The Effect of Episodic Future Thinking on Intertemporal Monetary Choice: Evidence from a Three-Level Meta-Analysis

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Abstract

Purpose: To address inconsistent findings in prior research and expand understanding of the relationship between episodic future thinking (EFT) and intertemporal decision-making.

Method: This study employed a three-level meta-analytic approach, incorporating comprehensive moderating variables to comprehensively analyze the magnitude of EFT's effect on intertemporal decision-making and the role of these moderating variables in this relationship.

Results: Main effect tests revealed that EFT moderately enhanced individuals' preference for delayed rewards (g = 0.5). Moderation effect tests showed that the valence, vividness, or personal relevance of episodic future thinking content could significantly influence this mechanism.

Limitations: The study only examined the influence of EFT on monetary intertemporal decision-making preferences under immediate conditions and did not extensively explore the duration of this effect. This study only investigated that the valence of EFT content could influence monetary intertemporal decision-making preferences and did not examine in detail the impact of specific emotions on this effect.

Conclusion: Episodic future thinking moderately increases individuals' preference for delayed rewards, with significant moderating effects of personal relevance, valence, and vividness of EFT content.

Full Text

The Impact of Episodic Future Thinking on Monetary Intertemporal Decision-Making: Evidence from a Three-Level Meta-Analysis

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Abstract:
[Objective] This study addresses inconsistent findings in prior research and expands our understanding of the relationship between episodic future thinking (EFT) and intertemporal decision-making. [Methods] Using a three-level meta-analytic approach, we incorporated comprehensive moderating variables to systematically analyze the magnitude of EFT's effect on intertemporal decision-making and the role of these moderators. [Results] The main effect test revealed that EFT moderately enhanced individuals' preference for delayed rewards (g = 0.5). Moderation tests demonstrated that the valence, vividness, and personal relevance of EFT content significantly influenced this mechanism. [Limitations] The study only examined the impact of EFT on monetary intertemporal decision-making preferences under current conditions, without exploring the duration of this effect. Additionally, while we investigated how EFT content valence affects monetary intertemporal decision-making preferences, we did not examine the specific impact of particular emotions. [Conclusions] Episodic future thinking moderately increases individual preference for delayed rewards, with personal relevance, valence, and vividness of EFT content showing significant moderating effects.

Keywords: Episodic future thinking; intertemporal decision-making; three-level meta-analysis; moderating effect

In daily life, we encounter various decisions such as holiday travel (choosing between affluent nearby scenery versus budget distant travel), drinking (choosing between occasional indulgence versus longevity), and movie watching (choosing between theater premieres versus waiting for online streaming). Intertemporal decision-making refers to the process by which individuals weigh alternatives occurring at different time points, primarily between present and future options, to make choices (Liang & Liu, 2011). Research typically asks participants to choose between immediate but smaller rewards (e.g., 10 yuan now) versus delayed but larger rewards (e.g., 100 yuan in one month), which constitutes monetary intertemporal decision-making.

Intertemporal decision-making not only affects individual well-being but also relates to social and national stability (Wu et al., 2020). The phenomenon where the subjective value of future rewards decreases over time is called delay discounting (Frederick et al., 2002; Sellitto et al., 2011). During decision-making, people tend to prefer immediate but smaller rewards. Increased delay discounting leads to many maladaptive behaviors such as smoking (MacKillop et al., 2011), alco-

hol addiction (Bobova et al., 2009), and gambling (Reynolds, 2006). A meta-analysis found that several psychiatric disorders, including major depression, schizophrenia, bipolar disorder, and eating disorders, exhibit increased delay discounting rates (Amlung et al., 2019). How to reduce delay discounting rates and enhance prospective thinking and future decision-making capabilities has become an urgent issue in psychological and management research. Intertemporal decision-making, as a complex behavior, involves dynamic interactions among three neurocognitive systems (Peters et al., 2011): (1) an evaluation network responsible for calculating the subjective value of future rewards; (2) a self-control network responsible for delaying gratification through cognitive control and conflict monitoring; and (3) a prospective memory network responsible for representing future outcomes. Research based on intertemporal decision-making network models has summarized methods for reducing delay discounting (Rung & Madden, 2018; Schacter et al., 2017), including mindfulness-based interventions (Hendrickson & Rasmussen, 2017), contingency management (Giles et al., 2014), visualization training (Parthasarathi et al., 2017), episodic future thinking (EFT; Bulley & Gullo, 2017), and working memory training and financial management guidance, finding EFT to be the most effective approach for reducing delay discounting.

