The Effects of Fear and Happiness on Intertemporal Decision Making:
The Proposed Approach/Avoidance (Inhibition) Motivation Model

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This thesis titled
The Effects of Fear and Happiness on Intertemporal Decision Making:
The Proposed Approach/Avoidance (Inhibition) Motivation Model

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Abstract

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The Effects of Fear and Happiness on Intertemporal Decision Making: The Proposed Approach/Avoidance (Inhibition) Motivation Model

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The approach/avoidance (inhibition) motivation is evidenced in both humans and lower organisms. The current study proposed the approach/avoidance (inhibition) motivation model to predict and explain the effects of fear and happiness on intertemporal decision making. Participants ($N = 237$) were randomly assigned to 3 conditions: the fearful condition, the happy condition, and the neutral condition. Movie clips were used to induce fear and happiness. Happiness activates the approach motivation and fear activates the avoidance motivation. Results showed that participants in the happy condition approached rewards as soon as possible and approach losses as late as possible, and that participants in the fearful condition avoided potential threats (smaller rewards and larger losses) as possible as they could. However, participants in the fearful condition had no difference from those in the neutral condition. Possible reasons were discussed. Methodological and other limitations were also discussed.
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Chapter 1: Introduction

Intertemporal choices are decisions taking into account time (Berns, Laibson, & Loewenstein, 2007). Distinct from other species, humans have the capacity to pursue temporally distant goals based on intertemporal tradeoffs (Luo, Ainslie, & Monterosso, 2014). The delay discounting/intertemporal decision-making paradigm is a behavioral choice task that has been well used to explore this capacity in laboratories (Augustine, & Larsen, 2011; Coffey, Gudleski, Saladin, & Brady, 2003; Hirsh, Morisano, & Peterson, 2008; Hirsh, Guindon, Morisano, & Peterson, 2010; Kirby, Petry, & Bickel, 1999; Kirby, Winston, & Santiesteban, 2005; Luo et al., 2014; Rounds, Beck, & Grant, 2007). The dilemma for making intertemporal decisions is the tradeoff of magnitude and immediacy of expected gains (e.g., would you prefer $54 today or $75 in 117 days?) or expected losses (e.g., would you prefer losing $34 today or $45 in 7 days?). Hypothetical gains are more often used in this paradigm than hypothetical losses, especially in the studies of the effects of emotions on intertemporal decision making.

Delay discounting describes the psychological tendency to decrease the subjective value of a given monetary reward as the delay before receiving the amount increases (Hirsh et al., 2010). Generally speaking, individuals prefer obtaining rewards sooner over later. That is, future rewards are discounted due to the time delay (Wittmann & Paulus, 2007). Similarly, individuals prefer losses to come later rather than sooner because future losses are discounted due to time delay. The rate \( k \), based on how the subjective value of a reward/loss changes depending on its arrival time, is known as the rate of delay discounting. There are several factors that may influence the magnitude of \( k \): for
example, uncertainty/risk, the duration between the choice-making and the reception of the reward/loss, inflation of currency, expectations of changing utility, and so on (Frederick, Loewenstein, & O’Donoghue, 2003; Wittmann & Paulus, 2007). However, higher discounting rates have been associated with negative outcomes in academic performance, self-regulation, and other life domains, and have also been associated with a variety of impulsive and addictive behaviors such as smoking, drug use, pathological gambling, and so on (Bickel & Marsch, 2001; Hirsh et al., 2010; Kirby et al., 1999).

Based on previous empirical studies, the discounting rates for monetary rewards and losses are asymmetric which implies that loss discount rates are not the same as gains rates (Loewenstein & Prelec, 1992; Shelley, 1994). However, the directions of gain/loss discounting asymmetry could be inconsistent. For example, the study of Loewenstein and Prelec (1992) showed that individuals discounted rewards higher than they discounted the same amounts of losses, while Shelley (1994) found that individuals discounted loss higher than they discounted gains. The inconsistent results of the two studies might be from how the experimental questions were framed differently. Framing refers to the phenomenon that the reference point can be affected by the way in which a choice is expressed (Loewenstein, 1988). Three question frames can be used to investigate intertemporal choices and the gain/loss discounting asymmetry: namely, neutral (i.e., asking participants to specify how much they would like to pay for obtaining an object immediately and then how much for obtaining an object following a time delay), delay (i.e., asking participants how much they would like to pay for obtaining an object immediately, instructing them to imagine that they have made the purchase, and then
asking for the smallest amount they would accept for delayed consumption), and expedite frames (i.e., asking participants how much they would like to pay for obtaining an object following a time delay, instructing them to imagine that they have paid that amount, and then asking for the most they would like to pay for expedited consumption to eliminate the delay). Delayed rewards were higher than expedited rewards and both had a higher discounting rate than the neutral-framed rewards (Shelley, 1993; 1994). The neutral frame only induces gain/loss discounting asymmetry associated with the sign effect (Shelley, 1994).

Most previous research on delay discounting/intertemporal decision making focused on stable individual differences rather than situational factors. For example, delay discounting procedures have been well used as a behavioral method of assessing trait impulsivity in various substance-abusing populations (e.g., cocaine-dependent individuals, opioid-dependent individuals, and cigarette smokers) though results on the correlation between self-reported and behavioral impulsivity measures were not consistent (Bickel, Odum, & Madden, 1999; Coffey et al., 2003; Madden, Petry, Badger, & Bickel, 1997). Studies indicated that substance-abusing individuals not only discounted delayed monetary rewards significantly greater than healthy individuals but also discounted delayed abused-substance rewards significantly more than they discounted delayed monetary rewards. Wittmann and Paulus (2007) proposed that impulsive individuals have greater delay discounting rate because they perceive the duration of time differently. They overestimate the time period, as compared to self-controlled individuals. Neural studies demonstrated that “fronto-striatal circuits, which are
modulated by the dopamine system, are crucial for temporal processing in the seconds range” (Wittmann & Paulus, 2007, p. 196). These areas are similar to those that are activated when individuals choose immediate and smaller rewards in delay-discounting tasks.

