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EMBODIED PATHWAYS TO SUSTAINABLE WELL-BEING: INTEROCEPTIVE AWARENESS, RESILIENCE, AND STUDENT LIFE SATISFACTION

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Abstract

Sustainable higher education necessitates prioritizing student well-being as a foundational psychological resource for long-term development. Amidst intensifying academic and urban pressures in Asian metropolises, this study investigates the embodied cognitive pathways underlying students' life satisfaction. Specifically, it examines whether interoceptive awareness influences life satisfaction and assesses the serial mediating roles of cognitive reappraisal and psychological resilience. Using a cross-sectional quantitative design, we collected data from 593 full-time university students (aged 18–25) in Shanghai, China. A serial mediation analysis using PROCESS Model 6 revealed that interoceptive awareness positively predicts life satisfaction ($\beta = .36$, $p < .001$). While the isolated indirect pathway via cognitive reappraisal was nonsignificant, psychological resilience emerged as a robust independent mediator ($\beta = .16$). Crucially, the model confirmed a significant serial mediation effect ($\beta = .03$): bodily awareness facilitates cognitive reappraisal, which subsequently strengthens resilience, ultimately enhancing life satisfaction. These findings highlight that cultivating interoceptive and self-regulatory capacities offers a vital, sustainable mechanism for university counseling and support services to foster enduring student mental health.

Keywords: Interoceptive Awareness, Psychological Resilience, Cognitive Reappraisal, Sustainable Student Well-Being, Serial Mediation Analysis

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Introduction

Life satisfaction describes how individuals evaluate the overall quality of their lives based on standards that matter to them (Diener et al., 1985; Pavot & Diener, 2008). For university students, this evaluation reflects not only their private affective experience but also their experiences of academic demands, interpersonal relationships, self-development, and future planning. Students aged 18 to 25 are often situated in emerging adulthood, a phase characterized by self-discovery, changing responsibilities, and increasing autonomy (Arnett, 2000). Within university life, they are expected to build competence, regulate emotions, develop stable relationships, and form a clearer sense of personal direction (Chickering & Reisser, 1993). These developmental tasks make student well-being an important concern for universities that seek to support sustainable student growth rather than only short-term academic performance.

Within a sustainability framework, student well-being should be viewed as part of human and educational sustainability rather than only as an individual psychological outcome. The United Nations 2030 Agenda positions health, well-being, and quality of education as closely connected dimensions of sustainable development (United Nations, 2015). Education for sustainable development also emphasizes learners' capacity to live, participate, and act in ways that support long-term personal and social development (United Nations Educational, Scientific and Cultural Organization, 2017). For universities, this means that sustainable education depends not only on curriculum quality but also on students' capacity to maintain psychological resources, continue learning under pressure, and participate in campus life without avoidable deterioration in well-being.

In large urban settings such as Shanghai, university students may face academic competition, employment uncertainty, family expectations, and social comparison (He & Liu, 2025; Wen & Jin, 2025; Yang et al., 2022). Recent studies have linked academic involution environments among Chinese university students with stronger stress responses and mental exhaustion (Liu et al., 2024; Ni et al., 2024). Psychological resilience, academic pressure, peer pressure, and employment-related concerns have also been linked to Chinese university students' mental health and adjustment (Fan et al., 2024; Ning et al., 2024; Yang et al., 2022). These pressures affect students beyond cognition. Stress, fatigue, anxiety, and emotional arousal often manifest as bodily sensations such as muscle tightness, respiratory changes, gastrointestinal distress, or cardiac reactivity (Craig, 2002; Khalsa et al., 2018; Schulz & Vögele, 2015). Students who can notice and interpret these interoceptive cues are more likely to understand their affective states and adjust their responses before distress becomes overwhelming (Mehling et al., 2012; Price & Hooven, 2018). For this reason, interoceptive awareness may be an important but underused psychological resource for understanding students' positive adjustment.

Interoceptive awareness describes the capacity to notice, interpret, and make sense of signals arising from within the body (Mehling et al., 2012). Theoretical work on interoception and embodied cognition suggests that bodily states shape emotional experience, self-understanding, and self-regulation (Craig, 2002; Khalsa et al., 2018; Varela et al., 1991). From this view, the way students attend to internal cues may shape how they recognize stress, regulate emotions, and evaluate their lives. Previous studies have connected interoceptive awareness with psychological well-being and life satisfaction (Sünbül & Özcan, 2022; Hanley et al., 2017), but the explanatory mechanisms in university student populations remain insufficiently specified.

