Trajectories of Perceived Stress among Students in Transition to College: Mindset Antecedents and Adjustment Outcomes

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Abstract

There is growing evidence of a clear association between students' perceived stress and their adjustment to life at college. However, the predictors and implications of distinct changing patterns of perceived stress during the transition to college life are less clear. To address these research gaps, the current study aims to identify distinct patterns of perceived stress trajectories among 582 Chinese first-year college students ($M_{age} = 18.11$, $SD_{age} = 0.65$; 69.40% female) across the first 6 months upon enrollment. Three distinct profiles of perceived stress trajectories, i.e., low-stable (15.63%), middle-decreasing (69.07%), and high-decreasing (15.29%), were identified. Moreover, individuals who followed the low-stable trajectory showed better distal outcomes (specifically, higher levels of well-being and academic adjustment) 8 months after enrollment than those who followed the other two trajectories. Furthermore, two types of positive mindset (a growth mindset of intelligence and a stress-is-enhancing mindset) contributed to differences in perceived stress trajectory, either independently or jointly. These findings highlight the significance of identifying different patterns of perceived stress among students during the transition to college, as well as the protective roles of both a stress mindset and a mindset of intelligence.

Keywords Perceived stress trajectories · Stress mindset · Mindset of intelligence · Well-being · Academic adjustment · College students

Introduction

The transition to college is often stressful because students must cope with multiple developmental tasks, such as living away from the family home for the first time and adapting to a changing social environment (Arnett, 2016). It is well established that college students with greater perceived stress have poorer adjustment outcomes, such as a higher risk of mental health problems and lower academic engagement (Bruffaerts et al., 2018; Hoyt et al., 2021; Tasso et al., 2021). However, there are two important limitations in the body of empirical knowledge regarding college students' stress experiences. First, most studies have concentrated on vocationally-oriented fields (e.g., nursing students; Zhang et al., 2019) or specific stress symptoms (e.g., post-traumatic stress disorder; Bryant et al., 2015), with scant research on the general student population during challenging periods. In particular, the impact of stress experiences during transition to college, which involves several often concurrent challenges posed by shifting circumstances and social roles, has been understudied. Second, there have been few longitudinal studies, with most research focusing on the short- or long-term consequences of stress (e.g., depression), which limits the understanding of fluctuations in stress experiences during college and why some students thrive while others suffer under stressful conditions. Unpacking the profiles of individual stress experiences is essential to identifying at-risk groups and providing adequate support to help students flourish in college (Ewing & Hamza, 2023). The current study aims to fill these research gaps by examining stress trajectories among first-

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year college students and the potential antecedents and distal outcomes of these trajectories.

Stress in the Transition to College

Studies have shown that the experience of stress is common among college students, with one meta-analysis reporting that half of college students had been found to experience considerable levels of stress (Wu et al., 2021). Students face a variety of sources of stress, including assessment deadlines, financial worries, interrelationship conflicts, and job concerns (Bojuwoye, 2002; Hudd et al., 2000). First-year students encounter particular challenges as many are experiencing a dual transition: both a developmental transition from adolescence to adulthood and also a life transition to college (Cheung et al., 2020). For instance, new college students must often adjust to a new social environment while making academic progress (Bojuwoye, 2002) in the absence of their previous support structure (e.g., family and friends) (Hudd et al., 2000). First-year college students are also regarded as being in the stage of emerging adulthood (Kwan et al., 2021), which is characterized by a period of exploration and identity formation as well as a sense of instability and uncertainty as individuals navigate the transition into adulthood. Additionally, research suggests that the first year of college has a significant effect on students' academic functioning and their well-being throughout their whole time at college (Fond et al., 2020). Furthermore, the COVID-19 pandemic exacerbated the stress situation for college students (Wu et al., 2021). Periods of public health measures, such as lockdown and quarantine, are extremely challenging for the college student population, among whom stress levels and mental health issues are significantly elevated at these times and can approach clinical levels (Fischer et al., 2020). The current pandemic thus provides a unique opportunity to gain a deeper understanding of the characteristics and consequences of stress experienced throughout college and particularly in the first year.

Despite the growing body of evidence suggesting that first-year college students experience above-average levels of stress, there are several limitations to the literature on this topic. One limitation is that the relevant studies have relied heavily on cross-sectional or two-wave longitudinal designs, neither of which can shed light on the fluctuations in college students' stress experiences over time (for better or worse) or whether the patterns of these fluctuations are influenced by their initial perceptions of stress. Additionally, college students may not have equal experiences of stress during the period of their transition (Duchscher, 2008). Stress and coping models that highlight the importance of appraisal in the stress response (Lazarus, 1984) posit that people can have different perceptions toward the same stressor. It is also evident from the few studies available that college students may show distinct patterns of stress perception over time (Ewing & Hamza, 2023; Kasky Hernández & Kahn, 2020). For instance, it was found that students exhibited distinct adjustment trajectories, with some being well-adjusted and others showing a decline in adjustment (Kasky Hernández & Kahn, 2020), and another study of Western college students identified distinct profiles of distress (e.g., high distress, moderately increasing distress) at the first-year (Ewing & Hamza, 2023). Given the support that these studies provide to the idea that stress experiences during transitions may be heterogeneous and vary over time, understanding the changes in students' perceptions of stress over time should be informative for identifying the characteristics and consequences of stress experienced by students making the transition to college amid the COVID-19 pandemic.

Perceived Stress Trajectories and Distal Outcomes

According to Selye's stress theory (1978), individuals' emotional and behavioral outcomes can be negatively affected by a high or chronic level of stress because coping with stress drains their resources and psychological energy. Among college students specifically, many studies have demonstrated the detrimental effects of stress experiences on well-being and academic functioning (Bruffaerts et al., 2018; Hoyt et al., 2021; Tasso et al., 2021). On measures of well-being, college students who perceive higher levels of stress report more depressive symptoms, greater anxiety, and lower levels of life satisfaction (Hoyt et al., 2021; Samaha & Hawi, 2016). On measures of academic functioning, higher levels of perceived stress in students are associated with more academic frustration and lower levels of academic adjustment, perseverance, and achievement (Bruffaerts et al., 2018; Tasso et al., 2021). Although the literature in these two domains is extensive, it is mostly focused on the effects of stress in a single domain. Furthermore, it is less clear whether these relationships hold for stress trajectories. The current study therefore aims to identify stress trajectories among first-year college students and explore the associations between different stress trajectories and students' well-being and academic adjustment.

