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The Effect of Nostalgia and Future Self-Continuity Induced by Different Sensory Channels on Intertemporal Decision Making

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Abstract: This study investigates the effects of nostalgia and future self-continuity across different sensory channels on intertemporal decision-making. It employs a 4 (visual/auditory/auditory-visual/neutrality) × 2 (high vs. low future self-continuity) between-subjects experimental design. In the preliminary experiment, questionnaires were distributed to 160 college students, and the most nostalgic music and videos were selected through voting. In the formal experiment, 240 students from various majors across the university were randomly assigned. All college students were randomly assigned to complete three tasks: nostalgia priming (childhood images/nostalgic music/animation videos), future self-continuity manipulation (self-similarity writing task), and intertemporal decision matching. The findings suggest that nostalgia serves a dual temporal function by linking past experiences with future orientation, while the malleable nature of future self-continuity offers a novel pathway for decision-making interventions. This study proposes a novel triadic framework integrating nostalgia, future self-continuity, and intertemporal decision-making, alongside a multisensory intervention paradigm, providing empirical support for mental health applications.

Keywords: Cross-Temporal Decision-Making; Audiovisual Channels; Future Self-Continuity; Nostalgia

1. Introduction

Have you ever stumbled upon such a store in a mall? Stepping inside feels like stepping back into the 1980s – vintage electric fans, snacks, mugs, black-and-white TV cartoons, and old radio tunes all transport you to that era. You might think, "It's been so many years, but I'm still the same person..." At this moment, you might pay for nostalgia or not, but you're reminded of your long-term savings plan. In daily life, people often face the dilemma between immediate gains and delayed rewards, a process called intertemporal decision making.

Intertemporal decision making is a core cognitive process where individuals weigh immediate versus delayed rewards, playing a pivotal role in key life domains like financial investment, health management, and career planning [1]. Yet humans exhibit a universal 'nearness bias' —a tendency to prioritize smaller immediate gains over larger future rewards [2]. This bias frequently obstructs long-term goals, making it a critical issue in psychology and behavioral economics that demands urgent resolution.

Emotions, as key variables influencing intertemporal decision-making, have been demonstrated to promote delayed gratification through positive emotions and trigger short-term choices via negative emotions [3,4]. However, nostalgia—a complex emotional experience blending warmth and melancholy [5,6]—remains underexplored in intertemporal decision-making. Beyond stimulating positive emotions and strengthening social connections and life meaning [7], nostalgia may also construct emotional bonds between past and present by enhancing temporal coherence [8]. This characteristic suggests its unique potential to influence future-oriented intertemporal decision-making, though its specific mechanisms remain unclear in existing research.

Meanwhile, there is room for further exploration in the pathways of nostalgia induction. Nostalgia is often triggered by sensory cues such as visual and auditory stimuli [9]. Neuroscience studies have confirmed that single sensory channels (e.g., music, images) can effectively evoke nostalgic emotions [10,11], while brain imaging studies indicate that audiovisual integration has significant advantages in emotion recognition [12]. However, existing research mostly focuses on single-channel induction, with limited

exploration of the differences in induction effects between dual-channel (e.g., video) and single-channel approaches. Moreover, culturally adaptive nostalgic materials for China's Generation Z population still require systematic screening, which constitutes a critical gap in current research.

Beyond emotional factors, future self-continuity—defined as an individual's perception of the connection between their present and future selves [13]—serves as another key determinant of intertemporal decision-making. Individuals with high future self-continuity are more likely to perceive their future selves as' real versions of themselves,' exhibiting lower time discount rates and stronger long-term planning tendencies [14,15]. Notably, the reinforcing effect of nostalgia on self-continuity [8] aligns closely with the core concept of future self-continuity, suggesting a potential interplay between the two that may jointly influence intertemporal decision-making. However, existing research has yet to elucidate the underlying mechanisms of their interaction.

2. Literature Review

2.1 Inter-Temporal Decision-Making

Inter-temporal decision-making is the cognitive process by which individuals weigh and choose between gains or losses in different time dimensions. The core of this process lies in the subjective valuation differences between immediate and delayed outcomes, which is widely present in fields such as financial savings, health management, and educational investment. The decision outcomes directly affect an individual's long-term well-being [2,16].

The systematic study of intertemporal decision-making began with the scientific explanation of the "time discounting" phenomenon. Time discounting refers to the psychological tendency where future rewards are systematically devalued compared to immediate rewards, which is the core mechanism explaining human "recent preference" [17]. Frederick pointed out in a review that individuals generally have a short-sighted tendency of "preferring immediate small gains over future large gains" [2], which although can meet short-term psychological needs, may lead to long-term resource allocation imbalance, such as excessive debt and neglect of preventive health investment, etc.

