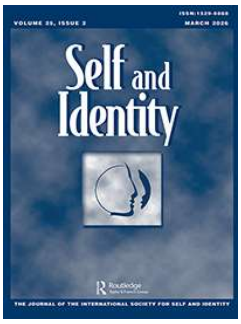

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The impact of uncertainty on future anxiety in college students: The mediating role of future self-continuity and the intervention effects of letter-writing activity

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ABSTRACT

In the post-pandemic era, the sense of uncertainty among Chinese college students has generally increased, further leading to the emergence of future anxiety. However, the discussion on the internal psychological mechanisms triggered by uncertainty and intervention strategies remains insufficient. In this study, two sub-studies were conducted among Chinese college students to explore the psychological mechanisms through which uncertainty triggers future anxiety and examine the role of letter-writing intervention in alleviating future anxiety caused by uncertainty. In Study 1, a questionnaire survey ($N = 833$) was administered to examine the mediating effect of future self-continuity on the link between uncertainty and future anxiety, utilizing a simple mediation model for analysis. In Study 2, a randomized controlled trial ($N = 185$) was conducted to confirm that improving future self-continuity through letter-writing can interrupt the emergence of future anxiety prompted by uncertainty. The findings of this research indicated that future self-continuity functions as a mediating factor in the relationship between uncertainty and future anxiety among college students. Additionally, engaging in letter-writing activities may act as an indirect means to alleviate future anxiety.

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Uncertainty; future self-continuity; future anxiety; letter-writing activity

1. Introduction

In recent years, China has experienced sustained economic deceleration and increasingly fierce competition in the job market. Data from the National Bureau of Statistics indicates significant employment pressure among young adults (Yang & Xue, 2023). These macroeconomic conditions have exacerbated college students' sense of uncertainty regarding their future development, fostering prevalent phenomena such as delaying job seeking through postgraduate entrance exams and pursuing civil service positions for stability (Li, 2023). Concurrently, heightened uncertainty has been associated with elevated levels of future anxiety among college students (e.g., Duplaga & Grysztar, 2021; Paredes et al., 2021). Against

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this backdrop, this study aims to examine how uncertainty influences future anxiety among Chinese college students and explore effective interventions for future anxiety mitigation.

1.1. Uncertainty and future anxiety

Uncertainty has been described as a situation in which something is unknown or as the experiential state of not being sure what will happen (Papenfuss et al., 2022). Scholars have argued that people have the psychological need to feel certain about their world, whereas uncertainty is threatening and can lead to anxiety, worries, and other uncomfortable feelings (Hogg, 2007). Indeed, uncertainty has been incorporated into theoretical models of anxiety (e.g., Carleton, 2016; Grupe & Nitschke, 2013; Hirsh et al., 2012), and numerous empirical research findings also support the association between the two (e.g., Papenfuss et al., 2021, 2022). In these studies, anxiety is often characterized as a physiological experience or emotional state, or as an emotional disorder meeting specific clinical criteria.

In recent years, future anxiety has gained increasing attention as a distinct form of anxiety among college students (e.g., Paredes et al., 2021; Regnoli et al., 2024). Zaleski (1996) defined it as "an anticipated state of worry where individuals realize their inability to cope with impending adverse situations and their potential consequences." It is important to acknowledge that future anxiety and clinical anxiety disorders share a core cognitive feature: the presence of worry and prospective concerns about negative future events (Özdemir & Kuru, 2023; Zaleski, 1996).

However, the primary distinctions lie on a continuum of severity, pervasiveness, and physiological manifestation. The core features of future anxiety, as a typically subclinical experience, include: 1) primarily involving prospective cognitive concerns about specific and often realistic negative future events (e.g., career development, academic achievement; Hammad, 2016); 2) focusing on uncertainty evaluation rather than immediate emotional disturbance; and 3) typically not accompanied by significant physiological symptoms (e.g., palpitations, panic). This contrasts with clinical anxiety disorders, which are characterized by excessive, uncontrollable, and functionally impairing worry. Clinical anxiety mainly manifests as pathological emotional and physiological responses, often stemming from cognitive distortions about threats (e.g., overgeneralization, catastrophic thinking; Özdemir & Kuru, 2023).

Based on existing research evidence, the negative impacts of future anxiety on individuals' psychosocial functioning manifest at three levels: cognitively, it significantly reduces positive future expectations (Bujnowska et al., 2019); behaviorally, it leads to excessive risk avoidance tendencies; and developmentally, prolonged unmitigated future anxiety may develop into clinical anxiety disorders (Tashiro, 2004), severely impairing mental health and subjective well-being (Öztekin et al., 2025; Paredes et al., 2021). Particularly in the post-pandemic era, where environmental uncertainty has substantially increased, future anxiety has transcended individual psychological issues to become a pressing public health concern (Duplaga & Grysztar, 2021).

Given that uncertainty has been established as a significant precipitating factor for various anxiety symptoms (Carleton, 2016), and that future anxiety shares underlying mechanisms with other forms of anxiety disorders (Zaleski, 1996), this study proposes

research hypothesis 1, namely that uncertainty will positively predict future anxiety in college students.