Antecedents of Perceived Stress Trajectories

Knowledge of the antecedents of perceived stress during college transition is crucial to identifying at-risk students and planning effective interventions (Robotham, 2008). Inspired by the life course health development model, the present study focuses on the psychological resources that might influence individual perceived stress, because resilient coping with the substantial changes that occur during

emerging adulthood can have a significant effect on life course outcomes (Halfon & Forrest, 2017). Specifically, it was expected that two mindsets (mindset of intelligence and stress mindset) that are highly pertinent to students would be key indicators of perceived stress among college students.

Mindsets (also known as implicit theories) are core beliefs regarding the nature and functioning of human characteristics or characteristics of the world (Dweck, 1999; Walton & Crum, 2021). Mindset of intelligence refers to a belief regarding whether intellectual abilities are "carved in stone" (fixed mindset) or can be developed through an individual's own effort with guidance and support from others (growth mindset) (Dweck & Yeager, 2019). Students with a growth mindset tend to view academic setbacks as learning opportunities and are more willing than those with a fixed mindset to adopt positive coping strategies (Yeager & Dweck, 2012), and these factors account for the greater resilience and higher performance of students with a growth mindset of intelligence when facing academic challenges during a school transition (Dweck & Yeager, 2019). Similarly, students' perceived stress should diminish if they interpret academic challenges, which are their major stressors, in a positive way. For instance, it was found that young adults who believed that their intelligence could improve reported significantly lower levels of stress 4 months later (Huang et al., 2022). Another study suggested that college students with a growth mindset of intelligence reported less perceived stress and, in turn, made a more positive adjustment (with more academic engagement and fewer mental health issues) than their fixed-mindset counterparts (Zhao et al., 2021).

Stress mindset might be another contributing factor, as the theory holds that mindsets of stress can have self-fulfilling consequences in various domains (e.g., health and learning) through attention, motivation, and physiological reactions toward stress (Crum et al., 2013, 2017). Specifically, compared with a stress-is-debilitating mindset, a stress-is-enhancing mindset is supposed to encourage individuals to (i) pay closer attention to the beneficial effects of stress rather than displaying an attentional bias toward its negative consequences (Crum et al., 2017), (ii) be motivated to actively deal with stressful events rather than seek to reduce or avoid stress (Walton & Crum, 2021), and (iii) exhibit physiological thriving rather than overactive physiological responses (Crum et al., 2013). These three responses might have a significant impact on individual perceptions of stress levels, with empirical studies having found that individuals who hold a stress-is-enhancing mindset report significantly lower levels of perceived stress (Huebschmann & Sheets, 2020; Kim et al., 2020).

Although studies have examined how a single mindset influences individual stress levels, it is likely that these two mindsets interact in the formation of students' perceived stress trajectories. Conceptually, implicit theories are domain-specific (Dweck, 1999), such that an individual can have distinct mindsets of stress and intelligence. Among emerging adults, whose lives are frequently marked with stress and academic challenges, each mindset might uniquely affect their lives and stress perception. Although there are no empirical findings to confirm the interaction of two mindsets on perceived stress, some insights can be gleaned from a recent intervention study (Yeager et al., 2022), which found that a synergistic mindset intervention (targeting both mindset of intelligence and stress mindset) enhanced stress-related cognitions, physiological activities, and psychological well-being among adolescents. Accordingly, the current study investigates the interactive effect of the two mindsets on perceived stress trajectory to paint a more comprehensive picture of how psychological resources can help individuals to thrive under stress. Given the lack of sufficient evidence in the literature, no specific hypotheses on these interactive effects are proposed.

Current Study

Previous research has identified a negative association between perceived stress and adjustment outcomes during college, yet there is a paucity of research investigating the changing nature of perceived stress, particularly during crucial college transitions. Additionally, it is unclear how mindset antecedents contribute to perceived stress trajectories and what the implications of distinct changing patterns of perceived stress are for adjustment outcomes. To address these gaps in the literature, the current study pursued the following three aims. Firstly, the present study aims to identify how perceived stress changes and potential heterogeneity exist during the first 6 months of enrollment among Chinese first-year students. It was hypothesized that there are distinct perceived stress trajectories among first-year college students (Hypothesis 1). No predictions were made about the number or nature of the trajectory classes because of the paucity of research into the correlation between the experience of stress in college and diverse patterns of perceived stress among students. Secondly, this study aims to investigate whether distinct patterns predicted adjustment outcomes at a fourth timepoint of 8 months after enrollment. It was hypothesized that first-year college students on high perceived stress trajectories exhibit lower levels of well-being (specifically, higher levels of depressive and anxiety symptoms and lower life satisfaction) and academic adjustment than those on moderate or low perceived stress trajectories (Hypothesis 2). Lastly, this study aims to explore whether the main and interactive effects of mindset of intelligence and stress mindset explain the

profile membership of perceived stress trajectories. It was hypothesized that first-year college students with a growth mindset of intelligence and/or a stress-is-enhancing mindset are less likely to follow an elevated perceived stress trajectory (through a main or interaction effect) (Hypothesis 3).

Methods

Participants and Procedure

This study is part of an ongoing longitudinal health-related research project focused on a Chinese university student cohort. Participants were recruited from first-year students at two public universities in Beijing, China and two public universities in Hubei, China. All participants were from universities with academic tracks. The participants were invited to complete an online survey at each of four time-points. The time taken by each participant to complete the survey was recorded automatically by the online system and used to evaluate whether the questionnaire was answered carefully. The response was considered invalid if the questionnaire was completed in less than 15 min. A total of 598 students (69.60% females) participated in the online survey and were included as valid respondents at Time 1 (T1, October 2020). Of the T1 participants, 569 (4.85% attrition rate), 519 (13.21% attrition rate), and 397 (33.61% attrition rate) gave valid responses at Time 2 (T2, December 2020), Time 3 (T3, April 2021), and Time 4 (T4, June 2021), respectively. To ensure that each trajectory analysis was based on at least two measurement points, participants who gave valid responses to at least two waves from T1 to T3 were chosen. The analytic sample for exploring stress trajectories comprised 582 participants (69.40% females), accounting for 97.32% of the original sample. Of the 582 participants, 275 were from universities in Beijing and 307 were from universities in Hubei. 397 of these participants responded to the survey at T4 and were therefore included when investigating the outcomes of the trajectories.

