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Childhood experiences of threat and deprivation predict distinct depressive symptoms: A parallel latent growth curve model

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ABSTRACT

Background/aim: There is growing awareness that specific childhood trauma (CT) may confer to the unique risk of depression, but little is known about this. The present study seeks to provide insight into how CT subtypes may impact distinct depressive symptoms over time based on the dimensional model of adversity (DMA).
Methods: A total of 3535 college freshmen participated in a 2-year, four waves longitudinal tracking study. A conditional parallel latent growth curve model (LGCM) was constructed to examine the impacts of different types of CT (threat and deprivation) on the development of depressed mood and anhedonia, and whether these relationships vary across gender.
Results: Our findings revealed that threat and deprivation could differentially relate to depressed mood and anhedonia. Both threat and deprivation predicted initial depressed mood levels ($\beta = 0.309$, $p < 0.001$; $\beta = 0.175$, $p < 0.001$, respectively) and its trajectory ($\beta = -0.139$, $p = 0.068$; $\beta = -0.168$, $p < 0.05$, respectively). Only deprivation predicted anhedonia levels ($\beta = 0.318$, $p < 0.001$) and trajectory ($\beta = -0.218$, $p < 0.001$). This pattern of relationships between CT and depressive symptoms varied across gender.
Conclusion: These findings highlight specific pathways and symptomatic manifestations of the impacts of different CT subtypes on depression and are consistent with the hypothesis of DMA. Threat and deprivation predicted more severe depressed mood, whereas deprivation uniquely conferred to the risk of depression via elevated anhedonia. Meanwhile, the deleterious effects of CT would persist during early adulthood. Gender differences were also discussed.

1. Introduction

Environmental experiences in childhood and adolescence play a meaningful role in shaping health across the lifespan. It has been repeatedly established that exposure to traumatic experiences during this period is a risk factor for psychopathology. Depression is one of the most well-documented poor health outcomes of childhood trauma (CT) (Cohen et al., 2017; Liu, 2017). CT exposure not only increases the average risk of depression onset (Li et al., 2016), but also predicts depression course more chronic, severe, and treatment-resistant in depressed individuals (Nanni et al., 2012).

Most of the previous studies used the cumulative risk approach to establish the relationship between CT and depression, which focuses on the amount of CT exposure rather than the distinct types of CT (Evans et al., 2013). However, different types of CT may confer unique depression risks (Infurna et al., 2016). Despite the cumulative risk approach effectively reflecting the "dose-response" relationship between CT and depression and has been widely used, it generally lacks specificity, which shows obvious limitations in distinguishing between distinct types of CT. The cumulative risk approach implicitly assumed that the underlying mechanisms by which all CT experiences affect the development of depression are the same (McLaughlin and Sheridan, 2016), which is highly tenuous. Although some studies highlighted the unique effects of different types of CT, there is no theoretical basis for

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the classification of CT types (e.g., social/non-social, physical/psychological) to explain why different traumatic experiences have different effects and consequences.

To address this issue, McLaughlin and Sheridan proposed the Dimension Model of Adversity (DMA) (McLaughlin et al., 2014; Sheridan and McLaughlin, 2014) based on the distinct impacts of CT on neural development. The DMA differentiates between experiences of *threat* and *deprivation*. *Threat* is conceptualized as an actual or perceived threat of harm to one's physical integrity, including sexual abuse, physical and emotional threat, and other forms of violence (e.g., community, domestic violence). *Deprivation* involves an absence of expected inputs (cognitive or social inputs) from the environment, such as institutionalization and neglect. The DMA hypothesized that threat experiences affect the development of the neural structure that underlie emotional learning, involving the limbic system (e.g., amygdala). Behavioral studies have found that changes in emotional perception, attention, reaction to emotional stimuli, and emotional regulation in children with violence exposure (Heleniak et al., 2016; McLaughlin et al., 2016; Pollak and Sinha, 2002; Pollak and Tolley-Schell, 2003). In relative, *deprivation* is hypothesized to be associated with alterations in brain regions involved in cognitive function and reward processing (e.g., the ventral striatum). Alterations in neural networks that support complex cognitive abilities have been found in individuals experiencing deprivation, particularly in frontoparietal networks that support executive function (McLaughlin et al., 2014; McLaughlin et al., 2017; Sheridan and McLaughlin, 2014). Children with early deprivation have difficulties in several cognitive functions, such as language and executive functions (Pollak et al., 2010; Spratt et al., 2012). Meanwhile, Individuals experiencing deprivation may have reduced neural responsiveness of reward circuits during reward anticipation and outcome phases (Dennison et al., 2019). Children exposed to CT, especially those who experienced deprivation, showed changes in reward learning. DMA proposes a novel and promising conceptual framework for understanding the impacts of different types of CT on neural development and ultimately behavior. According to the core principle of DMA, the neurodevelopmental processes affected by threat experiences differ (at least in part) from those affected by deprivation (McLaughlin and Sheridan, 2016). Therefore, the health consequences (e.g., the manifestation of depressive symptoms) of different neurodevelopmental pathways may also be at least partially different, which can only be identified when the distinct depressive symptoms were examined separately.

