Immediate Emotions and Subjective Stakes in Risky Decision-Making under Uncertainty

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Background: Previous research has shown that immediate emotions and cognitive processing of the stakes of outcomes influence decision-making under uncertainty. The effects of perceived beneficial stakes and different types of immediate emotions on decision-making is an important topic that has received little attention in the literature. This study investigated the effects of trait anxiety and anticipatory emotions (fear, sadness, excitement and comfortability) on the perception of thee stakes of outcomes and behavioural intentions. **Method**: Participants from the community completed a task measuring anticipatory emotions and their perceived stakes of risky and beneficial outcomes in a range of uncertain situations. Trait anxiety was also measured. **Results:** Results revealed that anticipatory emotions (except for sadness), trait anxiety and subjective stakes all demonstrated significant associations with risky behavioural intention in uncertain situations. Anticipatory emotions, but not trait anxiety, had stable effects on stake perceptions. However, trait anxiety moderated the effect of excitement on risky behavioural intention. In addition, positive emotions (comfortability and excitement) and beneficial stakes demonstrated consistent effects in the decision-making process. **Conclusions:** The current study sheds light on future immediate-emotion-based interventions for deficits in uncertain decision-making.

Keywords: anticipatory emotions; immediate emotions; risk; decision-making; anxiety; uncertainty

People make decisions under conditions of uncertainty when they are not sure what outcomes will follow these decisions (Loewenstein et al., 2001). The outcomes of a risky option may involve potential losses, gains, or both losses and gains (Charpentier et al., 2017; Schonberg et al., 2011; Smithson, 2010). Decision-making involves evaluating the outcomes of possible choice alternatives based on subjective stakes or values (aversive stakes for losses that indicate the severity of negative outcomes and beneficial stakes for gains that indicate the favourability of positive outcomes) and the probabilities of those outcomes occurring (Einhorn & Hogarth, 1985; Loewenstein & Lerner, 2003; Loewenstein et al., 2001).

Individuals vary in their preference for options in a given situation as a result of differences in subjective stakes and/or probabilities.

Researchers have been interested in how different kinds and aspects of emotions influence decision making under uncertainty (Kusev et al., 2017). There has been increasing attention on the effects of immediate emotions, which are emotions that are experienced at the time of the decision (Bishop & Gagne, 2018; Lerner et al., 2015). The feelings-as-information theory postulates that people attend to their immediate emotions as a source of information (Schwarz, 2011). Feelings are conditioned to reflect whether the events in the environment are beneficial or aversive, which, in turn, provides feedback to stake evaluation (Schwarz, 2011; Schwarz & Clore, 1983, 2003). However, research often fails to clarify which specific type of immediate emotion is being examined, which can lead to confusion in understanding the effects of emotions. Loewenstein and Lerner (2003) propose that the immediate emotions experienced by decision-makers are the combined effect of incidental and anticipatory emotions. The incidental emotions can derive from stable trait-like dispositional moods and situational emotions that are elicited by events other than the decision at hand. In contrast, anticipatory emotions stem from thinking about the future consequences of the decision at hand. Based on the feelings-as-information theory, anticipatory emotions and cognitive processing of stakes and probability are related (Loewenstein et al., 2001; Schwarz & Clore, 2003), while anticipatory emotions can have effects on risk-taking tendency independent of cognitive evaluations (Loewenstein et al., 2001). This study aims to investigate the effects of different types of immediate emotions in risky decision-making and explore the potential interactions between these different types of emotions.

Interaction between anticipatory and incidental emotions

Given that decision-makers often experience incidental emotions and anticipatory emotions simultaneously, it is possible that the two interact in decision-making (Gasper & Clore, 1998; Loewenstein & Lerner, 2003). Previous studies have focused on the associations between trait anxiety (TA) and state anxiety as an example of this interaction (Endler & Kocovski, 2001). TA makes people perceive things as more relevant to their state anxiety (Gasper & Clore, 1998), which leads to greater informational influence of the state anxiety on decisions. In terms of the associations between incidental anxiety and anticipatory emotions, the incidental influence from an anxiety disorder can increase the intensity of negative anticipatory emotion, while decreasing the intensity of positive anticipatory emotion (Henker et al., 2002; Suveg & Zeman, 2004). It was also found that TA was positively associated with increased physiological responses in anticipation in decision making (Miu et al., 2008). However, not many studies have investigated the interaction between incidental anxiety and anticipatory emotions on decision-making processes. The limited studies that have explored this area have indicated that trait social anxiety may have inhibitory effects on experiencing positive anticipatory emotions and, in turn, inhibit positive perceptions of social risk-taking (Kashdan & Steger, 2006).

The Influence of Immediate Emotions on Decision-Making

Most of the literature in the area of emotions and decision-making has focused on negative emotions and the aversive stakes of a decision (Lerner et al., 2015; Loewenstein & Lerner, 2003) and shows that negative emotions increase aversive subjective stakes (Lerner et al., 2015; Levy, 1992; Schwarz, 2011). However, beneficial stakes and positive emotions have been overlooked and received little attention in the literature (Schonberg et al., 2011). It is possible that positive emotions may signal beneficial outcomes and increase subjective beneficial stakes of the emotion-relevant decision (Schwarz, 2011). Alhakami and Slovic

(1994) showed that negative anticipatory emotions, such as feeling unpleasant, awful or painful, elicited by certain events led to low beneficial stake perception. However, MacLeod and Byrne (1996) found that people high in incidental anxiety, as a specific negative emotion, did not generate less future beneficial events compared to a control group. These mixed findings suggest that understanding the effects of emotions on decision-making requires a differentiation of different kinds of immediate emotions and going beyond simply categorising emotions as positive or negative (DeSteno et al., 2000; Lerner & Keltner, 2000). The following sections will explore the effects of one incidental mood (TA) and four anticipatory emotions (sadness, fear, excitement and comfortability) in uncertain decision-making.