Two mechanisms are especially relevant. The first is cognitive reappraisal: regulating emotion by changing how a situation is understood, thereby modifying its emotional significance (Gross, 2015; Gross & John, 2003). Interoceptive awareness may give students earlier, clearer information about emotional arousal, making reappraisal more accessible. Another one is psychological resilience, the ability to adapt to stressful circumstances, regain stability, and

continue functioning effectively (Masten, 2001). It may translate bodily awareness and emotion regulation into more stable life satisfaction. However, few studies have tested these constructs together in a serial model among Chinese university students.

To address these empirical and theoretical gaps, this study integrates perspectives from embodied cognition, emotion regulation, resilience research, and sustainability-oriented higher education. The primary objective is to investigate the embodied cognitive pathways underlying students' life satisfaction in Asian urban contexts by determining whether interoceptive awareness predicts life satisfaction among Shanghai university students. Furthermore, the study evaluates the distinct mediating mechanisms of cognitive reappraisal and psychological resilience, testing whether they operate serially within a comprehensive structural model. Ultimately, identifying these psychological pathways aims to inform actionable strategies for sustainable mental health, resilience cultivation, and holistic student support services in Asian higher education.

Literature Review

Theoretical Framework

Interoceptive awareness refers to individuals' conscious engagement with internal bodily cues and their ability to use these cues in self-regulation (Mehling et al., 2012). Cognitive reappraisal refers to modifying how an emotion-eliciting situation is interpreted before the resulting emotional response is fully formed (Gross, 1998; 2015). Psychological resilience reflects the ability to maintain or recover adaptive functioning in the context of trauma (Masten, 2001). Life satisfaction represents a global cognitive assessment of one's life based on personal criteria (Diener et al., 1985).

Embodied cognition and conservation of resources (COR) theory provide a theoretical basis for understanding how bodily awareness may relate to students' life evaluations. Embodied cognition theory holds that cognitive and emotional activities are rooted in bodily states and perceptual experiences and that internal bodily information participates in individuals' construction of the self, situations, and meaning (Lakoff & Johnson, 1999; Varela et al., 1991). From this perspective, awareness and interpretation of internal bodily signals may influence how individuals recognize emotions, understand stress, and evaluate their lives. Therefore, interoceptive awareness, as a cultivable mind-body resource, may support emotion regulation and self-regulation (Price & Hooven, 2018).

COR theory further explains the subsequent psychological mechanisms. According to this theory, individuals strive to build and preserve valued psychological resources. Stress may emerge when individuals believe that their available resources are being depleted, are at risk, or are inadequate for current demands (Hobfoll, 1989). Higher interoceptive awareness may help individuals identify stress signals earlier (Füstös et al., 2013); cognitive reappraisal may assist them in reframing stressful situations and regulating emotional responses (Gross & John, 2003); and psychological resilience may serve as a key adaptive resource that supports recovery and sustained functioning under challenge (Masten, 2001). Thus, interoceptive awareness, cognitive reappraisal, and resilience may form a connected resource-building process associated with life satisfaction.

The proposed model also reflects a sustainability-oriented student support perspective. Higher education institutions increasingly need to address well-being, adjustment, and mental health as parts of long-term student development and sustainable education (United Nations Educational, Scientific and Cultural Organization, 2020; 2024). This perspective aligns with whole-university approaches, which emphasize embedding student well-being across institutional systems rather than treating it as an individual counseling issue (Dooris et al., 2020; Worsley et al., 2022). Therefore, life satisfaction is not treated as an isolated positive emotion. It is a cognitive indicator of how students evaluate their overall life circumstances

and may reflect whether they have enough psychological capital to continue learning, adapt to academic and social pressure, and participate in university life (Diener et al., 1985; Pavot & Diener, 2008). Interoceptive awareness, cognitive reappraisal, and psychological resilience may therefore represent connected pathways through which universities can support sustainable student well-being.

Interoceptive Awareness and Life Satisfaction

Interoceptive awareness is considered relevant to adaptive functioning because it helps individuals attend to internal cues that reflect stress, fatigue, bodily tension, and emotional arousal. By recognizing these signals, individuals may better understand their internal condition and adjust their responses more effectively (Füstös et al., 2013; Price & Hooven, 2018; Schulz & Vögele, 2015). This view is consistent with interoceptive theories suggesting that bodily signals contribute to emotional experience and self-awareness (Barrett & Simmons, 2015; Craig, 2002; Critchley & Garfinkel, 2017). Empirical research indicates that interoceptive awareness is connected to mental health and life satisfaction (Sünbül & Özcan, 2022; Hanley et al., 2017). However, this relationship remains underexamined among university students in Shanghai. Thus, the present study proposes that:

Hypothesis 1: Interoceptive awareness is positively associated with life satisfaction.