Early studies on intertemporal decision-making focused on the influence of task characteristics (such as delay duration, reward amount, and outcome probability) on choices, forming classic theoretical frameworks such as the discount utility model [18,19]. However, as research progressed, scholars gradually realized the crucial role of individual internal factors, with emotions and self-awareness becoming two core exploration directions. At the emotional level, Jiang Yuanping et al. (2022) found through experiments that positive emotions can enhance an individual's patience and future orientation, significantly increasing the proportion of delayed reward choices [3]; while Yu Shengxiang et al. (2017)'s research showed that negative emotions such as fear would intensify the immediate preference, causing individuals to be more inclined to choose short-term certain results [4]. At the self-awareness level, the individual's ability to integrate the self's time dimension - especially the perception and identification of future self - has been proven to be an important psychological variable for regulating intertemporal decision-making, providing a theoretical connection point for future self continuity and nostalgia emotion intervention studies.

This field of research began with the explanation of the "time discounting" phenomenon, that is, the systematic devaluation of future rewards compared to immediate rewards, which explains the widespread "recent preference" in humans. As research progressed, emotions and self-awareness became key influencing factors, such as positive emotions can increase the proportion of delayed reward choices [3], while negative emotions tend to intensify the immediate preference [4].

Among the many factors influencing intertemporal decision-making preferences, emotions are considered a key variable. Research indicates that positive emotions are typically associated with patience and future orientation, making individuals more inclined to delay gratification, while negative emotions tend to trigger short-termism and instant gratification [5].

Despite growing interest in emotional influences on decision-making, nostalgia, a multifaceted emotion experienced across cultures, has received limited scholarly attention in intertemporal decision-making research, and thus constitutes the central focus of the present

study.

2.2 Nostalgia

Nostalgia is a complex emotional experience that combines both negative and positive emotions. It refers to the warm reminiscence of the pleasant past experiences related to the self, triggered by specific cues, often accompanied by a slight sense of loss. Its core lies in the psychological adaptive function of reconfiguring one's self-identity, social connections, and the meaning of life, such as stimulating positive emotions and enhancing self-continuity [20,6-7]. Nostalgia is everywhere, often triggered by external stimuli in daily life, such as visual, auditory, and olfactory sensory cues [9]. In recent years, neuroscience research has successfully induced nostalgic emotions through auditory [10,21-23]. visual images [21,24] , and olfactory [25]. Murray et al. (2016a) discovered through brain imaging technology that audiovisual integration has significant advantages in emotion recognition, highlighting the importance of dual sensory channels in emotional intervention [12]. Yet, most existing research on nostalgia relies on induction through a single sensory channel, with relatively little attention given to the potential effects of dual- or multi-channel stimuli on nostalgia elicitation. Moreover, individual and contextual factors such as culture, age, and gender may moderate the effectiveness of nostalgia induction. Consequently, within the Chinese cultural context, the careful selection of nostalgic materials that resonate with Generation Z is particularly important.

Accordingly, Hypothesis 1: Dual sensory channels such as videos (audiovisual stimuli) are more effective than single sensory channels in eliciting nostalgic experiences.

As well as nostalgic academic cognition has undergone a crucial transformation from "pathological emotion" to "adaptive psychological resource". Before the mid-20th century, the psychological community generally regarded nostalgia as a need-to-be-intervened negative emotion (such as homesickness, psychological regression) [26,27]; while Wildschut et al. (2006)'s pioneering research demonstrated through empirical evidence that nostalgia has significant psychological adaptive value, which can effectively stimulate positive emotions [7], enhance self-esteem levels, strengthen social connection, and help individuals recover psychological resources when facing stress. Subsequent studies further confirmed that nostalgia can strengthen self-continuity and enhance positive expectations for the future, thereby alleviating anxiety and loneliness [8,28].

Nostalgia is a mixed emotion that blends joy and sorrow, encompassing both warm memories of cherished pasts and accompanying feelings of loss and melancholy [5-6,28]. Unlike ordinary memories, the core feature of nostalgia lies in its "self-integration function" - not merely a simple recollection of past events, but also the reconstruction of self-identity, the significance of social connections, and the value of life [7]. Research indicates that nostalgia often stimulates positive emotions, enhances life meaning and social connections [7], thereby promoting psychological resource recovery and future orientation. However, nostalgia may also trigger negative experiences like sadness and melancholy. This emotional duality suggests that nostalgia influences intertemporal decision-making through dual pathways: promoting delayed gratification while enhancing immediate preference, forming a theoretical question worthy of in-depth exploration.