Studies investigating the relationship between delay discounting and cognitive ability/intelligence showed inconsistent results. Monterosso, Ehrman, Napier, O’Brien and Childress (2001) found no association between delay discounting and IQ in a cocaine-dependent population. However, de Wit, Flory, Acheson, McCloskey and Manuck (2007) showed a negative moderate correlation between preference for immediate and smaller rewards and IQ in middle-aged adults. That is, for the middle-aged adults, those with higher IQ scores had a greater preference on delayed and larger rewards. Furthermore, Shamosh and Gray (2008) demonstrated that individuals with higher IQs had a statistically significant tendency to prefer delayed and larger rewards over immediate and smaller ones. In addition, socioeconomic status, age and education level accounted for heterogeneity in effect-size magnitude. The possible reason could be that delay discounting may require intellectual abilities to assist in the interplay between more cognitive and more affective types of executive control. Hindon, Jameson, and Whitney (2003) reduced the availability of cognitive resources by increasing participants’ working memory load while making intertemporal judgments. Their results showed that higher working memory load led to greater discounting of delayed monetary rewards. That is, participants with higher memory load had a greater preference on smaller and immediate rewards than those with lower memory load. Hirsh et al. (2008) found that
personality and cognitive ability interacted in shaping intertemporal choice making. Brief cognitive measure (BCM: Morisano, 2008) was used to assess cognitive ability. BCM is a brief scholastic aptitude test including 28 SAT-like items measuring verbal (critical reading; 18 items) and quantitative (a mix of trigonometry, geometry, and algebra questions; 10 items) ability. In this study the researchers used an unweighted total score of correct answers for statistical analysis. In detail, extraverts had higher discounting rate when they were of low cognitive ability; and emotionally stable individuals had lower discounting rate when they were of high cognitive ability.

Rounds et al. (2007) employed the delay discounting paradigm to study individuals with social anxiety. They found that individuals with high scores on social anxiety discounted future rewards significantly greater than those with low scores under no-threat condition. However, under threat condition, they did not find that individuals with high social anxiety scores showed significant difference in discounting future rewards from those with low social anxiety scores. Also, they did not find between-group preference difference.

**Incidental Emotions and Intertemporal Decision Making**

Recently, there has been increased interest in examining incidental emotions that influence intertemporal choice-making processes (Augustine & Larsen, 2011; Hirsh et al., 2010; Luo et al., 2014). Incidental emotions refer to the emotions that are experienced at the moment of choice but arise from sources unrelated to the choice task (Rick & Loewenstein, 2007). Any influence of incidental emotions on intertemporal decision making suggested that decisions were influenced by factors unrelated to the utility of
their consequences. Therefore, perhaps incidental factors (e.g., visceral factors) including but not limited to incidental emotions is the reason why the exponential discounting model (Samuelson, 1937) did not work well. This model assumes that the discounting rate is constant no matter how long the delayed time period is. Based on this model, individual prefers one of two rewards expected after unequal time delays, the mere passage of time does not change the preference (Lee, 2013). Furthermore, studies on the influence of incidental emotions or other visceral factors on intertemporal decision making may give a rational explanation on why we human being are not always rational decision makers though we thought we were and we wish we were.

The extant models.

Several theories and models suggest that incidental emotions impact intertemporal decision making. The affect-as-information model (Gohn & Clore, 2002) emphasizes that emotion is an integral part of judgment and people routinely use their feelings to make judgments and decisions. In detail, emotions convey the information of value, positive or negative aspect of things. Thus, emotion is directly useful both as motivation and information. In contrast, Bower (1981) proposed the associative model, which implied an indirect path for the influence of emotion on judgment. That is, emotion serves as a memory unit to influence associative networks by activating mood-congruent beliefs and memories during the decision-making process. The hot-cool model proposed by Metcalfe and Mischel (1999) assumes that affect and cognition play with each other to produce behavioral responses and that two different subsystems control the affective and cognitive representations, respectively. The emotionally “hot” system works on a “here-
and-now” principle that depends on the emotional arousal, and the emotionally ‘cool’ system relies on deliberation and planning that include a long-term perspective (Metcalf & Mischel, 1999, p. 183). Thus, based on this model, the relative strength of the emotionally “hot” and “cool” systems determines the preference for an immediate reward/loss or for a delayed reward/loss (Hirsh et al., 2010).

Oreg and Bayazit (2009) proposed the theory of judgments and decision making to support the perspective of affect regulation. That is, stable individual difference variables (e.g., trait personality variables) are related to decision processes to the extent that those individual differences interact with underlying motivations of achieving consistency, comprehending reality, or regulating internal affective states. In regulating internal affective states, decisions are based on the degree to which individuals attempt to approach and maximize pleasure (i.e., positive affect). This is consistent with the result of neural studies that the brain areas involved in choosing the immediate reward are heavily innervated by midbrain dopamine system (McClure et al., 2004).