Previous studies found that EFT can effectively reduce delay discounting in intertemporal decision-making, with effect sizes ranging from 0.00 to 1.49 (Hollis-Hanse et al., 2019; Rung & Madden, 2018). However, some studies found no effect of EFT on delay discounting (Hu et al., 2017; Palombo et al., 2016; Zhang, 2018). Some research even found that participants performing negative EFT tasks showed increased delay discounting rates compared to control conditions (Liu et al., 2013; Zhang et al., 2018). These inconsistent findings may be related to certain potential influencing factors. The greatest advantage of meta-analysis is its ability to integrate and summarize existing literature, exploring the main reasons for differences in research results from the perspective of moderating variables, thereby opening new avenues for subsequent research (Cheung, 2019). Therefore, this study adopted meta-analytic techniques to systematically analyze the relationship between EFT and intertemporal decision-making and its moderating mechanisms.

1.1 The Impact of Episodic Future Thinking on Monetary Intertemporal Decision-Making

Episodic future thinking refers to the psychological process by which individuals project themselves into the future to pre-experience future events, representing a fundamental function of human consciousness (Wang & He, 2020; Zhang et al., 2018). The essence of EFT is not so much a way of thinking as a mental simulation of events that people may personally experience in the future. This psychological process generally requires two abilities: the capacity to construct detailed, vivid scenarios of future events to achieve goals, and the ability to experience mental time travel (Yang et al., 2020). Based on past memories, EFT

recombines information into simulations of future events, making the intangible future more concrete and guiding people's future decisions (Addis, 2020; Atance & O'Neill, 2001; Benoit et al., 2018). Boyer (2008) first linked EFT to intertemporal decision-making, suggesting that EFT could reduce impulsive decisions and emphasizing the importance of feelings and emotions. Subsequently, Peters and Büchel (2010) found that imagining future scenarios made individuals prefer delayed rewards. Benoit et al. (2011) asked participants to imagine future consumption scenarios, and results showed that participants' delay discounting significantly decreased after the imagination task. Even when controlling for the emotional valence of EFT, EFT tasks still made participants prefer delayed rewards (Lin et al., 2014; O'Donnel et al., 2017). These studies all indicate that individuals' preference for delayed rewards in monetary intertemporal decision-making is influenced by EFT (Bullley et al., 2019).

As research progressed, scholars began exploring the internal mechanisms through which EFT influences intertemporal decision-making. The emotion-of-episodic-prospection hypothesis posits that EFT content typically carries different emotional valences, and individuals' preferences for intertemporal decision options are influenced by the emotional circuits activated by these valences (Busby et al., 2021). Positive or negative valence EFT leads individuals to experience future events positively or negatively. Individuals in negative emotional states perceive low certainty-control, while positive emotions are associated with high certainty-control (Smith & Ellsworth, 1985), and individuals' delay discounting is affected by certainty-control, with those having high certainty-control preferring delayed rewards (Song et al., 2021). However, other studies found that both positive and neutral valence EFT can increase participants' preference for delayed rewards, suggesting that emotional valence is not the only factor affecting intertemporal decision-making. According to the attention allocation model, as attentional resources allocated to time processing decrease, individuals' subjective time distance shortens (Buhusi & Meck, 2006). Wang and He (2020) examined attention resource allocation during EFT and found that when EFT tasks had higher personal relevance, self-related events continuously captured individuals' attentional resources, causing subjective time distance to shorten and consequently changing intertemporal decision preferences. Construal level theory, on the other hand, suggests that psychologically distant events are represented by high construal levels, and construal level significantly influences judgment and decision-making (Trop & Liberman, 2003). According to this theory, if future events activate high-level construal, individuals tend to focus on larger but delayed utility (high construal level) rather than more immediate but smaller satisfaction (low construal level) (Trope & Liberman, 2010). Cheng et al. (2012) compared the effects of recalling versus imagining life scenarios four years in the future on intertemporal decision-making and found that participants' imagination of future events generated future-oriented mindsets, promoting high-level construal of future events and consequently increasing preference for delayed rewards.

Given the controversy surrounding the mechanism of EFT's effect on intertemporal decision-making, foreign scholars Ye (2022) and Rösch (2022) conducted integrative analyses on this topic, revealing the relationship between EFT and intertemporal decision-making, but with some limitations. The former used traditional meta-analytic methods that could not explain correlations among effect sizes within studies nor maximize the use of effect sizes from original literature. The latter selected intertemporal decisions across different domains, including money and health, and the selected literature showed significant publication bias. Additionally, it did not consider factors such as age, gender, temporal distance of imagined events in EFT, control task valence, or delay discounting task indicators, thus failing to reveal the specific mechanism of EFT's effect on intertemporal decision-making. In light of this, this study employs three-level meta-analytic techniques to comprehensively and accurately explore the direction and magnitude of EFT's influence on intertemporal decision-making, resolving controversies among research findings.

