Anxiety and intertemporal decision making: The effect of the behavioral inhibition system and the moderation effects of trait anxiety on both state anxiety and socioeconomic status

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ABSTRACT

Based on Gray's theory, which links the behavioral inhibition motivation system (BIS) to the personality trait of "anxiety", the present study examined whether anxiety (trait vs. state), BIS sensitivity, and family socioeconomic status in childhood (SES) had an interactive or independent impact on intertemporal decision-making processes. The study also investigated whether participants with high trait anxiety had a significantly different choice preference on the immediate but smaller (SS) rewards over the larger but delayed (LL) rewards. Participants ($N = 108$) were randomly assigned to either the anxiety or the control condition. Results showed that people with a higher BIS score tended to choose less SS rewards. Trait anxiety was found to moderate both state anxiety and childhood SES to influence intertemporal decision processes. We further found high or low trait anxiety significantly influenced people's choice preference. Speculations on the psychological meanings of the findings were discussed from the perspective of biased risk perception. Limitations and implications were also discussed.

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Behavioral economics has played an important role in the field of decision making. In recent years, intertemporal decision making (also called delay discounting), which trades off the magnitude and immediacy of monetary rewards, has been extensively investigated from the perspective of impulsivity. For example, studies supported that drug-dependent individuals, who usually have high impulsive scores, show an excessive preference on the sooner but smaller (SS) hypothetical monetary reward over the larger delayed (LL) reward, compared to non-drug-dependent controls (Cheng, Lu, Han, Gonzalez-Wallejo, & Sui, 2012; Coffey, Gudleski, Saladin, & Brady, 2003). However, some recent studies provided evidence that impulsivity might not be the sole source explaining this kind of behavior. For example, people's perception of prospective time duration (Zauberman, Kim, Malkoc, & Bettman, 2009) and sensitivity of the behavioral inhibition system (Tuk, Trampe, & Warlop, 2011) influenced intertemporal preferences. Thus, the present study continued to examine the sources independent of impulsivity which might influence intertemporal choice preference. In particular, we focused on the behavioral inhibition motivation system, trait anxiety, and state anxiety. In addition, family socioeconomic status in childhood (SES) is considered as a factor in the present investigation because people's preference on monetary options might be significantly influenced by their early family economic status (Griskevicius, Tybur, Delton, & Robertson, 2011).

The behavioral inhibition system was first proposed by Gray (1987; Gray & McNaughton, 2000). According to the Reinforcement Sensitivity Theory (RST), there are three conceptual biological-based motivation systems: the behavioral approach system (BAS), the fight/flight/freeze system (FFFS), and the behavioral inhibition system (BIS). The BAS reacts to both unconditioned and conditioned positive stimuli by facilitating appetitive behaviors. The FFFS responds to all aversive stimuli, unconditioned and conditioned, by activating specific defensive behaviors (e.g., freezing or avoidance). The BIS is responsible for solving goal conflicts including approach–avoidance, approach–approach, and avoidance–avoidance conflicts. Thus, the BIS inhibits ongoing conflicting behaviors, engages in risk assessment, and increases attention to environment and memory which might help resolve goal conflicts (Corr, 2009).

In intertemporal decision-making processes, people's ability to evaluate a money–time tradeoff may also depend on the BIS. That is, independent of less desire for SS rewards, people also suppress the response to choose SS incentives to obtain long-term greater benefits. A recent study, recording mouse movements during an entire decision-making process, demonstrated that the mouse trajectories were less direct when participants chose LL rewards, compared to the trajectories when participants chose SS rewards (Dshemuchadse, Scherbaum, & Goschke, 2013). This finding indicated that participants who chose LL rewards experienced more of a struggle between the two choice options in order to finally overcome their attraction to SS rewards. Moreover, Reynolds, Ortengren, Richards, and de Wit (2006) showed that self-report impulsivity measures and the behavioral inhibition capacity

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measured by the Go/no-go task and the Stop task, which require participants to perform speeded responses on 'go' trials and to inhibit responses on 'no-go' or 'stop' trials, are uncorrelated.

In the present study, the behavioral inhibition system was measured by the BIS/BAS scales (Carver & White, 1994), considering that previous studies showed mixed relationship on relationship between intertemporal decision making and the capacity of response inhibition measured by the Go/No-go task (Cheng et al., 2012; Reynolds et al., 2006). The BIS/BAS scales is a self-report questionnaire to assess the sensitivity of the behavioral inhibition system and the behavioral approach system. Tuk et al. (2011) did an experiment to investigate the relationship between intertemporal decision making and the BIS sensitivity. They instructed participants in the experimental condition to drink a large amount of water to create a situation of response inhibition on bladder urgency. They found that people with a high BIS score (i.e., 1 standard deviation above the mean) preferred LL rewards over SS rewards than people with a low BIS score (i.e., 1 standard deviation below the mean) in the experimental condition.