According to this literature the researchers proposed, Hypothesis 2: In a nostalgic state, individuals are more likely to choose delayed gratification in intertemporal decision-making.

Beyond emotional factors, intertemporal decision-making is significantly influenced by future self-continuity. Research has demonstrated that self-continuity moderates the relationship between nostalgia and intertemporal decision-making [29], with future self-continuity being a sub-concept of self-continuity. Future self-continuity refers to an individual's perception of the connection and consistency between their current self and future self [13]. When the future self is perceived as the "real self," individuals tend to exhibit lower time discount rates and greater willingness to make sacrifices for future benefits. Time discount, a core mechanism in intertemporal decision-making, describes the systematic devaluation of future rewards compared to immediate ones [30]. Studies have shown that higher levels of future self-continuity correlate with stronger satisfaction in areas such as saving, health, and learning planning [14,15].

2.3 Future Self-Continuity

Future self-continuity is the core sub-dimension of self-continuity, referring to the degree of closeness, consistency and emotional identification that an individual perceives between the current self and the future self (usually the self at a specific point in time, such as the self-10 years from now) [13].

Its essence is the individual's cognitive assessment of "whether the future self belongs to the category of the true self" and is manifested as the extent to which future self's goals, needs and experiences are incorporated into current decision-making considerations. It can be measured through visual assessment (such as the overlapping circle scale) and self-report (such as the target consistency score) [31].

The theoretical basis of the theory of future self-continuity stems from the "time extension model" of self-awareness, which posits that the self-concept is not confined to the present but is a dynamic integrated entity spanning the past, present, and future. The degree of an individual's identification with their self at different time points directly influences intertemporal behavior [15]. Hershfield et al. (2012a)'s neuroimaging study provided crucial evidence for this theory: when individuals perceive a high degree of continuity between their current self and future self, the activation intensity of core regions related to the self (such as the medial prefrontal cortex, paracentral lobule) significantly increases [32], and this activation pattern is significantly correlated with a reduction in time discounting and an enhancement of delayed reward preference, indicating that high future self-continuity can reduce the subjective depreciation of future outcomes by incorporating the future self into the current self-concept.There is a stable mutual prediction relationship between future self-continuity and positive coping style, but future self-continuity only predicts negative coping style [33].

Research on the association between future self-continuity and intertemporal decision-making has formed rich empirical support. Hershfield et al. (2012b)'s experiment found that individuals with high future self-continuity exhibited stronger long-term orientation in saving behavior, academic planning, and health investment, and were more willing to give up immediate satisfaction for future gains [34]; He et al. (2019)'s research on a specific group further confirmed that the low future self-continuity of drug addicts was significantly related to their excessive immediate drug-seeking behavior, and enhancing future self-continuity could effectively improve their intertemporal decision-making biases[14]. Bartels and Rips (2010)'s theoretical model pointed out that future self-continuity affects intertemporal decision-making through two paths: the former refers to integrating future goals into the current self-goal system, and the latter refers to the positive emotional projection of the future self; both jointly reduce time discounting and promote delayed satisfaction [35].

Hypotheses 3: The researchers proposed that individuals with high future self-continuity are more likely to choose delayed gratification.

More importantly, there may be a potential connection between nostalgia and future self-continuity. By reviving cherished memories, nostalgia strengthens the emotional bond between past and present selves. Not only does nostalgia allow individuals to relive pleasant past moments, but it also reinforces the sense of temporal coherence in one's self-identity, enabling the integration of present and future experiences [36,37]. This temporal integration aligns closely with the concept of future self-continuity. Therefore, we hypothesize that nostalgia not only directly influences intertemporal decision-making but also indirectly promotes delayed gratification by enhancing future self-continuity. In other words, when nostalgia experiences combine with high future self-continuity, individuals are more likely to resist immediate rewards in favor of long-term benefits. So, it must be hypothesized as; Hypothesis 4: Nostalgia states and future self-continuity interact to jointly influence intertemporal decision-making behavior.

3. Methodology

This research has two stages of experiment (preliminary experiment and formal experiment) as follows:

3.1 Preliminary Experiment: Screening of Nostalgia Materials

3.1.1 Materials and participants

Candidate materials were screened from domestic social platforms (Xiaohongshu, TikTok, Bilibili) and comprised three categories: images (childhood games, snacks, and campus scenes of Generation Z), music (classic Chinese children's songs and pop songs from 2000-2010),

and videos (childhood animation clips). Neutral materials consisted of emotionless instrumental music. A total of 160 online questionnaires were distributed for the pre-experiment to evaluate the candidate materials. All questionnaires were completed by college students aged 18 to 22. Among the participants, 49(30.63%) were males and 111(69.37%) were females.Example of the selected nostalgic materials is shown in Figure 1.



