The Effect of Emotion on Intertemporal Decision-Making

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Date: 2019-03-21T00:00:00+00:00

Abstract

In recent years, the influence of emotion on intertemporal decision-making has gradually emerged as a new research trend. Based on the timing of emotion occurrence during the intertemporal decision-making process, emotions can be categorized into pre-decision emotion, emotion during decision-making, and post-decision emotion. Currently, research on emotion and intertemporal decision-making, particularly studies examining how pre-decision emotion influences intertemporal decision-making, has mostly remained at the stage of revealing phenomena, with relatively few studies directly investigating the underlying mechanisms of influence. Comprehensively employing behavioral experiments and neuroimaging methods to reveal the behavioral and neural mechanisms through which emotion influences intertemporal decision-making from the perspectives of cognitive and decision-making processes will help deepen our understanding of the psychological mechanisms underlying intertemporal decision-making and assist individuals in better utilizing and controlling emotions to make more satisfactory decisions. Future research should also enhance the depth and ecological validity of investigations, such as by examining the effects of dynamic emotions, everyday emotions, and complex emotions on intertemporal decision-making, and by conducting more attempts and explorations in emotion intervention.

Full Text

The Effect of Emotion on Intertemporal Choice

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Abstract: In recent years, the influence of emotion on intertemporal choice has gradually emerged as a new research trend. Based on when emotions occur during the decision-making process, they can be classified into three categories:

pre-decision emotions, emotions during decision-making, and post-decision emotions. Currently, most studies on emotion and intertemporal choice—particularly those examining how pre-decision emotions affect intertemporal choice—remain at the stage of phenomenon description, with relatively few studies directly testing the underlying mechanisms. Integrating behavioral experiments and neuroimaging techniques to reveal the behavioral and neural mechanisms through which emotion influences intertemporal choice from the perspectives of cognitive and decision-making processes will deepen our understanding of the psychological mechanisms of intertemporal choice and help individuals better utilize and regulate emotions to make more satisfactory decisions. Future research must strengthen both depth and ecological validity, such as by investigating the effects of dynamic emotions, daily emotions, and complex emotions on intertemporal choice, while also pursuing greater exploration and innovation in emotional intervention.

Keywords: emotion; intertemporal choice; pre-decision emotions; emotions during decision-making; post-decision emotions

1 Introduction

Intertemporal choice refers to the process of weighing costs and benefits that occur at different time points to make a selection (Frederick, Loewenstein, & O' donoghue, 2002). Such decisions require decision-makers to trade off immediate gains and losses against future ones, representing important choices that affect both individual welfare and national interests. For instance, in investment contexts, investors face intertemporal dilemmas between selecting financial products with small but quick returns versus those with large but slow returns. In energy extraction, policymakers must choose between maximizing immediate benefits without regard for future generations or limiting current extraction to ensure sustainable resource use.

Since the 1930s, economists and psychologists have proposed numerous models to describe intertemporal choice behavior. In 1937, Nobel laureate Samuelson (1937) first introduced the Discounted-Utility Model, which posits that people discount future utility at a constant rate (the discounting rate), with the sum of discounted future utilities representing the total utility assigned to an option. However, as an increasing number of anomalies unexplained by this model emerged, researchers developed alternative discounting models by modifying the discount function (Laibson, 1997; Loewenstein & Prelec, 1992; Mazur, 1984), such as the Hyperbolic Discounting Model and Quasi-Hyperbolic Discounting Model. Nevertheless, decision-making based purely on precise computational thinking seems inconsistent with actual behavior, as people cannot always maintain a highly rational computational mindset in an uncertain world. Consequently, some scholars began deviating from mainstream theoretical approaches, proposing heuristic models from a bounded rationality perspective, including

the Attribute-Comparison Model (Read, 2001), Similarity Model (Leland, 2010), Equate-to-Differentiate Model (Li, 2004), and Tradeoff Model (Scholten & Read, 2010). These models suggest that intertemporal decision-making does not follow a maximization rule based on discounted summation but rather involves comparing differences between dimensions to select the dominant option.