**The proposed theoretical model: The approach/avoidance (inhibition) motivation model.**

In what follows, based on empirical studies (discussed below), the current study proposed a theoretical model, the approach/avoidance (inhibition) motivation model (see figure 1). This model tried to explain and predict how an incidental distinct emotion influences intertemporal decision making.
Loewenstein (1996) proposed that visceral factors, such as the cravings related to various substance-abuses, drive states (hunger, thirst, and sexual desire), emotions and physical pains, might influence decision making, leading to discrepancies between self-interest and behavior. However, he did not further to explain why cravings for a variety of drugs and drive states such as hunger and sexual desire had similar effects on decision making. For example, hungry people had a greater preference for smaller and sooner access to apple juice (Kirby & Logue, 1997); opioid deprivation caused heroin addicts to have a heightened preference for smaller and sooner amounts of heroin over larger and delayed amounts (Giordano et al., 2002); and men lowered their risk estimates for sexually transmitted diseases during masturbation (Ariely & Loewenstein, 2006). People might take it for granted that hunger is associated with eating as soon as possible, but there were situations in which people don’t want to eat even though they feel hungry.
Furthermore, studies found that visceral factors instigated impatience not only for the desire under manipulation (e.g., an increase in the desire for food leads to a greater preference for immediate and smaller food by exposing to food rewards) but also for the rewards outside manipulation (e.g., increased sexual desire by exposure to sex cues such as bikinis or the pictures of pretty women leads to steeper delay discounting of monetary rewards) (Baumeister, 2002; Metcalfe & Mischel, 1999; Van Den Bergh, Dewitte, & Warlop, 2008; Wilson & Daly, 2003). Therefore, based on related neurological findings suggesting that rewards are processed similarly in the brain, Van Den Bergh et al. (2008) proposed that “a general reward system may give rise to nonspecific effects: exposure to ‘hot stimuli’ from one domain may thus affect decisions in a different domain” (p. 85). They found male participants discounted monetary rewards greater after exposure to sex cues such as pictures of nonnude female models. Also, the sensitivity of the reward system moderated the effects of sex cues on delay discounting. That is, male participants with high sensitive BAS discounted monetary rewards greater after sex cue exposure than those with low sensitive BAS. They used the 48-item SPSRQ questionnaire (Torrubia, Avila, Molto, & Caseras, 2001) to assess Gray’s behavioral approach and inhibition systems. An example of the sensitivity to reward (SR) is “Do you often do things to be praised?” and an example of the sensitivity to punishment (SP) is “Are you often afraid of new or unexpected situation?”

Correspondingly, Berman, Burklund, & Lieberman (2009) proposed that inhibition of motor, cognitive, and affective responses originates in the same neurological areas. They demonstrated that intentional inhibition in the motor domain, via the right
inferior frontal cortex (rIFC), leads to inhibitory spillover in the affective domain. In detail, increased activity in the rIFC along with reduced activity in the amygdala was observed while participants intentionally inhibited motor responses (go/no-go task, e.g., go male/no-go female) during the presentation of negatively-valenced stimuli (face expressions). Usually, negatively-valenced images were expected to produce amygdale activation (Costafreda, Brammer, David, & Fu, 2008). Further, Tuk, Trampe, and Warlop (2011) investigated the effect of controlling a filling bladder, (which is associated with inhibition) on impulse control in intertemporal decision-making domain. They found that higher levels of bladder pressure resulted in an increased ability to resist impulsive choices in hypothetical monetary decision making, which indicates intentional inhibition in one domain can spill over to another unrelated domain. They also found the sensitivity of behavioral inhibition system (BIS) moderated the effects of urine urgency on intertemporal decision making. They used the 24-item BIS/BAS Scale (Carver & White, 1994) to assess Gray’s behavioral approach and inhibition systems.

Gary (1981) proposed that two general neurological motivational systems underlie behavior and affect: a behavioral inhibition system (BIS) and a behavioral approach/activation system (BAS). BIS regulates aversive motivation while BAS controls appetitive motivation (Gray, 1987a, 1987b). According to Gray (1987a, 1987b), the BIS is sensitive to punishment, nonreward, and novel stimuli while the BAS is sensitive to reward, nonpunishment, and escape from punishment. Thus, BIS activation causes inhibition of movement toward goals and is responsible for the experience of negative emotions such as anxiety, fear, frustration, and sadness; BAS activation leads to increase
of movement toward goals and is responsible for the experience of positive emotions such as happiness, hope, and elation. However, later research on the two behavioral systems has made some new findings. For example, approach motivation is mostly connected to concepts of appetite, incentive, and reward, while avoidance motivation is mainly connected to concepts of aversion, threat, and punishment (Elliot, Eder, & Harmon-Jones, 2013). The approach system facilitates appetitive behavior (e.g., moving toward a desired goal) and generates approach-related affects (e.g., happiness, elatedness, anger, and sadness). Electroencephalographic (EEG) and neuroimaging data demonstrate that approach of incentives and rewards tends to relate to increased activation in areas of the left prefrontal cortex which suggests that the circuitry underlying approach is partially localized in these areas (Carver, 2004; Harmon-Jones & Allen, 1998; Sobotka, Davidson, & Senulis, 1992). Camerer, Loewenstein, & Prelec (2005) argued that “the same dopaminergic reward circuitry of the brain is activated for a wide variety of different reinforcers” (p. 86). The avoidance system, however, facilitates aversive behavior (e.g., moving away from a threat) and generate avoidance-related affects (e.g., fear, anxiety, relief, calmness) (Carver, 2006; Davidson, 2002). EEG and neuroimaging studies demonstrate that the presence of threat and punishment tends to relate to increased activation in areas of the right prefrontal cortex which suggest that the circuitry underlying avoidance is partially localized in these areas (Carver, 2004; Sobotka et al., 1992). More recent studies on response inhibition found that brain areas in the right inferior frontal cortex (rIFC), the anterior cingulated cortex (ACC) and the dorsolateral prefrontal cortex (DLPFC) tend to have increased activation when individuals inhibit
ongoing responses (Aron, Robbins, & Poldrack, 2004; Berman et al., 2009; Menon, Adleman, White, Glover, & Reiss, 2001; Shackman, MeMenamin, Maxwell, Greischar, & Davidson, 2009).