1.2. The mediating role of future self-continuity

Although some studies have explored the association between perceived uncertainty and future anxiety (e.g., Duplaga & Grysztar, 2021; Paredes et al., 2021), few research has yet investigated the underlying mechanisms of this influence. Uncertainty identity theory suggests that uncertain environments create ambiguity in an individual's attitudes, values, and behaviors, thereby threatening their self-identity (Hogg, 2007). From this we hypothesize that this may be an important psychological mechanism by which uncertainty produces future anxiety.

Since an individual's self-identity relies on their perception of continuity and coherence across their past, present, and future selves, future self-continuity has long been considered a fundamental component of self-identity's structure (Xue et al., 2024). Future self-continuity refers to how closely an individual associates their present self with their future self. Individuals who have high future self-continuity have a clear idea of who they want to be in the future, frequently have optimistic opinions about who they will become, and experience a close connection between their present and future selves (Han et al., 2025). Previous research has confirmed that uncertainty creates a subjective distance between an individual's present and past selves (e.g., Yang et al., 2020). However, there is a lack of exploration into how uncertainty influences the perceived connection between an individual's present and future selves. Some studies suggest that uncertainty can undermine an individual's sense of control (Landau et al., 2015). While in comparison to individuals with a high sense of control, those with a low sense of control tend to be more negative and pessimistic about the future, perceiving fewer connections between their present and future selves (Anderson & Galinsky, 2006). This suggests that uncertainty may reduce future self-continuity in college students.

On the other hand, future self-continuity has been shown to be a crucial psychological factor for individuals in transitional life phases, as it supports an individual's resilience and adaptability in coping with difficult situations (Levin et al., 2024). According to the possible selves theory, individuals who have a clearer, more authentic view of their potential selves and feel a stronger connection between their present and future selves are more inclined to adopt positive behaviors to realize their ideal future selves (Corte et al., 2022; Markus & Nurius, 1986). In other words, individuals possessing higher future self-continuity are more inclined to implement proactive coping strategies to improve their present situations. A lack of information and knowledge about possible future events can lead to future anxiety (Czapinski & Peters, 1991). However, individuals with higher future self-continuity are likely to be more proactive in seeking information, thereby reducing future anxiety caused by insufficient information.

Based on above, we propose research hypothesis 2, namely that future self-continuity plays a mediating role in the relationship between uncertainty and future anxiety. Uncertainty diminishes a college student's perception of future self-continuity, which subsequently results in the college student experiencing future anxiety.

1.3. Intervention effects of letter-writing activity

Building on the premise that future self-continuity is the internal mechanism through which uncertainty triggers future anxiety, this study employs a letter-writing activity to mitigate the negative impact of uncertainty on future self-continuity, thereby alleviating future anxiety among college students. Existing research amply confirms the significant therapeutic potential of writing interventions in the realm of mental health. Among these, Expressive Writing (EW) and Best Possible Self (BPS) writing are two prominent paradigms. This study aims to review and differentiate these two paradigms, and on this basis, propose a novel letter-writing intervention designed to enhance future self-continuity more directly and effectively.

The early expressive writing paradigm typically required participants to write about their deepest thoughts and feelings related to a stressful event (Pennebaker & Beall, 1986; Ruini & Mortara, 2022). However, subsequent meta-analyses revealed significant heterogeneity in the effects of such purely emotion-focused writing (Frattaroli, 2006), which prompted researchers to explore more effective intervention components. Subsequent research has attempted to integrate cognitive reappraisal into expressive writing. By guiding individuals to reflect on how a stressful event might positively shape their future identity and goals, this approach has been shown to significantly enhance intervention effectiveness (e.g., Lu & Stanton, 2009).

Meanwhile, Best Possible Self (BPS) writing, introduced by King (2001), represents another important direction in interventions. Given its focus on positive future experiences, some scholars also consider it a form of positive expressive writing focused on future aspirations (Hoult et al., 2025). This method not only requires individuals to envision an ideal future self and engage in role-playing but may also ask them to formulate specific plans to achieve this possible self (e.g., Shapira & Mongrain, 2010). Research has shown that BPS writing not only significantly enhances subjective well-being but also improves physical health (Auyeung & Mo, 2019; Heekerens & Eid, 2021).

Synthesizing these more nuanced understandings of both paradigms, it is plausible that their therapeutic effects are partly mediated by an implicitly enhanced future self-continuity. For instance, reappraising the influence of the past on the future (in EW) or vividly imagining a future self (in BPS) can indirectly strengthen the perceived connection across time. However, neither paradigm targets future self-continuity as its primary and explicit mechanism. Their processes are often unidirectional (from present to future in BPS) or reflective (from past to present/future in EW).

Recognizing that external sources of uncertainty are often intractable, a more practical therapeutic approach involves strengthening the internal psychological mechanisms that can serve as a buffer against its negative effects. Building on this rationale, and to address the limitations of existing methods, this study aims to enhance future self-continuity directly and explicitly through a structured, bidirectional, and dialogic process via a letter-exchange intervention. Unlike the unidirectional imagination in BPS or the reflective reappraisal in EW, our letter-exchange intervention establishes an active dialogue between the present and future selves. The crucial step – responding from the perspective of the future self (Chishima & Wilson, 2020) – is inspired by Gestalt therapy's "empty chair" technique (Perls et al., 1951). This requires participants to "role-play" and articulate the viewpoint of their future selves, thereby facilitating a more profound integration of

their temporal selves than what is achievable through one-way reflection or imagination. The research by Chishima and Wilson (2020) confirms that it is precisely this explicit focus on a bidirectional psychological exchange mechanism that makes it more effective in enhancing future self-continuity than unidirectional writing.