Previous studies have shown that highly trait-anxious individuals are more likely to interpret uncertainty as threatening and are more likely to pay attention to threatening stimuli and negative events (Derakshan & Eysenck, 1997; Gasper & Clore, 1998). A number of studies have demonstrated that TA is associated with elevated subjective aversive stakes under conditions of uncertainty (Butler & Mathews, 1983; Hartley & Phelps, 2012; Mitte, 2007; Stöber, 1997) and reduced anticipation of positive outcomes (MacLeod et al., 1997). However, little research has directly investigated the link between TA and stakes of positive outcomes. It is likely that individuals with higher TA underestimate the value of positive outcomes as a result of paying less attention to those outcomes. As such, a direct examination of the link between TA and positive stakes is warranted.

In terms of risk-taking tendency, theoretically, higher perceived aversive stakes alongside high TA would lead to avoidant behaviours in order to protect against potential risks. However, findings in the literature are mixed. Some studies have supported this hypothesis (Gambetti & Giusberti, 2012; Maner et al., 2007; Maner & Schmidt, 2006; Raghunathan & Pham, 1999), while others did not find a significant link between TA and

risk-taking tendency (Gu et al., 2017). Despite the fact that different studies use different measures of risk-taking tendency (from abstract behavioural tasks to survey-based risk-taking tendency), it should also be noted that the reported correlations between TA and risk taking tendency were all negative but small (between around -0.1 to -0.2) and were based on student samples.

Regarding anticipatory emotions, this study adopted the arousal-based hypothesis for selecting four anticipatory emotions. Sadness is a negative and low arousal emotion, derived from the appraisal of loss and misfortune (Raghunathan & Pham, 1999). Lab-induced sadness is associated with greater risk-taking tendency for a higher reward in the gain-domain (Raghunathan & Pham, 1999). In addition, situational sadness was found to be related to greater purchasing behaviours in consumers (Cryder et al., 2008). Sad decision-makers pursue benefits to compensate for the feelings of loss and misfortune, which implies increased subjective beneficial stakes. However, the effect of anticipatory sadness has rarely been investigated.

Fear is a negative and high arousal emotion. It is associated with perceptions of uncertainty of an outcome, along with low control over a situation (Raghunathan & Pham, 1999). Similar to anxiety, fear is positively associated with a higher perception of aversive stakes and, thus, lower risk-taking tendency (Lerner et al., 2007; Heilman et al., 2010).

Excitement is a positive, high arousal emotion that is triggered by uncertainty in the future but is focused on future benefits (Baumgartner et al., 2008; Lee & Andrade, 2015). A study by Lee and Andrade (2015) reported that, in the financial domain, anticipatory excitement is associated with viewing the world more optimistically, which inferred increased subjective beneficial stakes and decreased aversive stakes.

Comfortability is positive and low in arousal since it refers to feeling relaxed, ease from pain and relief from worries (Dobrzykowski, 2017). Comfortability is rarely

investigated in risky decision-making even though it is used in uncertainty-relevant inventories such as the Personal Uncertainty Scale (Clampitt et al., 2000).

The Current Study

Previous research has not clearly distinguished different types of immediate emotions, and thus has neglected the potential interactions among different types of immediate emotions and decision-making. In addition, limited attention has been paid to positive outcomes and the effects of positive emotions on the decision-making process. The current study aims to investigate the associations between risky behavioural intention under uncertainty and patterns of emotional activity among individuals with different levels of TA by investigating the role of subjective beneficial and aversive stakes. Figure 1 illustrates the hypothesised pattern and associations.

In the study, participants rated TA levels, anticipatory emotions, aversive/beneficial subjective stakes and behavioural tendency across various uncertain situations. Firstly, it is hypothesised that TA (H1a) and negative anticipatory emotions (fear and sadness) (H1b) will be positively correlated with aversive stakes, while positive anticipatory emotions (excitement and comfortability) (H2c) will be negatively correlated with aversive stakes; TA (H1d) and negative anticipatory emotions (H1e) will be negatively correlated with beneficial stakes, while positive anticipatory emotions (H1f) will be positively correlated with beneficial stakes.

Regarding the relationship between anticipatory and incidental emotions, it was hypothesised that TA level would be negatively correlated with positive anticipatory emotions and positively correlated with negative anticipatory emotions (H2). It is also hypothesised that TA will moderate the effects of the four anticipatory emotions, amplifying the associations of these emotions with subjective stakes (H3).

Finally, we investigated how emotions influence risky behavioural intention via their influence on subjective stakes. The risk-as-feelings hypothesis argues that dispositional emotions, anticipatory emotions and cognitive perceptions of the stakes of the outcomes have independent influences on risky behavioural intention. It is hypothesised that aversive stakes, TA, fear and sadness will be negatively associated with risky behavioural intention (H4a), while the positive stakes, excitement and comfortability, will be positively associated with risky behavioural intention (H4b). In addition, it was hypothesised that TA will moderate the effects of fear and sadness, amplifying the negative associations of these emotions with risky behavioural intention (H4c). TA will also moderate the effects of excitement and comfortability, by reducing the positive associations of these emotions with risky behavioural intention (H4d).

