were instructed to create their individual code, which they had to enter at every study assessment. Participants were excluded from the analysis if they did not complete the baseline assessment and at least one daily diary assessment. The study was approved by the institutional review board of the Psychologische Hochschule Berlin. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1946 Helsinki declaration and its later amendments.

Measures

Baseline. Stress beliefs were assessed using the Beliefs About Stress Scale [26] (BASS). On three scales this self-report questionnaire measures negative stress beliefs (BASS-N; eight items) and positive stress beliefs (BASS-P; four items) as well as perceived control (BASS-C; three items). Example items are as follows: ‘Being stressed affects my health in the short term’ (BASS-N), ‘Being stressed enables me to work in a more focused manner’ (BASS-P), or ‘Being stressed is something I am able to influence through my actions’ (BASS-C). Items are rated on a 4-point scale from completely disagree (1) to definitely agree (4). Cronbach’s α in the current sample was .80, .88 and .77 for BASS-N, BASS-P and BASS-C, respectively.

At baseline, in order to describe the situational context of their university studies, participants were asked to report their study subject, the sum of weekly hours of courses they

had signed up for, and whether they had a part-time job, and to provide demographic variables (age, sex). To screen for symptoms of depression and anxiety, participants completed the depression (PHQ-9) and the anxiety (GAD-7) module of the Patient Health Questionnaire [49]. Cronbach's α in the current sample was .84 and .83. In order to control for unspecific effects of a general tendency to experience negative emotions, neuroticism was assessed using the respective subscale of the Big Five Inventory short form (BFI) [50]. Cronbach's α in the current sample was .67.

Daily Diary. To assess the daily stress process, participants were asked to report on their daily perceived stressors and affect for ten consecutive days. Participants' daily perceived stressors were assessed using the situational experience module of the Personality Dynamics Diary [51] (PDD). This module assesses the daily experience of social stress (PDD-SS; four items), workload (PDD-W; two items), positive events (four items) and absence of social contact (one item). Given the stress-related hypothesis of the current study, only scales on social stress and workload were analyzed. The PDD specifically provides the opportunity to assess both within- and between-person variance in situational experiences. Based on items of established measures of stress, adverse experiences and aversive interpersonal interactions the PDD-SS and PDD-W capture the most relevant daily experiences of social stress (hostility, e.g. 'I was blamed, criticized, or devalued by someone;' disappointment, e.g. 'I was left in the lurch by a close person') and workload (e.g. 'I had to deal with too many, or too difficult tasks'). Participants endorsed whether each item applied to them during the last day on a 4-point scale from 0 = very false to 3 = very true. Within-person and between-person Cronbach's α in the current sample lay at .83 and .88 for the PDD-SS and .87 and .95 for the PDD-W, respectively.

Daily positive and negative affect were assessed using the 10-item short form of the Positive and Negative Affect Schedule [52,53] (PANAS). The PANAS is one of the most widely used self-report questionnaires assessing positive (PANAS-P) and negative affect

(PANAS-N). Positive affect (e.g. excited, proud) and negative affect (e.g. upset, afraid) are assessed on two independent five-item scales, with responses ranging from 1 = ‘very slightly or not at all’ to 5 = ‘extremely’. Among other time frames, the PANAS has been validated to assess daily affect [54]. Within-person and between-person Cronbach’s α in the current sample lay at .85 and .92 for PANAS-P and .79 and .87 for PANAS-N.

The initial hypotheses of the present study included the effects of stress beliefs on daily coping behavior. However, a-priori hypothesized scales of coping did not achieve acceptable fit in multilevel confirmatory factor analysis and are therefore not reported within this manuscript. Data, analysis code, and psychometric evaluation of a-priori and post-hoc coping scales, as well as results regarding coping behavior and stress beliefs, can be found at: <https://osf.io/hdk26/>

Participants

122 individuals responded to the call for study participation. 111 (90.9%) returned the baseline assessment. $N = 98$ (80.3%) provided data on baseline assessment and at least one daily diary assessment and were therefore included in the final analysis. Throughout the ten-day daily diary period, participation was $n = 80$ (81.6%) on the day with the lowest amount of diary completion and $n = 98$ (100%) on the day with the highest diary completion; the mean daily participation lay at 87.5 participants (89.3%). Participants excluded for missing daily diary data did not differ from the final sample with respect to age, sex or stress beliefs (BASS-N, BASS-P, BASS-C).