Few studies directly explored the effects of specific incidental emotions on intertemporal decision making, though as Hirsh et al. (2010) suspected, the effects of different emotions on decision-making processes might not be the same. One reason might be that it is hard to separate the current incidental influence from the dispositional strength (Hirsh et al., 2010). For example, cognitive ability/IQ or personality traits (e.g., extraversion or neuroticism) could not be separated from the incidental factors when exploring the effect of incidental factors on making intertemporal decisions.

Some researchers examined the influence of the interaction between emotion and personality trait on intertemporal decision making (Augustine & Larsen, 2011; Hirsh et al., 2010). Hirsh et al. (2010) found that the interaction between extraversion and positive affect had a significant effect on intertemporal choice making. That is, extraverted people were more likely to prefer an immediate and smaller reward over a delayed and larger reward when the levels of induced positive mood increased. They did not find the main effect for positive mood and they thought the reason might be that it was difficult to induce strong positive emotions in the laboratory. They explained their results using the hot-cool model and neuropsychological models of intertemporal choice making (McClure et al., 2004). No effect size was reported. Augustine & Larsen (2011) investigated the effects of the interaction among affective prime (i.e., positive or negative), participants’ affective reaction to the affective prime (i.e., state affect), and trait-negative affect (i.e.,
neuroticism) on temporal discounting. They employed two different methods to prime/induce emotions. In the first study, they primed emotions using positive or negative affect words which were presented for 250ms before completing each item of intertemporal choice questions. Participants were told that they might see words flash briefly on the screen while they were doing the choice-making question. Also, participants were requested to focus on the words and try to memorize them. In the second study, researchers induced emotions using 20 slides chosen from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) for each condition. These slides were presented for 15 seconds each and participants were requested to pay attention to the images and imagine that they were watching the events depicted. Augustine & Larsen (2011) found that for participants in the negative affect condition, a high level of neuroticism predicted a lower discounting rate (i.e., more likely preferring delayed rewards) in the first study while a high level of neuroticism predicted a higher discounting rate in the second study. The authors explained the conflicting results of the two studies from the perspective of affect regulation. Individuals with high neuroticism are emotionally unstable and do not possess sufficient affect-regulatory ability. Thus, when the affective information is not salient (positive or negative words), people with high neuroticism could not sense the existence of the specific emotion and then could not regulate the emotion efficiently. However, when the affective information is salient enough (affective pictures), people with high neuroticism would regulate the negative emotion by choosing an immediate reward to try to maximize pleasure. The authors did not report effect size for both studies.
Luo et al. (2014) directly examined the association between primed emotions (fear and happiness) and intertemporal decision making using both behavioral and fMRI measures. They employed facial expressions to prime fearful, happy, or neutral emotions from trial to trial. Participants were required to make intertemporal choices while holding different emotional faces in memory. They found that primed fear and primed happiness had opposite effects on decision making. In detail, participants in the fear-priming condition preferred delayed rewards over immediate rewards with a greater frequency than those in the happiness-priming condition. No effect size was reported. In addition, they found that the right dorsolateral prefrontal cortex (dLPFC), which has been implicated in mediating withdrawal behavior (Berkman & Lieberman, 2010; Davidson, 2002), was more responsive to fearful faces than happy faces. In addition, greater activity in the posterior sector of the anterior cingulated cortex (ACC) was observed during the subsequent decision-making task. This area was found to be more active when larger and delayed alternatives were selected or when delay discounting was reduced (Luo, Ainslie, Pollini, Giragosian, & Monterosso, 2012; Peters & Buchel, 2010). Thus, they reasoned that withdrawal signals appearing in the right dLPFC “led to increased recruitment of the posterior part of the ACC during immediately subsequent decision making, through inhibition spillover” (Luo et al., 2014). Therefore, they attributed the impatience control effects of fear on intertemporal decision making to the inhibition spillover effects. This result is inconsistent with the result from the second study of Augustine & Larsen (2011).

However, a second careful comparison could lead us to find that the two studies were not contradictory. Luo et al. (2014) employed an emotional priming method similar
to that in the first study of Augustine & Larsen (2011). Both of them instructed participants to memorize the stimuli used for emotion priming during the decision-making task, and they did reach similar results with Luo et al. (2014) investigating specific emotions (i.e., fear and happiness), while Augustine & Larsen (2011) examined the interaction among negative emotion priming, state negative emotion, and neuroticism. That is, they both found that the involvement of negative emotions led to lower delay discounting (i.e., a greater preference on delayed and larger rewards). However, Augustine & Larsen (2011) employed an emotion induction method in the second study different from the method they used in the first study and the similar method used by Luo et al. (2014) (i.e., they did not ask participants to memorize the stimuli for the emotion induction during the decision-making task), and they found an opposite result as that from the results in their first study as well as Luo et al. (2014). Theoretically, the difference in methodology might be the key to explain the opposite results. The emotion induction task in the second study by Augustine & Larsen (2011) did not occur simultaneously with the decision-making task, so it makes sense that affect regulation began to work and deviated decision processes to an opposite direction while participants were making choices. However, Luo et al. (2014) asked participants to memorize facial expressions while making a choice, which meant emotion priming continued simultaneously with decision processes. Therefore, underlying mechanisms opposite in nature (sequential timing requirement for affect regulation versus simultaneous timing requirement for the inhibition spillover effects) led to opposite results.
What’s more, it is hard to use one extant model (e.g., the hot-cool model or the affect regulation model) to explain the findings from the above-mentioned three studies. Though Hirsh et al. (2010) explained their results based on the hot-cool model, the results from Augustine & Larsen (2011) could not be explained by this model because the results from two studies were opposite to each other. Neither could Luo et al. (2014) be explained because fear and happiness had opposite effects on intertemporal decision making. Based on the hot-cool model, emotional arousal no matter whether it is positive or negative should make people focus on “here-and-now” principle. Also, though Augustine & Larsen (2011) explained their results based on the affect regulation model, the results from Luo et al. (2014) could not be explained using this model because participants in the fear condition preferred not obtaining immediate monetary rewards. Usually choosing immediate rewards is regarded as maximizing pleasure (Augustine & Larsen, 2011).