Figure 1. Example of Nostalgic Materials

3.1.2 Experimental materials

College students rated the candidate materials on two criteria: nostalgic arousal (1-7 points, with higher scores indicating stronger emotional resonance) and familiarity (1-7 points, with higher scores indicating greater recognition). The selection criteria required a nostalgic arousal score of ≥5 and a familiarity score of ≥4. Based on the evaluation results, the final experimental materials were organised into three nostalgic conditions and one natural condition:

Image Condition: 10 nostalgic images (including vintage home decor, children's toys and supplies, and TV/computer screens), edited into a 2-minute and 3-second clip.

Music Condition: One nostalgic track "Let's Row the Boat" (2:23).

Video Condition: One audio clip of "Pleasant Goat and Big Big Wolf" (2:23).

Neutral Music Condition: Pure music (2:23).

3.2 Formal Experiment

3.2.1 Participants

A total of 492 college students were recruited via online platforms (WeChat and DingTalk) to complete an initial screening using the Nostalgia Trait Quality Scale. Participant selection was based on two criteria: (1) a completion time of at least 40 seconds, to exclude inattentive or random responses, and (2) a moderate score on the scale, to minimise potential bias associated with extreme nostalgia traits. Following screening, 240 valid participants aged 18–23 years were retained for the experiment, including 40 males (16.67%) and 200 females (83.33%). All participants reported no prior formal training in experimental psychology, had normal or corrected-to-normal vision, no colour blindness or colour vision deficiency, and had not previously participated in studies involving nostalgia induction or intertemporal decision-making.

Researchers randomly assigned participants to eight experimental groups of 30 individuals each. The study employed four nostalgic induction methods: visual stimuli through photo viewing, auditory stimuli through music listening, combined visual-auditory stimuli through video viewing, and neutral stimuli through pure music. Two levels of future self-continuity induction were applied: High Continuity Group required participants to imagine themselves 10 years later and list five similarities with their current self, while Low Continuity Group was asked to consider future world changes and list five features unrelated to their current self. To control for gender as a confounding variable, all groups maintained a balanced gender ratio of 5 males and 25 females. All participants completed the experiment independently in a quiet, well-lit laboratory to minimize environmental interference. Participants received credit rewards upon completing the experiment.

3.2.2 Experimental equipment

This experiment utilizes desktop computers from the Psychological Assessment Laboratory at Xi'an Eurasia University to ensure clear and stable visual stimuli presentation. Written materials are prepared on A6-sized paper during the experiment. Nostalgic materials (images, music, videos, and neutral content) are displayed through computer screens and headsets, with all headphones uniformly set to 60 decibels to maintain consistent auditory stimulation

intensity.

3.2.3 Research tools

3.2.3.1 Nostalgia priming materials

Pre-experimentally selected images, music, videos, and neutral materials; Nostalgia State Scale: The state-based nostalgia scale developed by Wildschut (Wildschut et al., 2006), 3 dimensions, consisting of 14 questions with a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). The internal consistency reliability of all 14 items was calculated by the valid sample data, which indicated that the scale had good internal consistency.In this study, Cronbach's α=0.98.

3.2.3.2 Future self continuity manipulation materials

Following Hershfield ershfield et al., paradigm: High Continuity Group: Participants were asked to imagine themselves 10 years later and list 5 similarities with their current self; Low Continuity Group: Participants were asked to consider future world changes and list 5 non-self-related characteristics; Future Self-Continuity Scale (FSCS): A visual rating scale developed by Hershfield [13], featuring 7 overlapping circles representing the "present self" and "future self" with 1-7 point scores, where higher scores indicate stronger continuity.Re-test reliability r = 0.7.

The Euler geometry circle, developed by Bartels and Urminsky (2011), is a tool for assessing future self-continuity. As shown in Figure 2, it consists of seven concentric circles with varying degrees of overlap, ranging from no overlap to complete overlap. The degree of overlap indicates the stronger the connection between the present self and the future self, reflecting greater future self-continuity. During the experiment, participants were asked to visualize the relationship between their present and future selves and then select the Eulerian geometry circle that best represented this relationship.

