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Motivational Conflict Influences Mixed Intertemporal Decision-Making: An Approach-Avoidance Motivation Theory Perspective

Authors: Sun Hailong, An Xinru, Li Aimei, Lai Huiyan, Li Zehong, Li Aimei

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Abstract

Many decisions faced by organizations and individuals involve neither pure gains nor pure losses, and often require simultaneous trade-offs between losses and gains at different future time points. Such decisions entailing both losses and gains are termed mixed intertemporal decisions. Previous research has typically adopted theoretical frameworks from pure gain or loss intertemporal decision-making, lacking theoretical construction and exploration of the decision-making process specifically tailored to mixed intertemporal decisions. Building upon this, the present study draws from approach-avoidance motivation theory to explore the process mechanisms by which motivational conflict influences mixed intertemporal decision-making. Study 1 aims to investigate the characteristics of motivational conflict in mixed intertemporal decisions and its relationship with decision-making behavior. Study 2 plans to independently manipulate endogenous factors (the relative magnitude difference between gains and losses) and exogenous factors (the degree of resource scarcity) that influence the level of motivational conflict, attempting to uncover the causal chain between the degree of motivational conflict and mixed intertemporal decision-making. Study 3 intends to utilize mouse-tracking technology based on decision process indicators to further explore the process mechanisms through which motivational conflict influences mixed intertemporal decision-making. We anticipate that these findings will elucidate and construct the mechanism of mixed intertemporal decisions from a motivational conflict perspective, while also providing scientific evidence for enterprise management and individual consumer decisions involving mixed intertemporal contexts.

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The Influence of Motivation Conflict on Mixed Intertemporal Decision-Making: An Approach-Avoidance Motivation Perspective

SUN Hai-Long[1], AN Xin-Ru[2], LI Ai-Mei[2], LAI Hui-Yan[1], LI Ze-Hong[1]

[1] School of Business, Guangdong University of Foreign Studies, Guangzhou 510006

[2] Management School, Jinan University, Guangzhou 510632

Abstract

Organizations and individuals frequently face decisions that involve neither pure gains nor pure losses, but rather require weighing trade-offs between gains and losses occurring at different future time points. Such decisions, which combine both beneficial and detrimental outcomes, are termed mixed intertemporal choices. Previous research has typically applied theoretical frameworks developed for pure gain or pure loss intertemporal decisions, resulting in a lack of theoretical construction and process exploration specifically matched to the unique characteristics of mixed intertemporal decision-making.

Addressing this gap, the present study draws upon approach-avoidance motivation theory to investigate the process mechanisms through which motivation conflict influences mixed intertemporal decisions. Study 1 aims to examine the characteristics of motivation conflict in mixed intertemporal decision-making and its relationship with decision behavior. Study 2 plans to manipulate both endogenous factors (the relative difference between gain and loss amounts) and exogenous factors (the degree of resource scarcity) that influence motivation conflict, attempting to reveal the causal chain linking motivation conflict level to mixed intertemporal choice. Study 3 intends to employ mouse-tracking technology to further explore the process mechanisms by which motivation conflict affects mixed intertemporal decisions based on decision process indicators. We anticipate that these findings will contribute to revealing and constructing a theoretical framework for mixed intertemporal decision-making from a motivation conflict perspective, while also providing scientific evidence for organizational management and individual consumption decisions involving mixed intertemporal contexts.

Keywords: mixed intertemporal choice, decision-making process, motivation conflict, approach-avoidance motivation, mouse-tracking technology

In real life, complex decision problems involving both losses and gains represent common challenges that organizations and individuals must regularly confront. At the organizational level, increased investment in research and development may reduce short-term profits while potentially securing greater competitive advantages and profits in the future. At the individual level, spending time and

money on further education entails immediate resource expenditures but may yield greater career advantages and benefits later on. When facing such complex decisions involving both gains and losses, learning how to weigh trade-offs and make high-quality decisions has become essential for decision-makers.

These future-oriented decision problems address one of the core issues in behavioral decision-making—intertemporal choice. Intertemporal choice refers to the trade-offs people make between options occurring at different time points (Frederick et al., 2002). Previous intertemporal decision research has primarily focused on pure gain or pure loss scenarios. However, in real life, organizations and individuals typically need to consider both losses and gains simultaneously before making a choice. For instance, money itself often implies a "gain first, lose later" characteristic, requiring individuals to "put money in their pocket" before making payments (Liu et al., 2009). Such intertemporal decisions involving both losses and gains are termed mixed intertemporal choices.