Depressive symptoms are not a single structure. Depressed mood and anhedonia are two distinct core depressive symptoms with distinct clinical manifestations and underlying mechanisms. Depressed mood is comprised of the presence of empty, irritable, sad mood, or complaint about somatic disturbance (Association, 2013), which relate to abnormal emotional processing function. Anhedonia is characterized by deficits in the ability to feel pleasure from previously rewarding and gratifying activities and situations (Hasler et al., 2004; Treadway and Zald, 2011), and involves reward dysfunction. Anhedonia is considered that can vary independently of other depressive symptoms (Drysdale et al., 2017; Molet et al., 2016). The growth of depressed mood and anhedonia are also independent during adolescence (Conway et al., 2017). As hypothesized by DMA, threat experiences mainly affect neural circuits related to emotional learning, leading to abnormalities in their emotional processing, which may be more relevant to depressed mood. In contrast, deprivation experiences may be more relevant to anhedonia due to their impacts on the reward circuit. Due to the specific mechanistic correlates that may exist between different depressive symptoms (depressed mood and anhedonia) and different types of CT (threat and deprivation), we believe that threat and deprivation may have different impacts on depressed mood and anhedonia.

The present study aims to gain insight into how threat and deprivation affect distinct depressive symptoms over time in university freshmen based on the DMA framework. The college freshmen are in a distinct period of development straddling the adolescent and young adult life stages. In this stage, college students are in the midst of changes, such as gaining more autonomy from parents (e.g., leaving the home), significant shifts in social roles, and instability in relationships (Arnett, 2000; Sussman and Arnett, 2014). Meanwhile, college is riddled with substantial instability, which may contribute to reduced social support and increased stress, leading to many challenges for college students. However, neurobiological deficits in cognitive and emotional functions affected by CT may make students difficult to cope with these developmental challenges. When struggles with these developmental challenges persist, individuals experience common psychological responses such as depressive symptoms (Cicchetti and Toth, 2009), which may potentially be related to these neurobiological deficits. Therefore, it is important to identify how different types of CT influence different dimensions of depressive symptoms in this unique stage and trajectories of these impacts over time.

In addition, we also tested sex differences in the association between CT and depression. Previous studies showed the potential moderating influence of sex on depressive symptoms. Girls displayed a higher depressed mood than boys, while boys had greater anhedonia, both in clinical (Bennett et al., 2005) and non-clinical adolescents (Crockett et al., 2020), as well as in adults (Chan et al., 2012). Therefore, it is necessary to clarify whether there are sex differences in the impact of CT on depressive symptoms.

Overall, the present study aims to identify the impacts of different types of CT on different depressive symptoms. We first examined trajectories of depressed mood and anhedonia within the context of a multi-wave, longitudinal design. Then, the impacts of threat and deprivation on the development of depressive symptoms were explored based on the DMA framework. The recent perceived stress was controlled when exploring the effect of CT subtypes on depressive symptoms, to remove the potential confounding effects caused by more recent stressors on the impacts of childhood stress (Grosse et al., 2016). Finally, sex differences in these relationships were examined. We hypothesized that threat and deprivation would differentially relate to depressed mood and anhedonia: threat was more closely associated with depressed mood, but deprivation was more closely related to anhedonia. Both threat and deprivation predict more severe depressive symptoms and influence their trajectories.

2. Methods

2.1. Participants and survey

Participants in the present study were recruited from a university in Hunan province, China. A total of four-wave surveys were conducted from 2019 to 2021. In the academic year 2019–2020, all 3800 incoming freshmen were invited to participate in the baseline survey (December 2019). We provided survey information on the questionnaires and distributed it to students during a class break. All participants were given written informed consent before completing the measures. Ultimately, 3535 students (2319 female, 1216 male, Age $_{\text{Mean}}$ = 18.01, Age $_{\text{SD}}$ = 0.77 at baseline) agreed to participate and provided fully completed questionnaires, which gave a response rate of 93.0 %. Due to the rapid spread of the virus in 2020, the school was closed and all students had to be placed in quarantine to protect public health. Therefore, an online survey was conducted via the "Questionnaire Star" website at the second wave data collection on June 2020. A total of 2953 students completed the second wave survey, with 582 missing (16 %). At the third wave data collection in December 2020, we have resumed the on-site unified survey due to the proper control of the epidemic. A total of 2883 students completed the third wave survey, with 652 missing (18 %). The fourth wave survey was conducted in December 2021, and total of 2926 students completed this survey with 609 missing (17 %). A MANOVA revealed no significant difference in the study variables between those who participated in all four waves' surveys and those who dropped out ($F_{(3, 3401)} = 1.224$, $p > 0.05$), indicating that the data were missing at random. Overall, 62.69 % of students (N = 2216) completed all waves of data collection. The study was approved by the Ethics Committee of the Second Xiangya Hospital of Central South University.