Sample characteristics can be seen in table 1. Participants predominantly identified as female and were evenly distributed across different study subjects. The mean course load per week matches the average for German university students [55] and the majority had a part-time job. About a third of the sample reported elevated symptoms of depression and anxiety, which corresponds with the mean prevalence of depression found in university student samples [56]. Moreover, the mean values of negative, positive and controllability

stress beliefs match those found in a previous university student sample [29]. Throughout the daily diary period, mean social stress was comparable to the validation student sample of the PDD [51] while mean workload was somewhat higher in the current sample.

Data analysis

Addressing the nested structure of the data, we estimated hierarchical linear models with repeated data entries at level 1 nested in participants at level 2. First, the fixed effects of stress beliefs (level 2: BASS) on each of the daily diary variables (level 1: perceived stressors, affect) were analyzed using random intercept models. To reduce multicollinearity, separate random intercept models were estimated for each BASS subscale (BASS-N, BASS-C, BASS-P) on each dependent variable (PDD-SS, PDD-W, PANAS-N, PANAS-P), resulting in $(3 \times 4 =)$ 12 models. Second, the main hypothesis – whether stress beliefs would influence positive and negative affect in response to stressors – was tested by adding work stress or social stress as a further variable in predicting affect (PANAS-N or PANAS-P), including cross-level interactions with stress beliefs. This resulted in $(3 \times 2 \times 2 =)$ 12 additional random slope models with focal cross-level interaction terms of each stress beliefs subscale and work stress (BASS-N* PDD-W or BASS-C* PDD-W or BASS-P* PDD-W) or stress beliefs and social stress (BASS-N* PDD-SS or BASS-C* PDD-SS or BASS-P* PDD-SS). Predictors were grand-mean centered, while dependent variables were not. To ensure that the cross-level interactions were due to within- rather than between-person variance in perceived stressors, the within- and between-person variance in PDD-W and PDD-SS were included as separate predictors. In order to estimate the incremental effect of stress beliefs above and beyond trait neuroticism, each tested association was additionally controlled for the effect of level 2 neuroticism and its interaction effects with daily perceived stressors.

Given the 24 associations tested in this study, the two-tailed level of significance was set at $p < .002$ to account for alpha error inflation. p -values for the hierarchical linear models were estimated using Satterthwaite correction. 99%-confidence intervals were estimated

drawing 5000 bootstrap samples. All analyses were performed using R 3.5 [57]. The employed data and analysis code, and a full list of variables, are available online at <https://osf.io/hdk26/>.

Results

Do beliefs about stress predict daily stressors and affect?

Higher controllability beliefs (BASS-C) significantly predicted higher positive affect (PANAS-P) throughout the ten-day daily diary phase (see table 2; for a detailed description of the hierarchical linear models, see Supplement 1). BASS-N and BASS-P were not associated with either daily work and social stressors or daily positive and negative affect.

Do beliefs about stress moderate the association of daily stressors and daily affect?

Negative beliefs about stress significantly moderated the within-person association of daily social stress and negative affect (table 3; for a detailed description of the hierarchical linear models see Supplement 1). More specifically, negative beliefs about stress augmented the association between social stress and negative affect (see figure 1b): When experiencing social stress, participants who held high negative beliefs about stress had higher daily negative affect (BASS-N +1SD: simple slope = 4.09; $SE=0.73$; $t = 10.99$, $p < .001$); however, for participants who held low negative beliefs about stress the association between daily social stress and daily negative affect was considerably smaller (BASS-N -1SD: simple slope = 2.12; $SE=0.35$; $t = 6.05$; $p < .001$).