Informed consent was obtained from all participants at the beginning of the study. All procedures were authorized by the Research Ethics Committee of the institution of the authors. The participants were instructed to read the instructions carefully and were informed that they could withdraw from the study at any moment without repercussions at each wave. Each questionnaire took around 30–40 min to complete.

To investigate the impacts of attrition, we compared the participants who attended all waves with those who dropped out at any wave on demographic information and the main variables. Participants who dropped out at either wave did not show any difference regarding the demographic information and main variables, compared with those who attended all waves ($ps > 0.19$).

Measures

Perceived stress (T1–T3)

Perceived stress was measured using the Chinese version of the 10-item Perceived Stress Scale (PSS; Cohen et al., 1983), to assess the degree to which situations in one's life were perceived as stressful. This scale was originally designed as a global measure of stress and has been widely used in previous research, showing satisfactory reliability and validity (Georgiou et al., 2020; Yan et al., 2021). The participants were asked to rate how frequently each item (e.g., "How often have you been upset because of something that happened unexpectedly?"; "How often have you felt nervous and stressed?") occurred in the last month on a 5-point Likert scale ranging from 0 (never) to 4 (very often). The PSS score ranges from 0 to 40, with higher scores reflecting higher levels of perceived stress. Cronbach's alpha for the current study was satisfactory ($\alpha = 0.80$ at T1, $\alpha = 0.80$ at T2, and $\alpha = 0.78$ at T3).

Predictors (T1)

Mindset of intelligence

The Chinese version of the Mindset of Intelligence Scale (Dweck, 1999) was used to evaluate participants' beliefs about the fixed or malleable nature of intelligence. This scale consists of six self-reported items, including three growth mindset statements (e.g., "You can always greatly change how intelligent you are") and three fixed mindset statements (e.g., "Intelligence is something that cannot be changed very much"). The participants marked their responses on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree). The three fixed mindset statements were reverse-coded such that a higher score reflects a stronger growth mindset of intelligence. Cronbach's alpha for this scale in the current study was 0.88.

Stress mindset

Stress mindset was measured using the Chinese version of the Stress Mindset Measure-General (SMM-G; Crum et al., 2013). The participants rated how strongly they agreed with each of the eight statements, including four items measuring a stress-is-enhancing mindset (e.g., "Experiencing stress improves my health and vitality") and four items measuring a stress-is-debilitating mindset (e.g., "Experiencing stress depletes my health and vitality"). The responses were graded on a 5-point Likert scale ranging from 0 (strongly

disagree) to 4 (strongly agree). The items measuring a stress-is-debilitating mindset were reverse-coded, with a higher score indicating a stronger stress-is-enhancing mindset. Cronbach's alpha for this scale in the current study was 0.76.

Demographics

The participants' age, gender (0 = female, 1 = male), subjective SES, and family income were included when exploring predictors of perceived stress trajectories, given previous findings regarding their associations with perceived stress (Ursache et al., 2015; Zhang et al., 2019). Additionally, since participants were recruited from two different regions—Beijing and Hubei—the location was therefore added as a covariate in the analysis that followed.

Outcomes (T4)

Life satisfaction

The participants' levels of life satisfaction were evaluated by the 5-item Satisfaction With Life Scale (SWLS; Diener et al., 1985). Each item (e.g., "In most ways, my life is close to ideal") was rated on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). A higher score indicates a higher level of life satisfaction. Cronbach's alpha for this scale was 0.94 in the present study.

Depressive symptoms

The 9-item Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) was used to assess participants' depressive symptoms over the last month. An example item is "Feeling down, depressed, or hopeless." Each item was rated on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day), with a higher summed score suggesting more severe depressive symptoms. A cut-off score of 9 was suggested in the Chinese population based on previous research (Ye et al., 2020). Cronbach's alpha for this scale was 0.90.

Anxiety symptoms

The Generalized Anxiety Disorder-7 (GAD-7) scale was used to assess the self-reported frequency of anxiety symptoms over the last month (Spitzer et al., 2006). An example item is "Trouble relaxing." The responses were made on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day), with higher scores representing more severe anxiety symptoms. The recommended cut-off score is 7 in the Chinese population (Ip et al., 2022). Cronbach's alpha for this scale in the current study was 0.93.

Academic adjustment

Academic adjustment was measured using the Student Adaptation to College Questionnaire (SACQ; Baker & Siryk, 1984). This scale has exhibited good reliability and psychometric properties and has been frequently applied in research on students' transition to university (Buote et al., 2007; Chavoshi et al., 2017). We adopted the 15-item Academic Adjustment subscale, which assesses self-perceptions of coping with the academic demands of the university (e.g., "Keep up-to-date with academic work"). The items were rated on a 5-point Likert scale ranging from 0 (strongly disagree) to 4 (strongly agree), with higher scores indicating better academic adjustment at university. Cronbach's alpha for this scale was 0.83 in the current study.

