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Affective forecasting during a horror attraction: Insights into Intolerance of Uncertainty☆

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ABSTRACT

In this field study, we examined for the first time how Intolerance of Uncertainty influences expectations about negative, positive, and anxiety-related affect alongside the accuracy of those expectations. The study was conducted at a horror attraction, which offers an immersive, uncertain and threat-related experience. Participants (n = 1029) completed a measure of forecasted negative, positive and anxiety-related affect prior to the experience. Immediately after the experience, they rated their actual subjective experience of each of these affective states. Additionally, confidence ratings were reported for each forecasted emotion so that metacognitive awareness of forecasting accuracy could be assessed. Results showed that participants high in IU anticipated and actually experienced less positive affect, more anxiety-related affect and more negative-affect compared to those low in IU. IU predicted bias (overestimations) in emotional forecasts for negative affect, but not for positive or anxiety-related affect. The findings demonstrate that IU may be related to affective forecasting, which has implications for transdiagnostic models and treatment of psychopathology.

1. Introduction

Individual differences in responses to uncertainty are captured by the construct of 'Intolerance of Uncertainty' (IU; Freeston et al., 1994). IU has been defined as "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016, p. 31). Higher levels of IU are associated with greater experiences of negative affective states such as anxiety and fear, both at clinical disorder level (for meta-analysis see McEvoy et al., 2019) and symptom level (e.g. physiological sensations, worry; for meta-analyses see Gentes and Ruscio, 2011; Osmanağaoğlu et al., 2018).

☆ Study data and analysis code are openly available here: https://osf.io/3b7hz/?view_only=4e30e36ee9e143df9730447b5764f52f

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This has sparked considerable interdisciplinary and translational research into the construct of IU. In particular, over the last decade, a significant proportion of this research has demonstrated that during uncertain situations, IU modulates a variety of cognitive and affective processes (e.g. attentional biases, safety learning, decision-making etc) that underpin anxiety and fear (for special issues, see Levy and Schiller, 2023; Morriss, Abend, et al., 2023; and meta-analysis, see Sahib et al., 2023). This research has informed the development of novel treatment approaches that focus on reducing IU (e.g., Dugas et al., 2022; Zemestani et al., 2021).

The future, whether it be moments or years away, is necessarily uncertain. Affective forecasting refers to the process of predicting one's own emotions in the future, either generally, or in response to a specific life event (e.g. election outcome, rejection by an employer; Wilson and Gilbert (2003). In general, humans appear to display an intensity bias whereby they overestimate the intensity of the emotions they will feel in relation to future experiences, both positive and negative (Buehler and McFarland, 2001; Dunn et al., 2003; Gilbert et al., 1998; although see Levine et al., 2012). There is clear individual variation in this bias (Dunn et al., 2007), with a range of psychopathology, including anxiety, stress, and mood-related conditions associated with a stronger intensity bias for negative emotions and a blunted intensity bias for positive emotions (for review see, Rizeq, 2024). Despite this relationship, and the intrinsic link between affective forecasting and uncertainty (see Miloyan et al., 2014), surprisingly little research has considered how IU impacts affective forecasting.

Affective forecasting plays a critical role in how we respond emotionally to uncertainty. This is evident in the 'Uncertainty and Anticipation Model of Anxiety' (UAMA; Grupe and Nitschke, 2013). The UAMA proposes that clinical anxiety stems from a biased overestimation of both the likelihood and potential negative consequences of future threats in uncertain situations. In other words, when people's affective forecasts about uncertain events are skewed towards expecting a negative outcome, they experience heightened anticipatory anxiety. Consequently, this can lead to cognitive and behavioural avoidance of uncertainty, which reinforces these negative biases by preventing them from being challenged. The processes highlighted in the UAMA suggest that individuals high in IU may have difficulty with affective forecasting, relative to those lower in IU, because they are likely to overestimate the probability that they will experience negative affect in uncertain situations. This biased estimate, in turn, may fuel anxiety and fear in relation to uncertain future events and situations.

Supporting this notion, Pepperdine et al. (2018) found that participants high in IU displayed biased emotional forecasts. When presented with both positive and negative uncertain scenarios, these individuals reported that they would feel more uncertain if they were in these scenarios and anticipated more negative outcomes, compared to those lower in IU. Interestingly, this pattern held true for both positive and negative scenarios. In contrast, Dev et al. (2024) found no association between IU and anticipated anxiety, also using hypothetical scenarios. Oglesby and Schmidt (2017) examined IU within a lab-based stressor task and found that IU was associated with higher levels of anticipatory anxiety. Whilst these studies suggest some bias in forecasting of emotions, to our knowledge, no study has examined forecasting in relation to actually experienced emotion in IU. It is therefore unclear whether higher IU is associated with biased affective forecasting, as the accuracy of predictions made by individuals with high IU has not been systematically evaluated or compared against experienced outcomes. Furthermore, the majority of relevant research in the context of IU has relied on hypothetical scenarios or lab-based tasks, where the level of immediate and felt uncertainty as well as potential threat are relatively low. As Shihita et al. (2016) highlight, to move the field forward, research examining IU, uncertainty and emotion needs to be conducted in contexts where there is notable uncertainty and threat, although this poses ethical challenges.