1.2 Moderating Variables in Episodic Future Thinking and Monetary Intertemporal Decision-Making

(1) Age

As people age, their cognitive levels, cognitive styles, and life experiences change. Similarly, EFT's impact on intertemporal choices may show heterogeneity across different ages. Previous research found that younger participants' ability to construct future scenarios was significantly higher than that of older participants (Rendell et al., 2012). Acevedo-Molina et al. (2020) compared the heterogeneity between younger and older adults in constructing detailed future scenarios, finding that younger adults found it easier to construct future scenario details and produced significantly more than older adults. Similarly, Mok et al. (2020) showed that older adults constructed future event scenarios less effectively than younger adults and preferred immediate rewards more strongly. These findings indicate that younger adults' EFT effects are superior to those of older adults, making them prefer delayed rewards more than older adults in intertemporal decision-making. Therefore, this study includes age as a moderating variable to examine EFT's effect on intertemporal decision-making.

(2) Population Type

When individuals face decisions between short-term gains and larger long-term gains, they need to inhibit impulses for immediate satisfaction based on long-term goals. When inhibitory control ability decreases, psychological or behavioral disorders may occur, manifested in intertemporal decision-making as a much stronger preference for immediate satisfaction than for pursuing delayed rewards (Gullo & Potenza, 2014; Mackillop et al., 2011). Research found that individuals with substance abuse disorders, pathological gambling, obesity, and other health-threatening behaviors have higher delay discounting rates compared to healthy controls (Story et al., 2014). EFT can effectively reduce delay discounting rates in special populations including healthy individuals (Scholten

et al., 2019), smokers (Chiou & Wu, 2017), obese individuals (Daniel et al., 2013), and alcoholics (Snider et al., 2016). Furthermore, EFT can reduce normal college students' demand for alcohol; compared to control groups imagining non-personal events or past events, imagining positive future events showed lower alcohol demand (Bulley & Gullo, 2017; Snider et al., 2016). Therefore, when EFT is applied to different population types, its effect on intertemporal decision-making may differ.

(3) Valence of Episodic Future Thinking Tasks

In studies on EFT and intertemporal decision-making, EFT manipulation is relatively simple, primarily involving imagining positive future events. Researchers therefore believe that EFT's effect on intertemporal decision-making is driven by the positive emotional value of episodic content (Lempert et al., 2015). To clarify the specific role of emotional valence, researchers have further manipulated the valence of imagined events in addition to setting imagination and control groups, but findings remain inconsistent. Liu et al. (2013) found that neutral valence EFT had no significant effect on different reward preferences, positive valence EFT reduced preference for immediate rewards, but negative valence increased preference for immediate rewards. However, Lin and Epstein (2014) found that both neutral and positive valence EFT could reduce delay discounting rates, and Bulley et al. (2019) also found that both positive and negative valence EFT could reduce delay discounting rates compared to neutral valence EFT. Whether all future imagination can reduce delay discounting or whether positive valence imagination has a greater effect requires further analysis.

(4) Personal Relevance of Episodic Future Thinking Tasks

Episodic future thinking is the psychological process of precisely constructing or simulating details of goal-related information (D'Argembeau et al., 2015), where personal goals and motivations significantly influence this process. Therefore, EFT is closely related to self-factors, and personal goal processing plays a particularly important role in forming mental representations of future events (Hu, 2018; Stawarczyk & D'Argembeau, 2015). Research found that future events related to personal goals and those unrelated to personal goals activate different neural activities in the brain, with the ventromedial prefrontal cortex only involved in encoding personally goal-relevant information under these two conditions (Rasmussen & Berntsen, 2014). One study using the classic future thinking task asked participants to imagine events they hoped would happen to themselves in the future (self-condition) and then complete the same task from others' perspectives (other-condition). Results showed that subjective well-being and psychological well-being were significantly positively correlated with individuals' ability to imagine future positive events only in the self-condition, not in the other-condition (MacLeod & Conway, 2007). Other studies found that goal-oriented EFT proved more emotional than non-goal EFT cues and could reduce delay discounting rates (O'Donnell et al., 2017). Therefore, the degree of personal relevance of imagined future events affects individuals' autonomous experience and sense of immersion, so this study includes personal relevance of

EFT as a moderating variable.

(5) Vividness of Episodic Future Thinking Tasks
Research shows that more vivid EFT content has a stronger influence on an individual's future-oriented decisions (Bromberg et al., 2015; Ciaramelli et al., 2019). Vividly imagined events are also considered more likely to occur, injecting more concrete episodic details into future options and reducing the abstractness of delayed rewards' construal level (Lempert & Phelps, 2016; Wu et al., 2015). Therefore, vivid imagination may make the future more certain, thereby reducing discounting rates to some extent (Bulley et al., 2016). This study thus includes vividness of EFT tasks as a moderating variable to explore differences in how EFT with varying vividness affects intertemporal decision-making.