Currently, research on mixed intertemporal choice is still emerging. Existing studies generally assume that mixed intertemporal decisions share the same decision-making process as pure gain or pure loss intertemporal decisions, positing identical choice preferences (Rao & Li, 2011; Sun & Jiang, 2015). However, recent research has found that compared to pure gain intertemporal tasks, individuals exhibit greater preference for delayed options in mixed intertemporal decisions where immediate gains are accompanied by small losses (Reyes-Huerta et al., 2021). This suggests that mixed intertemporal choice may involve a different decision-making process than pure gain or loss scenarios. More importantly, current theoretical models of intertemporal choice (such as attribute-based or alternative-based theories) have been constructed based on pure gain or loss contexts and fail to capture the essential characteristic of mixed intertemporal decisions that involve both gains and losses simultaneously (Sun et al., 2021). Clearly, existing theoretical models cannot provide effective theoretical guidance for this frontier research area of mixed intertemporal choice.

Examining the context of mixed intertemporal decisions, we argue that the fundamental decision-making process for individuals when both gains and losses coexist focuses precisely on the conflict between "pursuing gains" and "avoiding losses," which aligns with the approach-avoidance motivation theory that explores basic human psychological and behavioral patterns (Stillman et al., 2018). According to approach-avoidance motivation theory, "seeking benefits and avoiding harm" constitutes a fundamental human motivation, and individuals often face conflicts between approach motivation (focusing on positive stimuli) and avoidance motivation (focusing on negative stimuli), with the degree of motivation conflict influencing decision preferences (Elliot, 2013). For example, Etkin and Memmi (2021) revealed that motivation conflict affects individuals' time allocation decisions, finding that when people perceive greater motivation conflict, they increase work time allocation and decrease leisure time allocation. These studies demonstrate the logical connection between motivation conflict and decision outcomes, providing theoretical support for using approach-avoidance moti-

vation theory to reveal preference patterns in mixed intertemporal choice (Stillman et al., 2020; Etkin & Memmi, 2021). We contend that as a basic psychological characteristic of mixed intertemporal decisions, this approach-avoidance motivation conflict plays a crucial role in revealing and predicting individual decision preferences. However, questions remain: How does approach-avoidance motivation conflict influence individual preferences in mixed intertemporal decisions? What is the decision-making process through which motivation conflict affects mixed intertemporal choice? These issues urgently require answers.

Furthermore, the limited research on mixed intertemporal decisions has primarily relied on behavioral outcomes or goodness-of-fitting methods to examine individuals' decision strategies, which cannot clearly elucidate the decision-making process (Brandstatter et al., 2006). Scholars have noted that incorporating emerging process-tracing technologies such as mouse-tracking can help explore individuals' dynamic decision-making processes in motivation conflict (Stillman et al., 2018; Stillman & Ferguson, 2019). Therefore, drawing upon the approach-avoidance motivation theoretical framework, this study plans to comprehensively employ behavioral experiments and mouse-tracking technology to explore the influence of motivation conflict on mixed intertemporal decisions and its underlying process mechanisms. By proposing and attempting to construct a theoretical model of how motivation conflict affects mixed intertemporal choice, this research aims to deepen our understanding of the internal processing mechanisms of mixed intertemporal decisions. Additionally, the expected findings may extend to marketing and other fields, providing scientific evidence for organizational marketing and consumer purchase decisions in commonly encountered mixed intertemporal contexts.

2.1 Exploring Preference Patterns in Mixed Gain-Loss Intertemporal Decisions

Intertemporal decisions include two types: single-timepoint and multiple-timepoint intertemporal decisions. In mixed intertemporal decisions, each option (sooner-smaller option, SS vs. later-larger option, LL) simultaneously involves both losses and gains, thus belonging to the category of multiple-timepoint intertemporal decisions. According to mainstream decision theories in the single-timepoint intertemporal domain, individuals should follow a discounting calculation process, discounting the utility of outcomes at different future time points at the same rate (time discount rate) and showing greater preference for immediate gains (Amasino et al., 2019; Sun et al., 2020; Liang & Liu, 2011). So what choice preferences do people exhibit in mixed intertemporal decisions, which can be viewed as multiple-timepoint intertemporal choices? Researchers have conducted preliminary explorations around this question.

First, previous studies consistently show that compared to single-timepoint intertemporal tasks, individuals demonstrate stronger preference for delayed options in mixed intertemporal decisions. For example, Rao and Li (2011) added a common outcome of "losing ¥2,000,000 in one year" to a single-timepoint in-

tertemporal decision task (SS: receive ¥1,000,000 now; LL: receive ¥5,000,000 in 10 years), creating the simplest mixed gain-loss intertemporal task (SS' : receive ¥1,000,000 now and lose ¥2,000,000 in one year; LL' : lose ¥2,000,000 in one year and receive ¥5,000,000 in 10 years). The results showed that compared to single-timepoint intertemporal decisions, people preferred the delayed option more in mixed gain-loss intertemporal decisions. Further, Sun and Jiang (2015) added loss options at identical positions after the options in a single-timepoint intertemporal task (SS: receive 220 yuan in three weeks; LL: receive 270 yuan in five weeks), creating a mixed intertemporal task (SS' : receive 220 yuan in three weeks and pay 21 yuan in six weeks; LL' : receive 270 yuan in five weeks and pay 27 yuan in six weeks). Again, they found that compared to single-timepoint intertemporal tasks, people preferred the delayed option more in mixed gain-loss intertemporal decisions. Some studies even show that adding the same loss outcome at any position in a gain intertemporal task (SS: receive ¥120 in one week; LL: receive ¥150 in four weeks) reduces individuals' time discount rates and increases preference for delayed options (Jiang et al., 2014). Additionally, research has found that simply manipulating the description of a single-timepoint intertemporal task (e.g., "receive ¥45 today vs. receive ¥65 in 61 days") by reframing it as a mixed intertemporal task (e.g., describing "receive ¥45 today" as "receive ¥45 today because of a ¥20 penalty") also increases preference for delayed options (Faralla et al., 2017).