All other cross-level interactions between the BASS scales and the associations of perceived stressors and affect were not significant at the pre-specified alpha level of $p < .002$. However, the interaction of BASS-N with the within-person association of daily workload and positive affect appears to be noteworthy ($p = .002$; table 3; for a detailed description of the hierarchical linear models see Supplement 1). For participants with high negative beliefs about stress, higher daily workload was associated with lower daily positive affect (BASS-N

+1SD: simple slope = -0.80; $SE = 0.34$; $t = 2.89$; $p < .001$); in contrast, for participants with low negative beliefs about stress, higher daily workload was not associated with decreased daily positive affect (BASS-N -1SD: simple slope = 0.67; $SE = 0.33$; $t = 2.01$; $p = .048$; see figure 1a).

Are the reported effects robust to controlling for neuroticism?

In additional analyses, effects of stress beliefs were estimated controlling for the effect of level 2 neuroticism (see right columns of table 2) or neuroticism and its interaction effects with daily perceived stressors (see right columns of table 3). Controlling for neuroticism slightly (about 20%) reduced the effect of controllability beliefs (BASS-C) on overall positive affect (estimate 0.52 to 0.42) and the interaction effect of negative stress beliefs and daily social stress on negative affect (estimate 0.24 to 0.19). The interaction effect of BASS-N and daily workload on positive affect did not change after controlling for neuroticism. While those effects would not be considered significant based on the pre-specified alpha level for the main analyses ($p < .002$), they still remain below commonly used levels of significance ($p < .01$).

Discussion

The data from this daily diary study indicate that negative beliefs about stress do play a crucial role in determining the affective responses to stressors. Students with high levels of negative beliefs about stress showed strong negative affect when experiencing social stress, and tended to show decreased positive affect in response to work-related stress. In contrast, students with low levels of negative beliefs about stress showed no decline in positive affect in response to work-related stress and showed considerably lower increased negative affect in response to social stress. Moreover, those who perceived stress to be controllable showed increased positive affect throughout the ten-day daily diary period.

These results from real-life stressors corroborate initial laboratory evidence on the effects of stress beliefs on affective responses. Two studies found that instructing participants

to positively reappraise stress resulted in increased positive [16] and decreased negative affect [20]. The current study now provides evidence for such a relationship in non-manipulated stress beliefs held by university students experiencing real-world work and social stress, thereby extending the results of initial daily diary studies which focused solely on work stressors [43,44,46]. Moreover, controlling for baseline neuroticism only slightly reduced the effects of stress beliefs. This further indicates discriminant validity of stress beliefs from other stress related constructs like neuroticism, optimism, or resilience as found in previous studies [22,26,29]. However, in the present study, neuroticism was measured with a validated but very brief instrument. Further research should conduct a more in-depth assessment of neuroticism and should investigate discriminant validity with other personality variables and stress-related constructs, such as emotion regulation.

The current findings might also provide further explanation of how negative stress beliefs could lead to increased mortality in the long run [9,10]. Downstream modulation of affect has been identified as one potential pathway that could explain the effects of stress beliefs on well-being and health [11,13,21]. As confirmed by the current study, individuals with negative stress beliefs tend to have higher negative and lower positive affective reactions to daily stressors. Both negative and positive affective states have been identified to impact health by altering physiological functions, influencing health-related behavior and information processing, and affecting individuals' psychosocial resources [36–38,41,42]. Unfavorable affective states due to negative stress beliefs might, for example, increase maladaptive health behavior such as reduced physical activity and increased substance consumption [41], and might impair cognitive functioning [58–60], thus predicting morbidity and mortality in somatic and mental health disorders [61–65].

Positive stress beliefs, as measured by the BASS-P subscale, were not associated with daily affect in the current study. This might be due to the conservative approach of correcting for multiple testing, which reduces the likelihood of false positive results, but

comes with the tradeoff of higher false negative rates. On the other hand, positive stress beliefs (e.g. ‘stress enhances my performance’) might be more strongly correlated with other variables which were not assessed in the current study. Several studies found that experimental induction of positive stress beliefs was associated with increased work or test performance [14,22]. Additionally, one study [66] reported associations of higher positive stress beliefs with higher challenge appraisals of an experimental stressor (as opposed to threat appraisals). Future studies should investigate the potential relationship of positive stress beliefs with performance-related outcomes and stressor appraisals in a real-world setting.