Based on above, we propose research hypothesis 3, namely that exchanging letters with one's future self significantly improves future self-continuity, thereby blocking the adverse effects of uncertainty on future anxiety.

1.4. The current research

We conducted two studies with Chinese college students to investigate the mechanism of how uncertainty impacts future anxiety and the effectiveness of letter-writing as an intervention. Study 1 employed a questionnaire survey, followed by the construction of a simple mediation model with future self-continuity as the mediating variable. The model aimed to confirmatively explore the impact mechanism of uncertainty on college students' future anxiety. Building upon the findings of Study 1, Study 2 combined both survey and experimental methods to test the effectiveness of using letter-writing to strengthen future self-continuity and lower future anxiety caused by uncertainty. All research procedures in this study complied with the Helsinki Declaration and have received approval from the institutional review board of the author's affiliated institution.

2. Study 1

2.1. Participants

We distributed the questionnaires through an online survey platform, targeting college students nationwide (March 2023). A total of 855 responses were collected, from which we excluded 10 questionnaires due to patterned or straight-line responses, as well as 12 questionnaires containing outliers in age (e.g., over 25 years old) or academic year (e.g., graduate students). Ultimately, we obtained 833 valid responses, including 312 males (37.5%) and 521 females (62.5%). The participants' ages ranged from 18 to 25 years (M = 21, SD = 1.51). The distribution across academic years was as follows: 70 freshmen (8.4%), 168 sophomores (20.2%), 251 juniors (30.1%), and 344 seniors (41.3%). Informed consent was obtained from all participants prior to the survey, and they were informed that completing the questionnaire would earn them a 5-yuan reward. Respondents were also told that they could withdraw from the study at any time, and the anonymity and confidentiality of the survey results were emphasized. On average, participants took 2 to 15 minutes to complete the questionnaire (mean time = 7.4 min).

2.2. Measures

Uncertainty was assessed through the Uncertainty Scale developed by Liu (2018), which includes 11 items (e.g., "Faced with employment pressure, I feel uncertain about whether I can find a good job.," "With the rising housing prices, I feel uncertain about whether I will be able to afford a home in the future."), evaluated on a 7-point Likert scale ranging from 1 ("completely disagree") to 7 ("completely agree"). The overall uncertainty level was

represented by the mean score across these 11 items, with higher values reflecting greater levels of uncertainty. In this study, the scale showed good reliability, with a Cronbach's α of 0.872.

Future self-continuity was assessed using the Future Self-Continuity Questionnaire (FSCQ), originally developed by Sokol and Serper (2019) and later translated into Chinese by Shen et al. (2022). This questionnaire has shown strong reliability and validity in past studies and has been widely applied, including in Chinese contexts (e.g., Guo et al., 2024). The FSCQ includes 10 items (e.g., "How similar is your personality now to what it will be like 10 years from now?," "How vividly can you imagine what your family relationships will be like in 10 years from now?"), each rated on a 6-point Likert scale from 1 ("completely different" or "Barely able" or "Do not like at all") to 6 ("completely the same" or "Fully capable" or "Like very much"). The average score across the 10 items indicated the level of future self-continuity, with higher scores indicating higher levels. The questionnaire exhibited satisfactory reliability in this study with a Cronbach's *α* coefficient of 0.789.

Future anxiety was measured using the Future Anxiety Scale developed by Zaleski (1996). This scale consists of 29 items (e.g., "I am afraid to plan for the future," "I worry about the failures which await me"), including 5 reverse-scored items. It has demonstrated good reliability and validity within the Chinese cultural context (e.g., Yang et al., 2015). For this study, the scale was first translated into Chinese and then revised through discussion of the language expressions, resulting in the final version of the scale used in this research. Each item was rated on a 7-point Likert scale from "1 = strongly disagree" to "7 = strongly agree." The overall level of future anxiety was represented by the mean score of the 29 items, with higher scores reflecting greater future anxiety levels. The scale demonstrated high reliability in this study with a Cronbach's *α* coefficient of 0.941.

2.3. Statistical analysis

The data were subjected to descriptive statistics, correlation analysis, and mediation effect model analysis using SPSS 21.0 and the PROCESS macro plugin for SPSS. The significance of regression coefficients was assessed using the bootstrap method (Wen & Ye, 2014). By reconstructing the sample distribution through random sampling with replacement, 5000 samples were generated to obtain standard errors of parameter estimates and 95% bias-corrected confidence intervals. A confidence interval (CI) not including zero indicated statistical significance.

2.4. Results

To minimize common method bias, several procedural controls were implemented during the data collection phase following the recommendations of Zhou and Long (2004). For instance, we provided a clear cover letter emphasizing that the survey was for academic purposes only and ensuring participants of their complete anonymity. Additionally, we incorporated reverse-coded items in the scales to reduce the potential for patterned responses. After data collection, the Harman single-factor test was conducted to assess the presence of common method bias. Results from an unrotated exploratory factor

Table 1. Correlations and descriptive statistics for the measured variables ($N = 833$)(Author's Work/source: authors).