Second, previous research has found more violations of economic rationality in multiple-timepoint intertemporal decisions, including mixed intertemporal decisions, compared to classic single-timepoint intertemporal decisions. Scholten and Read (2014) found that in a single-timepoint intertemporal decision with gains (SS: receive ¥75 today; LL: receive ¥100 in one year), adding a small loss after the SS option (SS': receive ¥75 today and lose ¥5 in one year) or before the LL option (LL': lose ¥5 today and receive ¥100 in one year) to create a mixed intertemporal context objectively decreased the value of the corresponding option, yet paradoxically increased people' s preference for that option—demonstrating a "worse is better" effect. Similarly, in a single-timepoint intertemporal decision with losses (SS: lose ¥75 today; LL: lose ¥100 in one year), adding a small gain after the SS option (SS' : lose ¥75 today and gain ¥5 in one year) or before the LL option (LL' : gain ¥5 today and lose ¥100 in one year) to create a mixed intertemporal context objectively made the loss option less negative, yet decreased individuals' preference for that option—demonstrating a "better is worse" effect (Scholten & Read, 2014).

In summary, existing research has preliminarily explored choice preferences in mixed intertemporal tasks (Rao & Li, 2011; Jiang et al., 2014; Read & Scholten, 2012). On one hand, the results indicate that unlike single-timepoint intertemporal decisions, mixed intertemporal decisions often exhibit phenomena inconsistent with rational economic models such as time discounting. On the other hand, these studies typically fail to distinguish between mixed intertemporal tasks and pure gain or loss multiple-timepoint intertemporal tasks, often assuming no essential difference between them: pure gain or loss multiple-timepoint

intertemporal decisions are constructed by adding outcomes of the same nature to original single-timepoint tasks, while mixed intertemporal decisions are constructed by adding outcomes of a different nature than the original intertemporal options. However, we argue that mixed intertemporal decisions involving both gains and losses are more complex than pure gain or loss contexts, requiring simultaneous consideration of different motivational conflicts including loss vs. gain and time vs. outcome (Sun, 2018). Moreover, existing research has primarily employed outcome-based or model-fitting methods, where behavioral consistency at the outcome level cannot directly explain the actual decision-making process behind choices (Weber & Johnson, 2009; Johnson et al., 2008), nor can it provide more fundamental answers to the process mechanisms through which motivation conflict influences mixed intertemporal decisions.

2.2 Theoretical Mechanisms of Mixed Gain-Loss Intertemporal Decisions

Current theoretical explanations for mixed intertemporal decisions are primarily based on theoretical models developed for pure gain or loss multiple-timepoint intertemporal contexts, including the trade-off model and the sequence model (Sun et al., 2021). The former assumes individuals make decisions based on inter-dimensional utility comparisons (e.g., time dimension vs. money dimension) (Read & Scholten, 2012), while the latter assumes people make decisions based on the overall utility of options (Loewenstein & Prelec, 1993).

2.2.1 Trade-off Model

The trade-off model can be viewed as an attribute-based decision model (Scholten & Read, 2010). Attribute-based means decisions are made primarily through dimensional comparisons. For example, individuals compare the difference on the "outcome" dimension with the difference on the "time" dimension and ultimately choose the dominant option (Scholten et al., 2016). Specifically, the trade-off model assumes that in intertemporal decisions, individuals assign psychological values to the outcome dimension of different options and calculate the degree of psychological value difference in the "outcome dimension" across options. Simultaneously, individuals compare the psychological value differences in the "time dimension" between the two options. Finally, they make a decision by trading off the difference between the "outcome" dimension and the "time" dimension. If individuals perceive the psychological value difference in the time dimension as larger than that in the outcome dimension, they tend to decide based on the time dimension and show greater preference for immediately available options. If the difference in outcomes is perceived as larger than that in the time dimension, individuals tend to prefer the larger, delayed option.

Mixed intertemporal decisions simultaneously involve both gain and loss outcomes at different time points, essentially constituting multiple-timepoint in-

tertemporal decisions (Sun et al., 2021). According to the trade-off model, in multiple-timepoint intertemporal decision contexts, decision-makers first need to transform two dated outcomes into a single dated outcome, then compare the differences between time and outcome dimensions before making a decision (Scholten et al., 2016). Therefore, according to the trade-off model, there is no substantive difference between mixed intertemporal decisions and pure gain or loss multiple-timepoint intertemporal decisions, as both involve transforming multiple-timepoint outcomes into single-timepoint outcomes before dimensional comparison.