Some limitations need to be considered when interpreting the results of the present study. First, although university students were recruited via e-mail lists and online forums of several universities in German-speaking countries, participation might have been selective. Speaking against this, however, study subjects were evenly distributed among participants and workload and elevated psychological symptoms matched values found in student population samples. Nevertheless, as typically seen in studies using online recruitment, participants predominantly identified as female, thus limiting the ecological validity for individuals of male gender. Although the daily diary design resulted in 831 data points among 98 participants, considering the conservative approach to multiple testing, the power of this study for detecting small- to medium-sized effects is limited. Larger studies are needed to investigate smaller potential effects between stress beliefs and daily stress responses. The main strengths of the current study lie in the assessment of naturalistic stress processes on a daily basis. This enabled us to study the effects of stress beliefs outside of the lab, while at the same time reducing recall bias compared to studies assessing self-report of stress variables retrospectively over several days. However, since daily self-report of stress variables was assessed at the end of each day, some amount of recall bias might still be present. Future studies should apply event-related momentary assessments to further reduce a potential influence of daily recall effects. Moreover, assessing the occurrence of stressors beyond self-

report using personal sensing [67] or physiological indicators could facilitate research on the effects of stress beliefs outside the laboratory.

In conclusion, several studies indicate that stress beliefs are prospectively associated with mental and physical health outcomes. The current study explored the psychological mechanisms of stress beliefs in a health-risk population of university students under naturalistic stress. Individuals with exaggerated negative stress beliefs showed higher negative affective and (potentially) lower positive affective responses to daily stress. Given the importance of positive and negative affect as important predictors of various physical and mental health outcomes, the present findings confirm the relevance of stress beliefs as a potentially important variable influencing health outcomes in a real-world setting. Moreover, our results provide initial evidence for a psychological mechanism linking stress beliefs and health. Future research should attempt to reproduce the proposed psychological mechanism and explore the link with the physiological mechanisms shown in laboratory studies. Furthermore, initial studies suggest that stress beliefs might affect coping behavior as well [24,25]. Therefore, studies investigating both affective and coping responses as potential mechanisms of stress beliefs might be insightful. However, investigating the association of stress beliefs and coping should consider additionally assessing the availability of situational coping resources [13]. Moreover, larger studies should explore whether the moderation of the affective response to stress induced by stress beliefs prospectively mediates health outcomes in naturalistic settings.

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Compliance with ethical standards

The study was approved by the institutional review board of the Psychologische Hochschule Berlin. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1946 Helsinki declaration and its later amendments.

All participants provided written informed consent.

Data availability statement

The data and analysis code used in this manuscript are publicly available at the Open Science Framework: <https://osf.io/hdk26/> (DOI: 10.17605/OSF.IO/HDK26)

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Tables

Table 1
Sample Characteristics

	Baseline Characteristics
Age M (SD ; $MD=3$)	25.46 (6.65)
Gender, female f (%)	82 (83.7)
Subject of study f (%)	
Arts and Social Sciences	22 (22.4)
Law, Economics, Sociology	20 (20.4)
Medicine, Health Sciences	13 (13.2)
STEM, Engineering	20 (22.4)
Other	23 (23.4)
h courses per week M (SD ; $MD=2$)	16.38 (9.19)
Part-time job f (%)	71 (72.4)
PHQ-9 M (SD)	8.39 (5.18)
<10 f (%)	64 (65.3%)
≥ 10 f (%)	34 (34.7%)
GAD-7 M (SD)	6.98 (4.25)
<10 f (%)	69 (70.4%)
≥ 10 f (%)	29 (29.6%)
Stress Beliefs (BASS) M (SD)	
Negative Stress Beliefs (BASS-N)	24.08 (4.14)
Positive Stress Beliefs (BASS-P)	10.30 (2.85)
Controllability Beliefs (BASS-C)	9.04 (1.94)
Neuroticism (BFI) M (SD)	6.60 (1.93)
	10-day daily Stress Variables
Workload M (SD)	1.17 (0.88)
Social Stress M (SD)	0.26 (0.44)
Negative affect M (SD)	8.88 (3.72)
Positive affect M (SD)	15.72 (4.12)

Notes. MD = missing data.