Data Analytic Strategy

Descriptive analyses for all the main variables were conducted using SPSS Version 25.0. The trajectories of participants' perceived stress from T1 to T3 were examined through latent class growth analysis (LCGA) in Mplus Version 8.3 (Muthén and Muthén, 1998–2017). LCGA is a widely used and powerful tool for the study of heterogeneity, and facilitates the investigation of finite mixture distributions in a larger sample (Jung & Wickrama, 2008). Full information maximum likelihood estimation was used to handle missing data, as this has been demonstrated to offer more reliable standard errors than other methods (e.g., mean imputation, listwise deletion, or pairwise deletion) (Little & Rubin, 2002; Schafer & Graham, 2002). An unconditional latent growth curve model (LGCM) was first derived to explore the overall trajectory for all participants. An LCGA with two to five class solutions was then performed with the variance of all growth factors constrained to zero (i.e., intercept and linear slope). To account for differences in the time between assessments, we fixed the factor loadings of the slope estimate to 0, 1, and 3 (corresponding to baseline, 2 months, and 6 months, respectively) in both LGCM and LCGA. Decisions on the optimal solution of growth trajectories were based on theoretical interpretations and statistical considerations, including the Akaike information criterion (AIC), smallest Bayesian information criterion (BIC), sample-size adjusted Bayesian information criterion (Adj-BIC), bootstrapped likelihood ratio test (BLRT), adjusted Lo–Mendell–Rubin likelihood ratio test (Adj-LMR-LRT), entropy, and smallest class size (Nylund et al., 2007). As suggested by previous research, lower values of BIC and Adj-BIC indicate a more parsimonious model (Jung & Wickrama, 2008), a value of entropy closer to 1 reflects greater precision (Nylund et al., 2007), and a significant p value of BLRT and Adj-LMR-

LRT suggests that k classes are superior to $k-1$ classes (Lo et al., 2001).

Once the optimal model was selected, covariates and predictors of patterns (i.e., demographic variables and mindsets) were included in the model using the three-step approach with the R3STEP function in Mplus, which is based on multinomial logistic regression analysis. This approach protects the formation of latent trajectory classes from the effects of covariates and predictors, and can be used to independently investigate the impact of each predictor on latent groups while accounting for other predictors (Asparouhov & Muthén, 2014). To facilitate the interpretation of the main effects and potential interaction effects of the two mindsets, all predictor variables except gender and location were centered via z-standardization before the analysis. Finally, the BCH auxiliary function in Mplus was utilized to analyze mean differences in distal outcomes (i.e., life satisfaction, depressive symptoms, anxiety symptoms, and academic adjustment) across distinct perceived stress trajectory patterns. Both the three-step and BCH approaches were widely employed in longitudinal research examining predictors and outcomes of changing trajectories because they produced less biased estimation by adjusting for errors in the classification of individuals (Asparouhov & Muthén, 2014).

Results

Preliminary Analyses

Descriptive statistics and correlations among the main variables are presented in Table 1. Female participants reported significantly higher perceived stress than males in the first two waves ($ps < 0.04$). Participants with higher subjective SES reported significantly lower levels of perceived stress at all waves, and lower levels of depressive and anxiety symptoms and higher levels of life satisfaction and academic adjustment at T4 ($ps \leq 0.01$). Participants with higher family income also reported significantly lower perceived stress at all three waves ($ps \leq 0.01$), and lower anxiety levels at T4 ($ps \leq 0.002$). Furthermore, participants with a stronger growth mindset of intelligence reported significantly lower levels of perceived stress at all waves ($ps < 0.02$), and those with a stronger stress-is-enhancing mindset showed significantly lower levels of perceived stress in the first two waves ($ps \leq 0.001$). No significant differences were found between participants from Beijing and Hubei on age, gender, or stress mindset ($p \geq 0.81$). However, participants from Beijing reported significantly higher subjective SES ($F = 5.51$, $p = 0.02$), family income ($F = 19.94$, $p < 0.001$), and perceived stress ($F = 9.22$, $p = 0.003$) at baseline but lower levels of growth mindset of intelligence ($F = 37.52$, $p < 0.001$), compared with those from Hubei. Therefore, location ($0 =$ Beijing, $1 =$ Hubei) was included as a covariate in the three-step approach.

Distinct Trajectories of Perceived Stress

An LGCM was estimated to explore how the participants' perceived stress shifted over time. The unconditional LGCM showed that a linear model adequately fit the data of participants' perceived stress, $\chi^2(5) = 11.16$, $p = 0.05$, CFI = 0.99, TLI = 0.99, RMSEA = 0.05, SRMR = 0.02. The mean of the intercept ($b = 18.29$, SE = 0.24, $p < 0.001$) and slope ($b = -0.16$, SE = 0.08, $p < 0.001$) were statistically significant, indicating that the participants, on average, reported decreased perceived stress over time. Furthermore, the variance of both the intercept ($b = 25.74$, SE = 2.37, $p < 0.001$) and slope ($b = 0.17$, SE = 0.04, $p < 0.001$) was significant, indicating that there were significant interindividual differences in the levels of participants' perceived stress at baseline and in how their perceived stress changed over time. Given that these findings indicate that there may be heterogeneity in perceived stress trajectories, unconditional LCGAs with various cluster solutions were estimated[1]. The fit indices from an unconditional LCGA with two to five classes of perceived stress trajectories are presented in Table 2. All model indices suggested that a model with more classes was acceptable (i.e., a 5-class solution). The 4- and 5-class models, however, were not taken into consideration as there were classes including less than 5% of the total number of participants. Consequently, the three-class model was identified as the optimal solution, as it showed a high entropy, significant p values of BLRT and Adj-LMR-LRT, and a steadily decreasing BIC with an increasing number of groups (see Fig. 1). The first class contained 15.29% ($n = 89$) of the sample and described a high-decreasing trajectory, with high perceived stress at baseline and a significant decline over time (intercept: $b = 26.42$, SE = 0.79, $p < 0.001$; linear slope: $b = -0.98$, SE = 0.27, $p < 0.001$). The second class contained 69.07% ($n = 402$) of the sample and described a middle-decreasing trajectory, with moderate perceived stress at baseline and a steady reduction over time (intercept: $b = 18.26$, SE = 0.35, $p < 0.001$; linear slope: $b = -0.28$, SE = 0.10, $p = 0.004$). The third class contained 15.63% ($n = 91$) of the sample and described a low-stable trajectory, characterized by low perceived stress at T1 and a non-significant slope over time (intercept: $b = 9.96$, SE = 0.60, $p < 0.001$; linear slope: $b = -0.28$, SE = 0.21, $p = 0.18$).

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[1] Growth mixture modeling was also conducted, with no optimal solution found in the current study. Please see the Supplementary materials for more details.