Variables	*M*	*SD*	1	2	3	4	5	6
(1) Gender	—	—	1					
(2) Age	21	1.51	—0.03	1				
(3) Grade	—	—	0.10**	0.70**	1			
(4) Uncertainty	3.51	0.60	0.24**	0.01	—0.04	1		
(5) Future Self-continuity	3.35	0.59	—0.07*	0.07	0.04	—0.21**	1	
(6) Future Anxiety	2.91	0.81	0.10**	—0.06	—0.09*	0.57**	—0.41**	1

Note. *$p < 0.05$, **$p < 0.01$.

analysis showed 8 distinct factors with eigenvalues exceeding 1. The first factor explained only 30% of the variance, which is significantly below the 40% threshold. Thus, it can be inferred that common method bias did not severely impact the validity of this study.

Correlation analyses were conducted for gender, age, grade, and measurement variables. As shown in Table 1, there were significant negative correlations between uncertainty and future self-continuity ($r = —0.21$, $p < 0.01$) and significant positive correlations between uncertainty and future anxiety ($r = 0.57$, $p < 0.01$). Future anxiety and future self-continuity were significantly correlated negatively ($r = —0.41$, $p < 0.01$). Additionally, since age showed no significant correlations with other variables, only gender and grade were considered as control variables in subsequent analyses.

After standardizing variable scores, we conducted a mediation analysis using Model 4 from the SPSS macro. Controlling for gender and grade variables, uncertainty significantly positively predicted future anxiety ($\beta = 0.57$, $p < 0.001$, 95% CI = [0.46, 0.57]). The predictive effect of uncertainty on future anxiety declined but remained significant once the mediator variable was added ($\beta = 0.51$, $p < 0.001$, 95% CI = [0.46, 0.57]). Uncertainty significantly negatively predicted future self-continuity ($\beta = —0.21$, $p < 0.001$, 95% CI = [—0.28, —0.14]), and future self-continuity significantly negatively predicted future anxiety ($\beta = —0.30$, $p < 0.001$, 95% CI = [—0.35, —0.25]). The association between uncertainty and future anxiety was significantly mediated by future self-continuity (Effect size = 0.06, 95% CI = [0.04, 0.09]).

In summary, the results of Study 1 supported both Hypothesis 1 and Hypothesis 2, indicating that uncertainty triggers future anxiety in college students, and part of this impact is mediated by reducing future self-continuity.

3. Study 2

Building upon the findings of Study 1, which established that uncertainty erodes future self-continuity and subsequently heightens future anxiety, Study 2 was designed to test a psychological intervention. It is crucial to clarify that the goal of this intervention was not to reduce or alter individuals' perception of external uncertainty, as societal and structural uncertainties are often beyond an individual's direct control. Instead, the intervention targets the internal psychological mechanism identified in Study 1.

The logic is as follows: If uncertainty acts as a stressor that weakens the link between the present and future self (i.e., future self-continuity), then an intervention that proactively strengthens this link should serve as a protective buffer. By bolstering future self-continuity, we hypothesize that it is possible to mitigate the negative downstream

consequences of uncertainty on future anxiety, even while the perception of uncertainty itself remains unchanged. Therefore, Study 2 aims to test whether the letter-writing intervention can moderate the pathway between uncertainty and future self-continuity, thereby providing further, more robust support for the mediating role of future self-continuity discovered in Study 1. This shifts the focus from eliminating the external problem (uncertainty) to strengthening internal resilience (future self-continuity).

3.1. Participants

A total of 200 college students were recruited from online platform (Credamo). One participant from the experimental group and 14 participants from the control group were excluded due to answering time less than 10 minutes and failing to meet the minimum word requirement of 200 words. The final sample consisted of 185 participants, including 60 males (32.4%) and 125 females (67.6%). Students from freshmen to seniors were represented with 20 (10.8%), 38 (20.5%), 61 (33.0%), and 66 (35.7%) participants, respectively. The age of participants ranged from 18 to 25 years ($M = 21$, $SD = 1.40$).

3.2. Experimental materials and procedure

3.2.1. Intervention efficacy check

To verify the effectiveness of the letter-writing intervention before testing its moderating role, we recruited 68 undergraduate students ($M_{age} = 19$ years, 39.7% male) to participate in a single-group pre-test/posttest experiment. A power analysis using G*Power indicated 90% power to detect a medium effect size ($d = 0.4$). Participants completed pre- and post-intervention assessments of future self-continuity ($\alpha_{pre} = 0.692$, $\alpha_{post} = 0.717$) and future anxiety ($\alpha_{pre} = 0.893$, $\alpha_{post} = 0.914$) during a 45-minute offline session.

The intervention procedure was adapted from Chishima and Wilson (2020) and comprised three stages: envisioning one's future self, writing a letter to that future self, and responding from the future self's perspective (see supplemental material).

In the first stage, participants spent approximately five minutes writing a brief but realistic profile of themselves 3–5 years into the future, addressing aspects such as physical appearance, occupation, living situation, and social relationships (minimum 50 words).

Next, participants wrote a letter to their future selves based on the profile they had created, describing their current thoughts, feelings, goals, and concerns (minimum 200 words; duration: 15 minutes). After a short break, participants moved on to the final stage of the task.