2.2.2 Sequence Model

Unlike the trade-off model, the sequence model can be viewed as an alternative-based theoretical model (Loewenstein & Prelec, 1993). Alternative-based means each option is independently assigned a subjective value, and the option with the maximum subjective value is selected (Sun & Jiang, 2016). Specifically, the sequence model posits that when judging the value of a sequence, people consider not only the cumulative value of individual outcomes at each time point but also the value of overall sequence characteristics (Loewenstein & Prelec, 1993). These overall characteristics include improvement score and spreading score. The improvement effect depends on the trend of sequence outcomes (increasing or decreasing), with improving sequences that gradually become better increasing overall sequence value. The spreading effect depends on the degree to which sequence outcomes deviate from uniform distribution across continuous time, with deviations from uniform distribution weakening overall sequence value. According to the sequence model, mixed intertemporal decisions can be viewed as sequences with different trends—for example, mixed intertemporal decisions with loss first and gain later can be seen as increasing sequences, while those with gain first and loss later can be seen as decreasing sequences.

Although these theories offer some explanatory power for mixed intertemporal decisions, they have significant limitations. First, the trade-off model was primarily constructed for multiple-timepoint intertemporal decisions in pure gain contexts. Existing research has shown that no unified utility function exists across domains (Abdellaoui et al., 2013). Therefore, although mixed intertemporal decisions can theoretically be viewed as multiple-timepoint intertemporal decisions, direct evidence is lacking to test whether the trade-off model applies to mixed contexts involving both losses and gains (Scholten et al., 2016; Sun et al., 2021). Similarly, the sequence model' s explanation of mixed intertemporal decisions also has shortcomings (Jiang et al., 2017). For example, according to sequence model predictions, adding a small loss before the delayed option creates a mixed intertemporal decision that can be viewed as an increasing sequence (loss first, gain later), which should therefore be more preferred (Scholten & Read, 2014). However, Jiang et al. (2017) found that when a mixed intertemporal decision task constructed by adding a gain after a loss option could also be viewed as an increasing sequence, people actually showed lower preference

for the increasing sequence, contradicting sequence model predictions.

2.3 Exploring Mixed Intertemporal Decision Preferences from a Motivation Conflict Perspective

In recent years, researchers have proposed exploring intertemporal decision preferences from the perspective of individual motivation, a fundamental psychological characteristic (Bartels & Urminsky, 2011; Bartels & Urminsky, 2015; Stillman et al., 2020). For example, Frederick and Loewenstein (2008) demonstrated that in multiple-timepoint intertemporal decisions, final decisions often result from competition among different motives. The weights of different motives are often influenced by contextual factors, including anticipation, dread, extrapolation, and contrast effects. Furthermore, Urminsky and Kivetz (2011) showed through multiple experiments that adding a small amount of immediately available money before two options, while small in value, symbolically satisfies individuals' impulsive need for immediate money, thereby reducing the degree of motivation conflict between immediate and delayed goals and enabling individuals to wait more patiently for delayed outcomes. Moreover, research has shown that the influence of conflict level during decision-making has spillover effects, impacting subsequent judgments and decisions unrelated to the conflict situation (Kleiman & Hassin, 2011, 2013; Etkin & Memmi, 2021). For example, Etkin and Memmi (2021) found that conflict level affects individuals' subsequent time allocation in work, with greater perceived conflict increasing time spent on work and decreasing time spent on leisure.

Specifically, in mixed intertemporal decision contexts, individuals face decision tasks involving both gain and loss outcomes simultaneously, requiring trade-offs between "approaching benefits" and "avoiding harm." During decision-making, when individuals pursue a highly tempting option ("approaching benefits"), they may need to incur corresponding losses, while avoiding any loss ("avoiding harm") means forfeiting potential rewards. This "seeking benefits while avoiding harm" motivation conflict is precisely what approach-avoidance motivation theory addresses as a fundamental human psychological and behavioral pattern (Stillman et al., 2018). According to approach-avoidance theory, approach and avoidance motivations as basic motivational conflicts reflect how individuals interact with their environment and constitute core functions for humans to seek benefits, avoid harm, and adapt to their surroundings (Elliot, 2013). We believe that approach-avoidance motivation theory can provide a solid theoretical framework for revealing the process mechanisms through which motivation conflict influences mixed intertemporal decisions.