Throughout this evolution, emotion has progressed from being initially ignored and controlled to becoming a crucial variable in intertemporal choice research. In recent years, numerous studies have emerged in this field, examining emotion' s influence on intertemporal choice from various perspectives. However, the diversity of emotion types and research foci across studies has created confusion when synthesizing the relationship between emotion and intertemporal choice. Therefore, this paper systematically reviews how emotion affects intertemporal choice and its underlying mechanisms by organizing emotions according to their temporal occurrence in the decision-making process: pre-decision emotions, emotions during decision-making, and post-decision emotions. This organization aims to clarify the influence and role of emotion in intertemporal choice and deepen our understanding of its psychological mechanisms.

2.1 Pre-Decision Emotion

Pre-decision emotion, also called background or incidental emotion, refers to emotional experiences caused by factors unrelated to the current decision task that fluctuate with the quality of daily life experiences. For example, individuals' emotional states can be influenced by seemingly irrelevant weather conditions or physical health status. Although background emotions are not elicited by the decision task itself, they accompany the decision process and influence subsequent decisions by altering cognitive appraisals or directly exerting subtle effects on decision behavior. In most studies involving background emotion, researchers typically induce emotional states in participants before they begin the decision task to examine the relationship between background emotion and intertemporal choice. For instance, Pyone and Isen (2011) induced positive emotion through pictures and words, finding that positive emotion made participants more farsighted with better self-control and patience. Liu, Feng, Chen, and Li (2013) showed that participants who imagined positive emotional events preferred delayed rewards, whereas those who imagined negative emotional events preferred immediate rewards. Currently, most research on emotion and intertemporal choice focuses on the impact of pre-decision emotions.

2.1.1 Positive and Negative Emotions

Different valences of pre-decision emotions exert distinct effects on intertemporal choice. Synthesizing numerous studies reveals that positive emotions reduce individuals' time discounting rates, making them prefer long-term options, while negative emotions increase discounting rates, favoring short-term options. For

example, Ifcher and Zarghamee (2011) investigated whether positive emotion affects intertemporal choice, finding that mild positive emotion significantly reduced participants' discount rates compared to neutral emotion, leading to greater preference for larger, later rewards. Negative emotions made people more myopic, preferring smaller rewards that could be obtained sooner. Wang and Liu (2009) found that participants in a pleasant mood showed decreased discount rates and preferred delayed options, whereas those in a sad mood showed increased discount rates and preferred immediate options. Muraven, Baumeister, and Tice (1999) reported that when individuals experienced low mood, they tended to eat more delicious food or smoke more cigarettes in the present. Gray (2004) demonstrated that people in negative emotional states lacked rationality and foresight, making more impulsive choices compared to positive or neutral states. Chen (2007) found consistent results regarding how different emotions affect self-control, with negative emotion groups showing more impulsive choices than positive or neutral groups. Additionally, some studies found that positive affect similarly reduces discounting rates and promotes farsightedness. DeSteno, Li, Dickens, and Lerner (2014) found that gratitude increased patience in intertemporal choice. Guven (2012) discovered that residents whose happiness increased due to better weather conditions showed reduced impulsive consumption and increased rational saving behavior. Yang and He (2015) found that individuals with higher happiness levels preferred larger, later rewards in intertemporal choice tasks. Ye (2016) found that hope and power influenced intertemporal choice, with individuals experiencing high hope or high power becoming more patient and willing to wait for delayed options.