Method

Participants and Procedure

The initial sample consisted of 120 English-speaking community participants recruited from Prolific. Participants completed a pre-test survey that screened their familiarity of the situations that would be used in the main task, as participants are unlikely to provide meaningful responses if they have never heard of the given situation. Participants also completed the State-Trait Anxiety Inventory – trait anxiety subscale (STAI – Y2) in the pre-test survey. One participant who failed the attention check in the pre-test survey and 23 participants who reported "never heard of" to one or more situations in the main task were not invited to the main task. Ninety-seven participants were invited to the main task and eighty-four participants among them completed the main task. Four participants were excluded from the data-analysis due to failing the attention check. The remaining 80[1]

[1] To our knowledge, there was no well-established methods to compute power for the mixed-effects ordinal regression we were applying. G*Power using fixed-effect logistic regression as an approximation indicates that a minimum of 881 observations are required for detecting a small effect size (Odds ratio = 1.22, Oliver, May & Bell, 2017) at a power of 0.9 and a significance level of 0.05. Ali et al. (2016)'s simulation study indicates that

participants had a mean age of 35.90 (*SD* = 10.51), ranging from 19 to 64. All participants spoke English as their first language (*n* = 79) or fluently (*n* = 1). Among all the participants, 33.8% were males, 85% were Caucasian, and 56.3% had completed at least a tertiary education. The survey was conducted on the Qualtrics^{TM} survey platform. Participants were presented with the participant information sheet on the first page of the survey, provided informed consent by indicating that they agreed to participant in this study, and, finally, submitted the completed survey. Participants were remunerated £0.6 for completing the pre-test survey. Participants who completed the main task were remunerated additional £2.5 for their participation. This study was approved by the Human Research Ethics Committee at the Australian National University (Protocol number: 2017/513).

Materials

The State-Trait Anxiety Inventory – Trait Scale (STAI-Y2)

The trait scale of the STAI-Y2 (Spielberger, 1983; Speilberger & Vagg, 1984) consists of 20 items rated on a 4-point Likert scale (1 = *Almost never*, 4 = *Almost always*). The total score is used to indicate the level of TA. Higher total scores indicate higher TA levels. For the present sample, the internal consistency of STAI-Y2 was high, with a Cronbach's alpha of .94.

Uncertainty Situations and Ratings

The main task included 30 uncertain real-life situations selected from the item pool reported in Shou and Olney (2020). The authors generated a range of real-life situations from previous scales (such as the Domain-Specific Risk-Taking scale [Weber et al., 2002]) and lay persons' qualitative data. The situations covered ethical, financial, health, recreational (safety-related), recreational, and social domains to capture the patterns of decision-making more

50 groups (participants) with a group size of 30 (30 responses per participant) would lead to a power over 0.85 for five-category mixed-effects ordinal model. In addition, from the viewpoint of having accurate parameter estimation, a minimum of 420 observations (20:1 data-point to parameter ratio) are required for estimating fixed-effect parameters in the largest model in H4 (9 thresholds and 12 predictors). The current sample of 80 participants that provided 2400 observations in total (30 responses per person) would be sufficient.

comprehensively in people's lives (see Supplementary Table S1 for the selected situations).

Pre-test familiarity ratings. Participants were first required to rate their familiarity with the subject matter of the 30 situations. For example, for the item "logging working hours", participants rated familiarity on a 6-point Likert scale (1 = *Never heard of*, 6 = *Extremely familiar*). The 30 items were presented to participants in a randomised order.

Main rating task. The content of the situations chosen to represent each domain needed to be substantially different from each other to make sure that the collection of situations covered a wide range of events in that domain. One example is "logging more working hours than you have actually done when you don't know whether or not your supervisor will investigate". The first half of the sentence indicates a situation might induce either potential benefits or loss. The second half of the sentence specifies the uncertainty around the behaviour, in which the positive or negative outcomes of the behaviour are not known.

For each situation, participants rated their anticipatory emotions, subjective stakes and risky behavioural intention, in that order. This order is consistent with the decision-making model proposed by the risk-as-feelings hypothesis (Lowenstein et al. 2001). Participants were asked to rate the intensity of their anticipatory emotions elicited by each situation. Participants rated the intensity of sadness, fear, excitement and comfortability that they felt when they imagined experiencing these situations on a 9-point Likert scale (ranging from 'Not *at all'* to '*Extremely*'). Questions were phrased as *"In general, how do you feel about this situation."*

Given the same situation, participants rated their subjective stakes (i.e., how important the consequences could be for them) for negative outcomes (aversive stakes) and positive outcomes (beneficial stakes) on a 10-point Likert scale. For the aversive (beneficial) stake question, a specific negative (positive) outcome was given. For example, for the logging working hours situation mentioned above, the aversive outcome was *'Getting caught'* while

the beneficial outcome was '*Getting more pay'*. The question was phrased "*If the outcome following this situation is this (i.e. which has already happened): Getting caught (Getting more pay). How severe (beneficial) do you think this outcome is?"* In the question, it was specified that participants should imagine that these outcomes have already happened to control the outcome probabilities.

Finally, participants were asked to imagine that they were facing this situation and to consider how likely they were to engage in the behaviour (e.g., *"How likely are you to engage in this behaviour?"*), responding on a 10-point Likert scale ranging from 1 = "*Not likely at all"* to 10 = "*Extremely likely*".

Data analysis

Mixed-effects ordinal logistic regression was used to examine the associations among the endorsement of various variables. In each regression model, the dependent variable was treated as an ordered factor, all predictor variables were standardised and familiarity was included in all models as a controlling variable. A series of hierarchical mixed-model ordinal logistic regressions were conducted to test hypotheses H1 and H3 to identify the individual contribution of each step. The χ^2 test of log-likelihood change ($\Delta\chi^2$) between two models was used to compare the model fit, while the AIC/BIC of each model was used when testing the model complexity. For testing the moderation effect of anxiety on immediate emotions, forward stepwise procedure was used to select the best model. A final model with best AIC/BIC values was used to interpret the results. The ordinal regression models were performed using R program version 3.6.2 with the 'ordinal' (Christensen, 2019) and 'mixor' packages (Hedeker et al., 2015).