Based on the behavioral effects of anti-anxiety drugs (e.g., benzodiazepines and alcohol) on animals, anti-anxiety drugs specifically impair actions of the BIS (e.g., weakening passive avoidance tendency), Gray (1987) suggested that the BIS is the basis of personality dimension of anxiety. This conclusion has two assumptions: animals and human beings experience a similar state of anxiety; and anti-anxiety drugs have similar effects on both animals and humans. Newman, Wallace, Schmitt, and Arnett (1997) investigated the relationship between trait anxiety and the BIS measured by Go/no-Go tasks. They found that participants with high trait anxiety (i.e., scored in the top third on the state–trait anxiety inventory) responded more slowly than participants with low trait anxiety (i.e., scored in the bottom third) on Q-present trails. In the pre-training trials, participants were trained to inhibit responses to letter Q. Thus, this finding demonstrated stronger behavioral inhibition for people with high trait anxiety than low trait anxiety. In addition, previous studies showed trait anxiety was positively correlated to the BIS assessed by self-report questionnaires such as Gray–Wilson Personality Questionnaire (GWPQ; Wilson, Barrett, & Gray, 1989), and BIS/BAS scales (Knyazeva, Slobodskayaa, & Wilsonb, 2002; Muller & Wytykowska, 2005).

Trait anxiety is a stable personality trait, which is positively correlated with state anxiety (Endler & Kocovski, 2001). The influence of trait anxiety on judgment and decision making has attracted much interest (Eisenberg, Baron, & Seligman, 1998; Peng, Xiao, Yang, Wu, & Miao, 2014). For example, both Eisenberg et al. (1998) and Peng et al. (2014) found that people with high trait anxiety tended to be more risk aversive in decision making than people with low trait anxiety. Moreover, as Loewenstein and Lerner (2003) stated, dispositional traits and corresponding emotions might influence decision making in an interactive way. In support of this view, Hirsh, Guindon, Morisano, and Peterson (2010) found that extroversion and positive affect interacted to influence people's preference between SS and LL rewards when people were in a positive mood. For people in a high positive mood, those with a higher extroversion score preferred a SS reward over a LL reward than those with a lower extroversion score. Also, for people with high extroversion, those in a high positive mood were more likely to choose a SS reward than in a low positive mood. Thus, the present study investigated whether trait and state anxiety interacted to influence intertemporal decision-making processes with a pattern opposite to that depicted by the interaction between extroversion and positive affect, considering some opposite natures between positive affect and state anxiety, and extroversion and trait anxiety.

Socioeconomic status in childhood is a factor, which often interacts with other variables, to influence decision-making processes. For example, childhood SES (i.e., resource-scarce vs. resource-plenty environment, or 6 numerical options of household family income when participants grew up) affected intertemporal decisions with mortality cues (Griskevicius et al., 2011). With mortality cues, people growing

up in a high SES family (i.e., 1 standard deviation above the mean) preferred LL rewards while people in a low SES family (i.e., 1 standard deviation below the mean) tended to prefer SS rewards. Therefore, the present study also explored whether childhood SES interacted with other factors to affect individuals' intertemporal choice preference.

Based on Gray's theory, we took a first step to link anxiety and the behavioral inhibition motivation system to investigate how these factors influenced intertemporal decision making when state anxiety was manipulated. We made the following hypotheses. H1: Consistent with Tuk et al. (2011), for participants in the anxiety condition, those with a higher BIS score would more likely to choose LL rewards than those with a lower BIS score. H2: We reasoned that state anxiety interacted with trait anxiety to influence intertemporal decision making in the anxiety condition. More specifically, for individuals in a high anxious state, those with high trait anxiety were more likely to choose a LL reward than those with low trait anxiety; and that for people with high trait anxiety, those in a high anxious state preferred LL rewards than in a low anxious state. In addition, we reasoned childhood SES might interact with other factors to influence people's preference on summed SS rewards but had no specific predictions. Furthermore, people with high and low trait anxiety scores might show different choice preference when anxiety was manipulated.

1. Methods

1.1. Participants

Undergraduates ($N = 108$) were recruited via an online psychological experiment system. They received one course credit for participation. The majority were Caucasian (85%) and female (61%), with a mean age of 19.28. Students were eligible to participate if they had no known diagnosed mental disorders. Participants were randomly assigned to one of two conditions: the anxiety and the control condition.

1.2. Demographic questionnaire

The demographic questionnaire assessed age, sex, race, and family socioeconomic status (SES) in childhood. Childhood SES was classified into four categories based on yearly family income when participants were growing up: less than $30,000, $30,000 to $50,000, $50,000 to $100,000, and over $100,000. Childhood SES was treated as an interval-scale variable because the four levels roughly represent low, middle-low, middle-high, and high socioeconomic status.

1.3. State–trait anxiety inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983)

The STAI is a 20-item self-report measure of state and trait anxiety. Example items are "I feel frightened" and "I feel nervous." A 4-point scale was employed for participants to rate how anxious they felt at that moment and how often they felt anxious routinely from 1 (never) to 4 (always). This questionnaire has good reliability and internal consistency was reported between .86 and .95. The STAI has been widely used to assess state and/or trait anxiety in research (Newman et al., 1997; Peng et al., 2014). ($\alpha = .896$ for trait anxiety; $\alpha = .915$ for state anxiety).

1.4. BIS/BAS scales (Carver & White, 1994)

The BIS/BAS scales consists of 24-items assessing individual variability in the sensitivity of two motivational systems: the Behavioral Inhibition (avoidance) System and the Behavioral Approach (activation) System. Each item is a statement that a person may either agree or disagree with. A 4-point scale is used from 1 (very true for me) to 4 (very false for me). There are four subscales, one (7 items) assessing the BIS