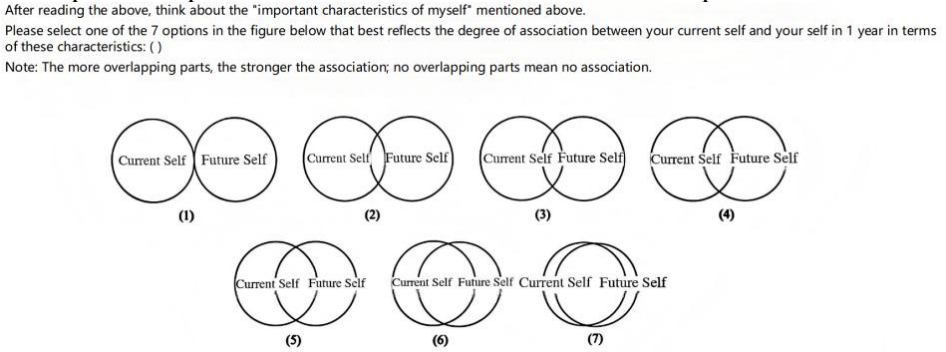


Figure 2. Euler Geometry Circles (Bartels and Urminsky, 2011)

3.2.3.3 Nostalgia trait scale (CHINOS)

Developed by He Jiaxun (2010) [38], comprising 14 items across interpersonal, family, and personal nostalgia dimensions with a 5-point Likert scale, showing an overall Cronbach's α=0.89.

3.2.3.4 Intertemporal decision-making task

The cross-period decision task employs the classic two-choice monetary decision paradigm, presenting a scenario with two options:

Option (A) offers an immediate reward (e.g., "receive 50 yuan immediately after the experiment").

Option (B) provides a delayed reward (e.g., "receive 90 yuan three months after the experiment").

3.2.4 Experimental procedure

The formal experiment was conducted individually, and the whole process lasted about 25 minutes. The overall experimental procedure is illustrated in Figure 3.

The specific process was as follows:

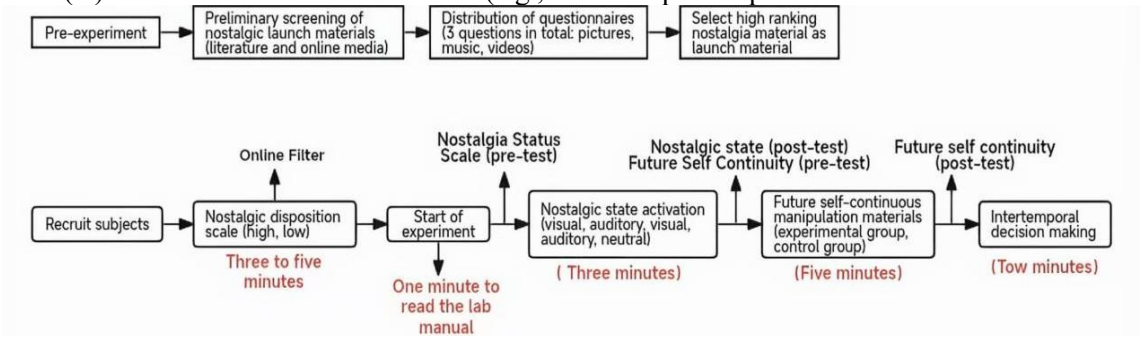


Figure 3. Experimental Flow Chart

Preparation phase (3 minutes):
The experimenter explains the experiment's purpose and procedure, emphasizing' truthful responses 'and' full concentration', then asks participants to sign the informed consent form. Participants wear headphones, adjust their posture for comfort, and familiarize themselves with keyboard operations (using only mouse clicks to select options).
Pre-test Phase (3 minutes):
First complete the Nostalgia State Scale (3 questions, no time limit). Upon completion, proceed automatically to the Nostalgia Activation Phase (5 minutes). Depending on participant group: Image Group: 10 nostalgic images displayed as slides, each lasting 15 seconds with automatic transitions. Music Group: Nostalgic music played with default background visuals. Video Group: Nostalgic videos shown in full-screen mode. Neutral Group: Neutral music with the same display method as the music group. During activation, participants must focus exclusively on viewing/listening materials and are prohibited from operating the computer.
The nostalgia induction phase is followed by a 10-minute manipulation session assessing future self-continuity. Participants complete a post-test (3 items) and a pre-test (FSCS scale) on future self-continuity. Group-specific materials are then presented, with no time limit for completing the tasks. The session concludes with a post-test (FSCS scale) to evaluate changes before and after the manipulation.
Inter-temporal decision task phase (2 minutes):
Participants complete an inter-temporal decision task by reading experimental materials and choosing between (A) (immediate reward) or (B) (delayed reward).
Final phase (2 minutes):
The experimenter explained the purpose of the experiment to the participants, avoiding cues such as "nostalgia priming" or "self-continuity manipulation" to prevent influencing their responses, recorded basic participant information, and thanked them for their participation.
During the experiment, the manual recorded the following data:
1-Pre-test and post-test scores of nostalgia state.
2-Pre-test and post-test scores of future self-continuity.
3-Selection results of cross-period decision-making.
All data were processed and analyzed using ANOVA and chi-square test in SPSS 27 after the experiment.