Table 1 Descriptive statistics and correlations among main variables (*N* = 582)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Perceived stress (T1)	1	–	–	–	–	–	–	–	–	–	–	–
2. Perceived stress (T2)	0.64**	1	–	–	–	–	–	–	–	–	–	–
3. Perceived stress (T3)	0.58**	0.63**	1	–	–	–	–	–	–	–	–	–
4. Life satisfaction (T4)	−0.40**	−0.48**	−0.45**	1	–	–	–	–	–	–	–	–
5. Depressive symptoms (T4)	0.36**	0.43**	0.44**	−0.46**	1	–	–	–	–	–	–	–
6. Anxiety symptoms (T4)	0.34**	0.43**	0.46**	−0.49**	0.73**	1	–	–	–	–	–	–
7. Academic adjustment (T4)	−0.34**	−0.46**	−0.45**	0.51**	−0.48**	−0.42**	1	–	–	–	–	–
8. GMI	−0.21**	−0.26**	−0.10*	0.12*	−0.08	−0.03	0.15**	1	–	–	–	–
9. SM	−0.14**	−0.20**	−0.08	0.09	−0.17**	−0.09	0.06	0.17**	1	–	–	–
10. Gender	−0.08*	−0.09*	−0.02	0.09	−0.05	−0.06	0.09	0.003	0.04	1	–	–
11. Age	−0.01	−0.03	−0.05	−0.01	0.01	0.02	−0.03	0.08	0.02	0.15**	1	–
12. SSS	−0.18**	−0.14**	−0.14**	0.26**	−0.13*	−0.13*	0.12*	0.04	−0.003	0.05	−0.05	1
13. Income	−0.12**	−0.14**	−0.13**	0.17**	−0.08	−0.17**	0.09	−0.05	−0.02	0.15**	−0.02	0.45**
M	18.14	18.04	16.99	3.32	5.74	4.27	1.96	3.86	2.30	–	18.11	4.81
SD	6.14	6.15	5.88	1.18	4.64	4.04	0.54	1.00	0.47	–	0.65	1.45

T1, T2, T3 and T4 = Time 1, 2, 3 and 4, respectively

GMI growth mindset of intelligence, *SM* stress mindset, *SSS* subjective socioeconomic status

*$p < 0.05$; **$p < 0.01$

Table 2 Model fit statistics for latent class growth analyses results (*N* = 582)

Classes	AIC	BIC	Adj-BIC	Entropy	Adj-LMR-LRT (*p* value)	BLRT (*p* value)	SC *n* (%)
2	10,415.45	10,450.38	10,424.98	0.74	<0.001	<0.001	142 (24.44)
3	**10,204.58**	**10,252.61**	**10,217.69**	**0.82**	**<0.001**	**<0.001**	**89 (15.29)**
4	10,154.12	10,215.25	10,170.81	0.78	0.01	0.01	18 (3.09)
5	10,124.36	10,198.59	10,144.62	0.77	0.02	0.01	17 (2.92)

The final class solution is bolded

AIC Akaike information criterion, *BIC* Bayesian information criterion, *Adj-BIC* sample-size adjusted Bayesian information criterion, *Adj-LMR-LRT* adjusted Lo–Mendell–Rubin likelihood test, *BLRT* bootstrapped likelihood ratio test, *SC* smallest class size

Fig. 1 Perceived stress trajectories of first-year college students. Error bars represent standard errors; the box size is proportional to the number of participants

High-decreasing; n=89; 15.29% Middle-decreasing; n=402; 69.07% Low-stable; n=91; 15.63%
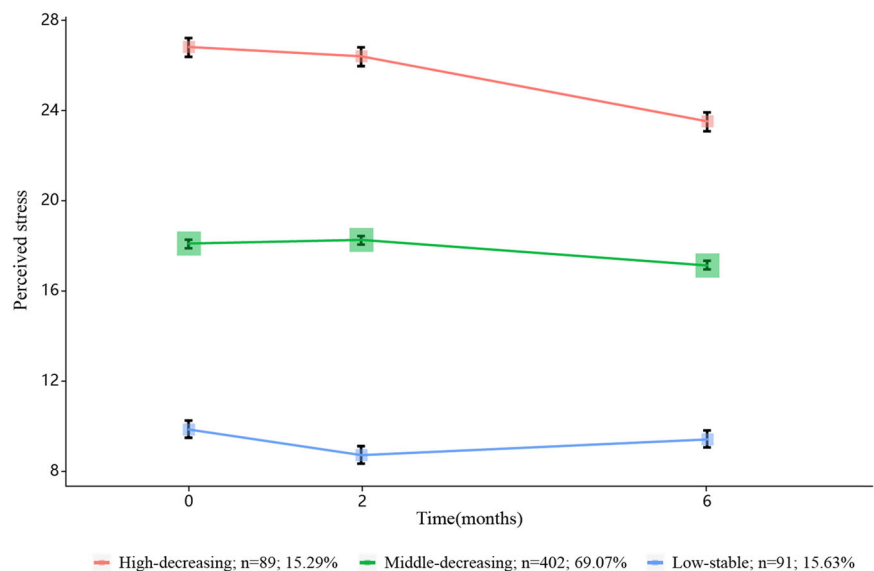
Additional ANOVA tests and paired sample t tests were conducted to determine whether there were statistically significant differences in perceived stress between and within the three patterns. According to Table 3, there were significant differences between the three groups regarding perceived stress at each wave ($p < 0.001$). Moreover, participants from the high-decreasing trajectory and the middle-decreasing trajectory reported significantly less perceived stress at T3 compared to T1 (ps < 0.05), providing further evidence for a decline in perceived stress over time among these two groups.

Distal Outcomes of Perceived Stress Trajectories

The second goal of the present study was to investigate associations between distinct patterns of perceived stress trajectories and distal outcomes at T4 (8 months after enrollment). The means and standard errors of distal outcomes for each pattern are presented in Table 4. The results indicated that, of the three groups, the low-stable group exhibited the most favorable results on all outcomes, with higher levels of life satisfaction, lower levels of depressive and anxiety symptoms, and better academic adjustment, and the high-

decreasing group reported the lowest academic adjustment and life satisfaction and highest depressive and anxiety symptoms. Students in the high-decreasing group, in particular, reported levels of depressive symptoms ($M = 9.19$; cut-off score $= 9$) as well as anxiety symptoms ($M = 7.85$; cut-off score $= 7$) that have already reached the Chinese population cut-off score.