In summary, although research has preliminarily explored the preference patterns and theoretical mechanisms of mixed intertemporal decisions, several limitations remain: (1) Studies still typically apply theoretical frameworks from pure gain or loss intertemporal contexts, ignoring the fundamental characteristic of mixed intertemporal decisions where individuals simultaneously hold both "pursuing gains" and "avoiding losses" motives. (2) There is a lack of

theoretical construction examining how motivation conflict influences mixed intertemporal decisions from an approach-avoidance motivation perspective. (3) Previous research has predominantly used behavior-outcome paradigms, lacking clear elucidation of the dynamic decision-making process through which motivation conflict affects mixed intertemporal choice, making it difficult to deeply characterize the decision process.

3 Research Proposal

The domain of mixed gain-loss intertemporal decisions represents an area of significant theoretical and practical value that urgently requires strengthened research. Focusing on the key question of "how motivation conflict influences mixed intertemporal decisions," this study plans to address several specific research questions: (1) What are the characteristics of motivation conflict in mixed intertemporal decisions? (2) How does motivation conflict in mixed intertemporal decisions affect individual decision preferences? (3) What are the process mechanisms through which motivation conflict influences individual decision preferences in mixed intertemporal decisions?

To this end, we plan to systematically explore the decision-making process mechanisms through which motivation conflict influences choice preferences in mixed intertemporal decisions, based on the approach-avoidance motivation theoretical framework and using a combination of behavioral experiments and mouse-tracking technology. We expect to conduct three studies comprising six experiments. Specifically: (1) Study 1 plans to explore the characteristics of motivation conflict in mixed intertemporal decisions and its relationship with decision preferences. First, we will employ a between-subjects experimental design using the intertemporal decision staircase preference paradigm to preliminarily reveal the relationship between decision conflict and choice preferences in mixed intertemporal decisions. Simultaneously, we will use a within-subjects repeated measures design to expand our findings, requiring individuals to self-report motivation conflict to further examine the relationship between motivation conflict and mixed intertemporal decisions. Study 1 will establish a paradigmatic foundation for subsequent studies. (2) Study 2 plans to manipulate both exogenous and endogenous factors affecting motivation conflict level to directly test the influence mechanism of motivation conflict on decision preferences in mixed intertemporal decisions. (3) Study 3 plans to use decision process indicators and mouse-tracking technology to further explore the decision-making process through which motivation conflict influences preferences in mixed intertemporal decisions. The study will use decision reaction time combined with mouse-tracking indicators such as mouse trajectories to reflect motivation conflict levels in mixed intertemporal decisions, revealing the dynamic process mechanisms through which motivation conflict influences mixed intertemporal choice.

3.1 Study 1: Exploring the Relationship Between Motivation Conflict and Choice Preferences in Mixed Intertemporal Decisions

Motivation is a psychological tendency or internal drive that initiates and maintains organismic action and directs it toward a goal (Elliot, 2013). Approach and avoidance represent the two most basic forms of motivation (Nie et al., 2022). Approach motivation refers to the activation of behavior by positive stimuli or directing behavior toward positive stimuli, which include positive emotions, monetary gains, etc. Avoidance motivation refers to the activation of behavior by negative stimuli or directing behavior away from negative stimuli, which include monetary losses, threats, etc. (Elliot, 2013). Mixed intertemporal decision tasks simultaneously involve both gain and loss outcomes, exposing individuals to both positive and negative stimuli and potentially triggering conflict between approach motivation for gains and avoidance motivation for losses.

According to approach-avoidance motivation theory, approach and avoidance motivation conflicts of different intensities influence individual behavior. Approach motivation enhances individuals' pursuit of and sensitivity to rewards, leading them to seek out rewards in the environment and exhibit more approach behaviors (Carver & White, 1994; Higgins et al., 1997). Avoidance motivation increases individuals' avoidance of and sensitivity to losses or potential punishments, leading them to be more vigilant about threats in the environment and exhibit more avoidance behaviors (Carver & White, 1994). The intensity of this approach-avoidance motivation conflict predicts the likelihood of corresponding behaviors, with final decisions depending on whether sufficient difference exists between the two motivational strengths to support or oppose a particular action (Guerrero et al., 2021). We infer that the stronger the conflict between approaching gains and avoiding losses, the longer individuals will hesitate before making a final decision. Compared to pure gain or loss multiple-timepoint intertemporal tasks, mixed gain-loss intertemporal decisions involve stronger approach-avoidance motivation conflict, and reaction time serves as a behavioral indicator of motivation conflict.

Specifically, Study 1 comprises two sub-studies. Study 1a employs a between-subjects design using an adaptive intertemporal decision time discounting paradigm (Reyes-Huerta et al., 2021) to compare pure gain or loss multiple-timepoint intertemporal decisions and preliminarily examine the characteristics of motivation conflict in mixed intertemporal decisions. Building on this, Study 1b further employs a within-subjects design, simultaneously requiring participants to self-report decision conflict levels across different choices to directly measure decision conflict and construct regression equations linking motivation conflict level with mixed intertemporal decisions, thereby further examining the relationship between motivation conflict and mixed intertemporal choice.