Currently, few empirical studies have examined the mechanisms through which different valences of pre-decision emotions influence intertemporal choice, with most researchers merely speculating about mechanisms and only a few directly testing them. First, some researchers have explained emotion' s influence from a cognitive process perspective. Pyone and Isen (2011) induced positive emotion through pictures and words, finding that positively-valenced participants chose larger, delayed rewards compared to neutral participants. They simultaneously measured participants' construal level and future orientation, discovering that positive emotion led to higher-level (forward-looking) thinking and stronger future orientation. Therefore, they proposed that positive emotion increases cognitive flexibility, enabling individuals to focus not only on immediate gains and losses but also on long-term outcomes, thereby preferring delayed options. Similarly, Ifcher and Zarghamee (2011) did not directly measure the mechanism but speculated that mild positive emotion enhances cognitive flexibility by broadening attention, promoting information openness, and improving information integration, causing participants to more holistically consider and compare total gains across present and future, ultimately choosing larger delayed rewards.

Furthermore, researchers have extended the cognitive process perspective to explain emotion's influence from a decision-making process angle. Classic intertemporal options contain two dimensions: time and monetary amount. Researchers have examined how emotion affects the salience of each dimension or their rel-

ative magnitudes to influence intertemporal choice. For example, Wang and Liu (2009) found that pleasant-mood participants had lower discount rates and preferred future options compared to sad-mood participants. They speculated that positive emotion activated high-level construal thinking, causing people to focus more on holistic meaning and thus attend more to the monetary dimension, leading to delayed choices. Conversely, negative emotion made people focus more on concrete, flexible attributes, attending more to the time dimension and thus preferring immediate options. Guan, Cheng, Fan, and Li (2015) directly investigated how emotion affects the decision process. They found that negative emotion made individuals prefer smaller, sooner rewards compared to positive and neutral emotions. To examine the underlying mechanism, they had participants complete time reproduction and response inhibition tasks after emotion induction. Results showed that during the time reproduction task, negative emotion states produced significantly shorter reaction times than positive or neutral states, suggesting that negative emotion made time perception feel longer. In contrast, emotion valence did not affect performance on the response inhibition task. These findings indicate that myopic, impulsive decisions under negative emotion may relate to altered time perception, with emotion influencing intertemporal choice by affecting the subjective experience of time duration.

Beyond cognitive and decision-making process explanations, a few researchers have interpreted emotion' s influence from an affect regulation perspective, particularly for negative emotions. According to affect regulation theory, individuals possess a drive to pursue pleasure, and those in negative emotional states adopt behaviors that can elevate their mood (Andrade, 2005), thus showing stronger tendencies to choose immediate rewards and obtain instant gratification. Studies of addicts and dieters have found that negative emotion can cause "motivational shifts," where short-term hedonic needs override long-term health goals, making individuals more likely to satisfy current desires at the expense of future objectives (Elster, 1999; Herman & Polivy, 2003). However, this mechanistic speculation currently lacks empirical support.

2.1.2 Specific Emotions

Most previous research has taken a macro-level approach, focusing on general, broad emotions—such as the positive and negative emotions discussed above—and their effects on intertemporal choice. Current research has moved beyond simple valence-based generalizations to examine, at a more detailed micro-level, the specific effects of different emotions within the same valence category. Different specific emotions within the positive valence category show relatively consistent effects: as previously discussed, individuals in positive emotional states become more patient when facing delayed rewards in intertemporal choice. However, different emotions within the negative valence category do not show entirely consistent effects. Lerner, Li, and Weber (2013) found that sadness created a myopic tragedy, making participants focus on immediately available

smaller monetary rewards rather than waiting for larger ones, thereby increasing discount rates. Yet Lerner et al. also found that disgusted participants were not more impatient than neutral participants, indicating that not all negative emotions produce this myopic effect. Consequently, scholars began reflecting on valence-based theories and proposed a specific-emotion decision theory—the Appraisal-Tendency Framework (ATF)—sparking a surge in specific emotion research. ATF theory posits that emotions have six cognitive appraisal dimensions: certainty (the predictability of future events), pleasantness (the degree of positive or negative feeling), attentional activity (whether the individual is attentive), control (whether events are controlled by the individual or the situation), anticipated effort (the degree of physical or psychological effort required), and responsibility (the degree to which others or the self are responsible for the event). People can distinguish different emotions based on these dimensions, with each dimension contributing differently to each emotion. The dimension that plays a dominant role in an emotion is called the core appraisal theme, which can trigger an implicit cognitive appraisal tendency toward future events. Thus, emotion influences decision-making through these cognitive appraisal tendencies. Because different emotions produce different appraisal tendencies, their effects on decision-making also differ (Adomdza & Baron, 2013; Lerner & Keltner, 2000, 2001; Lerner, Tiedens, & Gonzalez, 2006; Winterich, Han, & Lerner, 2010).