2.2. Measures

2.2.1. Childhood trauma

Threat and deprivation were measured with the Chinese version of Childhood Trauma Questionnaire (CTQ) (Zhao et al., 2005), which is a reliable and valid self-reporting instrument, containing 28 items and can yield five factors that evaluate five aspects of CT exposure: physical neglect, physical abuse, emotional neglect, emotional abuse, and sexual abuse. We created a threat exposure composite by summing the scores of physical abuse, emotional abuse, and sexual abuse, which showed adequate internal consistency (McDonald's omega = 0.869) in our sample. Deprivation exposure composite was created using the same procedures, including emotional neglect, and physical neglect, which showed acceptable internal consistency (McDonald's omega = 0.794) in our sample. In the present study, the CTQ was tested only in the baseline survey. The CTQ total also exhibited adequate internal consistency (McDonald's omega = 0.886) and good fit for 5-factor structure (CFI = 0.954, TLI = 0.948, RMSEA = 0.049, SRMR = 0.056) in our sample.

2.2.2. Perceived stress

In addition to childhood stress, the Perceived Stress Scale (PSS) (Reis et al., 2010) was used to assess participants' recent perceived stress in the current study, which contains 10 self-reported items to assess recent (last 1 month) perceived stress. The PSS was used to control for the potential confounding effects caused by more recent stressors on the impacts of childhood stress (Grosse et al., 2016) in all waves of current study. McDonald's omega (s) for the current sample were 0.806, 0.795, 0.804, and 0.814 in waves 1, 2, 3, and 4, respectively.

2.2.3. Depressive symptoms

The depressed mood was measured using the Chinese version of the Beck Depression Inventory-II (BDI-II) (H et al., 2014), which contains 21 self-reported items and has been well validated. The BDI-II was tested in all waves. McDonald's omega (s) for the current sample were 0.910, 0.931, 0.939, and 0.949 in the first, second, third, and fourth wave, respectively. Considering the presence of items on the BDI-II associated with anhedonia: 4 (loss of pleasure), item 12 (loss of interest), and item 21 (loss of interest in sex), we repeated our analysis using scores that removed these items (see Supplementary Materials).

The Snaith-Hamilton Pleasure Scale (SHAPS) (Snaith et al., 1995) was used to assess anhedonia, which is a 14-item, self-report scale intended to assess an individuals' hedonic experience in the most recent few days. The Chinese version of the SHAPS (Liu et al., 2012) was proven as a valid measurement in Chinese clinical and non-clinical samples and was used in all waves of the current study. McDonald's omega (s) for the current sample were 0.908, 0.960, 0.953, and 0.957 in waves 1, 2, 3, and 4, respectively.

2.3. Statistical analyses

SPSS 24.0 and Mplus 8.3 were used to perform descriptive statistics and build latent growth curve models (LGCMs). An LGCM examines longitudinal changes by estimating intercepts and slopes as latent variables (Bollen and Curran, 2006). The goodness-of-fit indices for these LGCMs were tested using χ^2/df, comparative fit index (CFI), Tucker-Lewis index (TLI), mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). CFI > 0.90 and TLI > 0.90 indicate acceptable model fit, and that two values >0.95 indicate good model fit. RMSEA and SRMR values should be lower than 0.08 and 0.06, respectively (Hu and Bentler, 1999). Prior to build LGCM, measurement invariance (MI) analyses should be performed to guarantee the changes that we observed are due to real changes in the phenomena but not because a change in the understanding of the test items (Liao et al., 2021). That is, we need to establish a metric invariance. Exploratory structural equation modeling (ESEM) with Weighted Least Squares Means and Variances adjusted estimation (WLSMV) was used for longitudinal MI. Since the value of chi-square (χ^2) is sensitive to sample size, three change (△) indices were chosen to estimate invariance between configural model and metric model: △CFI, △TLI, and △RMSEA (Cheung and Rensvold, 1999). Invariance was considered to be supported when △CFI and △TLI were each ≤0.01 and when △RMSEA was <0.015. After a measurement invariance was established, a parallel LGCM with time-invariant covariates (gender, threat and deprivation) and time-variant covariate (perceived stress) was constructed to examine inter and intraindividual changes of depressed mood and anhedonia, and the influence of different types of CT on depressed mood and anhedonia. The modeling process of LGCM is detailed in the Supplementary Materials. In addition, the MODEL TEST command (Wald test) in Mplus 8.3 was used to test possible gender differences.

