Acute Stress and Risky Decision-Making: The Moderating Effect of Excitatory Susceptibility

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Abstract

To explore the mechanism of stress on decision-making and its individual differences, and to reduce decision-making errors caused by stress in engineering operations, this study employed the Trier Social Stress Test and the Balloon Analogue Risk Task to examine the relationship between stress response and risk propensity under stress, and to investigate the moderating role of excitement susceptibility. The results demonstrated that under stress, individuals with greater cortisol responses exhibited more risk-taking behavior. Moreover, this effect was moderated by excitement susceptibility: for individuals with higher excitement susceptibility, greater cortisol response under stress predicted more risk-taking behavior; whereas for those with lower excitement susceptibility, cortisol changes did not predict risk propensity. These findings highlight the important role of excitement susceptibility in stress effects and provide scientific implications for personnel selection in high-pressure positions.

Full Text

The Relationship Between Acute Stress and Risk Taking: The Moderating Effect of Ease of Excitation

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Abstract

To explore the mechanism through which stress influences decision-making and its individual differences, and to reduce decision-making errors caused by stress

in engineering operations, this study employed the Trier Social Stress Test and the Balloon Analogue Risk Task to examine the relationship between stress responses and risk-taking tendencies under stress, and to investigate the moderating role of ease of excitation. The results demonstrated that greater cortisol responses under stress were associated with more risk-taking behavior. This effect was moderated by ease of excitation: individuals with high ease of excitation exhibited a positive relationship between cortisol response and risk-taking, whereas cortisol changes could not predict risk-taking tendencies in those with low ease of excitation. These findings highlight the important role of ease of excitation in stress effects and provide scientific insights for personnel selection in high-pressure positions.

Keywords: Acute stress, Risk taking, Ease of excitation, Cortisol, Heart rate

Introduction

Operators in high-risk domains such as aerospace, air traffic control, and nuclear power management, as well as in routine factory work, inevitably encounter stressful events involving time pressure, high workload, or emergencies. Previous research has identified stress as one of the most common causes of human error in operational settings (Svenson & Benson, 1993), as it triggers changes in emotional and cognitive functions, including attention, memory, and executive control (Lin et al., 2020; Luo et al., 2017; Zhang et al., 2015), ultimately leading to behavioral changes such as increased unsafe behaviors (Ramsey et al., 1983). However, the psychological mechanisms through which stress affects operational safety have not received widespread attention from researchers. One neglected aspect concerns risk-related attitudes and behaviors, which directly determine the safety of actual operations. Extensive psychological and accident analyses indicate that human error constitutes the primary source of industrial accidents (Heinrich, 1931), with decision-making errors representing one of the most frequent types of mistakes (Orasanu et al., 2001). How to enable operators to select the safest and most effective working methods under stressful conditions and avoid stress-related safety accidents and casualties represents a central concern for engineering psychologists in the stress domain. Investigating the psychological mechanisms underlying risk behavior under stress can help identify additional opportunities for intervention and holds important practical significance for reducing human error and ensuring operational safety.

Research demonstrates that organisms produce a series of physiological responses under stress (Dickerson & Kemeny, 2004; Kudielka & Kirschbaum, 2007): the fast-reacting sympathetic nervous system (SNS) is rapidly activated, with heart rate as its key metric increasing quickly and returning to baseline shortly after stressor removal; whereas the slow-reacting hypothalamic-pituitary-adrenal (HPA) axis responds more gradually, with cortisol as its typical neuroendocrine marker rising slowly following stressor presentation.