Prediction of Perceived Stress Trajectories

Lastly, multinominal logistic regression using the three-step procedure was used to determine whether the participants' demographic characteristics (i.e., gender, location, age, SES, family income), mindset of intelligence, stress mindset, and interactions between mindsets predicted classification into any of the latent trajectory classes. All possible comparisons for each of the predictors are provided in Table 5. To facilitate the interpretation of the results, age, SES, family income, mindset of intelligence, and stress mindset were standardized before analysis, and gender (0 = female, 1 = male), location (0 = Beijing, 1 = Hubei), was coded as a dummy. As indicated in Model 1, participants from Hubei (OR = 2.64, $p = 0.04$) and those with higher family income (OR = 1.83, $p = 0.01$) were more likely to follow the low-stable trajectory than the high-decreasing trajectory, as were participants with a growth mindset of intelligence (OR = 1.86, $p = 0.01$) and a stress-is-enhancing mindset (OR = 1.75, $p = 0.02$). Additionally, participants who hold a growth mindset of intelligence (OR = 1.53, $p = 0.01$) and believe that stress is enhancing (OR = 1.56, $p = 0.02$) were more likely to be classified into the low-stable trajectory, rather than the middle-decreasing trajectory.

Model 2 indicates that there was also an interaction effect between stress mindset and mindset of intelligence (OR = 1.46, $p = 0.004$) when the middle-decreasing group was defined as the reference group. Probing this interaction revealed that a higher level of stress-is-enhancing mindset predicted membership in the low-stable group only in participants with a stronger growth mindset of intelligence (i.e., 1 SD above the mean; $p = 0.004$). Among participants with a

Table 3 Descriptive of the three latent patterns of perceived stress trajectories

	Perceived stress trajectory classes						F
	Low-stable		Middle-decreasing		High-decreasing		
	M	SD	M	SD	M	SD	
Perceived stress (T1)	9.83$_a$	3.53	18.03$_b$	3.98	26.76$_c$	4.07	416.96***
Perceived stress (T2)	8.70$_a$	4.19	18.24$_b$	3.54	26.36$_c$	3.66	514.60***
Perceived stress (T3)	9.06$_a$	4.44	17.28$_b$	3.97	23.48$_c$	5.55	221.56***

T1, T2 and T3 = Time 1, 2, and 3, respectively. Means with various subscripts in a row were significantly different from one another ($p < 0.001$)

$_{abc}$Indication of significant differences between means, with $_a$being the lowest value and $_c$being the highest value

***$p < 0.001$

Table 4 Means differences for distal outcomes across perceived stress trajectories

Distal outcomes	Perceived stress trajectory classes						Overall test	
	Low-stable		Middle-decreasing		High-decreasing			
	M	SE	M	SE	M	SE	χ^2	p
Life satisfaction	4.35$_c$	0.14	3.24$_b$	0.07	2.22$_a$	0.23	77.34	<0.001
Depressive symptoms	2.27$_a$	0.42	6.07$_b$	0.29	9.19$_c$	0.85	80.41	<0.001
Anxiety symptoms	1.20$_a$	0.28	4.47$_b$	0.26	7.85$_c$	0.73	117.61	<0.001
Academic adjustment	2.40$_a$	0.08	1.89$_b$	0.03	1.65$_c$	0.09	45.88	<0.001

Groups with different subscripts differ at $p < 0.05$ based on a χ^2 test

$_{abc}$Indication of significant differences between means, with $_a$being the lowest value and $_c$being the highest value

Table 5 Multinominal logistic regression odds ratios for baseline predictors

| | Ref. High-decreasing | | | | Ref. Middle-decreasing | |
| | Middle-decreasing | | Low-stable | | Low-stable | |
	Coeff (SE)	OR	Coeff (SE)	OR	Coeff (SE)	OR
Model 1						
Gender (ref. girls)	0.23 (0.39)	1.26	0.38 (0.45)	1.46	0.15 (0.32)	1.16
Location (ref. Hubei)	0.76 (0.40)†	2.14	**0.97 (0.47)***	**2.64**	0.21 (0.33)	1.24
Age	0.26 (0.16)	1.30	0.01 (0.19)	1.00	−0.26 (0.13)†	0.77
Income	0.32 (0.22)	1.04	**0.61 (0.25)***	**1.83**	0.29 (0.16)†	1.34
SSS	0.04 (0.18)	1.37	0.21 (0.23)	1.23	0.17 (0.18)	1.18
SM	0.11 (0.19)	1.12	**0.56 (0.25)***	**1.75**	**0.45 (0.19)***	**1.56**
GMI	0.20 (0.21)	1.22	**0.62 (0.24)***	**1.86**	**0.42 (0.17)***	**1.53**
Model 2						
Gender (ref. girls)	0.22 (0.39)	1.25	0.35 (0.45)	1.42	0.13 (0.33)	1.14
Location (ref. Hubei)	0.75 (0.40)†	2.12	**0.93 (0.46)***	**2.53**	0.18 (0.33)	1.19
Age	0.29 (0.17)†	1.34	−0.02 (0.20)	0.98	**−0.31 (0.14)***	**0.74**
Income	0.32 (0.22)	1.38	**0.59 (0.24)***	**1.80**	0.26 (0.16)†	1.30
SSS	0.04 (0.18)	1.04	0.23 (0.22)	1.25	0.19 (0.18)	1.21
SM	0.01 (0.23)	1.01	0.42 (0.25)†	1.53	**0.41 (0.18)***	**1.51**
GMI	0.20 (0.21)	1.23	0.48 (0.25)†	1.62	0.28 (0.18)	1.32
SM × GMI	−0.16 (0.16)	0.85	0.22 (0.16)	1.24	**0.38 (0.13)****	**1.46**

OR odds ratio, SSS subjective socioeconomic status, SM stress mindset, GMI growth mindset of intelligence

Significant p values are bolded

$^{\dagger}p < 0.10$; $*p < 0.05$; $**p < 0.01$

weaker growth mindset of intelligence (i.e., 1 SD below the mean), stress mindset did not predict membership in the low-stable group ($p = 0.67$). Moreover, when the high-decreasing group was defined as the reference group, the interaction between stress mindset and intelligence mindset did not significantly predict any class membership differences.