Results

The effects of immediate emotions on subjective stakes

The descriptive statistics of variables are displayed in Table 1. Hierarchical mixed-model logistic regression models were conducted to predict aversive and beneficial stakes (in separate models) from immediate emotions. Step 1 included familiarity as the controlling variable and TA. In the Step 2 model, four anticipatory emotions were added to test the hypothesis that anticipatory emotions would influence subjective stakes. Next, interaction terms between TA and anticipatory emotions were added to test the hypothesis that moderation effects of TA on anticipatory emotions influence subjective stakes. The forward stepwise procedure was used to determine retention of the specific interaction term for the final model.

Results for subjective aversive stake are displayed in Table 2. TA was significantly positively associated with subjective aversive stakes (Step 1), partially supporting the hypothesis that higher TA would predict higher aversive stakes (H1a). However, the effect reduced after anticipatory emotions were included, which indicated that the effect overlapped with anticipatory emotions. Anticipatory fear and sadness were positively associated with aversive stakes, while comfortability and excitement were negatively associated with aversive stakes. This supported the hypothesis that negative (positive) anticipatory emotions would be positively (negatively) associated with aversive stakes (H1b, H1c).

Results for subjective beneficial stake are also displayed in Table 2. Since the effect of TA was not significant in Step 1, hypothesis H1d, that TA would directly influence subjective beneficial stakes, was not supported. The final model indicated that sadness was negatively associated with the beneficial stakes. While fear appeared to be positively associated with beneficial stakes in Step 2, a model with only familiarity, TA and fear demonstrated that fear was negatively associated with subjective beneficial stakes (b = -0.31,

p <.001). This indicated that the positive association between fear and subjective beneficial stakes in Step 2 could be due to a suppression effect induced by other anticipatory emotions. Comfortability and excitement were positively associated with subjective beneficial stakes and therefore the hypothesis that positive anticipatory emotions would be associated with higher subjective beneficial stakes (H1f) was supported.

The effects of trait anxiety on anticipatory emotions

The four mixed-model ordinal regression models presented in Table 3 include TA as the predictor, with the four anticipatory emotions as dependent variables to test the hypothesis that higher levels of TA would be associated with higher levels of fear and sadness and lower levels of comfortability and excitement (H2). Results showed that fear was positively associated with TA. The associations between TA and the positive emotions were not significant and therefore H2 was only partially supported.

The moderation effects of TA on the relationship between anticipatory emotions and subjective stakes

As shown in Table 2, TA significantly moderates the effect of fear on subjective aversive stakes. Fear had a stronger and more positive association with subjective aversive stakes when TA was high than when TA was low. TA also significantly moderates the effect of fear on subjective beneficial stakes. Fear had a more positive association with beneficial stakes when TA was high than when TA was low. A model with only familiarity, TA, fear and the interaction between TA and fear demonstrated that fear was negatively associated with beneficial stakes (b = -0.31, p <.001), while the interaction between TA and fear remained positive (b = 0.17, p <.001). This suggested that TA reduced the negative association between fear and perceived beneficial stakes. The relationship between fear and beneficial stakes became almost zero among participants whose TA was two standard deviations above the average (b = -0.31 + 2*0.17 = 0.03).

The combined influences of immediate emotions and subjective stakes on risky behavioural intention

A mixed-model ordinal regression was run to examine how emotions and cognitive evaluations of stakes jointly predict risky behavioural intention. The final model is reported in Table 4. The final model showed that TA was positively associated with risky behavioural intention. However, a hierarchical model predicting risky behavioural intention with TA entered prior to entering anticipatory emotions showed that the effect of TA was non-significant prior to entering the anticipatory emotions. This indicates that the positive effect of TA after entering anticipatory emotions may be an artefact due to a suppression effect.

The hypothesis that aversive stakes and negative anticipatory emotions are negatively associated with risky behavioural intention (H4a) was partially supported. Fear and aversive stakes were negatively associated with risky behavioural intention, while sadness did not have a significant effect on behavioural tendency. The hypothesis H4b that beneficial stakes and positive anticipatory emotions are positively associated with risk-taking tendency was supported.

TA significantly moderates the effect of excitement on risk-taking tendency. Excitement had weaker associations with risky behavioural intention when TA was high than when TA was low. The hypotheses that TA level would moderate the effect of both positive (H4c) and negative anticipatory emotions (H4d) on risk-taking tendency were partially supported. It is also worth noting that after controlling for the effects of emotions, the subjective beneficial stakes ($\Delta\chi^2(1) = 191$, $p < .001$) had a larger individual contribution to risky behavioural intention than subjective aversive stakes ($\Delta\chi^2(1) = 160$, $p < .001$).

Discussion

This study investigated the association between immediate emotions, subjective stakes, and participants' intention to engage in risky behaviours under uncertainty. As an incidental

mood, higher TA was found to be associated with increased subjective aversive stakes. This is consistent with the predictions of the feelings-as-information theory (Schwarz & Clore, 2003). TA signals threatening information about the decision and hence induced higher perceived aversive stakes. However, after entering anticipatory emotions, the effect became non-significant. This indicated that the effects of TA in decision-making can be explained by anticipatory fear, since fear is conceptually similar with TA.