Cognitive Reappraisal as a Mediator

Interoceptive awareness may be associated with life satisfaction via cognitive reappraisal. Theoretically, interoceptive prediction is central to emotional experience (Barrett & Simmons, 2015), and interoceptive awareness helps individuals identify and understand internal emotional and physiological changes (Craig, 2002). Thus, awareness of bodily and emotional states may provide a basis for cognitive reappraisal. Empirical evidence supports this pathway. Individuals with higher interoceptive awareness have shown more effective cognitive reappraisal in emotion-induction tasks (Füstös et al., 2013), and interoceptive attention has been found to facilitate emotion regulation strategies (Tan et al., 2023). Schuette et al. (2021) also pointed out a positive connection between interoceptive awareness and emotion regulation ability.

Cognitive reappraisal has also been associated with adaptive emotional and psychological outcomes. Those who habitually engage in cognitive reappraisal tend to report more positive emotion, lower levels of negative emotion, and improved psychosocial adjustment (Gross & John, 2003). Webb et al. (2012) showed that reappraisal-based strategies generally reduce negative emotional experience, while Aldao et al. (2010) found that cognitive reappraisal is linked to fewer psychopathological symptoms and better mental health. On this basis, cognitive reappraisal may mediate the relationship between interoceptive awareness and life satisfaction. Accordingly, it is proposed that:

Hypothesis 2: Interoceptive awareness and life satisfaction are mediated by cognitive reappraisal.

Psychological Resilience as a Mediator

From an embodied cognition perspective, interoceptive awareness may support resilience by helping individuals detect internal signals of stress or emotional arousal and adjust their responses before stress becomes overwhelming (Price & Hooven, 2018; Schulz & Vögele, 2015). Haase et al. (2016) observed that poorer psychological resilience was related to abnormal interoceptive processing, suggesting that bodily signal processing may be closely related to resilience. Similarly, Khalsa et al. (2018) emphasized that interoceptive processes are closely connected with emotion, stress regulation, and adaptive functioning.

Psychological resilience is an adaptive capacity that allows people to adapt to adversity, regulate distress, and sustain effective functioning in the face of stress (Masten, 2001). Consistent with this view, Hu et al. (2015) stated that higher trait resilience correlated with higher mental health and fewer psychological difficulties. Resilience has also been related to

life satisfaction and broader subjective well-being (Izaguirre et al., 2021; Yıldırım & Arslan, 2022). Psychological resilience may therefore provide one pathway linking interoceptive awareness with life satisfaction. Therefore, it is hypothesized that:

Hypothesis 3: Psychological resilience mediates the relationship between interoceptive awareness and life satisfaction.

Cognitive Reappraisal and Psychological Resilience as Serial Mediators

COR theory suggests that effective emotion regulation helps individuals conserve and accumulate coping resources (Hobfoll, 1989). Thus, cognitive reappraisal may reduce emotional resource loss and support resilience. Empirical evidence also demonstrates that cognitive reappraisal is positively correlated with personal resilience and resilience-related outcomes (Riepenhausen et al., 2022; Stover et al., 2024).

Related mediation studies further support the joint effect of cognitive reappraisal and resilience. According to Karreman & Vingerhoets (2012), resilience and cognitive reappraisal mediated the relationship between attachment style and psychological well-being. Izaguirre et al. (2021) reported that emotion regulation indirectly influenced life satisfaction through resilience. In Chinese student samples, cognitive reappraisal has also been identified as part of serial pathways predicting resilience (Zhou & Li, 2022). Thus, the present study proposes that:

Hypothesis 4: Cognitive reappraisal and psychological resilience serially mediate the relationship between interoceptive awareness and life satisfaction.

Research Methodology

Data Collection and Sampling

A cross-sectional quantitative survey design was adopted. To reach as many willing participants as possible under limited resources, convenience sampling (Etikan et al., 2015) was used to recruit eligible university students in Shanghai.

An a priori power analysis (G*Power 3.1; Faul et al., 2007) indicated that 119 participants were required, based on a medium effect size ($f^2 = 0.15$, Cohen, 1988), $\alpha = .05$, power $(1-\beta) = .95$, and three predictors. We used the Credamo online survey platform to collect 675 responses. After removing 82 invalid responses due to abnormal response times, failed attention checks, or patterned responses, we retained 593 valid responses for analysis. The participants were full-time university students in Shanghai, aged 18 to 25 years. The final sample included 191 males (32.2%) and 402 females (67.8%).