(6) Scenario Type of Episodic Future Thinking Tasks
Research indicates that EFT helps achieve cognitive functions such as goal achievement and future planning (Schacter et al., 2017), so EFT content is typically future goal-oriented. Furthermore, compared to general EFT content (e.g., "I will go home within two weeks"), EFT events related to future financial goals (e.g., "I will buy a new computer within two weeks") lead to greater reductions in monetary delay discounting rates (O'Donnell et al., 2017). Other research noted that health goal-related EFT can effectively reduce the calorie count of online food purchases (O'Donnell et al., 2018). This study posits that based on different imagined task scenarios, EFT's effect on intertemporal decision-making may differ.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) was used as the analysis guide for this meta-analytic study (Moher et al., 2015). Additionally, to improve research transparency, this study's purpose and hypotheses were preregistered on the Open Science Framework (OSF) (registration number: osf.io/5xnwb). The complete coding table, including all obtained effect sizes, moderating variables, and R analysis scripts, can be found in the online supplementary materials.

2.1 Literature Search

A combination of subject terms and free terms was used to search Chinese and English databases, with search scope covering article titles, abstracts, and keywords. For Chinese searches, four databases were used: China Excellent Master's and Doctoral Dissertations, CNKI, Wanfang, and VIP. Subject terms for episodic future thinking included "情景未来思维," with free terms including "前瞻性思维," "预期想象," and "心理时间旅行." Subject terms for intertemporal decision-making included "跨期决策," with free terms including "跨期选择," "延迟折扣," "时间折扣," and "时间贴现." English searches used PubMed, Web of Science, ProQuest, Embase, and Cochrane Library databases. Subject terms for episodic future thinking included "episodic future thinking," with free terms including "future thinking," "prospection," "episodic future thought," "imagining the future," "episodic simulation," and "future envisioning." Subject terms

for intertemporal decision-making included "intertemporal choice," with free terms including "delay discounting," "temporal discounting," "time discount*," and "inter* decision making." Additionally, the reference list method was used to screen and supplement literature from retrieved papers, with missing literature identified through Google Scholar title searches. The literature search timeframe was before March 2023, with a total of 2,226 documents retrieved by March 2023.

2.2 Literature Inclusion and Exclusion Criteria

Literature was selected based on the following criteria: (1) Full text must be available, not abstracts or conference papers; (2) Must be empirical research, excluding literature reviews, meta-analyses, case studies, and qualitative research; (3) Language must be English or Chinese, excluding other languages; (4) Studies must measure EFT's effect on intertemporal decision-making, excluding pre-post studies; (5) Only studies using monetary intertemporal decision tasks were included, excluding health, environment, and food intertemporal tasks; (6) Measurement tools must be clearly reported; (7) Sufficient data must be provided to calculate effect sizes, including means, sample sizes, t-values, F-values, chi-square values, etc. Two authors independently conducted literature screening, with disagreements resolved through discussion. One author responded to our request for complete data, and their data were included. Ultimately, 46 documents (5 Chinese and 41 English) were included in the meta-analysis, comprising 8,397 participants and 89 effect sizes (PRISMA flowchart shown in Figure 1 [Figure 1: see original paper]).

A total of 2,195 documents were obtained from database searches and 20 from other sources, totaling 2,215 documents. After removing duplicates, 1,958 documents remained. After initial screening, 134 documents remained. Ultimately, 46 documents were included in the meta-analysis (comprising 46 independent samples and 89 effect sizes). Figure 1 [Figure 1: see original paper] shows the PRISMA flowchart; note: n represents the number of documents. Duplicate documents: n = 257. Excluded after browsing titles and abstracts: n = 1,751. Excluded reviews, meta-analyses, and case studies: n = 73. Excluded after full-text reading due to unavailable data or deviation from main topic.

2.3 Literature Coding and Effect Size Extraction

Included literature was coded for: (1) Basic information (author name, publication date); (2) Mean participant age; (3) Participant gender ratio; (4) Participant population type (healthy, obese, smoker, other); (5) Control task valence (positive, neutral); (6) Control task scenario type (imagining specific events, unrelated tasks, no operation, other); (7) Farthest EFT imagination time; (8) EFT valence; (9) EFT personal relevance; (10) EFT vividness; (11) EFT arousal level; (12) EFT scenario type (future-related events, health behaviors, other); (13) Delay discounting task indicator (K-value, AUC, log-transformed K-value, proportion, other); (14) Longest delay time in delay discounting task.

Coding followed these principles: (1) Each independent sample in a study was treated as one effect size; if a study contained multiple independent samples, multiple effect sizes were extracted accordingly. (2) If original literature did not report independent sample sizes for different groups, the total sample size was divided by the number of groups as the sample size for each independent group (Quarmley et al., 2022). (3) If original literature was a longitudinal study, tracking results were coded separately. To avoid coding errors, two authors coded independently, with disagreements resolved through discussion. Inter-rater reliability was as follows: (1) mean participant age ICC = 1.00; (2) participant gender ratio ICC = 1.00; (3) participant population type Kappa = 0.98; (4) control task valence Kappa = 0.93; (5) control task scenario type Kappa = 0.96; (6) farthest EFT imagination time ICC = 1.00; (7) EFT valence ICC = 1.00; (8) EFT personal relevance ICC = 1.00; (9) EFT vividness ICC = 1.00; (10) EFT arousal level ICC = 1.00; (11) EFT scenario type Kappa = 0.84; (12) delay discounting task indicator Kappa = 0.97; (13) longest delay time in delay discounting task ICC = 1.00.