Meanwhile, no significant relationship was found between TA and beneficial stakes. This did not support the hypothesis, in accordance with the feelings-as-information theory, that anxiety would diminish beneficial subjective stakes. This corresponds with previous findings that anxiety does not decrease the perceived benefits (MacLeod & Byrne, 1996). One possible explanation is that when facing a risk under anxiety, losses will be thought about first, which gives subjective aversive stakes a consistent positive association with trait anxiety (Traczyk et al., 2015). However, benefits may still be perceived later if more time is allowed or deliberately cued.

The predictions of the valence-based feelings-as-information theory were supported for aversive and beneficial stakes: fear and sadness were positively associated with negative stakes and negatively associated with beneficial stakes (when potential suppression effects were taken out). The study also investigated the influence of TA on anticipatory emotions and found higher TA was only significantly associated with higher anticipatory fear. This supports findings that people with high TA experience higher levels of negative emotions in their daily-life, and this, in turn, affects the processes of decision-making under uncertainty. This finding further supports the conceptual similarity and association between anxiety and fear (Suveg & Zeman, 2004).

In addition, the only significant interaction effect on subjective aversive stakes was between TA and fear. Along with the finding that fear is the only anticipatory emotion

significantly associated with TA, these results imply that TA has a consistent association with anticipatory fear when evaluating the aversive stakes of an outcome. Decision-makers with higher TA may find trait-congruent emotions more informative. Fear is congruent with the theme of chronic threat-focus appraisals associated with TA, and hence was more relied on when judging the severity of an aversive outcome (Gasper & Clore, 1998).

A significant moderation effect of TA on anticipatory fear was also found when predicting subjective beneficial stakes. The negative association between fear and beneficial stakes was attenuated with the increase in the level of TA. One possible explanation is that the greater reliance on fear when judging aversive outcomes among individuals with higher TA means they may focus their attention more on aversive outcomes when using fear as information. This in turns reduces the decision-makers reliance on fear when judging beneficial outcomes.

Next, the investigation on the collaborative effects of emotions and stakes on risky behavioural intention revealed that TA did not have a significant effect on behavioural intention (prior to entering fear). This finding is different from the predictions of previous research, which has argued that higher TA levels would prevent decision-makers from engaging in risky behaviours (Loewenstein et al., 2001). However, there were mixed findings about this relationship. Several studies indicate that TA may not always diminish risk-taking behaviours. For example, Mitte (2007), using a similar uncertain real-life situation imagination task, failed to establish a consistent relationship of TA predicting risky behavioural intention. Similarly, Howlett and Paulus (2017) found no relationship between TA and risk-taking tendency with a gambling task that led only to potential gain. They proposed that the perception of beneficial stakes may inhibit the effects of TA in diminishing risk-taking. The current study is consistent with this proposal, since the decision-making task used deliberately reminded participants of the benefits.

For anticipatory emotions, higher fear was associated with lower risky behavioural intention while higher comfortability and excitement were associated with higher risky behavioural intention, independent from the subjective stakes. This indicates that anticipatory emotions do not fully rely on changing cognitive processing when influencing risk-taking behaviours. This finding is consistent with the claim of the risk-as-feelings hypothesis that emotions have an independent contribution towards risk-taking behaviours (Loewenstein et al., 2001). However, sadness did not have significant individual effects on risky behavioural intention. This is potentially because the situations in the survey did not strongly elicit sadness. The distribution of sadness was strongly positively skewed, indicating participants tended to react with little or no sadness towards the situations. Sadness could be more closely associated with aversive events that have occurred rather than uncertain risk that might happen in the future. This highlights an emotion-specific perspective of decision-making: different emotions within the same valence may not be elicited by the same kind of risky situations (Lerner & Keltner, 2000).

TA was found to moderate the effect of excitement on risky behavioural intention. The effect of excitement increasing risky behavioural intention was inhibited. This is consistent with the findings that TA inhibits the effects of positive anticipatory emotions in risk-taking, and further supports the proposal that higher TA can alter risk-taking behaviours by moderating the effects of anticipatory emotions on risk-taking tendency (Kashdan & Steger, 2006). One explanation for why excitement, instead of comfortability, was moderated by TA is that excitement is a high-arousal emotion triggered by uncertainty, which is similar to anxiety, with the difference being that excitement focuses on future benefits while anxiety focuses on dangers (Baumgartner et al., 2008; Derakshan & Eysenck, 1997; Gasper & Clore, 1998; Lee & Andrade, 2015). The shared similarities may have rendered the effects of excitement more susceptible to the influence of TA.

Finally, we also found that the beneficial subjective stakes demonstrated higher individual contribution in influencing the risky behavioural intention after controlling for emotions. One explanation is that the aversive stakes' effects on decreasing risk-taking tendency overlap with negative anticipatory emotions. After controlling for them, the cognitive realisation of how much benefit the risky-decision entails would play a more profound role in shaping risk-taking behaviours compared to subjective aversive stakes.

The results of the current study have potential practical implications. In real-life, deficits in decision-making under uncertainty manifest in two forms: overly risk-taking or overly risk-avoidant. This study shows that positive anticipatory emotions elicited in the moment of making those risky decisions could be one contributor for a higher tendency to take risk. One possible intervention to reduce extreme risk taking is to pair these risky behaviours with self-induced aversive outcomes in intervention programs or advertisements to elicit higher negative anticipatory emotions and, in turn, trigger a more severe perception of the aversive stakes. Similarly, changing the positive anticipatory emotions and perceived positive stakes can be a potential solution for the latter problem. The current study indicates that anxiety amplifies the effect of fear while reducing the effect of comfortability on risk-taking tendency. Practices prompting the imagination of beneficial outcomes may deter the negative effect on subjective stakes derived from the amplified effects of fear and decreased effects of positive emotions. These practices can potentially increase the perception of good stakes and help decision-makers to have a more comprehensive view on risk-taking by recognising the benefits.