According to ATF theory, emotions influence intertemporal choice by affecting the content of information processing through cognitive appraisal tendencies. For example, in Lerner et al.' s (2013) study, sad participants preferred immediate monetary rewards. Sadness is characterized primarily by low pleasantness and low control, so sad individuals facing immediate temptations in intertemporal choice easily lose self-control and believe immediate rewards provide instant comfort. Tice, Bratslavsky, and Baumeister (2001) similarly found that people make more impulsive choices when sad. DeSteno et al. (2014) found that gratitude increased patience in intertemporal choice, making participants more likely to select superior long-term options. From an ATF perspective, gratitude' s core appraisal dimension is high responsibility—grateful individuals believe that themselves and others should take positive responsibility for events, showing high involvement and strong responsibility, which leads them to adopt a long-term perspective and forgo immediate temptations for larger future gains (Lempert & Phelps, 2016). She, Zheng, Zhou, and Yang (2016) and She, Chen, Chen, and Yang (2017) induced fear through videos and personal recall, finding that fearful participants showed less patience in intertemporal choice than neutral participants, preferring smaller immediate rewards over larger future ones, indicating greater myopia in monetary acquisition. From ATF' s viewpoint, fear' s core appraisal dimension is uncertainty (Xu, Zhang, Wu, Li, & Luo, 2014; Lerner & Keltner, 2000). To reduce this uncertainty, participants tend to choose immediate options with closer temporal perception (She, Chen, Chen, & Yang, 2017). However, findings regarding fear' s effect on intertemporal choice are inconsistent. Luo, Ainslie, and Monterosso (2012) found that participants

shown fearful faces preferred delayed rewards more than those shown neutral faces, a phenomenon explained by the "inhibitory spillover" effect (Tuk, Trampe, & Warlop, 2011)—wherein inhibitory control is domain-general, and controlling fear emotions helps inhibit impulsive behavior in intertemporal choice.

In summary, current research on how pre-decision emotions influence intertemporal choice lacks depth and richness. Whether examining different valence emotions or different specific emotions within the same valence, most studies remain at the stage of mechanistic speculation. While ATF theory can explain most differential effects of same-valence emotions on intertemporal choice, it struggles to provide true mechanistic validation. Future research should integrate techniques such as functional magnetic resonance imaging (fMRI), event-related potentials (ERP), and eye-tracking to explore the psychological mechanisms, particularly from a decision-making process perspective, to deepen our understanding of this decision behavior.

2.2 Emotion During Decision-Making

Emotions during decision-making are emotional experiences elicited by the decision context. Based on whether they are experienced immediately, these emotions can be divided into immediate emotions and anticipated emotions. Immediate emotions are emotional reactions triggered and experienced during the decision process that affect psychological processing related to decision-making. Anticipated emotions, also called outcome-anticipated emotions, refer to predictions about emotional reactions that might result from future outcomes of a decision—emotions that are not currently experienced (Baumgartner, Pieters, & Bagozzi, 2008; Lowenstein & Lerner, 2003). Both immediate and anticipated emotions significantly influence the intertemporal decision-making process and its outcomes.