3. Results

Descriptive statistics of all observed variables are presented in Table 1. Across all three waves, depressed mood was positively correlated with anhedonia. Threat and deprivation were positively correlated with two depressive symptoms in all waves.

Metric measurement invariance over four time points was established for BDI-II and SHAPS respectively (see Supplementary Materials, Table S1). Prior to estimating a parallel LGCM for the depressed mood and anhedonia, we separately examined the trajectory of each variable via unconditional LGCM. For depressed mood, the linear growth model was not fit. The estimated time scores model provided the best fit for depressed mood (CFI = 0.957, TLI = 0.914, RMSEA = 0.060, SRMR =0.047). For anhedonia, the linear model was fit well (CFI = 0.952, TLI = 0.942, RMSEA = 0.065, SRMR = 0.030), the estimated time scores model provided the best fit for anhedonia (CFI = 0.987, TLI = 0.975, RMSEA = 0.043, SRMR =0.034). The result of different testing for models (use DIFFTEST option in Mplus) showed that there is significant difference between linear growth model and estimated time scores model ($\Delta S\text{-}B\chi^2 = 23.420$, $\Delta df = 2$, $p < 0.001$). Meanwhile, the estimated time scores model has lowest BIC (78,756.255, ΔBIC = 40.851 compared with linear growth model). Therefore, estimated time scores models were applied to both dependent variables. In the separately constructed unconditional LGCMs of depressed mood and anhedonia, the intercept means of depressed mood and anhedonia are 6.114 ($p <$ 0.001) and 24.063 ($p < 0.001$), respectively, significantly >0, indicating that the depressed mood and anhedonia had developed significantly when college students were first measured at baseline. The slope means of depressed mood and anhedonia are −3.537 ($p < 0.001$) and 0.959 ($p < 0.001$), respectively, indicating that the development of depressed mood is overall on the decline, and anhedonia is overall on the rise with subtle changes. The intercept variance and slope variance of depressed mood are 21.800 ($p < 0.001$) and 7.843 ($p = 0.032$), respectively, indicating the baseline level and change rate of depressed mood have significant individual differences. The correlation between intercept and slope of depressed mood is −0.465 ($p < 0.001$). The variances of intercept and slope of anhedonia are 13.477 ($p < 0.001$) and 8.353 ($p = 0.140$), respectively, indicating the significant individual difference of anhedonia level at baseline and no significant change rate. The correlation between intercept and slope of anhedonia is 0.100 ($p = 0.337$).

Next, we combined the two unconditional LGCMs to create an unconditional parallel LGCM (M1), which showed good fitness. The growth trajectories of depressed mood and anhedonia were positively associated with each other as evidenced by the significant covariances between the two intercepts and slopes (see Supplementary Materials, Table S2). To explore the effects of covariates on the two latent variables, parallel LGCM with gender, threat, deprivation, recent perceived

Table 1
The mean value, standard deviation, and correlations of study variables.

	1	2	3	4	5	6	7	8
1 Gender	1.00							
2 Threat	−0.037*	1.00						
3 Deprivation	−0.048**	0.474**	1.00					
4 T1BDI	0.054**	0.312**	0.300**	1.00				
5 T2BDI	0.024	0.157**	0.147**	0.398**	1.00			
6 T3BDI	0.005	0.175**	0.155**	0.415**	0.527**	1.00		
7 T4BDI	−0.038*	0.174**	0.172**	0.361**	0.421**	0.534**	1.00	
8 T1SHAPS	−0.050**	0.167**	0.304**	0.284**	0.118**	0.124**	0.119**	1.00
9 T2SHAPS	−0.049**	0.069**	0.160**	0.157**	0.240**	0.182**	0.172**	0.350**
10 T3SHAPS	−0.084**	0.098**	0.163**	0.188**	0.156**	0.278**	0.173**	0.325**
11 T4SHAPS	−0.092**	0.116**	0.171**	0.157**	0.156**	0.161**	0.287**	0.314**
12 T1PSS	0.050**	0.168**	0.041**	0.402**	0.186**	0.201**	0.167**	0.023
13 T2PSS	0.072**	0.120**	0.049**	0.201**	0.306**	0.217**	0.215**	0.080**
14 T3PSS	0.102**	0.073**	0.005	0.191**	0.223**	0.367**	0.236**	0.030
15 T4PSS	0.101**	0.097**	0.031	0.180**	0.186**	0.203**	0.352**	0.008
Mean	–	18.06	17.27	6.13	2.54	3.91	4.05	24.19
SD	–	4.66	5.88	6.78	5.10	6.39	6.87	5.94