Previous studies on the relationship between heart rate changes under stress and

risk-taking are relatively scarce, with only Wemm and Wulfert (2017) finding a positive correlation between risk-taking and heart rate elevation under stress in men. Research on cortisol, however, is more extensive. Prior studies have found that cortisol changes under stress significantly correlate with risk-taking tendencies. Using simulated public speaking to induce acute stress, researchers have observed that greater cortisol elevations predict more risk-taking behavior in risk decision-making tasks. Similar results have been found across several classic decision-making paradigms, including the Iowa Gambling Task (IGT), Game of Dice Task (GDT), and lottery decision-making tasks (Buckert et al., 2014; van den Bos et al., 2009; Starcke et al., 2008). Additionally, some studies have employed direct cortisol administration methods. For instance, Kluen et al. (2017) found that men injected with cortisol exhibited more risk-taking behavior in the Balloon Analogue Risk Task (BART), as evidenced by significantly increased pump counts and more balloons exploded. These studies collectively suggest a positive relationship between cortisol increases and risk-taking tendencies.

However, some studies have reported different findings. For example, research has found that rapid cortisol increases exert no significant effect on risk-taking (Kandasamya et al., 2014). Another study using the BART found that individuals pumped less under stress, with risk behavior showing complex interactions with personal traits such as gender and impulsivity (Wise et al., 2014). These contradictory results likely stem from neglecting individual differences in stress effects.

Indeed, people exhibit substantial individual differences in how they experience and respond to stress. Previous research has shown that factors such as age, gender, education level, and past experiences moderate individuals' stress responses and subsequent cognition and behavior (Kudielka et al., 2009). Identifying these individual difference factors not only enhances our understanding of stress mechanisms but also facilitates selection and targeted training for personnel in high-risk occupations.

Ease of excitation represents an individual trait closely related to both stress and decision-making, referring to the degree of sensitivity to external stimuli and internal changes. Smolewska et al. (2006) noted that individuals high in ease of excitation, due to their heightened sensitivity to external and internal changes, experience a sense of being overwhelmed when encountering environmental fluctuations, manifesting as tension, palpitations, anxiety, negative emotions, and impaired performance. They are more likely to detect somatic symptoms and environmental changes and are more affected by caffeine, hunger, pain, intense sensory input, and others' emotions (Aron & Aron, 1997). For example, research has found that dentists high in ease of excitation experience greater burnout and lower job satisfaction due to their heightened perception of patients' fear and pain (Meyerson et al., 2020). High ease of excitation individuals show greater heart rate elevations when encountering environmental changes (Kagan & Snidman, 2004) and exhibit cortisol increases in certain special populations (Ellis et

al., 2006; McLean et al., 2020). Thus, individuals with high ease of excitation are more likely to be affected by changes under stress.

Evers et al. (2008) examined perceived stress levels at work and found that ease of excitation correlated highly with occupational stress—higher ease of excitation predicted stronger perceived stress, greater job dissatisfaction, and poorer recovery. Vander Elst et al. (2019) also found that individuals with high ease of excitation experienced greater emotional exhaustion when facing high job demands compared to those with low ease of excitation. Research further indicates that ease of excitation significantly correlates with anxiety, depression/tendency, and well-being, with high ease of excitation individuals being more prone to anxiety, depression, and lower well-being and mental health levels (Ahadi & Basharpoor, 2010; Liss et al., 2008; Takahashi et al., 2020; Wu et al., 2021; Yano & Oishi, 2018). In summary, individual differences in ease of excitation are highly related to stress responses.

More importantly, ease of excitation is closely related to decision-making behavior. According to Reinforcement Sensitivity Theory (RST), when individuals encounter environmental changes and novel stimuli, they make different strategic choices (such as approach or avoidance behaviors) based on how they process environmental and stimulus information. Individuals with different levels of ease of excitation exhibit varying sensitivity to environmental changes and novel stimuli, leading to different processing styles and consequently different strategic choices and decision-making behaviors under such circumstances.

Smolewska et al. (2006) investigated the relationship between ease of excitation and strategic choice styles in decision-making through questionnaire surveys, finding that individuals high in ease of excitation may exhibit more conservative behavioral tendencies to avoid negative outcomes and unpleasant emotions. Further research has linked this behavioral tendency to relatively decreased prefrontal cortex activation and amygdala activity (Rizzo-Sierra, 2012). These preliminary findings suggest that ease of excitation, as an index of sensitivity to internal and external changes, is not only related to stress responses but may also influence risk decision-making behavior.