The Present Research

The purpose of the current study was to use the proposed approach/avoidance (inhibition) motivation model to predict and explain the effects of a negative and avoidance-related emotion (i.e., fear) and a positive and approach-related emotion (i.e. happiness) on intertemporal decision making. In the study, both intertemporal monetary rewards and intertemporal monetary losses were examined. To my knowledge, no empirical study has been conducted that explored the effects of incidental emotions on intertemporal choice-making using hypothetic monetary losses. Considering the gain/loss asymmetry (Loewenstein & Prelec, 1992; Shelley, 1994), a neutral question frame in the
intertemporal decision-making task was employed to elicit a pure sign effect (e.g., losing $50 today versus $64 in 10 days).

The current study used movie clips to induce fearful, happy, and neutral emotions during the decision-making processes. Many studies have demonstrated that movie clips have the capacity to induce distinct emotions (Hagemann, et al., 1997; Kumari, et al., 1996; Phillippot, 1993). Also, movie clips have been found to elicit emotions of higher intensity than slides (Julien & Over, 1988). Since it is hard for a movie clip to convey a pure emotion (i.e., usually multiple emotions were induced, for example, fear, sadness, and anxiety were experienced together when watching a negative movie clip) (Davidson, Ekman, Saron, Senulis, & Friesen, 1990), a word-search task was required to be completed to shift participants’ attention to the specific emotion before a specific movie clip was played (Lammers, Galinsky, Gordijn, & Otten, 2008). Furthermore, the movie clip was re-played while participants were doing the manipulation check task and the decision-making task in order to maintain the induced emotion. That is, participants listened to the movie clip when they were doing other tasks.

Based on the approach/avoidance (inhibition) motivation model, the current study expected to find that participants in the fearful condition had a significantly greater preference on the delayed and larger rewards and on the immediate and smaller losses than those in the happy and neutral conditions because the avoidance motivation was activated by fearful emotion and then made participants avoid smaller rewards and larger losses (potential threats). Correspondingly, participants in the happy condition had a significantly greater preference on the sooner and smaller rewards and on the delayed and
larger losses than those in the other two conditions because the approach motivation was activated by happy emotion and then made participants approach rewards as soon as possible and losses as late as possible (desired goals). In addition, participants with higher BIS scores preferred the delayed and larger rewards with a greater frequency than those with lower BIS scores and participants with higher BAS scores preferred the smaller and immediate rewards with a greater frequency than those with lower BAS scores. Considering the potential confounding effects of within-subject design on reward and loss questionnaires, this study used between-subject design.
Chapter 2: Methods

Participants

Two hundred fifty eight undergraduate students were recruited via SONA system. They received 1 course credit for participation. Participants were randomly assigned to 3 conditions: the fearful condition, the happy condition, and the neutral condition.

Questionnaires

BIS/BAS Scales (Carver & White, 1994) and Cognitive Reflection Test (CRT: Frederick, 2005) were employed. BIS/BAS Scales consist of 24-items assessing individual variability in the sensitivity of two motivational systems: Behavioral Inhibition (avoidance) System and Behavioral Approach (activation) System. Each item of this questionnaire is a statement that a person may either agree with or disagree with. A 4-point scale is used: 1 means very true for me, 2 means somewhat true for me, 3 means somewhat false for me, and 4 means very false for me. Example items are “Criticism or scolding hurts me quite a bit” (BIS item), “I go out of my way to get things I want” (BAS Drive item), “I am always willing to try something new if I think it will be fun” (BAS Fun Seeking item), and “When I am doing well at something I love to keep at it” (BAS Reward Responsiveness item). Cronbach’s $\alpha$ is 0.66 for BIS, for BAS, 0.66 for reward responsiveness, 0.59 for drive and 0.69 for fun seeking (Carver & White, 1994).

The CRT test consists of three mathematical questions, the scores of which are negatively associated with people’s preference on smaller, sooner rewards. That is, individuals who score higher on CRT are generally more patient on monetary choice making (Frederick, 2005). In addition, the CRT is an attractive test for separating people
into different cognitive groups: it only have three questions and can be administered in a short time period, but its predictive validity equals or exceeds other cognitive tests such as SAT and ACT that involve up to 215 items and take up to 3.5 hours to complete (Frederick, 2005).

State Affect Assessment

The Positive and Negative Affect Schedule (PANAS & PANAS-X; Watson, Clark, & Tellegen, 1988; Watson & Clark, 1994) was employed to assess state emotions. The PANAS questionnaire consists of 28 words describing different feelings and emotions. A 5-point scale is used (1 means Not at all and 5 means Extremely). The example words are “joyful,” “afraid,” “enthusiastic,” and “scared.” Cronbach’s median $\alpha$ is 0.93 for joviality, and 0.87 for fear (Watson & Clark, 1994).

Intertemporal Decision-making Measure

The Monetary Choice Questionnaire (MCQ: Kirby, Petry, & Bickel, 1999) was used. Participants were instructed to make choices as though they might actually receive the rewards. MCQ consists of 27 choice items assessing preference between a smaller reward today and a larger reward in the specified number of days. The examples are “Would you prefer $54 today, or $55 in 117 days?” and “Would you prefer $20 today, or $55 in 7 days?” The intertemporal decision-making questionnaire on hypothetical monetary losses was a modification of MCQ by changing rewards to losses. That is, the questionnaire still consists of 27 items assessing preference between a smaller loss today and a larger loss in the specified number of days. The examples are “Would you prefer
losing $54 today, or $55 in 117 days?” and “Would you prefer losing $20 today, or $55 in 7 days?”