	9	10	11	12	13	14	15
9 T2SHAPS	1.00						
10 T3SHAPS	0.397**	1.00					
11 T4SHAPS	0.333**	0.353**	1.00				
12 T1PSS	0.022	0.006	0.036	1.00			
13 T2PSS	0.206**	0.116**	0.108**	0.249**	1.00		
14 T3PSS	0.087**	0.078**	0.058**	0.297**	0.295**	1.00	
15 T4PSS	0.069**	0.033	0.160**	0.243**	0.254**	0.364**	1.00
Mean	24.99	24.24	23.80	17.10	14.65	16.08	16.07
SD	6.56	6.67	6.89	4.81	6.31	5.53	5.59

Notes: * $p < 0.05$, ** $p < 0.01$; Gender (1 = Male, 2 = Female).
Abbreviations: BDI, Beck depression inventory; SHAPS, Snaith-Hamilton pleasure scale; PSS, Perceived stress scale.

stress entered as covariates were next tested (M2) and exhibited good fit. Fit statistics for all models were presented in Table 2. Of note, for the depressed mood, both threat and deprivation significantly predict intercept (all $p < 0.001$), and deprivation significantly predict slope ($p < 0.05$). Threat also have influence on slope of depressed mood, although it only reached marginal significant ($\beta = -0.139$, $p = 0.068$). For anhedonia, deprivation was the only predictors of elevated baseline levels and slower change rates (all $p < 0.001$). In addition, gender significantly predicts the intercept for depressed mood ($p = 0.023$) and anhedonia ($p = 0.021$), and the slope for depressed mood ($p = 0.043$). These findings are displayed in Fig. 1. The levels of depressed mood and anhedonia in each wave were significantly influenced by corresponding perceived stress (all $p < 0.001$).

Finally, to examine the sex differences of the effects of threat and deprivation on depressive symptoms, we further tested our model by grouping male and female (M3). The different coefficients between male and female groups were observed. To test whether there were significant differences among coefficients, the MODEL TEST command (Wald test) in Mplus 8.3 was used (see Table 3). All main results were not changed in repeated analyses (see Supplementary Materials, Tables S3-S6).

Table 2
Fit statistics for latent growth curve models.

Model	χ^2/df	CFI	TLI	RMSEA (95 % CI)	SRMR
M1	10.65	0.972	0.945	0.052 (0.045, 0.060)	0.036
M2	3.850	0.976	0.959	0.037 (0.031, 0.042)	0.043
M3	2.781	0.970	0.954	0.041 (0.035, 0.047)	0.049

Notes: M1: parallel latent growth curve model without covariates; M2: parallel latent growth model with covariates (gender, threat, deprivation, and perceived stress); M3: two group (male and female) parallel latent growth model with covariates (threat, deprivation, and perceived stress).

4. Discussion

The present study explored the effects of different types of childhood trauma on different dimensions of depressive symptoms over time within the context of a multi-wave, longitudinal design. We found that the trajectory of depressed mood was a sharp decline between waves 1 and 2, then an uptrend was observed between wave 2 and wave 4, and become relatively stable. However, the trajectory of anhedonia was generally stable across four waves. For the predictors of depressive symptoms, our hypothesis has been mostly supported. The first key finding was that depressed mood was positively correlated with both threat and deprivation, and was more closely associated with threat. Only deprivation was positively correlated with anhedonia. The second key finding was that threat and deprivation predicted more severe depressed mood at baseline, and deprivation could predict changes of depressed mood over time. Meanwhile, deprivation also impacted the initial level and change rate of anhedonia. In addition, the levels of depressed mood and anhedonia in each wave were significantly influenced by contemporaneous perceived stress. Third, pattern of relationships between CT and depressive symptoms showed gender differences, indicating a greater influence of CT on females. Our findings provided insight into how different CT subtypes (threat and deprivation) may impact distinct dimensions of depressive symptoms over time in college students, deepening understanding of the impact patterns of CT on the development of depression across the lifespan.