A classic theory in decision-making—the Somatic Marker Hypothesis (Damasio & Tranel, 1991)—posits that decision-making is guided by "somatic marker signals" (such as emotions and feelings), which may be unrelated to the current decision context (Bechara, 2004; Naqvi et al., 2006). Therefore, although the physiological and emotional reactions triggered by stress are unrelated to the risk decision-making task itself, decision-makers' risk tendencies are still influenced by stress responses, with individual sensitivity to stress responses potentially playing a moderating role. However, systematic experimental evidence remains lacking regarding how individuals with different levels of ease of excitation exhibit different risk tendencies under stress.

Based on this, the present study employed the Trier Social Stress Test (TSST) to induce acute stress responses and used the Balloon Analogue Risk Task

(BART) to measure individual behavioral tendencies in risk decision-making. We examined how physiological stress responses, particularly cortisol and heart rate changes, affect risk-taking tendencies, and used the Highly Sensitive Person Scale (Aron & Aron, 1997) to assess individual ease of excitation, exploring its moderating role in the stress-decision relationship. Building on previous research, we proposed two hypotheses: (1) acute psychological stress-induced cortisol and heart rate responses would correlate with risk-taking tendencies; and (2) ease of excitation would moderate the relationship between stress responses and risk-taking, such that individuals with high ease of excitation would show risk tendencies more susceptible to stress responses, while those with low ease of excitation would be less affected.

Method

2.1 Participants

To determine the required sample size, a power analysis was conducted using G*Power 3.1.9.2 software (Faul et al., 2007). Results indicated that a linear multiple regression analysis required at least 34 participants to achieve a statistical power of 0.8 ($\alpha = 0.05$, $f^2 = 0.25$). Therefore, we recruited 43 healthy male college students aged 19–27 years (M = 22.26, SD = 2.06). Given that female cortisol levels are subject to substantial fluctuations due to menstrual cycle and medication use (e.g., oral contraceptives), female participants were not included in this study (Kudielka et al., 2009).

Participants were screened according to the following criteria to avoid potential confounding factors: (1) no prior experience with saliva collection experiments (used as an indirect screening method for previous stress induction participation); (2) no endocrine disorders such as thyroid or adrenal diseases, and no use of endocrine-related medications (e.g., hormonal drugs) within the past month; (3) no psychiatric or neurological disorders; (4) no periodontitis or oral wounds (including oral ulcers); (5) no cold, allergies, or acute episodes of chronic diseases, and no medication use within the past two weeks; (6) no excessive alcohol consumption (more than 100g daily) or smoking (more than 5 cigarettes daily); (7) no chronic symptoms of anxiety, depression, or insomnia, and no long-term reversed sleep-wake cycles; (8) normal body mass index; and (9) normal or corrected-to-normal vision.

During post-experiment debriefing, we discovered that one participant misunderstood the task instructions. Additionally, four participants were excluded due to insufficient saliva volume (three or more saliva samples failing to meet the minimum detection quantity), resulting in missing data. Consequently, data from these five participants were excluded, leaving 38 participants for subsequent analyses.

2.2 Experimental Procedure

Participants were instructed to avoid eating any food except plain water within two hours before arriving at the laboratory, to refrain from strenuous exercise, and to ensure adequate sleep. Considering the circadian rhythm of cortisol (Dickerson & Kemeny, 2004), all experiments were conducted between 13:30 and 18:00. The overall experimental procedure is illustrated in Figure 1 [Figure 1: see original paper]. Upon arrival, participants were re-screened for eligibility and provided informed consent. After completing the Highly Sensitive Person Scale and other questionnaires, participants rested for 30 minutes before baseline physiological data (cortisol and heart rate) and negative emotion ratings were collected in a relaxed state (S1). Following instructions on the BART rules, participants completed practice trials before undergoing the TSST. Immediately after the stress test, the second physiological and emotional measurements were collected (S2, 0 minutes), with subsequent collections at 15 minutes (S3) and 30 minutes (S4) post-stress test.