Measures

We collected data using a Chinese-language questionnaire. The questionnaire included demographic information and four standardized measures.

Life satisfaction was evaluated utilizing the Chinese Satisfaction With Life Scale (SWLS; Bai et al., 2011; Diener et al., 1985). Higher scores on the five 7-point Likert items indicate greater life satisfaction. Internal consistency (α) was .887 in the current sample.

Interoceptive awareness was evaluated utilizing the Chinese Multidimensional Assessment of Interoceptive Awareness version 2 (MAIA-2C; Teng et al., 2022). This instrument adopts a 6-point response format and consists of 31 items in seven dimensions. Higher scores reflect greater interoceptive awareness. Internal consistency (α) was .875 in the current sample.

Cognitive reappraisal was evaluated utilizing the cognitive reappraisal subscale of the Chinese Emotion Regulation Questionnaire (ERQ; Gross & John, 2003; Wang et al., 2007). The subscale's six items use a 7-point response format; higher scores reflect a stronger tendency to use cognitive reappraisal. Internal consistency (α) was .790 in the current sample.

Psychological resilience was evaluated through the Chinese 10-item Connor-Davidson Resilience Scale (CD-RISC-10; Campbell-Sills & Stein, 2007; Wang et al., 2010). The ten items use a 5-point response format; higher scores reflect greater psychological resilience. Internal consistency (α) was .893 in the current sample.

Procedure and Ethical Considerations

Ethical approval was acquired by Assumption University of Thailand's Institutional Review Board via the Institute for Research and Academic Service (IRAS; approval No. 131/2025). The survey was administered through Credamo. Before responding, participants reviewed an informed consent form describing the study purpose, voluntary participation, anonymity, confidentiality, and their right to withdraw. Participants could only proceed if they gave their approval.

Participants first completed demographic questions. They then completed the SWLS, MAIA-2C, cognitive reappraisal subscale of the ERQ, and CD-RISC-10. All questionnaire items required a response, which minimized missing data.

Data Analysis

Data screening and statistical analyses were conducted in SPSS 27.0, including descriptive statistics, Harman's single-factor test, reliability analysis, Pearson correlations, hierarchical multiple regression, and serial mediation analysis.

The serial mediation model was tested with Hayes's PROCESS Model 6 (Hayes, 2022). Gender and academic year were entered as demographic covariates. Gender was coded as 0 for male and 1 for female. Academic year was represented by four dummy variables, with senior students as the reference category. Indirect effects were estimated from 5,000 bootstrap resamples, with statistical significance determined by 95% confidence intervals that excluded zero.

Supplementary analyses examined associations between the seven interoceptive awareness subscales and cognitive reappraisal, psychological resilience, and life satisfaction. Pearson correlations were calculated first, followed by hierarchical regressions controlling for gender and academic year, with all seven subscales entered simultaneously. Collinearity diagnostics were also examined.

Post hoc gender analyses assessed the unequal gender distribution. Hierarchical regressions tested whether gender moderated component paths of the serial model by adding the relevant interaction terms after main effects and academic-year covariates. PROCESS Model 6 was then re-estimated separately for male and female participants, with academic year retained as a covariate and 5,000 bootstrap resamples used to evaluate indirect effects.

Research Results

Sample Characteristics

The final respondents included 593 university students in Shanghai aged 18-25 years, including 191 males (32.2%) and 402 females (67.8%). Most participants were fourth-year students (53.3%), and the largest disciplinary group was humanities and social sciences (52.4%).

Preliminary Analyses

We examined common method variance because all study variables were measured by self-report within the same survey. Harman's single-factor procedure included the full set of 52 items. The data showed adequate factorability, with a Kaiser-Meyer-Olkin value of .927 and a significant Bartlett's test, χ^2 (1326) = 14,603.61, $p < .001$. Ten components exceeded an eigenvalue of 1 in the unrotated solution, and the first component explained 25.38% of the variance. The absence of a dominant single component provided no clear indication of serious common method variance.

As shown in Table 1, all instruments demonstrated acceptable to good internal consistency in the reliability analyses. Cronbach's alpha coefficients were .887 for life satisfaction, .875 for interoceptive awareness, .790 for cognitive reappraisal, and .893 for psychological resilience.