Table 2

Hierarchical linear model of stress beliefs (Level 2) predicting variables of the daily stress process (Level 1).

	Estimate	SE	df	t	p	99%-CI			Estimate	SE	df	t	p	99%-CI	
	Workload (PDD-W)								Workload (PDD-W) controlling for neuroticism						
BASS-N	0.03	0.01	99.85	1.96	.052	-0.01	0.06		0.02	0.02	96.57	0.92	.358	-0.03	0.06
BASS-C	-0.05	0.03	95.76	-1.49	.137	-0.13	0.03		-0.02	0.03	95.21	-0.49	.628	-0.10	0.07
BASS-P	0.00	0.02	99.82	0.15	.883	-0.05	0.06		0.01	0.02	99.59	0.39	.699	-0.05	0.06
	Social Stress (PDD-SS)								Social Stress (PDD-SS) controlling for neuroticism						
BASS-N	0.00	0.01	100.77	0.07	.947	-0.02	0.02		-0.00	0.01	97.19	-0.33	.739	-0.02	0.02
BASS-C	-0.01	0.01	96.27	-0.68	.496	-0.05	0.03		-0.01	0.02	95.65	-0.37	.712	-0.05	0.04
BASS-P	-0.01	0.01	100.89	-0.63	.533	-0.03	0.02		-0.01	0.01	100.29	-0.56	.578	-0.03	0.02
	Negative Affect (PANAS-N)								Negative Affect (PANAS-N) controlling for neuroticism						
BASS-N	0.07	0.07	99.56	1.14	.257	-0.09	0.24		-0.01	0.07	96.78	-0.13	.894	-0.20	0.18
BASS-C	-0.30	0.13	95.85	-2.24	.027	-0.66	0.06		-0.17	0.14	95.26	-1.18	.241	-0.55	0.19
BASS-P	0.03	0.09	99.45	0.34	.733	-0.21	0.29		0.06	0.091	99.26	0.63	.53	-0.188	0.291
	Positive Affect (PANAS-P)								Positive Affect (PANAS-P) controlling for neuroticism						
BASS-N	-0.12	0.06	100.13	-1.89	.060	-0.28	0.04		-0.05	0.07	96.414	-0.66	.509	-0.22	0.13
BASS-C	0.52	0.13	95.84	4.11	<.001*	0.19	0.84		0.42	0.14	95.084	3.10	.003	0.08	0.77
BASS-P	0.24	0.09	99.87	2.61	.010	0.00	0.48		0.22	0.09	98.80	2.49	.015	0.01	0.44

Notes. Correcting for multiple testing only $p < .002$ is considered statistically significant. * $p < .002$.

Table 3

Hierarchical linear model of stress beliefs (Level 2) moderating associations of within- and between-person stress with daily affect and (Level 1).