2.4 Literature Quality Assessment

Referencing the literature quality assessment scale developed by Zhang et al. (2019), criteria included: (1) Participant selection: random selection = 2 points, non-random selection = 1 point, not reported = 0 points; (2) Data invalidity rate: invalidity rate $\leq$ 0.1 = 2 points, 0.1-0.92 = 1 point, >0.2 or not reported = 0 points; (3) Journal level: SCI, CSSCI (including extended version), and SSCI journals = 2 points, Peking University core journals = 1 point, ordinary journals and unpublished papers = 0 points. Each literature's total quality score ranged from 0-6 points, with higher scores indicating better quality. Scoring was conducted independently by two authors, with inter-rater reliability Kappa = 0.91.

2.5 Meta-Analysis Process

(1) Effect Size Calculation

This study used Hedges' g as the effect size indicator. Generally, Hedges' g values of 0.20, 0.50, and 0.80 represent small, medium, and large effects, respectively (Cohen, 1992). In this study, most literature effect sizes were calculated from means, standard deviations, and group sample sizes, while a few were converted from F-values and t-values (Harrer et al., 2021).

Independence among effect sizes is a crucial premise of traditional univariate meta-analysis, meaning only one effect size can be extracted from a study to ensure independence (Assink & Wibbelink, 2016). Notably, multiple effect sizes reported within the same study often come from the same sample, making them correlated. Traditional meta-analytic methods ignore this correlation, potentially leading to overestimation of overall effect sizes (Lipsey & Wilson, 2001). Three-level meta-analysis can better distinguish variance among sample, within-study, and between-study levels to provide more accurate result estimates, such

as considering dependencies among different effect sizes extracted from the same study without wasting rich information from studies containing multiple effect sizes (Assink & Wibbelink, 2016). This overcomes traditional meta-analysis limitations, fully utilizes original literature data, and increases statistical power (Cheung, 2019).

(2) Data Processing and Analysis
This study conducted three-level meta-analysis using R (X64 4.2.1-win), with relevant meta-analysis functions from the metafor package (Viechtbauer, 2010) and esc package (Lüdecke, 2019), following three-level meta-analysis tutorials by Harrer et al. (2021) and Assink and Wibbelink (2016) for R code development.

(3) Publication Bias
Publication bias exists because studies with positive results are more likely to be published, potentially causing published literature to inadequately represent the research field (Rothstein et al., 2005). Meta-analysis results can be affected by publication bias, so this study used Egger's regression test, Rosenthal's fail-safe N, and funnel plots to examine whether included literature had publication bias issues.

3.1 Study Characteristics

Through literature search and coding extraction, 46 documents were ultimately identified, including 5 Chinese and 41 English documents; 89 effect sizes were obtained, totaling 8,397 participants. Publication dates of included literature ranged from May 2011 to December 2022 (see Table 1). Moderating variable analysis results are detailed in Table 2 .

3.2 Publication Bias Test

Publication bias test results showed that effect sizes from various studies were evenly distributed on both sides and the upper part of the total effect size. Egger's test results showed $t = 0.704$, $p = 0.483$, intercept = 0.504, 95% CI [-0.90, 1.91]. Rosenthal's fail-safe N was calculated as 9,943, which is greater than $5\times k+10$ ($k = 90$). In summary, this meta-analysis study showed no significant publication bias issues (Egger et al., 1997; Rothstein et al., 2005; Wei et al., 2017).

3.3 Main Effect Analysis and Heterogeneity Test

Main effect analysis indicated that episodic future thinking could moderately ($g = 0.50$, 95% CI [0.356, 0.636]) influence individuals' preference for delayed options. In the total variance sources, sampling variance (level 1) accounted for 15.56%, within-study variance (level 2) for 54.32%, and between-study variance (level 3) for 30.12%. One-sided log-likelihood ratio tests found that both within-study variance ($p = 0.001$) and between-study variance ($p < 0.001$) were significant, indicating substantial differences in effect sizes extracted from the

same study (level 2) and different studies (level 3), allowing for moderation tests (Assink & Wibbelink, 2016; Hunter & Schmidt, 1990).