In this final stage, they were asked to imagine themselves living the lives they had previously described. They then re-read the letters they had written and, assuming the role of their future selves, wrote a response addressed to their present-day selves (minimum 200 words; duration: 15 minutes).

3.2.2. Main experiment procedure

After providing informed consent, all participants were assured of anonymity and received a 10-yuan compensation. They first completed a demographic information sheet followed by the Uncertainty Questionnaire (Liu, 2018). Using Credamo's intelligent randomization system with a block size of 4, participants were then stratified by gender and grade and randomly allocated in a 1:1 ratio to either the experimental ($n = 100$) or control group ($n = 100$). Chi-

square tests indicated no significant differences between the two groups in terms of gender ($\chi^2(1) = 0.958$, $p = 0.328$) and grade ($\chi^2(3) = 3.906$, $p = 0.272$). To comprehensively evaluate group comparability, this study further employed equivalence testing (TOST) for verification (Harms & Lakens, 2018; Xu et al., 2022). The results revealed strong evidence for gender proportion equivalence (90% CI [—0.068, 0.203] within ±0.30 margin, $ps < 0.001$), but insufficient evidence for grade equivalence (90% CI [—0.496, —0.007] not fully within ±0.40 margin). Consequently, grade level was included as a covariate in subsequent analyses to control for potential confounding effects.

The experimental group completed the same letter-writing task as the pretest. In contrast, the control group engaged in three writing tasks related to travel: (1) describing a destination they recently wished to visit and explaining why (minimum 50 words), (2) planning a detailed travel route and itinerary (minimum 200 words), and (3) recommending a travel route and itinerary for someone visiting their hometown (minimum 200 words). After completing the writing tasks, all participants were instructed to fill out the Future Self-Continuity Questionnaire (Sokol & Serper, 2019) and the Future Anxiety Questionnaire (Zaleski, 1996).

The Cronbach's α coefficients for the Uncertainty Questionnaire, Future Self-Continuity Questionnaire, and Future Anxiety Questionnaire in this survey were 0.706, 0.770, and 0.925, respectively.

3.3. Results

3.3.1. Manipulation check

A one-sample t-test was conducted to compare difference scores (posttest minus pretest) to zero. Participants showed significant increases in future self-continuity ($M_{pre} = 3.18$, $SD = 0.44$; $M_{post} = 3.49$, $SD = 0.46$; $M_{\text{diff}} = 0.31$, t (67) = 7.58, $p < 0.001$, $d = 0.92$) and significant reductions in future anxiety ($M_{pre} = 3.26$, $SD = 0.52$; $M_{post} = 3.02$, $SD = 0.65$; $M_{\text{diff}} =$—0.24, t (67) = —4.71, $p < 0.001$, $d = 0.42$). There was also a significant negative correlation between changes in future self-continuity and future anxiety ($r =$—0.292, $p < 0.01$), confirming the intervention's effectiveness in both increasing future self-continuity and reducing future anxiety.

3.3.2. Moderated mediation analysis

Independent samples t-tests revealed no significant difference between the experimental ($M = 3.54$, $SD = 0.72$) and control groups ($M = 3.60$, $SD = 0.50$) in uncertainty scores ($t =$—0.60, $df = 183$, $p = 0.55$, $d = 0.09$). The TOST analysis further confirmed equivalence, with the 90% CI [– 0.15, 0.33] entirely within our prespecified ±0.40 equivalence bounds ($ps < 0.05$), indicating moderate evidence for group equivalence in baseline uncertainty levels. In addition, the experimental group had significantly higher future self-continuity ($t = 4.59$, $df = 183$, $p < 0.001$, $d = 0.68$) and lower future anxiety ($t =$—2.32, $df = 183$, $p < 0.05$, $d = 0.34$) than the control group.

Correlation analysis (see Table 2) revealed that uncertainty was negatively correlated with future self-continuity ($r =$—0.239, $p < 0.01$) and positively correlated with future anxiety ($r = 0.566$, $p < 0.01$). future self-continuity was negatively correlated with future anxiety ($r =$—0.407, $p < 0.01$).

Table 2. Differences in variable scores between groups ($N = 185$) (author's Work/source: authors).

	M (*SD*)				
	Experimental Group ($n = 99$)	Control Group ($n = 86$)	1	2	3
(1) Uncertainty	3.54 (0.72)	3.60 (0.50)	1		
(2) Future Self-continuity	3.58 (0.47)	3.22 (0.58)	—0.239**	1	
(3) Future Anxiety	2.76 (0.76)	3.01 (0.70)	0.566**	—0.407**	1

Note. **$p < 0.01$.

A moderated mediation model was tested using PROCESS Model 7, with uncertainty as the independent variable, future self-continuity as the mediator, future anxiety as the dependent variable, group as the moderator (experimental group coded as 0, control group coded as 1), and grade as the control variable. All variables were transformed into Z-scores. Results showed that uncertainty did not significantly predict future self-continuity ($\beta = 0.08$, $p = 0.48$, 95% CI = [—0.15, 0.31]), but the interaction between group and uncertainty significantly predicted future self-continuity ($\beta = —0.34$, $p < 0.05$, 95% CI = [—0.65, —0.04]). Uncertainty positively predicted future anxiety ($\beta = 0.30$, $p < 0.001$, 95% CI = [0.16, 0.45]), and future self-continuity negatively predicted future anxiety ($\beta = —0.26$, $p < 0.001$, 95% CI = [—0.41, —0.12]) (see Table 3).