4.1. The trajectories of depressive symptoms

In this study, the development trajectories of depressed mood and anhedonia are non-linear patterns. For depressed mood, there was a sharp decline between waves 1 and 2, then an uptrend was observed between wave 2 and wave 4, and become relatively stable. The level of depressed mood was highest at baseline (December 2019), which may be due to maladaptation to the new environment. The freshmen who

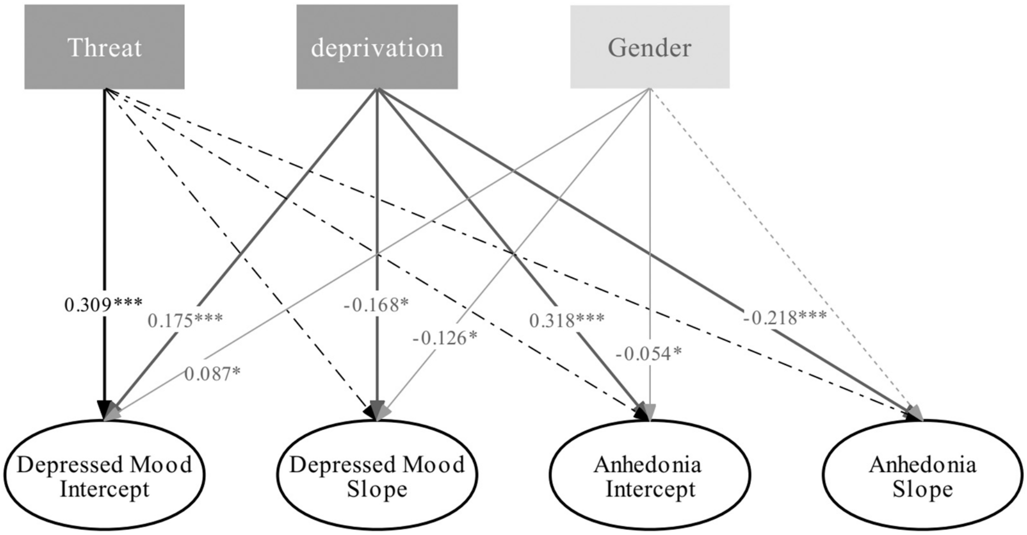

Fig. 1. Model for outcome variables (M2).
Notes: Model of the relation between covariates and depressive symptoms. Significant paths ($p < 0.05$) are represented by solid lines and non-significant paths ($p > 0.05$) are represented by dashed lines. In order to enhance figure clarity, not all correlations between predictor variables and endogenous variables were presented. $*p < 0.05$; $***p < 0.001$. Gender (1 = Male, 2 = Female).

Table 3
Summary of parameter estimates for LGCM (M3).

	Male		Female		Wald test[a]	
	β	p	β	p	value	p
Depressed mood intercept						
Threat	0.074	0.117	0.290	<0.001	13.521	<0.001
Deprivation	0.093	0.017	0.087	0.002	0.018	0.893
Depressed mood slope						
Threat	0.039	0.238	−0.176	<0.001	19.703	<0.001
Deprivation	−0.014	0.579	−0.070	0.016	2.153	0.142
Anhedonia intercept						
Threat	−0.050	0.296	−0.063	0.100	0.046	0.830
Deprivation	0.186	<0.001	0.296	<0.001	4.765	0.029
Anhedonia slope						
Threat	0.034	0.083	0.003	0.953	0.405	0.524
Deprivation	−0.045	0.008	−0.166	<0.001	10.664	0.001

Notes: Model controlled for covariates, including threat, deprivation, perceived stress.
[a] Wald test was used for difference test between coefficients of male and female.

have just entered the university are more prone to have depressed moods when faced with many challenges posed by changed living and study environments, as well as interpersonal relationships. At the second wave (June 2020), due to the prolonged lockdown and closure of school, a sharp decline of depressed mood was observed, which maybe thanks to the contribution of reduced academic stress and living with family members during this period. The result is consistent with a large epidemiological survey (Fancourt et al., 2021) and showed that depressive symptoms declined across the lockdown period. With the reopening of schools and accompanying academic tasks, the level of depressed mood of college students has rebounded, and tended to stabilize.

Anhedonia was generally stable across four waves. The trajectory of anhedonia shows a gentle rise between waves 1 and 2, and subtle fall from waves 2 to 4. In fact, longitudinal study has shown that anhedonia becomes more and more stable across adolescence and reflects a more trait marker of anhedonia at late adolescence (Bennik et al., 2014). Despite this, the anhedonia levels have seen a small increase during the lockdown and fell back after the lockdown ended. Other studies supported our findings (Landaeta-Diaz et al., 2021; Skumlien et al., 2021). There was no surprise that lockdown has kept people from engaging in activities they normally find enjoyable. Long-term heavy dependence on mobile phones and food also makes it difficult to get pleasure from it (Landaeta-Diaz et al., 2021). Meanwhile, social distancing may also lead to social isolation and, as a consequence, to feelings of loneliness (Banerjee and Rai, 2020).

In addition, our results showed that the initial level of depressed mood is significantly negatively correlated with its development trend, indicating that the decline rate in college students with a high starting level of depressed mood is slower than those with a low starting level. The initial level of anhedonia is not correlated with its change rate.