Sensitivity Analysis

As the participants were from four universities, university was dummy coded and included as a covariate in the three-step approach in the additional analysis. The main effect and interaction effect of stress mindset and mindset of intelligence on the prediction of class membership differences remain significant. Moreover, the association between patterns of perceived stress trajectories and their predictors and outcomes was also examined in SPSS Version 25.0 using multinominal regression analysis and a series of ANOVAs, with the main results remaining significant, indicating the robustness of the current findings.

Discussion

The challenges of emerging adulthood and transitioning to college are stressful for first-year college students, and the uncertainties associated with the COVID-19 pandemic have exacerbated this stress. There is accumulating evidence that students' perceived stress during transition periods (i.e., emerging adulthood) has a substantial effect on various domains of college adjustment (Anderson et al., 2021; Zahniser & Conley, 2018). However, changes in students' perceived stress across multiple timepoints throughout the stressful pandemic period remain unclear, and the potential antecedents and distal outcomes of perceived stress have been understudied in this population. Utilizing a longitudinal design combined with a person-centered approach, the current study identified three perceived stress trajectories: low-stable, middle-decreasing, and high-decreasing. Additionally, two types of individual mindsets (i.e., intelligence mindset and stress mindset) as measured at the start of the first year of college contributed to variations in trajectory. Students with the low-stable pattern exhibited higher levels of well-being and better academic adjustment than those following the other two trajectories. This study adds to the literature by providing insights about the nature of perceived stress trajectories over time during the college transition period among the first cohort of students to enroll in college following the onset of the epidemic. More importantly, it contributes an improved understanding of how positive mindsets and distal outcomes are linked with perceived stress trajectories.

Patterns of Perceived Stress Trajectories

Substantial changes in students' perceived stress levels were found over the course of the 6 months following enrollment; that is, they reported moderate stress levels that decreased gradually. This pattern is consistent with a classic study of students' integration, which indicated that students go through several stages after entering college, from the stage of separation (e.g., experiencing being away from their family) to the stage of incorporation (e.g., adapting to the new community) (Aljohani, 2016), and that stress levels should decrease gradually through these phases. More importantly, the current study illustrates the dynamic nature of stress experience and hints at significant individual variations in students' perceived stress trajectories as they faced the challenge of starting college during the pandemic. Three distinct perceived stress trajectories were identified among first-year college students: high-decreasing, middle-decreasing, and low-stable (supporting Hypothesis 1). The vast majority of the participants reported considerable levels of stress (PSS > 16 at all waves) and a smaller degree of decline (69.07% of that of the whole population). This finding contradicts a pre-epidemic study in which 70 percent of first-year students reported relatively low levels of stress (Ewing & Hamza, 2023). The high proportion of the sample fitting into the middle-decreasing group suggests that the experience of undergoing a transition period during the pandemic was highly stressful and requires more research attention. In concordance with an earlier study involving a sample of adolescents during a transition period (Schmeelk-Cone & Zimmerman, 2003), the results identified a subset of students who experienced high levels of stress and showed a decline over time (high-decreasing), nevertheless, to a limited extent in the current study. This could be because students' adjustment to the college was hampered by issues caused by the epidemic (e.g., lockdown) during the first 6 months (Yan et al., 2021), resulting in a limited reduction in their perceived stress. The results also identified another subset who reported low levels of perceived stress with minimal change over time (low-stable), which implies that there are advantages in investigating variations in patterns of perceived stress. Tailored intervention programs could be designed to help students in high-risk groups, who are especially susceptible to the detrimental effects of stress, cope with challenges during college adjustment. For this purpose, the early identification of students in high-risk groups (with elevated stress patterns) is also necessary. Meanwhile, individuals' stress patterns appear to be substantially influenced by their initial levels of perceived stress upon enrollment. This calls for future research to specifically focus on stress levels in the early stages of college life, as this appears to be a critical period for shaping perceived stress trajectories.

Distal Outcomes of Stress Trajectories

Another objective of the current study was to examine the distal outcomes of perceived stress trajectories. The results show that stress trajectories were significantly associated with students' academic adjustment and well-being. Specifically, the students in the low-stable group showed the most favorable psychological well-being and academic adjustment, and the students in the high-decreasing group exhibited the most severe depressive and anxiety symptoms, the lowest life satisfaction, and the poorest academic adjustment (supporting Hypothesis 2). These results are consistent with prior research and theories that suggested detrimental impacts of stress on well-being and academic performance (Selye, 1978; Tasso et al., 2021). The findings also support and extend research focusing on stress and college adjustment (Hoyt et al., 2021; Samaha & Hawi, 2016) by revealing the multifaceted nature of the effects of distinct stress trajectories on the subsequent development of college students during the transition period, which holds both opportunities for development and also risks. Notably, the depressive and anxiety symptoms reported by students in the high-decreasing group achieved the cut-off score for the Chinese population, suggesting that they need clinical diagnosis. High-density stressful experiences, as captured by a high-decreasing pattern, at such a crucial time might further worsen students' mental and physical health (Hypolite et al., 2022). These findings therefore re-emphasize the importance of focusing on stress perceptions and identifying at-risk groups during the early stage of college life.

Mindsets as Antecedents of Stress Trajectories

The current findings suggest that both mindset of intelligence and stress mindset play a significant role in explaining students' perceived stress during their first year at college. Supporting Hypothesis 3, the participating students who held a stress-is-enhancing mindset or a growth mindset of intelligence were more likely to follow the low-stable trajectory than the middle-decreasing or high-decreasing trajectories. This finding is consistent with the negative correlation between both forms of positive mindsets and individual stress levels found in variable-oriented studies (Crum et al., 2013; Zhao et al., 2021), and extends the literature on mindsets by providing evidence that such a conclusion is also applicable in person-oriented research. Indeed, mindsets of stress and intelligence have significant impacts on students' stress perceptions, not only in terms of absolute stress levels but also their perceived stress patterns.