The correlation findings indicated that interoceptive awareness had a positive relationship with life satisfaction ($r = .54$, $p < .01$), cognitive reappraisal ($r = .53$, $p < .01$), and psychological resilience ($r = .66$, $p < .01$). Cognitive reappraisal likewise showed a positive correlation with

psychological resilience ($r = .49$, $p < .01$) and life satisfaction ($r = .31$, $p < .01$). Psychological resilience was positively linked to life satisfaction ($r = .51$, $p < .01$).

Table 1 Descriptive Statistics, Reliability, and Bivariate Correlations

Variable	α	*M*	*SD*	1	2	3	4
LS	.887	4.26	1.19	—			
IA	.875	3.03	.49	.54**	—		
CR	.790	5.41	.73	.31**	.53**	—	
PR	.893	2.74	.65	.51**	.66**	.49**	—

Note: α represents Cronbach's alpha; *M* represents the mean score; *SD* represents the standard deviation. **$p < .01$. LS represents life satisfaction; IA represents interoceptive awareness; CR represents cognitive reappraisal; PR represents psychological resilience.

Hypothesis Testing Results

Table 2 displays the findings of the hypothesized serial mediation model.

Table 2 Unstandardized Path Coefficients and Standardized Indirect Effects

Panel A: Regression path coefficients

Outcomes	Predictors	*B*	*SE*	*β*	*t*	*p*	95% CI	R^2
CR	IA	.79	.05	.53	15.18	< .001	[.69, .89]	.286
PR	IA	.73	.05	.56	15.53	< .001	[.64, .82]	.465
	CR	.17	.03	.19	5.27	< .001	[.10, .23]	
LS	IA	.85	.11	.36	7.47	< .001	[.63, 1.08]	.337
	CR	-.04	.07	-.02	-.56	.579	[−.17, .09]	
	PR	.53	.09	.29	6.29	< .001	[.37, .70]	

Panel B: Standardized indirect effects

Indirect Effects	Effect	*SE*	95% CI
Total Indirect Effect	.18	.04	[.11, .25]
Ind1 IA→CR →LS	-.01	.02	[−.06, .03]
Ind2 IA →PR →LS	.16	.03	[.10, .22]
Ind3 IA →CR →PR →LS	.03	.01	[.01, .05]

Note: *B* = unstandardized coefficient; *SE* = standard error; *β* = standardized coefficient; CI = confidence interval; LS = life satisfaction; IA = interoceptive awareness; CR = cognitive reappraisal; PR = psychological resilience; gender and academic year were covariates; seniors were the academic-year reference group. Indirect effects were estimated using 5,000 bootstrap resamples.

Interoceptive awareness showed significant total ($\beta = .53$, $p < .001$) and direct associations with life satisfaction ($\beta = .36$, $p < .001$). Thus, Hypothesis 1 was supported.

The indirect effect through cognitive reappraisal was nonsignificant (β = -.01, 95% CI [-.06,.03]). Therefore, Hypothesis 2 was not supported.

The indirect pathway via psychological resilience was significant ($\beta = .16$, 95% CI [.10, .22]). Therefore, Hypothesis 3 was supported.

The serial indirect effect through cognitive reappraisal and psychological resilience was also significant ($\beta = .03$, 95% CI [.01,.05]), supporting Hypothesis 4. The direct and indirect effects remained substantively unchanged after controlling for gender and academic year. Detailed path coefficients are presented in Table 2 and Figure 1.