Simple slope analysis was conducted to further interpret the interaction effect. As illustrated in Figure 1 (which includes 95% confidence bands), in the control group, uncertainty significantly and negatively predicted future self-continuity ($\beta_{simple} = —0.27$, $SE_{simple} = 0.10$, $t = —2.60$, $p < 0.05$, 95%CI [—0.47, —0.06]), with a conditional indirect effect of 0.07 (95% CI [0.01, 0.16]). Conversely, in the experimental group, the predictive effect of uncertainty on future self-continuity was not significant ($\beta_{simple} = 0.08$, $SE_{simple} = 0.12$, $t = 0.70$, $p = 0.48$, 95%CI [—0.15, 0.31]), and the conditional indirect effect was also not significant (95%CI [—0.09, 0.03]).

The simple slope analysis revealed a critical insight: the negative relationship between uncertainty and future self-continuity, which was significant in the control group (replicating the pattern from Study 1), became non-significant in the experimental group. This suggests that the letter-writing intervention successfully buffered participants from the detrimental impact of uncertainty on their connection with their future selves. Consequently, by neutralizing this negative pathway, the

Table 3. Parameter estimates of the moderated mediation model ($N = 185$) (author's Work/source: authors).

Regression model		Goodness-of-fit index				Regression coefficient			
DV	IV	*R*	R^2	*F*	*β*	*t*	*p*	LLCI	ULCI
Future Self-continuity		0.32	0.10	3.94**					
	Uncertainty				0.08	0.69	0.48	—0.15	0.31
	Groups				—0.45	—2.83	0.01	—0.77	—0.14
	Groups*Uncertainty				—0.34	—2.20	0.03	—0.65	—0.04
	grade				0.03	0.38	0.71	—0.13	0.19
Future Anxiety		0.45	0.21	12.24***					
	Uncertainty				0.30	4.21	0.00	0.16	0.45
	Future Self-continuity				—0.26	—3.53	0.00	—0.41	—0.12
	grade				—0.11	—1.54	0.13	—0.25	0.03

Note. ***$p < 0.001$; **$p < 0.01$.

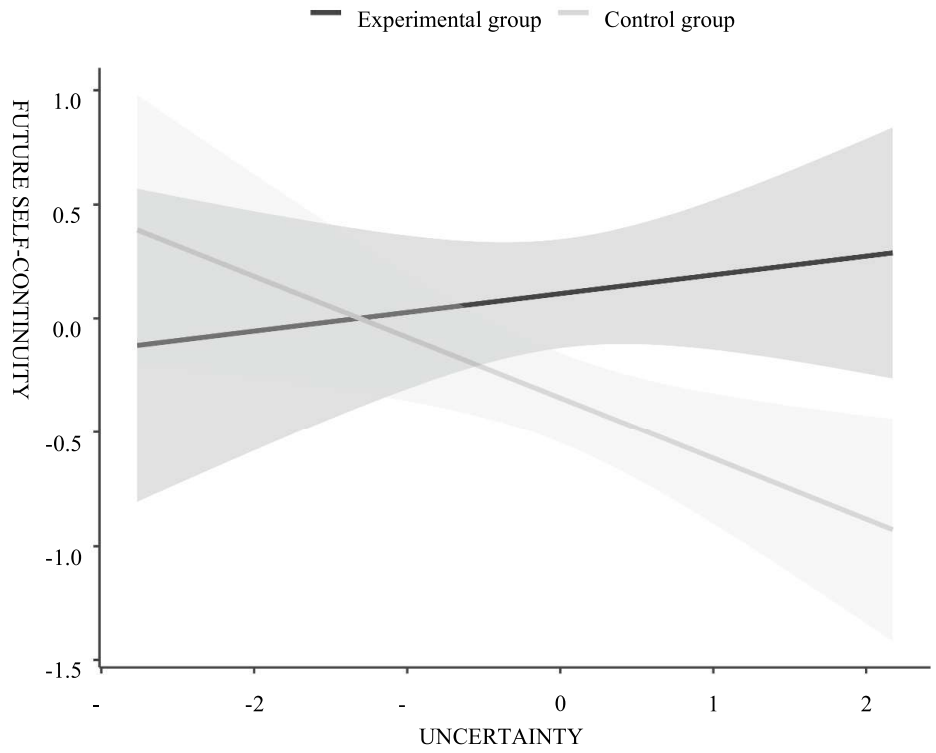

Figure 1. Interaction between groups and uncertainty on future self-continuity (author's Work/source: authors). Note. Shaded areas represent 95% confidence intervals.

intervention indirectly mitigated the downstream effect on future anxiety.Thus, Hypothesis 3 was supported.