4. Results

4.1 The Influence of the Sense Channel on Nostalgia

As shown in Table 1, the one-way ANOVA results indicate no significant differences in the pre-test scores of nostalgia across different sensory channels (F=0.94, p=0.42), suggesting no overall significant variation in the nostalgia assessment.

Table 1. Differential Analysis of Presynaptic Nostalgia in Different Sensory Channels

	N	M	SD	*F*	*p*
Images	60	9.10	2.50	0.94	0.42
Music	60	8.78	2.14		
Video	60	9.12	2.01		
Neutral	60	9.45	2.03		

As shown in Table 2, the one-way ANOVA revealed significant differences in post-nostalgia scores across sensory channels (F=19.83, p<0.001). Post-hoc multiple comparisons indicated that the image, music, and video groups scored significantly higher than the neutral group, suggesting these stimuli elicited nostalgia, whereas the neutral group did not.

Table 2. Post-Test Difference Analysis of Nostalgia across Different Sensory Channels

	N	M	SD	*F*	*p*
Images	60	11.57	2.32	19.83	＜0.001
Music	60	11.27	2.77		
Video	60	11.45	2.13		
Neuteral	60	8.62	2.54		

Table 3's one-way ANOVA results indicate that the post-test mean scores for nostalgia evoked by images, music, and videos were 11.57,11.27, and 11.45, respectively (F=0.23, p=0.79). As video functions as a dual-sensory channel while images and music serve as single-sensory channels, no significant differences were observed in nostalgia arousal among the three stimuli. This suggests that the priming effects of dual-channel versus single-channel nostalgia are indistinguishable, thereby disproving our Hypothesis 1.

Table 3. Analysis of Differences in Nostalgia State Caused by Different Sensory Channels

		N	M	SD	*F*	*p*
Nostalgia Beta	Images	60	11.57	2.32	0.233	0.792
	Music	60	11.27	2.77		
	Video	60	11.45	2.13		

4.2 The Influence of Nostalgia on Intertemporal Decision Making

Table 4's chi-square test reveals that across different sensory channels, the proportions of participants favoring long-term benefits in intertemporal decision-making for images, music, and videos were significantly higher than those in the neutral group (χ^2=22.75, df=3, p<0.001). This indicates that in nostalgic states, individuals are more inclined to choose delayed rewards in intertemporal decision-making, thus confirming Hypothesis 2.

Table 4. Analysis of the Chi-Square Test of Nostalgia on Intertemporal Decision-Making under Different Sensory Channels

	Short-term decision	Long-term decision	χ^2	*df*	*p*
Images	20	40	22.75	3	< 0.001
Music	19	41			
Video	21	39			
Neutral	41	19			

4.3 The Impact of Future Self-Continuity on Intertemporal Decision Making

As shown in Table 5, the results of one-way ANOVA showed that there was no significant difference in the pretest of future self-continuity, F=0.04, p=0.84, which indicated that there was no significant difference in the pretest of future self-continuity.

Table 5. Pretest Variance Analysis of Future Self Continuity

	N	M	SD	*F*	*p*
High Future Self Continuity	120	4.27	1.32	0.04	0.84
Low Future Self Continuity	120	4.30	1.28		

As shown in Table 6, the results of one-way ANOVA showed that the post-test scores of future self-continuity in the triggered group were significantly higher than those in the untriggered group (F=17.83, p<0.001), indicating that the triggered group had triggered future self-continuity, while the untriggered group did not.

Table 6. Post-Test Variance Analysis of Future Self-Continuity

	N	M	SD	*F*	*p*
High Future Self Continuity	120	4.57	1.45	17.83	<0.001
Low Future Self Continuity	120	3.80	1.36		

As shown in Table 7, the chi-square test revealed that the proportion of participants in the experimental group who chose long-term preference in intertemporal decision-making was significantly higher than that in the control group, with a χ^2 value of 14.38, degrees of freedom (df) of 1, and p<0.001. This indicates that individuals with higher future self-continuity tend to delay benefits in intertemporal decision-making, thereby confirming Hypothesis 3.

Table 7. Chi-Square Test Analysis of High and Low Future Self-Continuity on Intertemporal Decision-Making

	Short-term Decision	Long-term decision	χ^2	*df*	*p*
High Future Self-Continuity	36	84	14.38	1	< 0.001
Low Future Self-Continuity	65	55			

4.4 The Interaction between Nostalgia and Future Self Continuity

As shown in Table 8, this study reveals a significant interaction between nostalgia and high/low future self-continuity across different sensory channels. When individuals are immersed in nostalgic scenarios, their self-consistency is heightened, which in turn strengthens their sense of future self-connection, ultimately influencing their choices in intertemporal decision-making tasks. This confirms Hypothesis 4.