The current findings also suggest an interaction between the two mindsets in predicting the likelihood of students following particular perceived stress trajectories. Specifically, only students who held both positive mindsets had a greater chance of being placed in the low-stable group than

the middle-decreasing group. This finding supports the cognitive appraisal theory of stress, which emphasizes that individuals interpret stress with multilevel appraisals (Lazarus, 1984). Individuals with a stress-is-enhancing mindset are less likely to view the current stressors as threats in their primary appraisal (Crum et al., 2017). In addition, when students hold a growth mindset of intelligence and realize that their learning ability can be improved, they feel more in control when facing their academic challenges (their most common stressor), which constitutes a secondary appraisal (Burnette et al., 2020). When students already perceive considerable stress, having both positive mindsets might be necessary or at least beneficial for them to thrive. Such findings concur with a recent study emphasizing the significance of both mindsets for Western adolescents when they handle inevitable stress. These findings advance the understanding of implicit theory by revealing distinct mindsets that, although domain-specific, can jointly contribute unique explanatory value to the outcome of stress experiences, especially during the transition period. Future studies would benefit from considering multiple mindsets associated with the key scenarios (e.g., stress experiences) as potential influencing factors.

Interestingly, no significant interaction effects of both mindsets were found between the high-decreasing group and the low-stable group. Although research on implicit theories emphasized that such positive mindsets would be beneficial when individuals were under stress or facing challenges (Yeager & Dweck, 2020), the current findings imply that this may not always be the case, especially when individuals were under extreme stress. Since students in the high-decreasing group may have experienced a variety of difficulties, for instance, high levels of depressive and anxiety symptoms. In this case, psychological resources alone including positive mindsets may not be sufficient to reduce their stress levels. Multidimensional approaches to reducing individual stress experiences and fostering resilience will be essential to halting the spread of stress, for example, by providing supportive context (e.g., support from universities) rather than solely relying on psychological resources (Nurius et al., 2015). In line with recent research indicating that people may not benefit from new positive beliefs in all contexts (Hecht et al., 2021), the current findings reveal new insights into the "heterogeneity influences" of mindsets by unpacking a nuanced picture of the boundary effects of mindsets and highlighting the significance of the level of risk experienced by the individual. Collectively, future research would benefit from exploring the efficacy of tailored mindset interventions aimed at helping students develop adaptive stress perceptions during their transition to college. In particular, a synergistic mindset intervention may be beneficial for students experiencing stress during transitions, whereas external resources may be required for those who were at high risk.

Strengths, Limitations, and Further Research

The current study showed several notable strengths. Firstly, this study investigated the stress experiences of first-year college students who were experiencing a crucial transition period during COVID-19, and who were especially susceptible to the negative effects of stress, which had been neglected by previous research. The findings of distinct perceived stress trajectories underlined the necessary of early identification of students with high levels of stress, as they may experience persistent stress during such crucial period. Secondly, this study examined the association between mindsets (both independently and jointly) and trajectories of perceived stress, thereby providing a more comprehensive perspective on the impacts of mindset of intelligence and stress mindset on stress-related outcomes among university students.

In addition to these strengths, the current study also has several limitations. First, although a three-wave longitudinal design was employed in this study, the time span was limited to the first 6 months of college transition, which does not allow us to draw conclusions for a longer time period, for instance, the whole first year. Future studies are necessary to extend these findings by investigating perceived stress trajectories over a longer period (e.g., one year) and to explore if students' perceived stress level upon enrollment has ongoing effects on their later stress levels and patterns. Second, there is potential bias in the results from the measurement of the distal outcomes by student self-report. Also, academic adjustment does not adequately reflect the academic achievement of students under stress. It would be informative for future work to consider including objective indicators, such as official academic credits and biological indicators of well-being (e.g., cortisol levels). Third, the study sample was taken from a limited geographic region in China with a limited sample size, thereby limiting the generalizability of the findings. More research is needed to verify the current findings with a larger sample size and more complex models (e.g., growth mixture modeling).

Conclusion

Existing research suggests that higher levels of perceived stress are detrimental to adjustment outcomes among college students. Nevertheless, it is unclear how perceived stress changes across multiple timepoints, particularly when students are experiencing a transition period; research on distinct patterns of perceived stress trajectories and their associations with predictors and outcomes is much less. The current study offers significant new insights into inter-individual variations in students' perceived stress throughout the course of the first 6 months of college life, the mindset antecedents associated with these variations, and their distal effects.

The results of the current study identified three distinct stress trajectory subgroups: low-stable, middle-decreasing, and high-decreasing. Furthermore, the relationship between these patterns and distal outcomes indicated that students who followed the low-stable pattern reported better adjustment outcomes, and students who followed the high-decreasing pattern were most at risk for difficulties with academic adjustment and well-being. Finally, it was found that both stress mindset and mindset of intelligence were jointly associated with the prediction of these patterns. These findings emphasize the significance of accounting for heterogeneity in students' perceived stress trajectories during the college transition. Additionally, current findings extend implicit theory by providing a fresh perspective on taking multiple domain-specific mindsets jointly into account for their impacts on perceived stress, and also underscoring the heterogeneity of mindset influences under different levels of risk. These findings might inform future interventions to cultivate adaptive mindsets in conjunction with external resources in order to help emerging adults flourish under stress during the transition period.

Authors' Contributions S.Z. participated in conceptualizing the study, conducting statistical analyses, and drafting the manuscript. Y.Z. participated in data collection, conceptualization of the study, and interpretation of the results. C.Y. participated in the design and coordination of the study and contributed to the production of the draft manuscript. H.Z. participated in the design and coordination of the study, interpreted the results, and contributed to funding acquisition. M.X. participated in the interpretation of the data and provided critical reviews of the manuscript. P.C. participated in data collection, conceptualization of the study, and interpretation of the results. D.L. participated in the design and coordination of the study, provided critical reviews of the manuscript, and contributed to funding acquisition. All authors read and approved the final manuscript.

Data Sharing Declaration The datasets analyzed in the current study are not publicly available but are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest The authors declare no competing interests.

Ethical Approval The research procedure followed the Ethics Committees' guidelines and was approved by the Institutional Review Board of Beijing Normal University.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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