	Estimate	SE	df	t	p	99%-CI		Estimate	SE	df	t	p	99%-CI	
	Negative Affect (PANAS-N)							Negative Affect (PANAS-N) controlling for neuroticism						
BASS-N* between person Workload	-0.05	0.10	98.01	0.51	.614	-0.32	0.22	-0.11	0.11	97.28	-1.37	.307	-0.37	0.17
BASS-N* within person Workload	0.09	0.04	71.03	2.04	.045	-0.03	0.19	0.06	0.05	69.27	1.37	.175	-0.06	0.18
BASS-C* between person Workload	-0.14	0.17	94.43	0.85	.399	-0.58	0.29	-0.09	0.19	94.26	-0.43	.668	-0.59	0.41
BASS-C* within person Workload	-0.04	0.10	85.93	0.37	.714	-0.29	0.22	0.03	0.10	79.52	0.31	.756	-0.24	0.29
BASS-P* between person Workload	0.26	0.13	98.99	2.05	.043	-0.07	0.59	0.26	0.12	99.14	2.12	.036	-0.07	0.57
BASS-P* within person Workload	0.01	0.06	73.59	0.18	.855	-0.15	0.19	0.02	0.06	70.43	0.26	.797	-0.14	0.18
BASS-N* between person Social Stress	0.08	0.21	98.96	0.39	.699	-0.49	0.62	-0.20	0.25	93.41	-0.80	.426	-0.84	0.45
BASS-N* within person Social Stress	0.24	0.06	41.25	3.89	<.001*	0.08	0.41	0.19	0.07	32.14	2.91	.007	0.02	0.37
BASS-C* between person Social Stress	-0.23	0.41	94.26	-0.56	.577	-1.30	0.86	-0.25	0.41	92.13	-0.62	.539	-1.28	0.80
BASS-C* within person Social Stress	-0.15	0.15	29.37	-1.02	.316	-0.56	0.24	-0.03	0.15	29.57	-0.19	.845	-0.43	0.35
BASS-P* between person Social Stress	0.83	0.35	101.93	2.39	.019	-0.09	1.73	0.90	0.33	99.45	2.71	.008	0.04	1.74
BASS-P* within person Social Stress	-0.00	0.11	48.59	-0.03	.976	-0.27	0.27	-0.01	0.09	52.12	-0.07	.948	-0.25	0.24
	Positive Affect (PANAS-P)							Positive Affect (PANAS-P) controlling for neuroticism						
BASS-N* between person Workload	-0.17	0.11	96.85	1.62	.109	-0.45	0.11	-0.23	0.11	98.97	-2.23	.028	-0.51	0.05
BASS-N* within person Workload	-0.18	0.06	61.46	3.15	.002	-0.33	-0.03	-0.19	0.06	61.02	-3.00	.004	-0.36	-0.02
BASS-C* between person Workload	-0.50	0.17	96.23	3.01	.003	-0.92	-0.05	-0.43	0.19	96.37	-2.21	.030	-0.94	0.07
BASS-C* within person Workload	0.08	0.14	79.65	0.54	.589	-0.29	0.44	0.02	0.15	73.65	0.13	.896	-0.36	0.40
BASS-P* between person Workload	0.07	0.14	99.24	0.53	.595	-0.28	0.40	0.06	0.13	98.79	0.47	.638	-0.28	0.39
BASS-P* within person Workload	-0.10	0.09	70.15	-1.13	.262	-0.35	0.12	-0.10	0.09	67.10	-1.07	.290	-0.32	0.14
BASS-N* between person Social Stress	0.01	0.25	100.01	0.03	.980	-0.68	0.64	-0.06	0.29	94.33	-0.19	.853	-0.84	0.72
BASS-N* within person Social Stress	-0.05	0.09	40.68	0.55	.586	-0.27	0.20	-0.02	0.10	32.35	-0.15	.881	-0.26	0.26
BASS-C* between person Social Stress	0.03	0.46	95.17	0.07	.948	-1.20	1.21	0.18	0.47	93.23	0.38	.707	-1.01	1.38
BASS-C* within person Social Stress	0.15	0.18	15.86	0.85	.408	-0.31	0.63	0.10	0.19	18.35	0.50	.621	-0.42	0.62
BASS-P* between person Social Stress	-0.11	0.412	103.74	0.27	.792	-1.23	0.93	-0.08	0.39	101.65	-0.19	.845	-1.12	0.94
BASS-P* within person Social Stress	-0.22	0.13	41.32	1.69	.098	-0.58	0.10	-0.22	0.13	42.83	-1.63	0.11	-0.58	0.13

Notes. Correcting for multiple testing only $p < .002$ is considered statistically significant. * $p < .002$.

Figures

Figure 1. High (black line), mean (dark gray line), and low (light gray line) negative stress beliefs moderate the relationship between daily a) social stress and negative affect and b) workload and positive affect.

Figure captions

Figure 1. High (black line), mean (dark gray line), and low (light gray line) negative stress beliefs moderate the relationship between daily a) social stress and negative affect and b) workload and positive affect.