2.3 Stress Induction Procedure

The TSST incorporates social evaluative threat and uncontrollable elements, similar to workplace evaluation pressures and complex operational environments faced in high-pressure positions. Numerous studies have demonstrated that this test robustly induces cortisol responses that persist for extended periods (Dickerson & Kemeny, 2004), making it suitable for investigating cortisol effects on risk-taking under stress. Moreover, comparative research (Buchanan et al., 2012) has shown that the modified TSST (Buchanan et al., 2012; Buchanan et al., 2014) more effectively induces stress responses than the original version and has been widely applied in acute stress studies with Chinese participants (Jiang et al., 2017; Wu et al., 2017). Therefore, this study employed the modified version. The test comprises three phases—preparation, speech, and mental arithmetic—each lasting 5 minutes (total 15 minutes). Participants' performances were recorded by a video camera during the latter two phases.

First, the experimenter introduced the task scenario to participants in the preparation room: they were asked to imagine being accused of shoplifting in a supermarket and needed to prepare a speech to defend themselves before supermarket managers. Participants could take notes during preparation but had to deliver the speech without notes. After preparation, participants were guided to another room to complete the speech and mental arithmetic tasks. Three "supermarket managers" (one male, two female) sat in the room, all strangers to the participant, wearing white coats and maintaining serious expressions throughout. Participants began their timed speech immediately, presenting their defense to prove their innocence. After the speech, participants performed serial subtraction starting from 1022, subtracting 13 continuously. If an error occurred, they were instructed to restart from 1022. The mental arithmetic task lasted for 5 minutes.

2.4 Balloon Analogue Risk Task

We used the Balloon Analogue Risk Task (Lejuez et al., 2002) to measure risk-taking tendencies. As a classic naturalistic risk-taking paradigm, BART features risk that increases steadily as the balloon inflates, providing a more direct and natural definition of risk level that parallels the escalating tension in many real-world risk scenarios. The task has demonstrated high reliability and ecological validity (White et al., 2008). Task parameters in this experiment followed Fein and Chang (2008), with stimulus materials identical to those used in Gu et al. (2018) (see Figure 2 [Figure 2: see original paper]). Participants were seated 100 cm from the screen. Four practice trials preceded the formal experiment to familiarize participants with the task rules. To control for practice effects, explosion points in practice trials were pseudo-randomized.

In each trial, a red fixation cross appeared for 1000 ms, followed by a red balloon (initial visual angle: $3° \times 3.5°$). Below the balloon, the number of pumps and current points were displayed. The text "Please choose" appeared at the balloon's center, indicating that the participant could make a decision without time pressure. Participants could press the "F" or "J" key to inflate the balloon or stop pumping and collect the points. The key assignments for pumping and cashing out were counterbalanced across participants. After choosing to pump, the text disappeared, and feedback was presented after 1000–1200 ms. Two outcomes were possible: the balloon inflated by 5% of its original area and points increased, or the balloon exploded, displaying an exploded balloon image and resetting the trial's points to zero. Feedback duration was 1200 ms for both outcomes.

The predetermined explosion point was randomly distributed between 2–12 pumps (Fein & Chang, 2008; Kiat et al., 2016). The first pump never caused explosion; the second pump had a 1/11 probability of explosion, the third 1/10, the fourth 1/9, and so on, with explosion guaranteed at the twelfth pump (Lejuez et al., 2002). These parameters were not disclosed to participants. Each successful pump added 2 points (i.e., 2 points for the first pump, 4 for the second, 6 for the third, etc.) (Fein & Chang, 2008; Kessler et al., 2017).

Based on pilot results, completing 60 trials required approximately 20 minutes. Considering that salivary cortisol levels peak approximately 15 minutes after stressor onset (Dickerson & Kemeny, 2004), the decision task was divided into two blocks of 30 trials each to capture peak cortisol responses. A 3-minute break between blocks allowed for saliva collection, heart rate measurement, and emotion ratings.

The primary behavioral index was the mean adjusted number of pumps—the average number of pumps on non-exploded trials. Higher average pump counts indicate greater risk-taking tendencies (Lejuez et al., 2002).