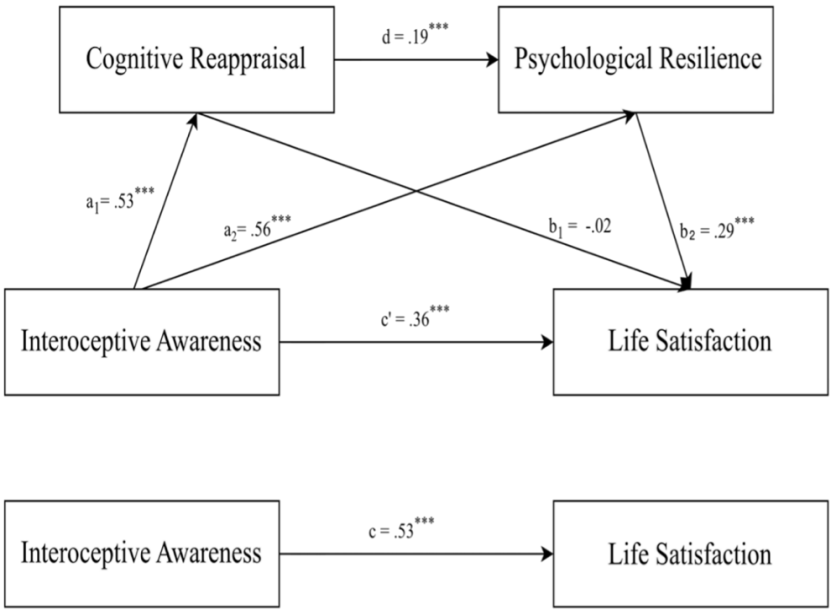

Figure 1 Serial Mediation Model Linking Interoceptive Awareness to Life Satisfaction
Note: The figure presents standardized coefficients. Gender and academic year were controlled in the analysis but are not shown; ***p < .001.

Supplementary MAIA-2C Subscale Analyses

Supplementary analyses are summarized in Table 3. The seven MAIA-2C subscales explained significant additional variance in cognitive reappraisal (ΔR^2 = .364, p < .001), psychological resilience (ΔR^2 = .511, p < .001), and life satisfaction (ΔR^2 = .337, p < .001), with no problematic multicollinearity (all VIFs < 1.90). Self-Regulation showed the strongest association with cognitive reappraisal (β = .27, p < .001), whereas Trusting showed the strongest unique associations with psychological resilience (β = .35, p < .001) and life satisfaction (β = .31, p < .001). Overall, Self-Regulation and Trusting were the two most consistently prominent MAIA-2C dimensions across the three outcomes.

Table 3 Multiple Regression Results for MAIA-2C Subscales

MAIA-2C Subscales	CR *r*	CR *β*	PR *r*	PR *β*	LS *r*	LS *β*
ND	.06	−.06	.22***	.09**	.26***	.17***
NW	.07	−.02	.23***	.12***	.18***	.12**
AR	.46***	.13**	.53***	.18***	.33***	−.05
EA	.38***	.09*	.29***	−.05	.20***	−.07
SR	.52***	.27***	.61***	.31***	.45***	.19***
BL	.43***	.08	.41***	−.02	.40***	.17***
Tr	.49***	.21***	.61***	.35***	.49***	.31***

Note: ND = Not-Distracting; NW = Not-Worrying; AR = Attention Regulation; EA = Emotional Awareness; SR = Self-Regulation; BL = Body Listening; Tr = Trusting; CR = cognitive reappraisal; PR = psychological resilience; LS = life satisfaction; *r* = zero-order Pearson correlation; *β* = standardized regression coefficient. Regression models simultaneously included all seven MAIA-2C subscales and controlled for gender and academic year. *p < .05. **p < .01. ***p < .001.

Post Hoc Gender Analyses

As shown in Table 4, gender significantly moderated the association between interoceptive awareness and cognitive reappraisal, ΔR^2 = .011, F(1, 585) = 8.84, p = .003, B = −.33, 95% CI

[−.55, −.11], with a stronger association among males. No significant gender moderation was found for the paths predicting psychological resilience or life satisfaction. Gender-stratified analyses showed that among males (n = 191), the indirect effect through cognitive reappraisal alone was nonsignificant (Effect = -.06, 95% CI [−.16, .04]). In contrast, the indirect effect through psychological resilience (Effect = .21, 95% CI [.10, .34]) and the serial indirect effect through two mediators were significant (Effect = .04, 95% CI [.01, .10]). The same pattern was observed among females (n = 402). These findings indicate that although gender moderated the association between interoceptive awareness and cognitive reappraisal, the principal mediation pattern was reproduced across both gender groups.

Table 4 Gender Moderation and Stratified Indirect Effects

Panel A: Tests of gender moderation across component paths						
Outcomes	**Interaction Term**	***B***	***SE***	***t***	***p***	**95% CI**
CR	IA × Gender	-.33	.11	−2.97	.003	[−.55, −.11]
PR	IA × Gender	-.07	.11	−.69	.493	[−.28, .14]
	CR × Gender	.04	.07	.65	.518	[−.09, .18]
LS	IA × Gender	.11	.27	.40	.687	[−.42, .63]
	CR × Gender	.16	.14	1.12	.263	[−.12, .44]
	PR × Gender	-.20	.21	−.98	.330	[−.60, .20]
Panel B: Gender-stratified standardized indirect effects						
Indirect Effects		**Male Effect**	**Male 95% CI**		**Female Effect**	**Female 95% CI**
Total Indirect Effect		.19	[.04, .36]		.17	[.09, .24]
Ind1 IA→CR →LS		−.06	[−.16, .04]		.00	[−.05, .05]
Ind2 IA →PR →LS		.21	[.10, .34]		.14	[.08, .20]
Ind3 IA →CR →PR →LS		.04	[.01, .10]		.02	[.01, .05]