2.2.1 Immediate Emotion

Because immediate emotions during decision-making are difficult to capture and measure and are susceptible to interference, researchers typically employ neuroimaging or eye-tracking methods. In intertemporal choice, studies have found that people generally prefer immediate over future rewards (e.g., Estle, Green, Myerson, & Holt, 2007). McClure, Laibson, Loewenstein, and Cohen (2004) discovered that when intertemporal options included an immediate reward, participants showed greater activation in dopamine reward regions related to emotion, including the ventral striatum, anterior cingulate cortex, and medial prefrontal cortex. Albrecht, Volz, Sutter, Laibson, and Von Cramon (2010) replicated this finding and noted that this activation pattern only occurred when individuals made decisions for themselves. Chen and He (2012) used self-reported emotion measures to find that near-future choice contexts activated stronger impulsive

emotions than distant-future contexts, leading to preferences for immediate gratification.

Although the exact number of processing systems involved in intertemporal choice remains unclear, some researchers propose that the interaction between two systems determines individual performance: the cool system and the hot system (Liu, Zhao, & Feng, 2012). Hot/cool system theory suggests that the hot system relates to impulsive behavior, is emotion-driven, manifests as simple conditioned reflexes, and responds quickly. In contrast, the cool system relates to self-control, is cognition-driven, more deliberate, and therefore slower (Metcalfe & Mischel, 1999). The aforementioned findings support the notion that facing immediate rewards produces greater emotional activation, with the hot system dominating decision-making. Moreover, emotion may diminish the role of cognitive executive functions in intertemporal choice. For example, Lin and Epstein (2014) examined how episodic future thinking affects intertemporal choice, finding that positive-valence episodic thinking increased discount rates in individuals with high working memory, high inhibitory control, and low dopamine genetic risk.

However, some research suggests that emotional arousal depends not on reward immediacy but on choice context. Lempert, Glimcher, and Phelps (2015) used eye-tracking to measure pupil dilation—an indicator of emotional activation—during intertemporal choice. They found that participants showed greater pupil dilation for options whose values changed little across a series of intertemporal choices (whether immediate or delayed) and for options with higher value than the average of previously chosen options. Emotional arousal thus influences intertemporal choice alongside other factors. Furthermore, Lempert, Johnson, and Phelps (2016) found that emotional arousal toward delayed options could also predict choice outcomes: pupil dilation increased with the subjective value of delayed options, and greater dilation predicted choosing the delayed option.

Previous research on immediate emotion' s effect on intertemporal choice has primarily focused on gains, with few studies examining emotional reactions to loss-related options. Xu, Liang, Wang, Li, and Jiang (2009) used event-related fMRI with two decision tasks featuring symmetric gain and loss patterns to investigate the neural mechanisms of time discounting. They found that the lateral prefrontal cortex and posterior parietal cortex were activated when discounting both future gains and losses, but activation was stronger when discounting losses. Additionally, during intertemporal choices involving losses, the insula, thalamus, and dorsal striatum were more active—regions typically associated with negative emotion. These findings suggest that individuals are more sensitive to intertemporal decisions involving losses, with stronger negative emotional activation. Research in intertemporal choice has documented that time discounting for future gains is typically greater than for future losses, an effect called the gain-loss asymmetry (Loewenstein, 1987). Xu et al.' s (2009) study provides a neuroimaging basis for explaining this phenomenon.

2.2.2 Anticipated Emotion

In intertemporal choice, researchers have identified phenomena that fundamentally deviate from temporal discounting processes, termed negative discounting. According to the time discounting assumption in intertemporal choice models, a loss of equal magnitude occurring in the future, after discounting, has less utility than a loss occurring now; therefore, people should prefer to incur losses in the future rather than now, resulting in positive discounting. However, research shows that when facing current versus future losses, people often prefer to experience the loss now—a phenomenon called negative discounting. For example, Hardisty and Weber (2009) presented participants with a parking ticket scenario where they could pay a fine now or in one year. If the fine was 250 yuan now but varied in amount for payment in one year, choosing to pay 250 yuan now when the future amount was less than 250 yuan constituted negative discounting. They found that 28.5% of participants showed negative discount rates. Van der Pol and Cairns (2000) found that people preferred illness to occur sooner rather than later. Berns et al. (2006) discovered that participants preferred immediate electric shocks to delayed ones, with some even preferring an intense immediate shock over waiting for a milder delayed shock. Harris (2012) found that for negative events like "losing an irreplaceable photo" or "losing a good friend," participants preferred these events to occur now rather than later.