2.5 Physiological and Psychological Measures

2.5.1 Cortisol Response We collected saliva samples using internationally standard disposable saliva collection tubes (Sarstedt, Rommelsdorf, Germany). Participants held a sterile cotton swab in their mouth for 1–2 minutes until fully saturated. Samples were stored at –22°C. Salivary cortisol concentrations were assayed using the second-generation Roche Cortisol II assay kit (Roche Diagnostics, Numbrecht, Germany), with a sensitivity of 1.5 nmol/L, detection range of 1.5–1750 nmol/L, and inter- and intra-assay coefficients of variation below 12.7% and 7.1%, respectively. Cortisol peak change rate, calculated as (peak cortisol minus baseline) divided by baseline, served as the index of cortisol change under stress (Drexler & Wolf, 2017; Hucklebridge et al., 2000).

2.5.2 Heart Rate Response As a physiological index of sympathetic nervous system activation, real-time heart rate data were collected and stored using a Polar device (RS800CX, Polar Electro, Finland), comprising a chest-worn sensor strap and a wrist-worn watch. Data were exported using Polar Pro Trainer software. Mean heart rates were analyzed across five phases: baseline (5 minutes), speech and mental arithmetic periods (continuous 10 minutes), and 0, 15, and 30 minutes post-stress test (3 minutes each). Similar to cortisol change calculation, heart rate peak change rate—(peak heart rate minus baseline) divided by baseline—served as the index of heart rate change under stress.

2.5.3 Emotional Response The Positive and Negative Affect Schedule (PANAS) (Watson & Clark, 1988) measured emotional changes before and after the stress test. The scale includes positive affect (e.g., "inspired," "enthusiastic") and negative affect (e.g., "upset," "hostile") dimensions, each comprising 10 items rated on a 5-point scale from "very slightly or not at all" to "extremely." Based on previous literature showing that the TSST increases negative affect, we used negative affect scores as a psychological index of stress induction effectiveness (Feldman et al., 1999).

2.6 Data Analysis

Data were analyzed using SPSS 22.0, with statistical significance set at $\alpha = 0.05$ (two-tailed). First, to verify successful stress induction, one-way repeated measures ANOVAs were conducted with measurement time as the independent variable on cortisol, heart rate, and negative affect scores. Second, Pearson correlation analysis examined relationships among variables. Finally, to test the moderating effect of ease of excitation, hierarchical regression was performed separately for cortisol and heart rate models: cortisol peak change rate and ease of excitation were mean-centered; the product of these centered variables was computed to create the interaction term; centered cortisol peak change rate and ease of excitation were entered in Step 1, and the interaction term in Step 2. The same procedure was applied to heart rate peak change rate.

Results

3.1 Manipulation Check

Results showed significant main effects of measurement time for all three stress indices (cortisol: $F(3, 111) = 36.56$, $p < 0.001$, $^2p = 0.50$; heart rate: $F(4, 148) = 81.80$, $p < 0.001$, $^2p = 0.69$; negative affect: $F(3, 111) = 14.39$, $p < 0.001$, $^2p = 0.29$). Variable change curves are shown in Figure 3 [Figure 3: see original paper].

Salivary cortisol levels at all post-stress test stages (6.94 ± 3.37 nmol/L; 9.96 ± 5.26 nmol/L; 7.60 ± 3.92 nmol/L) were significantly higher than baseline (3.93 ± 1.73 nmol/L) (all ps < 0.001), peaking at 15 minutes post-stress test, which was significantly higher than other post-stress stages (all ps < 0.001). Heart rate peaked during the stress test (92.89 ± 12.54 bpm), significantly higher than baseline (77.55 ± 8.42 bpm) and all post-stress periods (76.74 ± 10.94 bpm; 77.21 ± 8.45 bpm; 76.82 ± 7.89 bpm; all ps < 0.001). No significant differences existed among post-stress stages (all ps ≥ 0.44). Negative affect peaked immediately after the stress test (2.10 ± 0.64), significantly higher than baseline (1.65 ± 0.48) and other post-stress stages (1.71 ± 0.51; 1.61 ± 0.50) (all ps < 0.001), with the 15-minute stage significantly higher than the 30-minute stage ($p = 0.01$); other stage differences were non-significant (all ps ≥ 0.44).