Note: Gender was coded 0 = male and 1 = female; male n = 191; female n = 402. Academic year was controlled in all models. Panel B reports completely standardized indirect effects based on 5,000 bootstrap resamples. CI = confidence interval; IA = interoceptive awareness; CR = cognitive reappraisal; PR = psychological resilience; LS = life satisfaction.

Conclusion and Discussion

This study examined the association between interoceptive awareness and life satisfaction among university students in Shanghai and evaluated cognitive reappraisal and psychological resilience as mediating mechanisms. The major conclusions remained stable after controlling for gender and academic year, supporting the robustness of the main model in the present sample.

Interoceptive awareness was positively associated with life satisfaction, and this association remained significant after including both mediators. This result is aligned with interoceptive and embodied emotion theories, which suggest that internal bodily signals contribute to emotional experience, self-awareness, and self-regulation (Craig, 2002; Khalsa et al., 2018). It also aligns with empirical evidence linking interoceptive awareness with mental health and life satisfaction (Sünbül & Özcan, 2022; Hanley et al., 2017). Thus, the capacity to sense and comprehend bodily signals may provide an embodied basis for more positive life evaluations among university students in Shanghai.

The indirect effect through cognitive reappraisal was nonsignificant. Although interoceptive awareness was positively associated with cognitive reappraisal, cognitive reappraisal did not independently relate to life satisfaction once interoceptive awareness and psychological resilience were considered. Previous studies indicate a relationship between cognitive

reappraisal and adaptive emotional and well-being outcomes (Gross & John, 2003; Webb et al., 2012). However, its adaptive effect is sensitive to situational demands rather than being uniform across contexts (Aldao et al., 2015; Bonanno & Burton, 2013; Ford & Troy, 2019; Sheppes et al., 2011; Troy et al., 2013). The nonsignificant pathway therefore needs to be considered in relation to the context in which the participants are situated.

Academic involution (Neijuan) in Chinese higher education is characterized by intensified competition, excessive academic investment, repeated peer comparison, and competition for limited educational opportunities and resources (Liu et al., 2024; Wang et al., 2024). These pressures recur across academic competition and peer comparison. Liu et al. (2024) found that an academic involution atmosphere was associated with greater stress responses, with relative deprivation and academic involution involved in this relationship. Academic involution has also been associated with greater mental exhaustion among Chinese university students (Ni et al., 2024). In this context, cognitive reappraisal can help a student reinterpret a disappointing grade, an unfavorable comparison with a peer, or anxiety about academic performance. However, the next examination, ranking, internship opportunity, or peer comparison can reactivate the same competitive pressure. Under sustained academic involution, cognitive reappraisal may therefore regulate students' responses to particular stressful experiences without producing a sufficiently broad change in how they evaluate their lives as a whole.

Psychological resilience significantly mediated the relationship between interoceptive awareness and life satisfaction. Individuals with higher interoceptive awareness may demonstrate stronger psychological resilience, which is further correlated with higher life satisfaction. This interpretation aligns with findings linking interoceptive processing with resilient functioning. Haase et al. (2016) provided neurobiological evidence linking resilience to interoceptive processing. Lower resilience may reflect an imbalance in interoceptive processing, in which individuals pay less attention to ordinary bodily signals yet respond more strongly at the neural level to aversive bodily perturbations (Haase et al., 2016). This supports the view that awareness and interpretation of internal bodily states may support adaptive stress regulation. Additionally, psychological resilience has been associated with better mental health (Hu et al., 2015) and with life satisfaction and subjective well-being (Izaguirre et al., 2021; Yıldırım & Arslan, 2022). Therefore, psychological resilience may serve as an adaptive resource that links bodily awareness to a more positive life evaluation.