Loewenstein (1987) proposed that anticipated emotions about the future affect current choices. Specifically, when facing future negative events, people anticipate experiencing negative emotions (such as dread) while waiting—recognizing that the waiting period itself is painful. This anticipated negative emotion makes future negative events seem more aversive than immediate ones, leading to preferences for immediate negative outcomes and producing negative discounting. Building on this, Sun et al. (2015) experimentally demonstrated that negative discounting occurs because the total negative utility of future negative events derives not only from the events themselves but also from anticipated negative emotions and anticipated rumination (the inability to stop thinking about the negative event) during the waiting period. This study represents the first experimental attempt to validate the psychological mechanism underlying negative discounting; future research could use fMRI to directly verify whether individuals generate anticipated negative emotions when facing future negative events.

2.3 Post-Decision Emotion

Decision outcomes undoubtedly affect emotions—good outcomes bring joy, while bad outcomes cause disappointment. However, emotion's influence is not fleeting but rather a diffuse and enduring process. Post-decision emotions subsequently affect individuals' decisions regarding subsequent and even future related events, leading them to reinforce choices that brought joy and avoid those that caused

disappointment. For example, Zeelenberg and Pieters (2007) found in an ultimatum game that participants who experienced regret after the first round reduced their allocations in the second round. Experiencing regret led to reversal behavior in sequential choice tasks. Even when subsequent decision tasks differed from previous ones, experiencing regret altered participants' decision tendencies. In Raeva, Mittone, and Schwarzbach' s (2010) intertemporal choice task, participants completed two different decisions: first, a risk game choosing between two gambles; second, an intertemporal choice. They tested whether feedback type from the risk game affected intertemporal choices. In partial feedback conditions, only the chosen gamble' s outcome was revealed, whereas in complete feedback conditions, both gambles' outcomes were shown. Complete feedback included regret and happiness conditions. Results indicated that if participants experienced regret in the initial risk choice, they subsequently showed greater time discounting rates in the intertemporal decision, preferring short-term outcomes.

Currently, research on how post-decision emotions affect intertemporal choice remains relatively scarce, primarily focusing on regret and disappointment with less attention to positive emotions and lacking systematic theoretical explanation. Thus, the influence and mechanisms of post-decision emotions on intertemporal choice require further in-depth investigation.

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3 Future Directions

Although research on emotion' s influence on intertemporal choice has yielded many valuable findings, shortcomings remain in research depth, ecological validity, and exploration of emotional interventions, necessitating further attempts and exploration in future studies.

3.1 Research Depth

First, current research on emotion's influence on intertemporal choice—especially regarding pre-decision emotions—remains largely at the phenomenon-revealing stage, with few studies directly testing mechanisms from cognitive or decision-making process perspectives. Future research must strengthen mechanistic exploration of how emotion influences intertemporal choice. Second, with advances in technology, functional magnetic resonance imaging (fMRI), event-related potentials (ERP), and eye-tracking can dynamically and directly reflect the interaction between emotional processing and intertemporal decision-making. Currently, most studies on emotion and intertemporal choice are behavioral. Although some have used neuroimaging or eye-tracking to explore decision mechanisms (e.g., Albrecht, Volz, Sutter, Laibson, & Von Cramon, 2010; Lempert, Glimcher, & Phelps, 2015; McClure, Laibson, Loewenstein, & Cohen, 2004), most have not prioritized emotion as their primary focus. Future studies should integrate these techniques to dynamically and multimodally examine the neu-