3.2 Study 2: The Influence Mechanism of Motivation Conflict on Choice Preferences in Mixed Intertemporal Decisions

While Study 1 essentially explores the characteristics of motivation conflict and its relationship with individual decision preferences under natural decision-making conditions without experimental manipulation, Study 2 plans to use behavioral experiments to manipulate motivation conflict levels to further reveal how motivation conflict degree influences individual choice preferences in mixed intertemporal decisions. Based on the source of influencing factors, we distinguish between endogenous factors (the relative difference in value between gain and loss outcomes within decision options) and exogenous factors (external resource scarcity) (Shah et al., 2012).

Regarding endogenous factors, existing research indicates that relative value difference is closely related to the involvement of cognitive functions (McClure et al., 2004; García Guerrero et al., 2021). Studies on single-timepoint intertemporal choice have shown that compared to tasks with large relative value differences, people find decisions more difficult when relative value differences are small, requiring higher-level cognitive processing and deeper elaboration (McClure et al., 2004). Similarly, research in multiple-timepoint intertemporal decisions has found that the relative difference between stimuli rather than their absolute values affects decision motivation (Urminsky & Kivetz, 2011). Therefore, we speculate that in mixed intertemporal decisions involving both losses and gains, when the relative value difference between gains and losses is large, task difficulty is lower and motivation conflict is weaker. As the relative value difference between losses and gains decreases, individuals' difficulty in distinguishing between the two stimuli increases, intensifying motivation conflict. Further, how does increased approach-avoidance motivation conflict influence individual decision behavior? According to approach-avoidance motivation theory, when the relative values of positive and negative stimuli become similar, individuals' intensity of avoiding objects or options increases more rapidly than their intensity of approaching positive stimuli (García Guerrero et al., 2021). In other words, when stimulus relative values are similar, avoidance motivation is stronger than approach motivation. Enhanced avoidance motivation leads individuals to avoid negative stimuli such as losses or predators to protect against disease and death threats (Elliot, 1999). Therefore, we infer that under conditions where gain-loss relative differences are small (vs. large), approach-avoidance motivation conflict increases, with avoidance motivation becoming stronger than approach motivation, thus leading individuals to prefer immediately available gains (i.e., the smaller-sooner option) to avoid greater loss risks.

Regarding exogenous factors, existing research shows that resource scarcity affects individuals' attentional resources and weakens cognitive control (Shah et al., 2012, 2015; Mani et al., 2013). Since attention is limited, individuals can only focus on a limited number of things at one time (Lü et al., 2014; Li et al., 2016). In mixed intertemporal decisions, the coexistence of positive and neg-

ative stimuli creates motivation conflict between pursuing gains and incurring losses (Sun et al., 2021). As monetary resource constraints increase, limited attention leads to "attentional focus" on certain attributes while simultaneously causing "attentional neglect" of other attributes (Tan et al., 2016). This selective attentional focus and neglect reduces approach-avoidance motivation conflict. How does reduced approach-avoidance motivation conflict influence decision behavior? According to approach-avoidance motivation theory, in mixed intertemporal decisions, because certain attributes (or issues) capture individuals' attention, conditions of high (vs. low) resource scarcity unconsciously capture attentional resources, causing individuals to over-focus on scarce resources (e.g., money) and thereby increasing sensitivity to specific resource cues and triggering stronger approach motivation. Enhanced approach motivation prompts individuals to approach positive stimuli such as food or rewards. Therefore, we infer that in mixed intertemporal decisions, under conditions of high external resource scarcity (vs. low), approach-avoidance motivation conflict is weakened, approach motivation is enhanced, and individuals consequently show greater preference for options with larger gains (i.e., the larger-later option).

In summary, building on Study 1, Study 2 includes two experiments examining how motivation conflict influences individual choice preferences in mixed intertemporal decisions. First, by manipulating resource scarcity to reduce approach-avoidance motivation conflict intensity, we examine how this influences approach motivation and promotes approach behavior (Study 2a). Second, by manipulating the relative difference between loss and gain outcomes within options to increase approach-avoidance motivation conflict, we examine how this influences avoidance motivation intensity and promotes avoidance behavior (Study 2b).

3.3 Study 3: The Process Mechanism Through Which Decision Conflict Influences Choice Preferences in Mixed Intertemporal Decisions

Studies 1 and 2 primarily rely on decision outcomes; however, the decision-making process through which people resolve motivation conflict and make final choices in mixed intertemporal decisions remains unclear. Mouse-tracking technology, as an emerging process-tracing technique, provides a data-rich real-time window that helps explore the dynamic decision-making process mechanisms underlying individual motivation conflict (Stillman et al., 2018). Mouse-tracking measures computer mouse movements as participants make choices between options, providing a real-time data window into people' s decision strategies and internal cognitive mechanisms (Szaszi et al., 2018). The theoretical foundation of this technology assumes that dynamic movement is part of dynamic perception and cognition, with mouse movement trajectories capable of reflecting perceptual and cognitive processing in the brain in real time (Spivey et al., 2008). Compared to other techniques for exploring decision process mechanisms, mouse-tracking can directly provide millisecond-level dynamic decision process

tracking that is easy to understand (Stillman et al., 2020).