**Emotion Induction**

Participants did a specific word-search task first based on the condition they were assigned randomly to. They were given a list with 9 words and instructed to identify these words in a 10 x 9 letter matrix (Lammers et al., 2008). For example, participants in the fearful condition searched for fear-related words (e.g., scared, frightened, agitation, dread). Then they watched a corresponding fearful, happy, or neutral movie clip with the length around 4.5 minutes. The movie clip from the Big Bang Theory was used for inducing happiness, the movie clip from Misery for inducing fear, and the document clip of Ball Bearings for not inducing any emotion (the neutral condition). After watching the movie clip, participants kept headphones on to listen to the movie clips until they completed the decision-making task.

**Procedure**

This study was titled as “Affects and intertemporal decision making.” Participants were randomly assigned to one of the 3 conditions in advance. Regardless of conditions, after participants signed the consent form, they first completed hard copies of BAS/BIS questionnaire, PANAS, and the word-search task (participants were instructed to try their best to memorize those words while doing the word-search task); next, participants watched a movie clip on the computer based on which condition they were assigned to (participants were instructed orally to try their best to fit into the plots while watching the movie clip); after emotion induction, participants completed PANAS and the MCQ
reward/loss questionnaires on paper. The movie clip was played repeatedly during the
completion of the second-time PANAS and choice-making questions. After that,
participants completed CRT test on paper. Finally, participants were debriefed and
dismissed. Each participant did the experiment in a separate small room in the laboratory.
Chapter 3: Results

Participants who responded to the 27 choice-making questions without any change (i.e., choosing the immediate and smaller choices or the delayed and larger ones for 27 times) were removed, considering the very small chance that participants completely preferred the immediate and smaller choice or the delayed and larger ones instead of carelessness for the study. Summed choices over 2.5 standard deviations below or above the average were excluded from the analysis, which left a final sample of 237 (99 men and 138 women) participants.

Results showed that baseline happiness and baseline fear have no significant difference for the fearful, happy, and neutral conditions, $F_{(2,234)} = .312, p = .733; F_{(2,234)} = 1.490, p = .228$. Table 1 displayed mean and standard deviation of baseline fear and happiness for the 3 conditions. Results also showed the emotion induction was successful. Participants in the fear condition showed significantly greater fear than the other 2 conditions, $F_{(2,234)} = 83.418, p < .001$. Participants in the happiness condition showed significantly greater happiness than the other 2 conditions, $F_{(2,234)} = 46.023, p < .001$. Table 2 displayed mean and standard deviation of fear and happiness for the 3 conditions. Cronbach’s $\alpha$ is .955 for joviality, and .934 for fear. Cronbach’s $\alpha$ is .746 for BIS, for BAS, .544 for reward responsiveness, and 0.657 for fun seeking (impulsivity). Pearson’s correlation displayed positive correlations between scores of BAS reward responsiveness and BIS scores, and between BAS reward responsiveness and BAS fun seeking (impulsivity), $r = .166, p = .010; r = .314, p < .001$. Pearson’s correlation also displayed significant positive relationships between gender and BIS scores, and between
gender and scores of BAS reward responsiveness, \( r = .236, p < .001; r = .141, p = .031. \) That is, females \( (M_{BIS} = 21.123; M_{BASR} = 18.464) \) were more sensitive to behavioral avoidance (inhibition) motivation and behavioral approach (reward responsiveness) motivation than males \( (M_{BIS} = 19.444; M_{BASR} = 18.030). \) In general, females chose larger but delayed rewards and smaller but immediate losses with a greater frequency (Mean = 16.036) than males (Mean = 15.323).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Descriptive information of baseline fear and happiness for the 3 conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Baseline fear</td>
</tr>
<tr>
<td></td>
<td>( M )</td>
</tr>
<tr>
<td>Fear</td>
<td>2.37</td>
</tr>
<tr>
<td>Happy</td>
<td>2.06</td>
</tr>
<tr>
<td>Neutral</td>
<td>2.86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Descriptive information of fear and happiness for the 3 conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Fear</td>
</tr>
<tr>
<td></td>
<td>( M )</td>
</tr>
<tr>
<td>Fear</td>
<td>9.63</td>
</tr>
<tr>
<td>Happy</td>
<td>1.36</td>
</tr>
<tr>
<td>Neutral</td>
<td>1.97</td>
</tr>
</tbody>
</table>

In order to test whether the approach/avoidance motivation activated by happiness/fear predicted the choice-making behaviors, a 3 (conditions: fear, happiness, and neutral condition) X 2 (sign of payoffs: gains and losses) X 2 (gender: female and male) ANOVA was conducted on the summed choices of SS rewards \( (R1) \) and the summed choices of LL losses \( (L2) \). Both condition, sign of payoffs, and gender are
between-subject factors. The main effect for condition was significant, $F_{(2, 225)} = 5.011, p = .007$, $\text{partial } \eta^2 = .043$. The simple effect tests with Bonferroni correction (using .0167 as a cut-off) were performed on summed choices among the 3 conditions. Results showed that the participants in the happy condition (Mean = 12.422) chose smaller but immediate rewards and larger but delayed losses with a greater frequency than those in the fearful (Mean = 10.794) and neutral conditions (Mean = 10.659), $p = .019; p = .008$. The fearful condition and the neutral condition had no difference, $p = 1.00$. The sign effect was significant, $F_{(1, 225)} = 14.061, p < .001$, $\text{partial } \eta^2 = .059$. Participants discounted rewards significantly greater than they discounted losses. The main effect for gender was not significant, $F_{(1, 225)} = 2.892, p = .090$. There were no significant interactions among condition, sign of payoffs, and gender, all $p$s $> .10$. Figure 2 displayed mean of summed choices in the 3 conditions for both rewards and losses.
To test whether BIS sensitivity was related to the summed choices or moderate the effects of emotions on decision making, a regression analysis was conducted with condition (dummy-coded with the neutral condition as the reference group, the fearful condition as dummy1 and the happy condition as dummy2), sign of payoffs, gender, BIS score (mean-centered), and all two-way, three-way, and four-way interactions among BIS and other predictors. The results showed a significant three-way interaction among BIS score, dummy1, and gender, $F_{c_{BIS} \times gender \times dummy1 (1, 226)} = 5.571, p = .019, \Delta R^2 = .021$. The figure 3 displayed the significant interaction. In the fearful condition, the sensitivity of BIS scores did not moderate the effects of fear on decision making. In the
other two conditions, male participants with high BIS scores chose smaller but immediate
rewards and larger but delayed losses with a less frequency than those with low BIS
scores; and female participants with high BIS scores chose smaller but immediate
rewards and larger but delayed losses with a greater frequency than those with low BIS
scores.