3.4 Moderation Effect Test

This study examined the moderating effects of mean age, gender ratio, population type (healthy, obese, smoker, other), control task valence (positive, neutral), control task scenario type (imagining specific events, unrelated tasks, no operation, other), farthest EFT imagination time, EFT arousal level, EFT valence, EFT personal relevance, EFT vividness, EFT scenario type (future-related events, health behaviors, other), longest delay time in delay discounting task, and delay discounting task indicators (AUC, K-value, log-transformed K-value, proportion, other). Moderation test results showed that mean age ($F(1,83) = 0.124$, $p = 0.726$), gender ratio ($F(1,84) = 0.008$, $p = 0.929$), population type ($F(3,85) = 0.471$, $p = 0.703$), control task valence ($F(1,85) = 3.745$, $p = 0.056$), control task scenario type ($F(3,85) = 1.714$, $p = 0.170$), farthest EFT imagination time ($F(1,83) = 0.132$, $p = 0.718$), EFT arousal level ($F(1,19) = 2.943$, $p = 0.1030$), EFT vividness ($F(1,3) = 4.014$, $p = 0.052$), EFT scenario type ($F(2,86) = 0.445$, $p = 0.642$), longest delay time in delay discounting task ($F(1,81) = 0.767$, $p = 0.384$), and delay discounting task indicators ($F(4,84) = 0.745$, $p = 0.564$) all had non-significant moderating effects. However, EFT valence ($F(1,35) = 42.382$, $p < 0.001$) and EFT personal relevance ($F(1,30) = 13.432$, $p < 0.001$) showed significant moderating effects. Among continuous moderating variables, EFT valence ($\beta = 0.40$, 95% CI [0.28, 0.53]) and EFT personal relevance ($\beta = 1.05$, 95% CI [0.47, 1.64]) could significantly positively predict preference for delayed rewards.

3.5 Multicollinearity Test

Because this study had multiple significant moderating effects, multicollinearity among moderating variables needed to be examined. This study ultimately fitted a multi-moderator model including all significant moderating effects, with the comprehensive test showing significance ($F(2,29) = 16.288$, $p < 0.001$), indicating that at least one regression coefficient of moderating factors significantly deviated from zero (Hox, 2010). The regression coefficient for task valence (0.498) significantly deviated from zero ($t(29) = 3.827$, $p < 0.001$), indicating that EFT valence has a unique moderating effect on the association between episodic future thinking and intertemporal decision-making.

4 Discussion

This meta-analysis examined EFT's effect on people's intertemporal decision-making preferences, summarizing, coding, and analyzing results from 46 documents with 89 effect sizes. Results showed that EFT demonstrated greater preference for delayed rewards than control groups. Additionally, significant moderating effects were found for EFT task valence, vividness, and personal

relevance, meaning that imagining more positive and vivid future scenarios enhances preference for delayed rewards more than general future scenario imagination.

4.1 The Impact of Episodic Future Thinking on Monetary Intertemporal Decision-Making

EFT significantly increases preference for delayed rewards in monetary intertemporal decision-making. This can be explained by attention allocation theory and construal level theory. Attention allocation theory posits that non-temporal processing tasks and temporal processing tasks compete for attentional resources; more resources allocated to time distance processing lead to longer subjective time distance (Meck & Macdonald, 2007). The vividness, positivity, and personal relevance of EFT content continuously capture individuals' attentional resources, causing neglect in temporal perception processing and preference for delayed rewards. Attentional resources are important factors affecting decision-making, and most decision-making theoretical models include attention mechanisms (Kahneman & Tversky, 1979). Behavioral research also shows that gazing at an option increases preference for that option because gaze amplifies option value (Smith & Krajbich, 2019). During EFT tasks, individuals focus attention on delayed options, leading them to perceive delayed options as having greater value and thus prefer delayed rewards.

Construal level theory (Trop & Liberman, 2003) suggests that people tend to use high-level construal to represent psychologically distant events and low-level construal for psychologically near events, with construal level systematically influencing intertemporal decision-making. High-level construal represents more abstract descriptions of behavior, causing individuals to focus on delayed rewards; conversely, low-level construal makes individuals focus more on concrete immediate rewards (Trope & Liberman, 2010). EFT provides people with opportunities to imagine specific future details, shifting their representation of abstract future events from high-level to low-level construal. Imagining and describing rich details may make future outcomes more attractive, thereby increasing the likelihood of choosing delayed options (Bulley et al., 2019; Ozdes, 2021).

In summary, attention allocation theory suggests that EFT reduces delay discounting because cognitive resources are occupied by EFT tasks, shortening individuals' subjective time distance and leading to preference for delayed rewards. Construal level theory, however, maintains that this occurs because EFT tasks shift individuals' representation of future events from high-level to low-level construal, increasing the attractiveness of delayed rewards. Accordingly, it is not difficult to explain why EFT can enhance individuals' preference for delayed rewards in intertemporal decision-making.