Recent research in intertemporal decision-making has used mouse-tracking technology to preliminarily explore people' s decision strategies (O' Hora et al., 2016; Reeck et al., 2017; Schoemann et al., 2019). For example, O' Hora et al. (2016) used mouse-tracking to explore the decision-making process of subjective value evaluation in intertemporal decisions, showing that as subjective value differences between options increase, individuals more easily choose immediate gain options (shorter reaction times, smaller maximum deviation values). Reeck et al. (2017) classified individuals into two types based on mouse transition patterns between alternative options: integrative strategists and comparative strategists. Integrative strategists' mouse trajectories involve more transitions between different dimensions within options before comparing overall option values (i.e., alternative-based decision-making), while comparative strategists' mouse trajectories involve more transitions between different options on the same dimension (i.e., attribute-based decision-making). This research also found that different mouse transition patterns are closely related to choice preferences: comparative strategists prefer delayed options more than integrative strategists. Additionally, research has clarified how different experimental settings in intertemporal decision mouse-tracking studies (e.g., priming procedures, stimulus presentation positions, response processes) affect predictions (Schoemann et al., 2019). These studies provide a technical foundation for using mouse-tracking to explore how motivation conflict influences choice preferences in mixed intertemporal decisions, particularly regarding the selection of mouse-tracking indicators for different relative value differences and different populations.

Based on relevant mouse-tracking research in intertemporal decisions, we plan to use spatial attraction indices to represent motivation conflict levels. Spatial attraction refers to the degree of deviation in mouse movement trajectories between alternative options under certain experimental conditions, primarily using two indicators: maximum deviation (MD) and area under the curve (AUC). Maximum deviation refers to the maximum vertical deviation between the actual trajectory and the ideal trajectory (the straight line connecting the trajectory' s start and end points). Area under the curve is the geometric area between the actual trajectory curve and the ideal trajectory curve. Larger values indicate greater deviation toward the unchosen option (Zgonnikov et al., 2017). For mixed intertemporal decisions, based on theoretical derivations from Study 2, as motivation conflict increases (e.g., as the relative difference between gains and losses decreases), the actual mouse-tracking trajectory should significantly deviate from the ideal trajectory.

In summary, focusing on the core question of "how motivation conflict influences mixed intertemporal decisions and their process mechanisms," this study plans to comprehensively use behavioral experiments and mouse-tracking methods, combining outcome-based and process-based approaches, to systematically reveal the influence of motivation conflict on mixed gain-loss intertemporal decisions and its decision-making process through three logically progressive studies.

Study 1 reveals the characteristics of motivation conflict and its relationship with mixed intertemporal decisions under natural decision-making conditions. Study 2 verifies the causal chain linking motivation conflict to mixed intertemporal decisions through experimental manipulation. Study 3 uses mouse-tracking to reveal the process mechanisms through which motivation conflict influences mixed intertemporal decision preferences.

4 Theoretical Construction

Existing intertemporal decision theories, whether attribute-based trade-off models or alternative-based sequence models, cannot effectively reflect the fundamental characteristic of mixed intertemporal decisions involving trade-offs between "pursuing gains" and "avoiding losses," nor can they adequately reveal the process mechanisms through which motivation conflict influences mixed gain-loss intertemporal decisions. Therefore, based on the fundamental psychological characteristic of individual decision-making processes– "approach-avoidance motivation" –we attempt to construct a theoretical framework for how motivation conflict influences mixed intertemporal decisions. The theoretical model is shown in Figure 1 [Figure 1: see original paper].

First, we believe that approach and avoidance, as the two most basic forms of motivation, can be directly triggered by environmental stimuli (e.g., automatic eye-closing in danger) (Zhang et al., 2012) or by stimuli containing positive/negative valence. Positive valence stimuli trigger individuals'approach motivation, while negative valence stimuli trigger avoidance motivation (Krieglmeyer et al., 2013). Mixed intertemporal decisions involve positive and negative valence stimuli at different time points (i.e., gains and losses), thus simultaneously triggering approach and avoidance motivations and creating motivation conflict between "approaching gains" and "avoiding losses" during decision-making. Furthermore, this potential conflict between "seeking benefits" and "avoiding harm" in mixed intertemporal decisions influences individual decision preferences. Approach motivation leads individuals to exhibit action orientations of "bringing closer" positive valence stimuli, while avoidance motivation leads to avoidance behaviors (García Guerrero et al., 2021). For mixed intertemporal decisions with coexisting approach and avoidance motivations, we argue that if positive stimuli (i.e., gains) trigger stronger approach motivation than negative stimuli (i.e., losses), individuals will be more sensitive to gains and pursue larger-gain options such as delayed options. Conversely, if avoidance motivation is stronger, individuals will be more sensitive to losses and prefer options offering immediate gains or minimal loss risk to avoid potential losses from waiting for future outcomes. Additionally, if loss and gain values are equivalent, approach-avoidance motivation conflict intensifies, increasing decision time and making preferences more difficult to determine (Stillman et al., 2018).