This study also has some limitations. Firstly, since the current study used a self-report survey, the results may not reflect true behaviours in real-life. Although self-report measures have been commonly used, there could be some discrepancy between self-report and actual behavioural tendency due to differences in factors such as incentives, motivations and goals.

It is important for future studies to explore alternative measures or paradigms such as behavioural observations and behavioural tasks to examine the replicability of the current findings. In addition, we only focused on incidental trait anxiety. Future studies should measure other types of incidental emotions, such those measured by the Positive and Negative Affect Schedule to better understand the effects of different emotions. The Appraisal Tendency Framework (ATF) is an alternative classification system which focuses on the unique effects of specific emotions by adopting more characteristic dimensions beyond valence and arousal (Lerner et al., 2015). Future studies can investigate emotions in decision-making under uncertainty based on the ATF, to expand this more comprehensive framework. Finally, people may behave differently depending on the decision domains (Weber et al., 2002; Shou & Olney, 2021) due to differences in the perceived benefits and risks. Risks across different domain situations may elicit a different range of emotions. Future studies should examine how the links between emotions and behaviours could be different across different life domains.

To conclude, the current study contributed to a comprehensive framework of risky decision-making under uncertainty, demonstrating the association between emotional, cognitive and behavioural factors. Anticipatory emotions played more profound roles in the decision-making process as compared to incidental TA. Trait anxiety contributed to the process by moderating the effects of some of the anticipatory emotions. These results allowed for testing of a few assumptions from three important theoretical frameworks. Most assumptions were supported by the results, including the importance of positive emotions and beneficial stakes considering the contribution they each make in the decision-making process, as well as the differential contribution of incidental TA and anticipatory emotions, which calls for a greater awareness on differentiating between different kinds of immediate emotions. The findings of this study challenge the effects of the valence- and arousal-based

classification of immediate emotions. To sum up, the current study further supports the importance of immediate emotions in decision-making under uncertainty, while pointing out that positive emotions and the perception of benefits are crucial to decision-making and deserve more attention from future studies.

References

Alhakami, A. S., & Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk analysis*, *14*(6), 1085-1096. https://doi.org/10.1111/j.1539-6924.1994.tb00080.x

Baumgartner, H., Pieters, R., & Bagozzi, R. P. (2008). Future-oriented emotions: conceptualization and behavioral effects. *European Journal of Social Psychology, 38*(4), 685-696. https://doi.org/10.1002/ejsp.467

Bishop, S. J., & Gagne, C. (2018). Anxiety, depression, and decision making: a computational perspective. *Annual review of neuroscience*, *41*, 371-388. https://doi.org/10.1146/annurev-neuro-080317-062007

Butler, G., & Mathews, A. (1983). Cognitive processes in anxiety. *Advances in Behaviour Research and Therapy, 5*(1), 51-62. https://doi.org/10.1016/0146-6402(83)90015-2

Charpentier, C. J., Aylward, J., Roiser, J. P., & Robinson, O. J. (2017). Enhanced risk aversion, but not loss aversion, in unmedicated pathological anxiety. *Biological Psychiatry, 81*(12), 1014-1022. https://doi.org/10.1016/j.biopsych.2016.12.010.

Christensen, R. H. B. (2019). ordinal - Regression Models for Ordinal Data. R package version 2019.12-10. https://CRAN.R-project.org/package=ordinal.

Clampitt, P. G., Williams, M. L., & Korenak, A. (2000). *Managing organizational uncertainty: Conceptualization and measurement*. Paper presented at the International Communication Association, Acapulco.

Cryder, C. E., Lerner, J. S., Gross, J. J., & Dahl, R. E. (2008). Misery is not miserly: Sad and self-focused individuals spend more. Psychological science, 19(6), 525-530. https://doi.org/10.1111/j.1467-9280.2008.02118.x

Derakshan, N., & Eysenck, M. W. (1997). Interpretive biases for one's own behavior and physiology in high-trait-anxious individuals and repressors. *Journal of Personality and Social Psychology, 73*(4), 816-825. https://doi.org/10.1037/0022-3514.73.4.816

DeSteno, D., Petty, R. E., Wegener, D. T., & Rucker, D. D. (2000). Beyond valence in the perception of likelihood: The role of emotion specificity. *Journal of Personality and Social Psychology, 78*(3), 397-416. https://doi.org/10.1037/0022-3514.78.3.397

Dobrzykowski, T. M. (2017). Feeling Comfortable: A Humanbecoming Perspective. *Nursing Science Quarterly, 30*(1), 10-16. https://doi.org/10.1177/0894318416680511

Einhorn, H. J., & Hogarth, R. M. (1985). Ambiguity and uncertainty in probabilistic inference. *Psychological Review, 92*(4), 433. https://doi.org/10.1037/0033-295X.92.4.433

Endler, N. S., & Kocovski, N. L. (2001). State and trait anxiety revisited. *Journal of Anxiety Disorders, 15*(3), 231-245. https://doi.org/10.1016/s0887-6185(01)00060-3

Gambetti, E., & Giusberti, F. (2012). The effect of anger and anxiety traits on investment decisions. *Journal of Economic Psychology, 33*(6), 1059-1069. https://doi.org/10.1016/j.joep.2012.07.001

Gasper, K., & Clore, G. L. (1998). The persistent use of negative affect by anxious individuals to estimate risk. *Journal of Personality and Social Psychology, 74*(5), 1350-1363. https://doi.org/10.1037/0022-3514.74.5.1350

Hartley, C. A., & Phelps, E. A. (2012). Anxiety and decision-making. *Biological Psychiatry, 72*(2), 113-118. https://doi.org/10.1016/j.biopsych.2011.12.027

Hedeker, D., Archer, K. J., Nordgren, R., & Gibbons, R. D. (2015). mixor: Mixed-Effects Ordinal Regression Analysis. *R package*

Heilman, R. M., Crişan, L. G., Houser, D., Miclea, M., & Miu, A. C. (2010). Emotion regulation and decision making under risk and uncertainty. *Emotion, 10*(2), 257.