4.2 Analysis of Moderating Effects in the Relationship Between Episodic Future Thinking and Monetary Intertemporal Choice

Moderation test results showed significant moderating effects of EFT valence, with people showing greater preference for delayed options under higher valence EFT conditions. Bulley et al. (2019) believed that positive EFT significantly reduced delay discounting with a medium effect size. Similarly, Boyer (2008) proposed that emotions related to EFT might serve a "braking function," with positive EFT helping individuals counteract impulses to choose immediate options. Specifically, EFT allows people to pre-experience future events and generate anticipated feelings (Suddendorf & Moore, 2011). Anticipation of future events may expand the temporal window, bringing more positive influences and increasing tolerance for delayed rewards, making people prefer delayed rewards (Snider, 2016). These results indicate that EFT valence is an important factor in reducing delay discounting in monetary intertemporal decision-making, with higher valence EFT being more effective.

The moderating effect of EFT personal relevance was significant, with people showing greater preference for delayed options under higher personal relevance EFT conditions. Bromberg et al. (2015) found that vividly imagining future events increased preference for delayed rewards, and participants often overestimated the probability of positive events happening to themselves in the future; imagining self-related future events produced stronger emotional experiences and greater preference for delayed rewards. Yang (2016) also found that EFT tasks with higher self-relevance were more effective in enhancing people's preference for delayed rewards, specifically showing that EFT content detail quantity, vividness, emotional valence, and experience intensity were all significantly higher than in other EFT tasks. These results indicate that when EFT tasks have higher personal relevance, they cause higher valence and vividness of future events, which also leads to lower construal levels of future events and makes them feel temporally closer, so people prefer delayed options.

The moderating effect of EFT vividness was marginally significant, with more vivid EFT having greater efficacy in increasing intertemporal decision-making preference for delayed rewards. Bulley et al. (2019) believed that vivid EFT could increase the value of delayed rewards, providing stronger motivation for goal pursuit. This reflects the influence of construal level to some extent (Trope et al., 2010). Lempert and Phelps (2016) believed that more vivid EFT tasks generated more concrete details about delayed options, reducing the abstractness of delayed rewards' construal level. Therefore, vivid imagination makes the future more certain, thereby reducing individuals' delay discounting rates.

The moderating effect of age was not significant. Some scholars believe that older adults have a more short-sighted view of the future and are more inclined to give up delayed rewards because aging brings increased risks of poor physical condition and financial instability (Carstensen et al., 1999; Liu et al., 2016). In contrast, other researchers believe that compared to younger adults, older

adults' enhanced self-control and changes in lifestyle factors (e.g., interpersonal social roles, health concerns, and prosocial altruism) may make them prefer delayed gratification more (Sparrow & Spaniol, 2018). Other researchers point out that as people age, they may experience a sense of faster life pace and compressed time, which in turn reduces the subjective distance of future rewards (Lempert & Phelps, 2016; Rutt & Löckenhoff, 2016). However, most participants in this study were young and middle-aged adults, without large age-stage variations, so whether age can moderate EFT's effect on monetary intertemporal decision-making requires further verification.

The moderating effect of gender ratio was not significant, indicating that EFT's effect on enhancing preference for delayed rewards in intertemporal decision-making does not differ by gender. This is consistent with previous research (Cornwall et al., 2018; Lee et al., 2013). This may be because EFT is a capacity (Yang et al., 2020) with cross-gender stability, so gender ratio does not significantly moderate EFT's effect on intertemporal decision-making.

The moderating effect of population type was not significant, indicating no significant difference in EFT's effect on intertemporal decision-making across different population types. This is consistent with previous research (Dassen et al., 2016), showing that the EFT effect is widespread and relatively stable across different populations. Therefore, EFT can be used to reduce delay discounting rates in smokers, obese individuals, alcoholics, and others, helping them adopt healthier lifestyles.

The moderating effect of EFT task scenario type was not significant, meaning that EFT's effect on intertemporal decision-making does not differ significantly across different task scenario types. This may be because EFT can significantly reduce people's tendency to discount future rewards, caused by changes in temporal construal level, i.e., cognitive representation of time shifts from high to low level (Trope & Liberman, 2000). Other research points out that EFT manipulation's effect on enhancing farsightedness is mediated by shifting representation of future events from abstract to concrete levels, causing increased feelings of temporal proximity to future events and leading people to prefer delayed options. From a neural perspective, this effect appears related to functional coupling between valuation and prospective memory networks (Peter & Büchel, 2010). These conclusions indicate that the impact on intertemporal decision-making is mainly related to factors in EFT content that can change the abstractness of future events (e.g., EFT vividness, EFT valence) rather than simple EFT scenario types (health scenarios, future-related scenarios, etc.).

The moderating effects of control task scenario type and valence were not significant, meaning that control task scenarios and valence do not affect the relationship between EFT and intertemporal decision-making. The reason people prefer delayed options due to future scenario imagination is that it can shorten the subjective temporal distance of future events and reduce their construal level. Control task scenario types and valence obviously do not have this function, so their moderating effects on EFT's impact on intertemporal decision-making are

not significant.