Second, the degree of motivation conflict in mixed intertemporal decisions is influenced by motivational factors, including exogenous and endogenous factors. Exogenous factors primarily refer to motivational factors outside decision

options, such as the scarcity of resources decision-makers possess (attentional resources, monetary resources, time resources). Endogenous factors depend on characteristics of the mixed intertemporal decision task itself, such as the relative difference between gain and loss outcomes. On one hand, as external resource constraints increase, limited attention leads to "attentional focus" on certain attributes while simultaneously causing "attentional neglect" of other attributes, thereby reducing approach-avoidance motivation conflict. Reduced approach-avoidance motivation conflict leads people to focus on the most urgent matters, increasing sensitivity to specific resource cues. For example, hungry people can identify food-related cues faster (Radel & Clément-Guillotin, 2012), and thirsty people can identify water-related cues faster (Zhao & Tomm, 2018). Similarly, in mixed intertemporal decisions, external resource scarcity (i.e., monetary resource scarcity) weakens approach-avoidance motivation conflict, strengthens approach motivation, and leads individuals to prefer options with larger gains (i.e., larger-later options). On the other hand, the relative difference between gains and losses in mixed intertemporal decisions also affects motivation conflict. In mixed intertemporal decisions with both positive and negative valence stimuli, due to the asymmetry between gains and losses, negative stimuli elicit greater physiological and psychological responses than positive stimuli (Taylor, 1991). Avoidance motivation triggered by negative stimuli of equal intensity may be stronger than approach motivation triggered by positive goal frames. Therefore, as the relative value difference between losses and gains decreases, motivation conflict increases, but avoidance motivation becomes stronger than approach motivation, triggering more avoidance behaviors.

Additionally, although traditional behavioral experimental manipulations provide mature research paradigms for revealing individual motivation conflict intensity in intertemporal decisions, reaction time is a comprehensive behavior that may be influenced by multiple factors such as individual decision preferences (intuitive vs. rational) (Stillman et al., 2018). Previous research measuring motivation conflict solely through temporal responses has certain limitations. In contrast, mouse-tracking technology can provide more understandable, intuitive, and precise decision process tracking (Melnikoff et al., 2021). During decision-making, when individuals move the mouse and sampling occurs at sufficiently high speeds, the mouse movement trajectory composed of these points can reflect perceptual and cognitive processing in the brain in real time (Cheng & González-Vallejo, 2017). Therefore, we use mouse-tracking technology to clarify individuals' decision processes when facing motivation conflict in mixed intertemporal decisions and extract process indicators of how motivation conflict influences mixed intertemporal decisions. Generally, mouse-tracking technology uses indicators such as maximum deviation (MD) and area under the curve (AUC) across all trial trajectories to explore decision characteristics during individual decision-making (Zgonnikov et al., 2017). We hypothesize that in mixed intertemporal decisions, motivation conflict intensity is closely related to trajectory maximum deviation and area under the curve, with increased approach-avoidance motivation conflict causing significant deviation from the ideal trajectory between

alternative options and larger area under the curve. Furthermore, existing research shows that transition frequency between options is an effective indicator of decision strategies, with decision-makers whose mouse trajectories involve more transitions between different dimensions tending to prefer delayed gains. Therefore, we believe that mouse trajectory transitions in mixed intertemporal decisions can also help predict potential decision preferences.

In conclusion, mixed gain-loss intertemporal decisions represent not only a common and important decision type in daily life but also a frontier research area in intertemporal decision-making (Thorstad & Wolff, 2018). Building upon solid previous research, this study reveals the dynamic decision-making process mechanisms through which decision motivation conflict influences mixed intertemporal decisions from a motivation conflict perspective, contributing to both research and theory construction in this area. On one hand, by exploring the influence of decision motivation conflict on mixed intertemporal decisions, this research will advance theoretical explanations of the decision process mechanisms underlying mixed intertemporal choice. On the other hand, we attempt to reveal the motivations behind preference patterns in mixed intertemporal decisions based on the theoretical perspective of approach-avoidance motivation conflict, effectively responding to previous calls for enhanced research on mixed intertemporal decisions (Scholten et al., 2016). Moreover, this study not only attempts to reveal the relationship between motivation conflict and choice preferences in mixed intertemporal decisions but further distinguishes factors influencing motivation conflict into exogenous and endogenous factors—the former such as resource scarcity, the latter being the relative value difference between gain and loss outcomes. Through systematic manipulation of exogenous and endogenous factors to strengthen approach or avoidance motivation and thereby alter motivation conflict levels, we attempt to deeply characterize the causal chain linking motivation conflict to choice preferences in mixed intertemporal decisions.

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