*Figure 3.* The significant interaction between BIS (-1 stands for 1 standard deviation
below and 1 stands for 1 standard deviation above), condition (fear vs. neutral), and
gender.
To test whether the sensitivity of BAS reward responsiveness was related to the summed choices or moderate the effects of emotions, another regression analysis was conducted with condition (dummy-coded with the neutral condition as the reference group, the fearful condition as dummy1 and the happy condition as dummy2), sign of payoffs, gender, score of BAS reward responsiveness (mean-centered), and all two-way, three-way, and four-way interactions among BAS reward responsiveness and other predictors. The results showed two significant three-way interactions, $F_{C_{BAS} \times \text{sign of payoffs} \times \text{dummy1}} (1, 225) = 3.936, p = .048, \Delta R^2 = .014$; $F_{C_{BAS} \times \text{sign of payoffs} \times \text{gender}} (1, 226) = 13.783, p < .001, \Delta R^2 = .050$. Figure 4 and 5 displayed the significant interactions. In the happy and neutral conditions, participants with high scores of BAS reward responsiveness chose smaller but immediate rewards and larger but delayed losses with a less frequency than those with low scores of BAS reward responsiveness. In addition, male participants with high scores of BAS reward responsiveness chose larger but delayed losses with a less frequency than those with low scores of BAS reward responsiveness.
Figure 4. The significant interaction between BAS reward responsiveness (-1 stands for 1 standard deviation below and 1 stands for 1 standard deviation above), condition (fear vs. neutral), and sign of payoffs (reward vs. loss).
Furthermore, I conducted a 3rd regression analysis including BIS score, BAS score and all their interactions with condition, sign of payoffs, and gender. Condition was dummy-coded with the neutral condition as the reference group, the fearful condition as dummy1 and the happy condition as dummy2, and BIS scores and the scores of BAS reward responsiveness was mean centered. The results did not change the significance of the above-mentioned interactions. Hence, the approach and the avoidance (inhibition) motivations seemed independent of each other.
Chapter 4: Discussions

The main purpose of the current study was to verify the proposed approach/avoidance (inhibition) motivation model, which explains and predicts the effects of emotions on intertemporal decision making. It is agreed that happiness is approach-related emotion and fear is avoidance-related emotion in both behavioral and neural studies (Carver, 2004; 2006; Gray, 1987a; Higgins, 1997; Luo et al., 2014; Murphy, Nimmo-Smith, & Lawrence, 2003). In a neuralanatomic meta-analysis, Murphy et al. (2003) suggested that greater activity in left prefrontal cortex than right prefrontal cortex was observed for happiness via distinct 3-D distributions of activation foci for approach-related and avoidance-related emotions. Luo et al. (2014) found that greater activity was observed in the areas of dLPFC and ACC via fMRI. Therefore, in the current study, induced happiness activated the approach motivation and induced fear activated the avoidance (inhibition) motivation. Thus, participants in the happy condition tried to approach incentives as soon as possible and punishment as late as possible; and participants in the fearful condition tried to avoid potential threats (smaller rewards and larger losses) as possible as they could. The results supported the predictions that participants in the happy condition did choose smaller but immediate rewards and larger but delayed losses with a greater frequency than those in the fearful condition and in the neutral condition, and that participants in the fearful condition chose larger but delayed rewards and smaller but immediate losses with a greater frequency than those in the happy condition.
Though using different methods of emotion induction (movie clips were used in the current study while face expressions used in Luo et al. (2014)), both Luo et al. (2014) and the current study showed that happiness and fear had opposite effects on intertemporal decision making. One step further from Luo et al. (2014), the current study also found the difference between happiness and the control condition. The reason might be in that movie clips usually induce more intense emotions (Julien & Over, 1988). However, similar as Luo et al. (2014), the current study did not find choice difference between the fearful condition and the control condition. Based on manipulation check on induced emotions, induced fear (Mean = 9.63) was much less intense than induced happiness (Mean = 19.22) though it was significantly higher in the fearful condition than in the other two conditions. Hence, using movie clips to induce fear might be not good enough. Further studies may explore other more effective methods to induce distinctive emotions. Besides, an alternative but opposite explanation could be that the neutral movie clip lasting over 4 minutes used in the current study might induce negative emotions such as bored, irritable, and upset, which activated the avoidance motivation. Compared the self-reported emotions after watching the movie clips with the baseline emotions, many participants were found to report negative emotions such as irritable, depressed, upset, nervous, and jittery after watching an emotionless document clip about Ball Bearings. Thus, participants in the neutral condition were not neutral in emotion, so it was possible that there was no difference between participants in the fear condition and those in the neutral condition. Luo et al. (2014) did not explore the possible reasons about the nondifferences between the happy condition and the neutral condition, and between the
fear condition and the neutral condition. They put emphases on explaining why fear affected intertemporal decision making opposite to happiness based on neural imaging results. Fear activated brain areas underlying the avoidance (inhibition) motivation. They did not examine brain areas activated by happiness. Therefore, the current study was not a replicate study on Luo et al. (2014) though both studies used similar behavioral measures on the relationship between distinctive emotions (fear and happiness) and intertemporal decision making.