Henker, B., Whalen, C. K., Jamner, L. D., & Delfino, R. J. (2002). Anxiety, affect, and activity in teenagers: Monitoring daily life with electronic diaries. *Journal of the American Academy of Child & Adolescent Psychiatry, 41*(6), 660-670. https://doi.org/10.1097/00004583-200206000-00005

Howlett, J. R., & Paulus, M. P. (2017). Individual differences in subjective utility and risk preferences: the influence of hedonic capacity and trait anxiety. *Frontiers in Psychiatry, 8*, 88. https://doi.org/10.3389/fpsyt.2017.00088

Kashdan, T. B., & Steger, M. F. (2006). Expanding the topography of social anxiety: An experience-sampling assessment of positive emotions, positive events, and emotion suppression. *Psychological Science, 17*(2), 120-128. https://doi.org/10.1111/j.1467-9280.2006.01674.x

Kusev, P., Purser, H., Heilman, R., Cooke, A. J., Van Schaik, P., Baranova, V., ... & Ayton, P. (2017). Understanding risky behavior: the influence of cognitive, emotional and hormonal factors on decision-making under risk. *Frontiers in psychology, 8*, 102. https://doi.org/10.3389/fpsyg.2017.00102

Lee, C. J., & Andrade, E. B. (2015). Fear, excitement, and financial risk-taking. *Cognition and Emotion, 29*(1), 178-187. https://doi.org/10.1080/02699931.2014.898611

Lerner, J. S., Han, S., & Keltner, D. (2007). Feelings and consumer decision making: Extending the appraisal-tendency framework. *Journal of Consumer Psychology, 17*(3), 181-187. https://doi.org/10.1016/S1057-7408(07)70027-X

Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition & Emotion, 14*(4), 473-493. https://doi.org/10.1080/026999300402763

Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and Decision Making. *Annual review of psychology, 66,* 799-823. https://doi.org/10.1146/annurev-psych-010213-115043

Levy, J. S. (1992). An introduction to prospect theory. *Political Psychology*, 171-186. Retrieved from: http://www.jstor.org/stable/3791677

Loewenstein, G., & Lerner, J. S. (2003). The role of affect in decision making. In *Handbook of Affective Science* (pp. 619-642): Oxford University Press.

Loewenstein, G., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin, 127*(2), 267-286. https://doi.org/10.1037/0033-2909.127.2.267

MacLeod, A. K., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology, 105*(2), 286-289. https://doi.org/10.1037/0021-843X.105.2.286

Maner, J. K., Richey, J. A., Cromer, K., Mallott, M., Lejuez, C. W., Joiner, T. E., & Schmidt, N. B. (2007). Dispositional anxiety and risk-avoidant decision-making. *Personality and Individual Differences, 42*(4), 665-675. https://doi.org/10.1016/j.paid.2006.08.016

Maner, J. K., & Schmidt, N. B. (2006). The role of risk avoidance in anxiety. *Behavior Therapy, 37*(2), 181-189. https://doi.org/10.1016/j.beth.2005.11.003

Mitte, K. (2007). Anxiety and risky decision-making: The role of subjective probability and subjective costs of negative events. *Personality and Individual Differences, 43*(2), 243-253. https://doi.org/10.1016/j.paid.2006.11.028

Miu, A. C., Heilman, R. M., & Houser, D. (2008). Anxiety impairs decision-making: psychophysiological evidence from an Iowa Gambling Task. *Biological psychology*, *77*(3), 353-358. https://doi.org/10.1016/j.biopsycho.2007.11.010

Heilman, R. M., Crişan, L. G., Houser, D., Miclea, M., & Miu, A. C. (2010). Emotion regulation and decision making under risk and uncertainty. Emotion, 10(2), 257. https://doi.org/10.1037/a0018489

Raghunathan, R., & Pham, M. T. (1999). All negative moods are not equal: Motivational influences of anxiety and sadness on decision making. *Organizational Behavior and Human Decision Processes*, *79*(1), 56-77. https://doi.org/10.1006/obhd.1999.2838

Schonberg, T., Fox, C. R., & Poldrack, R. A. (2011). Mind the gap: bridging economic and naturalistic risk-taking with cognitive neuroscience. *Trends in Cognitive Sciences, 15*(1), 11-19. https://doi.org/10.1016/j.tics.2010.10.002

Schwarz, N. (2011). Feelings-as-information theory. *Handbook of Theories of Social Psychology, 1*, 289-308. https://doi.org/10.4135/9781446249215.n15

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*(3), 513-523. https://doi.org/10.1037/0022-3514.45.3.513

Schwarz, N., & Clore, G. L. (2003). Mood as information: 20 years later. *Psychological Inquiry, 14*(3-4), 296-303. https://doi.org/10.1080/1047840X.2003.9682896