3.2 Correlation Analysis

Cortisol peak change rate marginally correlated with mean pump count ($r = 0.31$, $p = 0.06$), indicating that greater cortisol changes under stress were associated with more pumps. Heart rate peak change rate did not correlate with pump count ($r = –0.01$, $p = 0.95$) but significantly correlated with ease of excitation ($r = 0.34$, $p = 0.04$), such that higher ease of excitation predicted greater heart rate changes under stress. All other variable correlations were non-significant (all ps ≥ 0.29).

Table 1 presents descriptive statistics and correlation results for all variables.

3.3 Moderating Effect

Hierarchical regression results for cortisol are shown in Table 2 . Ease of excitation significantly moderated the relationship between cortisol change under stress and risk-taking ($B = 0.04$, $\beta = 0.39$, $p = 0.03$, 95% CI: [0.01, 0.07]). Simple slope tests (Figure 4 [Figure 4: see original paper]) revealed that when ease of excitation was one standard deviation below the mean, cortisol peak change rate did not significantly predict mean pump count ($\beta = –0.18$, $p = 0.49$, 95% CI: [–0.50, 0.24]). However, when ease of excitation was one standard deviation above the mean, cortisol peak change rate significantly and positively predicted pump count ($\beta = 0.86$, $p = 0.01$, 95% CI: [0.20, 1.03]). In contrast, ease of excitation did not moderate the relationship between heart rate change under stress and risk-taking ($B = 0.06$, $\beta = 1.06$, $p = 0.68$, 95% CI: [–0.23, 0.35]).

Discussion

This study examined the relationship between cortisol responses under acute stress and risk-taking tendencies, and the moderating role of ease of excitation. Results showed significant increases in cortisol, heart rate, and negative affect from baseline following the stress task, with gradual recovery to baseline levels, confirming that the TSST effectively induced acute stress responses. Correlation analysis indicated that pump count under stress was unrelated to heart rate changes but marginally related to cortisol changes—greater cortisol change rates predicted more pumps and riskier behavior. More importantly, ease of excitation significantly moderated the relationship between cortisol and risk-taking under stress: for low ease of excitation individuals, cortisol changes could not predict risk-taking, whereas for high ease of excitation individuals, greater cortisol increases under stress predicted more risk-taking behavior.

Our findings demonstrate a positive relationship between cortisol change rate under stress and risk-taking tendencies. Previous TSST studies have similarly shown that stronger cortisol responders perform more poorly on the Iowa Gambling Task, exhibiting riskier behavior (van den Bos et al., 2009). Buckert et al. (2014) used a group TSST and found that participants with cortisol increases above 2.5 nmol/L were more risk-taking than those with smaller increases. Starcke et al. (2008) reported that higher cortisol levels in the stress group predicted lower scores and more frequent selection of the riskiest options in the Game of Dice Task. Studies using direct cortisol administration have reported similar patterns (Kluen et al., 2017; Putman et al., 2010). These findings collectively support our cortisol-risk behavior relationship results.

Although we did not replicate the positive relationship between heart rate changes under stress and risk-taking, this is understandable. Research on heart rate and risk decision-making remains limited. While Wemm and Wulfert (2017) found that greater heart rate elevation predicted riskier decisions in men, their stress group included only 11 male participants, with insufficient sample size potentially biasing results. Heart rate, as the primary physiological index of the fast-reacting SNS, typically returns to baseline within approximately 5 minutes after stressor offset (e.g., Singer et al., 2017; Wu et al., 2017). Consequently, the fast-reacting system was not activated during the risk decision-making task. In contrast, cortisol responses peak approximately 10–20 minutes post-stressor (Petrowski et al., 2010; Rimmele et al., 2009), placing the decision task within the cortisol response peak period. Thus, cortisol shows stronger temporal coupling with the decision task than heart rate.