4. General discussion

Amidst the ongoing rise in uncertainty in society, this study aimed to analyze the internal psychological mechanisms through which uncertainty triggers future anxiety in college students and intervene to lower such anxiety. Firstly, this study confirmed that future self-continuity serves as a mediating factor in the psychological process connecting uncertainty with future anxiety. Secondly, the efficacy of letter-writing in enhancing future self-continuity was examined on an exploratory level. Building upon this, a randomized experimental study was conducted, confirming that the letter-writing intervention serves as an effective strategy to bolster future self-continuity. Crucially, this enhancement of future self-continuity appears to buffer college students against the anxiogenic effects of uncertainty. While the intervention does not eliminate their perception of uncertainty, it effectively severs the toxic link between uncertainty and the erosion of self-continuity, thereby preventing the subsequent rise in future anxiety. This provides a practical pathway for intervention, focusing on internal resilience when external stressors are intractable.

4.1. The mechanisms of uncertainty on future anxiety

The results of this study indicated that uncertainty significantly predicts higher levels of future anxiety in college students. Many previous studies exploring the relationship between uncertainty and anxiety have constrained uncertainty to specific sources (e.g., uncertainty of illness) (e.g., Cypress, 2016) or focused on individuals' negative perceptions about uncertainty (e.g., intolerance of uncertainty) (e.g., Anderson et al., 2012; Carleton et al., 2012). Moreover, anxiety in these studies is often defined as a physiological emotional experience. In contrast, this study conceptualizes uncertainty as individuals' general perception of a constantly changing and uncertain social environment (Liu, 2018). Additionally, future anxiety is more about cognition rather than a physiological emotional experience (Zaleski, 1996). Despite conceptual differences, the findings still align with earlier conclusions, suggesting the universality of uncertainty leading to anxiety across contexts.

In addition, the study confirmed that future self-continuity mediates the relationship between uncertainty and future anxiety. Building upon Uncertainty-Identity Theory (Hogg, 2007), we found that uncertainty significantly diminishes individuals' future self-continuity. Concurrently, this study also validated that future self-continuity negatively predicts future anxiety, aligning with Possible Selves Theory (Markus & Nurius, 1986) and existing empirical research (e.g., Rutchick et al., 2018; Sokol & Serper, 2019). Previous theories suggest that the influence of future self-continuity on future anxiety is a gradual process, wherein individuals with clearer, more positive future self-perceptions progressively engage in active information seeking and behavioral adjustments, thereby reducing future anxiety (Corte et al., 2022; Markus & Nurius, 1986). However, the experimental results of this study (a single 45-minute letter-writing intervention significantly enhanced future self-continuity and reduced future anxiety) suggest that the impact of future self-continuity on future anxiety may not solely rely on long-term behavioral adjustments, but can also directly alleviate anxiety through immediate self-cognitive restructuring. This finding expands our understanding of the mechanisms by which future self-continuity operates, hinting at its potential to adjust individuals' psychological states in a short timeframe.

In addition to uncertainty-identity frameworks, it is also important to consider how our findings relate to other prominent models of anxiety, such as mindfulness-based and cognitive-behavioral approaches. Mindfulness-based interventions aim to reduce anxiety by encouraging individuals to cultivate present-moment awareness and adopt an attitude of nonjudgmental acceptance toward uncertainty (e.g., Borquist-Conlon et al., 2019). Meanwhile, cognitive-behavioral models (e.g., Heimberg et al., 2014) target maladaptive beliefs and cognitive distortions about the future, helping individuals reframe negative expectations and reduce anxiety. Both approaches emphasize momentary emotion regulation, either by anchoring awareness or restructuring thought patterns. In contrast, the current study highlights future self-continuity – a temporally extended self-concept – as a critical mechanism through which individuals cope with uncertainty. Rather than merely focusing on immediate cognitive changes or emotion regulation, this model emphasizes the coherence between present and future selves as a buffer against future-oriented anxiety. Such coherence may promote long-term planning, future-oriented motivation, and meaning in life

(Chishima et al., 2021; Hong et al., 2024). This perspective not only enriches current understandings of self-identity and anxiety, but also opens new directions for future interventions.

4.2. Intervention effects of letter-writing activity

The results of Study 2 supported the effectiveness of letter-writing interventions for uncertainty-induced future anxiety. In the randomized controlled trial, uncertainty showed a significant negative predictive effect on future self-continuity within the control group, and future self-continuity significantly mediated the relationship between uncertainty and future anxiety. However, neither of these effects was significant in the experimental group.

Three possibilities were proposed to explain how letter-writing indirectly intervened future anxiety in this study. Firstly, the letter-writing may interrupt the future anxiety triggered by uncertainty, possibly through expanding the participant's vision of the future. In uncertain situations, individuals often restrict their focus on the future and instead concentrate more heavily on the present (Amir et al., 2018; Li et al., 2015). For instance, some studies have validated that uncertainty promotes individuals to choose smaller immediate gains over larger future benefits (Wu et al., 2022). The results of this study have shown that letter-writing enhances the future self-continuity of participants and expands their vision of the future, whereas this may enable participants to view current dilemmas from the perspective of a longer timeframe, thereby alleviating the negative emotions associated with current dilemmas (Chishima et al., 2021). Secondly, letter-writing may interrupt the future anxiety triggered by uncertainty by enhancing the participants' sense of control. Previous studies have indicated that uncertainty threatens individual's basic psychological need for control (Landau et al., 2015). By engaging in letter-writing activity, individuals form a more positive and optimistic image of their future selves, contributing to improved self-control, proactiveness, and a sense of control in facing dilemmas (Fu et al., 2020; Sokol & Serper, 2019). This, in turn, reduces the perceived uncertainty or threat factors and significantly lowers individual future anxiety levels (Zvolensky et al., 1998). Third, the letter-writing intervention may alleviate anxiety by promoting wise reasoning. Recent research demonstrates that adopting a future-oriented temporal perspective significantly facilitates wise reasoning – a metacognitive capacity to navigate social challenges with intellectual humility, recognition of uncertainty, consideration of others' viewpoints, and integration of diverse perspectives (Zhang et al., 2024). Specifically, reflecting on one's future self through letter-writing encourages a distanced and abstract mode of thinking, which enhances wisdom-related processes such as self-distancing and perspective-taking (Kross & Grossmann, 2012; Zhang et al., 2024). This shift toward a broader temporal viewpoint helps individuals reframe immediate uncertainties within a larger context, thereby reducing anxiety through wiser, more balanced reasoning (Baltes & Staudinger, 2000; Jiang et al., 2025).