Shou, Y., & Olney, J. (2020). Attitudes toward risk and uncertainty: The role of subjective knowledge and affect. *Journal of Behavioral Decision Making*. https://doi.org/10.1002/bdm.2217

Shou, Y., & Olney, J. (2021). Measuring risk tolerance across domains: Scale development and validation, *Journal of Personality Assessment*, https://doi.org/10.1080/00223891.2021.1966019

Smithson, M. (2010). Understanding uncertainty. *Dealing with Uncertainties in Policing Serious Crime, 16*(1), 27-48. https://doi.org/10.22459/dupsc.05.2010.03

Speilberger, C. D., & Vagg, P. R. (1984). Psychometric properties of the STAI: a reply to Ramanaiah, Franzen, and Schill. *Journal of Personality Assessment, 48*(1), 95-97. https://doi.org/10.1207/s15327752jpa4801_16

Spielberger, C. D. (1983). Manual for the State-Trait Anxiety Inventory STAI (form Y) (" self-evaluation questionnaire"). Retrieved from: http://hdl.handle.net/10477/1873

Stöber, J. (1997). Trait anxiety and pessimistic appraisal of risk and chance. *Personality and Individual Differences, 22*(4), 465-476. https://doi.org/10.1016/S0191-8869(96)00232-2

Suveg, C., & Zeman, J. (2004). Emotion regulation in children with anxiety disorders. *Journal of Clinical Child and Adolescent Psychology, 33*(4), 750-759. https://doi.org/10.1207/s15374424jccp3304_10

Traczyk, J., Sobkow, A., & Zaleskiewicz, T. (2015). Affect-laden imagery and risk taking: the mediating role of stress and risk perception. *PloS One, 10*(3), e0122226. https://doi.org/10.1371/journal.pone.0122226

Weber, E. U., Blais, A. R., & Betz, N. E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. Journal of behavioral decision making, 15(4), 263-290. https://doi.org/10.1002/bdm.414

Table 1

Descriptive Statistics of Variables

	M	*SD*	Skewness	Cronbach's α
Trait anxiety	47.35	11.20	0.22	.94
Anticipatory emotions				
Fear	5.03	2.68	-0.14	.93
Sadness	2.83	2.43	1.16	.96
Comfortability	3.65	2.31	0.65	.84
Excitement	3.69	2.32	0.37	.90
Subjective aversive stakes	6.96	2.82	-0.77	.91
Subjective beneficial stakes	7.31	2.37	-0.93	.90
Risk-taking tendency	4.70	3.21	0.29	.81

Table 2

Hierarchical Models with Subjective Stakes as Dependent Variables

	Aversive Stake		Beneficial Stake	
	b	SE	*b*	*SE*
Step 1	$\Delta\chi^2$= 195, df = 2, *p* <. 001 AIC =98, BIC = 9961 RE = 0.62		$\Delta\chi^2$= 14, df = 2, *p* <. 001 AIC =9390, BIC = 9459, RE = 1.03	
Familiarity	-0.55**	0.04	0.14**	0.04
TA	0.20*	0.10	0.15	0.12
Step 2	$\Delta\chi^2$= 1333, df = 4, *p* <. 001 AIC =8567, BIC = 8660, RE= 0.66		$\Delta\chi^2$= 354, df = 4, *p* <. 001 AIC =9034, BIC = 9127, RE = 1.08	
Familiarity	-0.15**	0.04	0.04	0.04
TA	0.11	0.10	0.13	0.12
Fear	1.19**	0.07	0.14*	0.06
Sadness	0.13*	0.06	-0.33**	0.06
Comfortability	-0.56**	0.06	0.36**	0.06
Excitement	-0.40**	0.05	0.52**	0.05
Final model	$\Delta\chi^2$= 12, df = 1, *p* <. 001 AIC =8557, BIC = 8656, RE = 0.69		$\Delta\chi^2$= 10, df = 1, *p* = .002 AIC =9027, BIC = 9125, RE = 1.06	
Familiarity	-0.15**	0.04	-0.04	0.04
TA	0.12	0.10	0.12	0.12
Fear	1.20**	0.07	0.14*	0.06
Sadness	0.12*	0.06	-0.34**	0.06
Comfortability	-0.57**	0.06	0.35**	0.06
Excitement	-0.40**	0.05	0.51**	0.05
Fear x TA	0.16**	0.05	0.14**	0.04

Note. *p < .05; ** p < .01; *b* = coefficient from ordinal logistic regression; SE = standard errors; RE = Random intercept variance for the mixed-model ordinal regression.

Table 3

The Influences of Trait Anxiety on Anticipatory Emotions

	$\Delta\chi^2$	*b*	SE	RE
Fear	8.1**	0.30**	0.10	0.72
Sadness	1.4	0.30	0.24	4.34
Comfortability	2.0	-0.10	0.08	0.34
Excitement	1.6	0.13	0.10	0.73

Note. ** $p < .01$; RE = Random intercept variance; *b* = coefficient from ordinal logistic regression.

Table 4

The Final Model with Risk-Taking Tendency as the Dependent Variable

	b	SE
	RE = 0.37	
Familiarity	0.55**	0.05
TA	0.17*	0.08
Fear	-0.49**	0.06
Comfortability	0.93**	0.07
Excitement	0.24**	0.05
Excitement x TA	-0.10*	0.04
Subjective beneficial stakes	0.70**	0.05
Subjective aversive stakes	-0.73**	0.06

Note. *$p < .05$; ** $p < .01$; RE = Random intercept variance; *b* = coefficient from ordinal logistic regression.

Figure 1

A hypothetical framework demonstrating the roles of immediate emotions in risky decision-making under uncertainty. The dotted line indicates moderation effects.