ral basis of emotion' s influence on intertemporal choice. Additionally, most current research examines how different valence emotions affect intertemporal choice; future studies could investigate how different arousal levels influence these decisions. For example, Sohn et al. (2015) used fMRI to examine how high-arousal positive and negative emotions affect intertemporal choice. Behaviorally, individuals preferred smaller immediate rewards in high-arousal positive and negative states compared to neutral states. Neuroimaging results showed decreased activation in cognitive control-related brain regions when choosing smaller immediate rewards under high-arousal conditions. These findings suggest that high-arousal emotions increase impulsivity and inhibit consideration of larger long-term goals. Finally, emotion' s influence on intertemporal choice has primarily been studied using laboratory emotion induction. With technological development, future research could employ mobile applications for real-time surveys and big data methods to collect daily emotions and explore how everyday emotional experiences affect intertemporal choice behavior.

3.2 Ecological Validity

First, most existing research examines emotion' s influence under single-decision conditions. However, in real life, people' s choices constantly change, and emotion' s effects are not transient but rather persistently diffuse, with briefly induced emotions exerting lasting influences on subsequent decisions. Therefore, investigating dynamic temporal dimensions will deepen understanding of emotion' s influence on intertemporal choice. Second, emotions experienced in daily life are rarely single but typically involve one or several dominant emotions mixed with others; thus, examining how complex emotions affect intertemporal choice represents a future research direction. Moreover, emotion can directly affect intertemporal choice or indirectly influence it by affecting cognitive processing. Research has shown that emotion' s influence on intertemporal choice is mediated or moderated by other factors. For example, Guan et al. (2015) found that emotion likely affects intertemporal choice by influencing time perception. Yang and He (2015) found that self-enhancement needs mediated the relationship between subjective well-being and intertemporal choice. Self-enhancement need is an intrinsic motivation to boost self-worth—a strong drive to obtain positive feedback or evaluation about oneself (Sedikides & Strube, 1995). Individuals with low well-being have stronger self-enhancement needs, which makes them more myopic in intertemporal choice, preferring money or goods that can be obtained quickly. Conversely, individuals with high well-being have weaker self-enhancement needs and prefer larger, later options. Thus, appropriately guiding individuals to reduce self-enhancement needs can help them focus more on the future. Hirsh, Guindon, Morisano, and Peterson (2010) argued that whether emotion affects discount rates in intertemporal choice depends on individual personality traits. They found that extraverted individuals preferred immediate rewards more in positive than negative emotional states, believing that extraverts are more driven by reward stimuli and thus make more impulsive choices in positive moods. Therefore, emotion' s influence on intertemporal

choice cannot be generalized but is subject to multiple factors. Future research identifying more mediators and moderators between emotion and intertemporal choice could effectively control emotion' s influence on decision-making by manipulating these factors, helping people make more satisfactory decisions.

3.3 Intervention Exploration

Research on the relationship between emotion and intertemporal choice serves not only to deepen understanding of intertemporal choice mechanisms but, more importantly, to improve people' s intertemporal decisions and reduce myopic behavior in daily life based on these findings. However, research on intervention methods and techniques in this area has only just begun. Peters and Büchel (2011) demonstrated that episodic prospection can effectively reduce impulsivity in intertemporal choice by modulating valuation and prospection networks. Only the addition of positive contextual prospection imagery can reduce preference for immediate options (Liu, Feng, Chen, & Li, 2013). Gross (2013) found that emotion regulation strategies such as cognitive reappraisal and expressive suppression can reduce negative emotional reactions and elicit positive emotions, thereby promoting rational choice. Bickel et al. (2011) discovered that working memory training to improve memory capacity can reduce delay discounting rates in drug addicts to some extent. Currently, these methods and techniques remain at the research stage, far from actual implementation and clinical application. Therefore, it is necessary to improve and extend existing methods to make them more standardized and operable. Simultaneously, exploring and developing new methods and techniques such as biofeedback training and neurofeedback training will enable research findings on emotion and intertemporal choice to better serve individuals and society.

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Manuscript received: November 6, 2018
This research was supported by the National Natural Science Foundation of China Youth Science Fund Project (71601121)
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