Table 8. Chi-Square Test Analysis of the Interaction Effect between Nostalgia and High/Low Future Self-Continuity on Intertemporal Decision-Making across Different Sensory Channels

Cross-period		High Future Self Continuity	Low Future Self Continuity	χ^2	*p*	*LR*
Short-term Decision	Images	8.3%（3）	26.2%（17）	8.10	0.04	0.04
	Music	16.7%（6）	20%（13）			
	Video	33.3%（12）	13.8%（9）			
	Neuter	41.7%（15）	40%（26）			
Long-term Decision	Images	32.1%（27）	23.6%（13）	6.95	0.07	0.07
	Music	28.6%（24）	30.9%（17）			
	Video	21.4%（18）	38.2%（21）			
	Neuter	17.9%（15）	7.3%（4）			

5. Discussions

5.1 The Effect of Sensory Channels on Nostalgia Induction

Contrary to Hypothesis 1, the results indicated no significant difference in nostalgia induction intensity among visual, auditory, and audio-visual channels. All three sensory channels effectively triggered nostalgia, but their effectiveness was statistically equivalent. This finding challenges the intuitive assumption that multimodal stimulation produces stronger emotional responses and can be reasonably explained by the convergence-reactivation theory [39-41].

According to this theory, emotional memories (including nostalgic memories) are not stored based on a single sensory cue but are encoded through the convergence of multi-modal information (visual, auditory, semantic) in the cerebral cortex, forming integrated "episodic memory traces". When external stimuli (regardless of single or dual channel) can activate these self-relevant memory traces, similar levels of nostalgia will be evoked. In other words, the core determinant of nostalgia induction is not the number of sensory channels but the "self-relevance" and "cultural resonance" of the stimulus content [42]. For Generation Z participants in this study, the selected materials (e.g., Pleasant Goat and Big Big Wolf, Let's Row the Boat) are highly familiar and closely linked to their childhood self-experiences. This strong self-relevance offsets potential differences in induction effectiveness caused by channel types.

This result is supported by previous empirical evidence: Janata found that music-induced nostalgia and visual cue-induced nostalgia had no significant difference in autobiographical memory activation, and the intensity of nostalgia was mainly determined by the personal importance of the memory [43]. Barrett (2010) confirmed that music and image-induced nostalgia were highly similar in emotional value and meaning construction [44]. Thus, the present study supplements this line of research by verifying in the Chinese cultural context that when stimuli have sufficient self-relevance, single-channel and dual-channel stimulation achieve functionally equivalent effects in nostalgia induction. This revision of traditional cognitive assumptions provides a new theoretical perspective for the design of nostalgia induction materials in future research and practical interventions.

5.2. The Independent Effect of Nostalgia on Intertemporal Decision-Making

Consistent with Hypothesis 2, the results showed that nostalgia significantly enhanced individuals' preference for delayed rewards in intertemporal decision-making. Regardless of whether nostalgia was induced by visual (childhood images), auditory (classic songs), or audio-visual (animation clips) channels, the proportion of participants choosing delayed benefits was significantly higher than that in the neutral group. This finding aligns with the core view of nostalgia's adaptive function [7] and extends its application to the field of intertemporal decision-making.

Nostalgia, as a mixed emotional experience blending warmth and mild loss, its promotion of delayed gratification may stem from two key psychological mechanisms. First, nostalgia activates positive emotional resources: It evokes warm memories of the past, enhances self-esteem, sense of life meaning, and social connection [36], which in turn reduces impulsive decision-making tendencies [45] and increases patience for future rewards. Moreover, nostalgia strengthens self-continuity across time: By revisiting past experiences related to the self, nostalgia constructs a coherent narrative of (past-self → present-self) [36], making individuals more likely to extend this continuity to the future-self and thus value long-term gains. This explains why nostalgic individuals are less prone to short-sighted choices and more willing to sacrifice immediate satisfaction for future benefits.

5.3. The Independent Effect of Future Self-Continuity on Intertemporal Decision-Making

Hypothesis 3 was supported: individuals with high Future Self-Continuity (FSC) were significantly more likely to choose delayed rewards than those with low FSC. This finding echoes Ersner-Hershfield's neuroimaging research, which demonstrated that when individuals perceive a high degree of connection between the present and future self, the activation of self-relevant brain regions (e.g., medial prefrontal cortex) is enhanced, thereby reducing time discounting, the core mechanism

of intertemporal decision-making [31,46].