The moderating effects of farthest EFT imagination time and longest delay time in delay discounting tasks were not significant. A potential reason is that when considering future events that may occur in several months, the same degree of temporal scope expansion can occur as when considering events years ahead; therefore, regardless of how far into the future participants imagine, the effect on delay discounting may be the same. From a neural perspective, similar brain regions are activated whether participants imagine relatively distant or relatively near futures, such as vmPFC and hippocampus (Bulley & Schacter, 2020), and the degree of delay discounting reduction is similar (Palombo et al., 2015).

The moderating effect of EFT arousal level was not significant, indicating that EFT with different arousal levels does not significantly differ in affecting intertemporal decision-making preferences. Research shows that increased physiological arousal prolongs perceived event duration, while decreased physiological arousal shortens perceived time. Although physiological arousal affects subjective temporal perception of future events to some extent (Lake et al., 2016), it does not interfere with individuals' judgments of future time distance. Moreover, because both strong positive and negative valence imagination tasks produce high physiological arousal, but their effects on intertemporal decision-making are opposite, this leads to the non-significant moderating effect of EFT arousal level.

The moderating effect of delay discounting task indicators was not significant, meaning that when testing EFT's effect on intertemporal decision-making using different indicators, the effect is stable, consistent with previous research (Bromberg et al., 2017; Hu et al., 2017). AUC-related indices and K-value-related indices are two main types of delay discounting indices. This study found that EFT's effect on AUC-related indices was greater than on K-value-related indices. However, no study has directly compared EFT's effectiveness in reducing delay discounting across different indices (Hamilton et al., 2015). These two indices are based on different mathematical models and are typically derived from different measurement methods (Odum, 2011). Further research is needed to examine the meanings and differences between AUC and K-related indices.

5 Theoretical Contributions, Limitations, and Future Directions

First, this study confirmed that EFT can moderately increase preference for options with longer delays but larger rewards in monetary intertemporal decision-making ($g = 0.50$), revealing the mechanism of EFT's effect on monetary intertemporal decision-making preferences, responding to and explaining controversies among existing research conclusions in this area, and confirming the explanatory power of attention allocation theory and construal level theory in

this mechanism. Second, this study utilized the unique advantages of three-level meta-analysis technology in handling effect size dependency to comprehensively and systematically reveal reasons for heterogeneity in EFT's effect on monetary intertemporal decision-making preferences. This study is the first to use three-level analysis technology to examine gender ratio, age, control task valence, control task scenario type, EFT personal relevance, farthest EFT imagination time, longest delay time in delay discounting tasks, and delay discounting task indicators as potential moderating variables affecting EFT's influence on monetary intertemporal decision-making preferences, confirming that when EFT content has higher valence, personal relevance, and vividness, people show greater preference for options with longer delays but larger rewards. This provides more convincing integrative conclusions and theoretical interpretations for previous controversial research and suggests that subsequent studies in this area need to consider the importance of EFT content valence, vividness, and personal relevance in this mechanism. Second, this study enriches and improves existing meta-analytic research in this field, providing scholars with an integrative research framework. Finally, compared to meta-analyses by Ye (2022) and Sarah (2022), this study is the first to include Chinese literature on this topic, contributing to theoretical construction of localized research in this area.

This study also has several limitations requiring improvement: First, due to limitations in included literature, this study only examined the impact of EFT on monetary intertemporal decision-making preferences under current conditions. Future research can further explore the duration of this effect. Second, this study only discussed how EFT content valence affects monetary intertemporal decision-making preferences without examining the specific impact of particular emotions; subsequent research can conduct more specific studies on particular emotions. Third, research shows that past episodic thinking can also reduce delay discounting (Lempert et al., 2017); however, due to limited research numbers, this study could not explore this separately, so future research can examine the stability of this mechanism and differential effects between EFT and past episodic thinking in reducing discounting. Fourth, for several moderation analyses, the number of studies included in each subgroup was unbalanced, requiring future research across subgroups.

6 Conclusions

This three-level meta-analysis found that EFT can increase people's preference for options with longer delays but larger rewards in monetary intertemporal decision-making tasks. The relationship between the two is influenced by EFT valence, EFT vividness, and personal relevance, but not by age, gender, participant population, control task valence, control task scenario type, EFT scenario type, farthest EFT imagination time, EFT arousal level, longest delay time in delay discounting tasks, or delay discounting task indicators, showing strong stability.

*Indicates literature used in the meta-analysis

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Author Contribution Statement
Cheng Zihan: Drafted the manuscript; Implemented research procedures, such as conducting experiments or surveys; Acquired, provided, and analyzed data.
Bi Cuihua: Proposed and designed the research, including specific ideas or methods; Revised the final version.
Wu Qi: Conducted literature coding and quality assessment; Revised the final

version.

Note: Figure translations are in progress. See original paper for figures.