Previous studies have only explored the effects of letter-writing on enhancing individual academic performance (e.g., Barnett et al., 2019), career planning (e.g., Chishima & Wilson, 2020), or exercise habits (e.g., Rutchick et al., 2018). This study takes a step further by extending the application of letter-writing to the field of mental health, offering a nuanced and expanded perspective on how letter-writing can be utilized.

5. Limitations and future directions

While this study makes both theoretical and practical contributions, several limitations should be acknowledged. First, our examination of the relationship between uncertainty and anxiety did not account for potential confounding effects of personality traits. Specifically, individuals with lower intolerance of uncertainty may develop more negative cognitions in uncertain situations (Carleton et al., 2012). Neuroticism as a personality trait can heighten sensitivity to environmental stressors and emotional instability (Barlow et al., 2014; Rosellini & Brown, 2011). Furthermore, sense of control – defined as one's perceived ability to influence outcomes – when diminished, may exacerbate the negative effects of uncertainty and weaken self-continuity (Gibbs et al., 2023). Future studies should incorporate these factors to strengthen the reliability of causal inferences.

Secondly, while this study used a randomized experimental design to manipulate and test the immediate effects of letter-writing on enhancing future self-continuity and indirectly reducing future anxiety, it did not examine the long-term effects of this activity. Previous research has yielded inconsistent conclusions about the long-term intervention effects of a brief one-time letter-writing activity. Some studies have demonstrated that a single short letter-writing activity can significantly predict the level of career planning in students one month later (e.g., Chishima & Wilson, 2020), while others have found that a one-time letter-writing activity does not have significant long-term effects on improving students' academic performance (e.g., Barnett et al., 2019). Chishima et al. (2021) pointed out that if experimental manipulations can induce changes in individuals' thought patterns and be repeatedly activated over time in specific contexts, such activities may promote lasting changes. Considering the goal of therapeutic interventions is to achieve lasting improvement, future research should explore how to leverage the intervention of letter-writing into long-term effects.

Third, despite matching the intervention in terms of time and writing effort, the control task might not have achieved a comparable level of cognitive and emotional engagement as the future-oriented letter-writing task. This disparity in engagement could potentially confound the observed intervention effects. Specifically, the absence of a parallel reflective component – such as writing back from the perspective of an experienced traveler – further limited the equivalence of the two conditions and the depth of psychological processing. Consequently, future research should consider refining the control condition or include manipulation checks to ensure that the control task engages participants at a psychologically comparable depth.

Finally, this study's causal inferences warrant careful consideration due to methodological constraints. In Study 1, the cross-sectional design, while revealing statistically significant mediation patterns, inherently limits causal interpretation by failing to establish temporal precedence or adequately control confounding variables (Rohrer et al., 2022). Study 2's experimental manipulation of the mediator (future self-continuity) provided preliminary evidence for the directional pathway from enhanced future self-continuity to reduced future anxiety. However, the absence of experimental manipulation for the independent variable (uncertainty) precludes definitive conclusions about the complete causal chain from uncertainty to future self-continuity to anxiety. To strengthen causal claims, future investigations should implement full experimental designs that systematically manipulate both uncertainty conditions and

future self-continuity interventions. Additionally, incorporating longitudinal or intensive longitudinal designs (e.g., daily diary studies) would help establish temporal dynamics while capturing potential reciprocal relationships between these constructs. Such methodological advancements would not only address the current limitations but also provide deeper insight into the developmental trajectories of uncertainty-induced anxiety.

Although social environments inherently contain elements of uncertainty that present challenges for individuals, the results of this study demonstrate that individuals can reduce the psychological impact of uncertainty on mental health by adjusting their connection to their future selves. Letter-writing is a straightforward and implementable intervention that can be independently undertaken to effectively mitigate the negative effects of uncertainty. Popularizing this intervention among college students holds significant practical importance, particularly in an era of increasing social complexity and change.

Disclosure statement

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Authors' contribution

Jingjing Chen was responsible for research design, data analysis, and writing the first draft of the manuscript. Wenting Huang was responsible for data collection. Jie Bai gave suggestions on the experimental design and the first draft of the paper. All authors read and approved the final manuscript.

Data availability statement

The data sets generated for this study are available on request to the corresponding author.

Ethics statement

The study protocol was approved by the Ethics Committee of the Nanjing Forestry University prior to the commencement of the study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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