FSC reflects the extent to which individuals identify with their future self [13]. For those with high FSC, the future self is perceived as an extension of the present self, and future gains are thus regarded as "rewards for the current self", leading to a lower willingness to devalue future benefits. In contrast, individuals with low FSC tend to view the future self as a "stranger", resulting in insufficient attention to long-term interests and a preference for immediate gains. This mechanism is also verified in specific groups: He et al. (2019) found that drug addicts with low FSC showed more impulsive drug-seeking behavior, and enhancing FSC effectively improved their intertemporal decision-making biases [14]. The present study further confirms the universality of this effect in college students, highlighting FSC as a stable predictor of intertemporal decision-making tendencies.

5.4. The Interaction Effect between Nostalgia and Future Self-Continuity

The most important finding of this study is the significant interaction between nostalgia and FSC (supporting Hypothesis 4), which enriches the understanding of the joint influence of emotion and self-cognition on intertemporal decision-making. Specifically, in the high FSC group, nostalgia further amplified the preference for delayed rewards—especially in the visual and auditory single-channel conditions; while in the low FSC group, the promotional effect of nostalgia was weakened, and only the audio-visual channel showed a relatively prominent compensatory effect.

This interaction can be explained by the "self-narrative integration model": nostalgia promotes intertemporal decision-making by enhancing the coherence of self-narrative across time [8], but this effect relies on the individual's existing level of FSC. For individuals with high FSC, they already have a strong sense of connection with the future self. Nostalgia further strengthens the emotional bond between the past, present, and future self, making the "current sacrifice for future gain" a more consistent self-behavioral choice. In contrast, individuals with low FSC lack sufficient identification with the future self. Even if nostalgia evokes positive emotions and past self-continuity, it is difficult to extend this continuity to the future, resulting in the failure of positive emotions to be converted into long-term decision-making motivation [47].

The compensatory effect of the audio-visual channel in the low FSC group may be due to its richer contextual information: compared with single-channel stimulation, video integrates visual and auditory cues, which can more comprehensively activate episodic memories and strengthen the vividness of self-narrative [41]. This enhanced vividness may partially make up for the lack of FSC, prompting individuals to temporarily perceive a stronger connection with the future self and thus increase delayed reward choices. This finding provides important insights for targeted intervention design: for groups with low FSC (e.g., adolescents with poor self-planning ability, addicts), audio-visual nostalgic materials may be more effective in promoting rational decision-making [21,48].

6. Limitations, Implications, and Future Research Directions

Despite this study covering multiple sensory channels of nostalgia induction and their effects on intertemporal decision-making, however, several limitations should be acknowledged. First, the fixed duration of nostalgic stimulation (143s) may have compressed variability across channels, potentially attenuating modality-specific differences. In addition, individual differences in sensory preferences were not assessed, which may have confounded channel effects with participant predispositions. The sample consisted exclusively of college students aged 18–23 years and exhibited a substantial gender imbalance, limiting the generalisability of the findings. Moreover, intertemporal decision-making was operationalised using a simplified binary monetary choice task, which may not fully represent the complexity of real-world decisions in domains such as health or career planning.

Nevertheless, the study provides important theoretical and practical contributions. Theoretically, it advances an integrated framework linking nostalgia, future self-continuity, and intertemporal decision-making, contributing to research on emotion–cognition interactions. The findings challenge the assumption that multi-channel sensory stimulation necessarily enhances emotional intensity, suggesting instead that nostalgia primarily operates through the activation of core autobiographical memory–self

associations. Furthermore, the results highlight future self-continuity as an emotional amplifier that strengthens the impact of nostalgia on delayed decision preferences.

From an applied perspective, the findings inform the design of nostalgia-based interventions aimed at promoting long-term impulsivenesssssking, particularly among Generation Z. Tailored nostalgic stimuli may help mitigate short-term preference bias and support interventions targeting impulsivity or procrastination. Future research should vary stimulus duration, assess individual sensory preferences, include more diverse samples and decision contexts, and employ longitudinal or neuroimaging approaches to examine the durability and mechanisms of nostalgia-based effects.

7. Conclusion

The type of sensory channel does not influence the intensity of nostalgia induction. All three sensory channels (visual, auditory, and video) effectively induce nostalgia states, though their induction effects show no significant differences. Both nostalgia and future self-continuity independently promote delayed gratification choices: Nostalgia significantly increases the proportion of individuals with long-term preferences, with groups exhibiting higher future self- continuity showing significantly stronger delayed gratification tendencies than those with lower continuity. There is an interaction between sensory channels and future self -continuity: Under high continuity conditions, visual and auditory channels demonstrate more pronounced effects in enhancing long-term preferences. Conversely, under low continuity conditions, video channels exhibit more prominent compensatory effects.

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