Further hierarchical regression analysis revealed that individuals high in ease of excitation were more susceptible to the influence of cortisol changes under stress on risk-taking. A possible explanation is that high ease of excitation individuals are more alert to stimuli and environmental changes and are more easily activated or aroused by internal and external stimuli (Liss et al., 2008; Smolewska et al., 2006). When large amounts of cortisol are released under

stress, these individuals may more intensely experience physiological changes and exhibit stronger risk-taking tendencies under cortisol arousal. According to Reinforcement Sensitivity Theory, the balance between behavioral inhibition and approach systems plays a crucial role in decision-making. Under normal conditions, the behavioral inhibition system dominates, leading to relatively conservative behavior in uncertain situations—"stop, look, listen, and prepare to respond" (Gray, 1991, p. 110). However, under high physiological arousal, high ease of excitation individuals show reduced behavioral inhibition system function and weakened inhibitory effects (Smolewska et al., 2006), leading to enhanced preference for immediate rewards and more risk-taking behavior under cortisol influence (Starcke & Brand, 2016). Conversely, low ease of excitation individuals are less affected by internal and external stimuli, show relatively less sensitivity to physiological state changes, and experience smaller psychological functional changes, thus maintaining their usual risk tendencies even under cortisol influence.

These results partially support the Somatic Marker Hypothesis (Damasio & Tranel, 1991). Although the stress test was unrelated to the decision-making task itself, high ease of excitation individuals' decisions were significantly influenced by stress hormones. One possible reason is that due to their heightened sensitivity to external stimuli and internal changes, high ease of excitation individuals more acutely detect somatic signal changes and may mistakenly interpret cortisol level fluctuations as "somatic marker signals" to guide decision-making.

Regarding stress intensity, participants' cortisol peak change rates in this study were comparable to those observed in more natural high-pressure scenarios in previous research, such as firefighting tasks (Rosalky et al., 2017), suggesting that our induced stress level reached "high-pressure" conditions similar to real work scenarios. Thus, our findings are generalizable to actual operational contexts. Second, this study not only theoretically reveals how individual differences affect risk-taking under stress but also provides practical guidance for high-pressure engineering operations. While engineering psychology research has found that stress affects risk behavior (Chang et al., 2017), few studies have examined individual differences in these effects. Our results indicate that high ease of excitation individuals are more likely to exhibit different behaviors in high-pressure environments (e.g., emergency situations) than in low-pressure conditions. This reveals the underlying reasons for behavioral differences in decision errors across populations—high ease of excitation individuals are more vulnerable to stress effects and show riskier behavior than others when encountering emergencies. This suggests that in personnel selection for high-pressure positions, beyond basic demographic variables, measures of sensitivity traits such as ease of excitation should be included to help identify candidates better suited for high-pressure roles.

This study has several limitations. First, due to sample size constraints, the correlation between cortisol change rate and risk-taking only reached marginal significance. Future research should expand sample sizes or employ multiple

studies using other classic risk decision paradigms to validate our findings. Second, because female cortisol levels show substantial fluctuations (Kirschbaum et al., 1999; Kudielka & Kirschbaum, 2005), many cortisol studies have excluded female participants (Pabst et al., 2013; Putman et al., 2010; Yamakawa et al., 2016). Consequently, our conclusions may not generalize to female populations. Future research should expand samples and strictly control for menstrual cycle and medication use to validate the cortisol-risk-taking relationship in women.

In summary, this study found that under acute stress, the relationship between cortisol changes and risk-taking is moderated by ease of excitation. Individuals with high ease of excitation show increased risk-taking as cortisol increases. This may be related to their heightened sensitivity and arousability to internal and external stimuli. Building on previous stress research, our findings further emphasize the importance of individual difference factors, particularly ease of excitation, providing deeper understanding of stress-related decision errors and their mechanisms, and offering insights for reducing decision-making risks in stressful situations and enhancing scientific personnel selection for high-pressure positions.

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