The results of the current study was also consistent with Tuk et al. (2011). They did a study on urine urgency and they found that participants in the high urgent condition chose larger but delayed rewards with a greater frequency than those in the low urgent condition. Since ACC is important for bladder control, increased urine urgency activated the avoidance (inhibition) motivation (Griffiths & Tadic, 2008). Therefore, both studies showed that the avoidance motivation activated by different visceral factors played similar roles on the intertemporal decision making occurring simultaneously. In addition, the results of the current study was consistent with Van Den Bergh et al. (2008). They found exposure to sex cues led to preference on smaller but immediate rewards and they proposed a general reward system (appetitive motivation) was underlying ‘hot stimuli’ (Metcalfe & Mischel, 1999) such as hunger (desire for food) and sexual desirability. Since they proposed the general reward system based on related neurological findings demonstrating that rewards are processed in the similar brain areas (McClure et al., 2004), the general reward system was the same as the approach motivation system proposed in the current study.
The current study displayed the robust sign effect, consistent with previous empirical studies (Cheng et al., 2012; Loewenstein & Prelec, 1992; Shelley, 1994). The sign effect describes the phenomenon that the discounting rates for monetary rewards and losses are asymmetric, which means that loss discount rates are not the same as gains discount rates. The results showed that participants discounted rewards significantly greater than they discounted the same amounts of losses, indicating that losses loomed larger (Kahneman & Tversky, 1979; Tversky & Kahneman, 1984). The direction of gain/loss asymmetry was the same as Loewenstein and Prelec (1992).

Furthermore, the current study used BIS/BAS Scale (Carver & White, 1994) to measure the sensitivity of behavioral approach system and behavioral avoidance (inhibition) system. The results supported the reliability of the scale. Consistent with Carver and White (1994), females were more sensitive to behavioral inhibition system and behavioral approach (reward responsiveness) system; BIS scores were positively correlated with scores of BAS reward responsiveness, and the scores of BAS reward responsiveness were positively correlated with scores of BAS fun seeking. Test-retest reliabilities for BIS, BAS reward responsiveness, and BAS fun seeking in the current study were similar as those in Carver and White (1994). The results also supported the independence of BIS and BAS physiological systems. That is, both the approach and avoidance effects reflected an activation of the corresponding motivational system instead of a deactivation of the opposite motivational system (Tuk et al., 2012). However, the final behavioral effects are conceived as mutually inhibitory of the two opposite motivational systems, indicating a competition between approach and avoidance.
(inhibition) in response to a particular situation (Torrubia et al., 2001). Perhaps because the co-existence of multiple emotions made the behavioral effects complicated, the moderation of BIS scores and the scores of BAS reward responsiveness on the choice-making behavior was not found, though BIS scores and the scores of BAS reward responsiveness did interact with conditions, gender, and sign of payoffs. It was hard to explain these significant interaction findings at this point.

There were several limitations of the current study. First, considering the fact that induced emotions could elapse very quickly, participants were requested to listen to the movie clip for the second time when they were doing emotion induction check and decision-making tasks. The potential problem with this design was habituation. Participants might habituate to the plots, so their induced emotions elapsed more quickly. Further studies might be done by modifying the procedure of this part to let participants listen to fearful, happy, or neutral sounds to keep emotion induction, or not to re-play the movie clips when participants were doing the tasks. Second, the document clip of Ball Bearings was used as a control group assuming no emotion being induced. However, negative emotions might be induced since watching an over 4-minute uninteresting ball bearings document clip was enough to make people feel bored. Thus, further studies might add a second control group without watching any neutral movie clip to see whether there would be any difference between the fearful condition and the control condition. Third, since the Monetary Choice Questionnaire (MCQ: Kirby, Petry, & Bickel, 1999) was designed almost 20 years ago, the amounts used in the questionnaire might be too small to bring significant difference even if specific emotions were induced successfully.
Thus, follow-up studies might increase the amounts of rewards and delayed period to see whether emotions could affect decision making. Forth, self-report of subjective emotions is always open to questions, but I cannot find a better assessment on induced emotions. Last, individual difference on emotion induction was a problem though movie clips were believed to have the capacity to induce more intensely distinct emotions than other emotion priming or induction methods (Julen & Over, 1988). The word-search task before watching movie clips and random assignment were the methods the current study resorted to reduce the influence of individual difference on emotion induction.

In conclusion, the current study used the proposed approach/avoidance (inhibition) motivation model to predict and explain the effects of distinctive emotions on decision making. The approach/avoidance (inhibition) motivation was introduced due to the fact that approach/avoidance motivation is evidenced both in human beings and in lower organisms (Elliot & Covington, 2001). All organisms might possess some form of approach/avoidance mechanism for the sake of survival because approach and avoidance responses move the organism toward potential desired goals and away from potential threats. Also, as Elliot and Covington (2001) argued, the approach/avoidance motivation is “fundamental and basic, and should be construed as the foundation on which other motivational distinctions rest” (p. 74). Therefore, the proposed motivation model might be the basic and deepest psycho-physiological model moderating the effects of emotions or other visceral factors on decision-making processes. Potentially this model may rationalize a variety of perceived irrational behaviors such as impulsivity and bias.
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