4.2. Predictors of depressive symptoms

As time-invariant covariates, threat, deprivation, and gender were next included in our model. Recent perceived stress was also included in our model as time-variant covariates in order to control for the potential confounding effects caused by more recent stressors on the impacts of childhood stress. As robust findings reported by previous studies that CT would lead to deleterious consequences across the life span (Liu, 2017; Norman et al., 2012), our study tries to identify how different CT subtypes (threat and deprivation) may impact different dimensions of depressive symptoms (depressed mood and anhedonia) over time.

Our finding showed that levels of depressed mood and anhedonia in each point, especially depressed mood, were influenced by recent perceived stress at the corresponding time point. After controlling for perceived stress, as we hypothesized, deprivation, but not threat, is uniquely related to anhedonia. In our study, individuals who have higher deprivation scores showed a higher initial level of anhedonia. The association between CT and anhedonia has been established (Berenbaum and Connelly, 1993). Further studies extended this association and showed that neglect may specifically relate to anhedonia (Fan et al., 2021; J and H, 2014). Some researchers explained this relationship within the motivational context, suggesting that approach system deficits are related to anhedonia, but avoidance system dysfunction is more closely associated with depressed mood (Carver, 2006; Trew, 2011). Based on the DMA framework, experiences of deprivation may be characterized by deficits in the approach system, but threat is linked to dysregulation of the avoidance system (McLaughlin et al., 2014; Pollak et al., 2000). The DMA highlighted the central role of learning. Atypical reward learning and blunted reward circuits reactivity were observed in individuals who were exposed to deprivation (Hanson et al., 2015; Hein et al., 2020; Sheridan et al., 2018). Therefore, disruptions in reward processing and underlying neural circuitry (e.g., the ventral striatum) influenced by impaired learning may explain the link between deprivation and anhedonia (Hanson et al., 2015; Sheridan et al., 2018). The unexpected finding is deprivation predicted slower increases in anhedonia, although the levels of anhedonia are overall stable across three waves. It may due to individuals with higher deprivation scores had higher initial levels of anhedonia and thus exhibited lower growth. The blunted reward sensitivity following deprivation exposure (Herzberg and Gunnar, 2020) may also be associated with slower changes. Future studies should investigate it in more detail.

Depressed mood was related to both threat and deprivation. As we mentioned above, threat was hypothesized to affect the development of neural structures involved in emotional learning (McLaughlin et al., 2014). McLaughlin et al. found that children who were exposed to threat had worse performance in discriminating between threat and safety cues during fear-conditioning (McLaughlin et al., 2016), and exhibited similar magnitude of fear responses to threat and safety cues, reflecting either fear generalization to safety cues or associative learning deficits (McLaughlin et al., 2016). A recent longitudinal study found that threat exposure predicted greater use of avoidant strategies in adolescence (Milojevich et al., 2019), while long-term avoidance is associated with increased negative automatic thoughts and greater emotional distress (Aldao et al., 2010; Compas et al., 2017). Meanwhile, another study also indicated that children exposed to threat have greater emotional reactivity to negative events than nonexposed children (McLaughlin et al., 2014). Therefore, it is not surprising that individuals with higher threat exhibited higher initial depressed mood levels in our sample. We also found the association between deprivation and depressed mood. Indeed, in addition to atypical reward learning, deprivation is also associated with deficits in cognitive function, especially in executive function (McLaughlin et al., 2014). Exposure to deprivation may lead to impairment in social cognition and social-emotional learning via broader cognitive deficits, thereby increasing depressed mood level. From this it appears, threat and deprivation affect depressed mood in different pathways. Threat and deprivation not only predicted initial depressed mood level but also predicted its slower rate of improvement, suggesting that the harmful effects of threat and deprivation are persistent during emerging adulthood. Impaired emotional learning and cognitive function in individuals who are exposed to CT may make it difficult to cope with so many challenges and to adjust to new social roles during this period (Geoffroy et al., 2016). Although both threat and deprivation predicted more severe depressed mood and slower improvement rate, depressed mood appeared to be more associated with threat experiences. This is also consistent with a recent study showing that depression trajectory is more associated with threat than other types of CT (Iob et al., 2022).

In addition, gender can significantly positively predict the initial depressed mood level, but negatively predict anhedonia at baseline. This is consistent with previous findings that girls displayed higher depressed mood than boys, while boys had greater anhedonia, both in clinical (Bennett et al., 2005) and non-clinical adolescents (Crockett et al., 2020), as well as in adults (Chan et al., 2012). Furthermore, gender can also predict the change rate of depressed mood, suggesting that depressed mood improved more slowly in girls than in boys. The previous study also found similar gender differences in the trajectory of depressive symptoms (Kouros and Garber, 2014), which may be due to the cognitive vulnerabilities in girls (Hankin and Abramson, 2001).