The serial mediating effect of cognitive reappraisal and psychological resilience was also significant. Previous studies show that interoceptive awareness can facilitate cognitive reappraisal in emotion regulation tasks (Füstös et al., 2013) and may support the use of emotion regulation strategies (Tan et al., 2023). Cognitive reappraisal has also been positively associated with resilience-related outcomes and personal resilience (Riepenhausen et al., 2022; Stover et al., 2024). Because resilience is closely linked to life satisfaction and positive mental health (Hu et al., 2015; Yıldırım & Arslan, 2022), these findings suggest that bodily awareness may support cognitive reappraisal, which in turn strengthens resilience and contributes to more positive life evaluation. This explanation is supported by previous mediation research suggesting that adaptive emotion regulation and resilience may operate together as psychological mechanisms underlying life satisfaction and mental health outcomes (Izaguirre et al., 2021; Karreman & Vingerhoets, 2012). Thus, interoceptive awareness was indirectly associated with life satisfaction via the serial pathway of cognitive reappraisal and psychological resilience.

The MAIA-2C subscale findings further indicate that the different dimensions of interoceptive awareness are not equally related to psychological functioning. Self-Regulation was most closely associated with cognitive reappraisal, whereas Trusting was particularly strongly related to psychological resilience and life satisfaction. These results correspond to the conceptual content of the MAIA dimensions. Self-Regulation reflects using attention to bodily

sensations to regulate psychological distress, whereas Trusting reflects experiencing the body as safe and reliable (Mehling et al., 2012; Teng et al., 2022). These suggest that the adaptive relevance of interoceptive awareness depends not only on noticing bodily signals but also on the capacity to use those signals for regulation and to experience the body as a reliable source of information.

Gender moderated only the association between interoceptive awareness and cognitive reappraisal, which was stronger among males. Gender did not moderate the remaining component paths, and the same mediation pattern emerged in both groups. Thus, the female-majority composition did not account for the principal mediation findings.

This study contributes to student well-being research by incorporating interoceptive awareness into a sustainability-oriented higher-education framework and by distinguishing the roles of cognitive reappraisal and psychological resilience. The subscale results further identify Self-Regulation and Trusting as prominent interoceptive dimensions, while the mediation results highlight resilience as the more consistent link with life satisfaction. Together, these findings extend sustainable student well-being beyond cognitive and environmental factors to include embodied self-regulatory resources.

These findings have direct implications for university mental-health support. Because Self-Regulation and Trusting were the most consistently prominent interoceptive dimensions, student programs could place greater emphasis on helping students recognize bodily signs of stress, use bodily information to regulate distress, and develop a safer and more trusting relationship with bodily sensations. Orientation programs, well-being courses, workshops, or student-development activities could incorporate brief body-awareness and mindfulness practices. A systematic review and meta-analysis found that mindfulness-based approaches may reduce anxiety among college students (Li et al., 2023). University counseling centers could also incorporate selected principles from Mindful Awareness in Body-Oriented Therapy, including attention to bodily sensations, sustained internal attention, and appraisal of bodily experience, and connect these processes with cognitive reappraisal and resilience-oriented coping strategies (Price & Hooven, 2018).

At the institutional level, these practices can be organized within a stepped support system. Brief interoceptive and self-regulation skills can be offered broadly through courses, orientation, workshops, or digital resources; students experiencing greater stress can receive structured group-based emotion-regulation and resilience programs; and individualized body-oriented interventions can be provided through counseling services when appropriate. Embedding reusable self-regulation and resilience skills within routine educational and counseling systems is consistent with whole-university approaches that treat student mental health as an institutional responsibility rather than only a response to acute distress (Dooris et al., 2020; Worsley et al., 2022). In this sense, strengthening interoceptive self-regulation and resilience supports the broader goals of sustainable student development. It aligns conceptually with the United Nations goals of Good Health and Well-Being and Quality Education (United Nations, 2015). However, several limitations warrant consideration. First, the sample consisted exclusively of university students aged 18-25 years in Shanghai and included a higher proportion of females (67.8%) than males. Although the gender-stratified analyses reduced some concerns, the smaller male subsample yielded less precise male-specific estimates, and the observed gender difference in the interoceptive awareness-cognitive reappraisal association requires replication. Future studies could adopt more gender-balanced samples across cities, regions, and institutional types. Furthermore, self-report measures may have made the findings susceptible to response styles, temporary emotional states, self-presentation, and shared method effects. Although the Harman test did not identify a dominant single factor, it cannot conclusively exclude common method bias. Subsequent investigations could further reduce this concern by temporally separating measurements and using multiple assessment methods,

such as behavioral tasks, physiological indicators, interview-based assessments, or data from different sources. Finally, because the data were cross-sectional, the study cannot establish causal direction or temporal sequencing. Although the hypothesized serial mediation model was rooted in theory, future studies utilizing longitudinal or intervention designs are fundamentally needed to validate these causal pathways.

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