Moreover, we also test whether these relationships between CT subtypes and depressive symptoms are varied across gender. We found that the pattern of associations between CT and depressive symptoms was overall stable in both males and females, that is, both threat and deprivation were associated with depressed mood, but only deprivation was associated with anhedonia. However, some differences were also found. Threat could significantly predict the initial levels and change rates of depressed mood only in female group, but not in male. These results may suggest that depressed mood in male was more likely to be influenced by more recent stressors rather than stressors in childhood. This may also explain why we got marginally significant results for the effect of threat on depressive mood slope without grouping (existing gender differences). However, the effect of threat on depressed mood in female group remained significant after controlling for the effect of recent perceived stress. Meanwhile, deprivation could not predict change rates of depressed mood in male group. It may represent that the harmful effects of deprivation on depressed mood in males are not as persistent as in females. Of note, there was significant difference in the coefficients of deprivation on initial levels and change rates of anhedonia between males and females, although significant in both groups. It may represent a greater sensitivity to deprivation experiences in females than in males. This is a matter of concern. Previous findings on gender differences in CT sensitivity are substantially mixed. Some studies suggested particular impact of CT on symptom severity (e.g., depression) and functioning in male patients, which possibly reflects higher stress vulnerability in men (Kocsis-Bogar et al., 2018; Pruessner et al., 2019). Other studies have proved the stronger association between CT and depression in females than in males (Thomas et al., 2022; Wei et al., 2021). There are also some studies did not find the sex differences (Arnow et al., 2011; Cutajar et al., 2010). It had also been reported that there were gender differences in the links between different types of CT and depressive symptoms (Banducci et al., 2014; Gallo et al., 2017). The only one study differentiated different types of CT to explore gender differences of association between CT and depressive symptoms, suggesting that females were more vulnerable than males to the effects of five types of CT exposure (Wei et al., 2021). Our findings are consistent with this study and showed that females were more vulnerable than males to the influence of both threat and deprivation. However, we cannot assert due to the possibility that females who experienced CT exhibit more internalizing problems (e.g., depression), while more externalizing problems (e.g., aggressive) in males. We believe that it would be valuable in future research to clarify whether there is gender specifically in the sensitivity of specific types of CT.

There are inevitably some limitations in this study. First, the retrospective assessment of CT using CTQ may be subject to recall biases and influenced by the current mood state of participants. Future prospective studies may be able to overcome this issue, or combine self-reported with parent-reported questionnaires to reduce information biases as possible. Second, in the current study, the unpredictable COVID-19 outbreak has disrupted the natural development of depressive symptom trajectories in college students. Relatedly, the corresponding online questionnaire measurements may be also biased. It does not affect the veracity of our results. Previous studies have demonstrated a close equivalence between paper-and-pencil and internet versions of BDI-II (Hollandare et al., 2010) and SHAPS (Montoro et al., 2022). Nonetheless, the current study provided new knowledge about how different types of CT differently affect distinct dimensions of depressive symptoms, which holds great translational promise. As we mentioned above, the cumulative risk approach implicitly assumes that all CT experiences influence the development of depression through the same underlying mechanisms (McLaughlin and Sheridan, 2016), but the consequences stemming from specific types of CT may be distinct. Understanding the specific pathways and symptomatic manifestations of the impacts of different CT subtypes on depression can guide more precise prevention and intervention approaches.

5. Conclusions

In conclusion, our findings provided insight into how different CT subtypes (threat and deprivation) impact distinct dimensions of depressive symptoms (depressed mood and anhedonia) over time in college students. Both threat and deprivation were correlated with depressed mood, especially threat experiences. However, deprivation, but not threat, was uniquely correlated with anhedonia. Meanwhile, threat and deprivation not only predicted more severe depressive symptoms but also predicted their changes over time, suggesting that the deleterious effects of threat and deprivation would persist during early adulthood. The influences of CT subtypes on depressive symptoms were different across gender, suggesting the greater impacts of CT in females. Our findings advanced understanding of the unique effects of specific trauma types on depression across the lifespan and can guide more precise prevention and intervention approaches for trauma-related depression.

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CRediT authorship contribution statement

Xiang Wang conceived the study. The data analysis, results interpretation, and original manuscript writing were done by Xiang Wang. Jingjie Lu and Qian Liu reviewed the original manuscript. Xiang Wang, Jingjie Lu, Qian Liu, Quanhao Yu, Feng Gao, Yan Han, and Xingze Liu collect research data. Rui Yao provided supports for our data collection. Jie Fan and Xiongzhao Zhu supervised this work. All authors read and approved the final manuscript.

Conflict of Interest

The authors declared no potential conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2022.09.061.

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