Although uncertainty is consistently linked to negative emotion in the clinical literature, it is also a key component of thrilling leisure activities, such as reading mystery novels, going on rollercoasters, or watching horror films (Clasen, 2021; Knobloch-Westerwick and Keplinger, 2006; Miller et al., 2023; Zillmann et al., 1996). There is an emerging literature on enjoyment of horror experiences in particular, which highlights that moderate uncertainty is a key element that can make these unpleasant experiences enjoyable as well (Andersen et al., 2020). The construct of IU has primarily been studied in the context of negative affect, due to theoretical links with anxiety and fear. Some studies also include positive scenarios but focus still on negative affect (e.g., see Pepperdine et al., 2018), but recent research suggests that IU may not only heighten negative affect (e.g. anxiety, frustration) but also dampen positive affect (e.g. excitement, happiness) in uncertain situations (Morriss et al., 2023). To our knowledge, this has only been examined via scenarios that are explicitly positive and negative and not in a context where the positive affect may co-occur with negative affect, such as in a recreational horror experience.

In this field study, we examine how IU is related to affective forecasting in the context of a horror experience. The experience is designed to provide immersive horror with high levels of fear and uncertainty immediately prior to and during the experience. In this study, we consider two measures of affective forecasting: accuracy and bias (see Rizeq, 2024). Accuracy refers to how closely a participant anticipates their forthcoming affective states, irrespective of the direction of any errors. Bias refers to the direction of any errors in forecasting, i.e., their over- or underestimation of positive or negative affect.

We additionally examine how IU is related to metacognition regarding one's own affective forecasting ability. Previous research has suggested that some of the adverse mental health outcomes associated with IU are mediated by metacognitive processes (Chen et al., 2021; Huntley et al., 2022) such as beliefs about being able to control one's worry. However, to our knowledge, metacognitive awareness of one's ability to forecast emotions has not previously been explored. In cognitive research, subjective confidence ratings are evaluated against actual cognitive performance to capture metacognitive awareness (Fleming & Lau, 2014). In this study, we adapt this methodological approach to address metacognitive awareness of affective forecasting, defined as the ability to accurately rate confidence in relation to their forecasted emotions; someone with high metacognitive awareness would report greater confidence in affective forecasts that turn out to be more accurate, and less confidence in affective forecasts that turn out to be less accurate. This metacognitive awareness is important because research and clinical evidence increasingly suggest that metacognitive processes are critical in improving therapeutic outcomes (McEvoy, 2019). Self-awareness of inaccuracies in one's expectations about emotional experiences may be a crucial first step in addressing their negative effects.

The primary aim of this research was to examine how IU is associated with affective forecasting in the context of an uncertain, threat-related experience. This primary aim was operationalised into the following research questions. Is IU associated with:

1) expectations of positive, anxious, and negative affect?

2) actual experiences of positive, anxious, and negative affect?

3) biases in affective forecasting of positive, anxious, and negative affect?

A secondary aim of the research was to investigate whether IU is associated with metacognitive processes in affective forecasting. The secondary aim was exploratory and operationalised into the following research questions: Is IU associated with:

4) confidence in expectations of positive, anxious, and negative affect?

5) metacognitive awareness of accuracy of affective forecasting of positive, anxious, and negative affect (i.e. associations between confidence and forecasting accuracy)?

Based on the previous literature, we hypothesized that, relative to those lower in IU, individuals higher in IU would: anticipate feeling

more negative and less positive affect during the experience (RQ1); have specific biases in their affective forecasting towards overestimating negative and underestimating positive affect (RQ3). Research questions 2, 4 and 5 were exploratory with no clear direction for the hypotheses on the basis of previous literature.

2. Methods

The measures, complete data, analysis code and output are available here: https://osf.io/3b7hz/?view_only=4e30e36ee9e143df9730447b5764f52f. This study received ethics approval (229 / 2022, case number: 1–10–72–124–22) from the Research Ethics Committee of Central Region Denmark.

2.1. Participants

Visitors were recruited at a commercial horror experience (Dystopia Haunted House) across eight days, during which a team of research assistants approached attendees in an opportunistic (i.e., convenience sampling) manner and invited them to participate in the study. Because recruitment was done in the field without a controlled sampling frame, an exact response rate could not be calculated. A total of 1029 individuals agreed to participate (536 females, 484 males, 3 non-binary, 1 'other', 5 did not report their gender; mean age = 30.94 years, *SD* = 10.25 years, age range = 13–67, 4 participants did not report their age). For analyses using gender as a control variable, only participants reporting male or female gender identity were included because of the low frequency of non-binary and other gender identities. Participants reported that they were internally (n = 572) or externally (n = 441; missing responses = 16) motivated to attend the event, e.g., persuaded to attend by friends. Some participants had visited the attraction in prior years (n = 272). Each year, the attraction gets redesigned, however 73 participants had visited the attraction earlier the same year or did not answer this question; these participants were excluded from the analyses.

2.1.1. Procedure

The commercial horror attraction, Dystopia Haunted House, lasts for approximately 50 min and consists of 55 thematically connected rooms. Most often, visitors navigate through the rooms in groups of three to six, where live actors, scenery, sound and special effects create an intense and immersive horror experience. To collect data for this field experiment, the study was explained verbally to visitors by research staff, and an information sheet and consent form were provided. Informed consent was obtained from all participants with legal guardians providing consent for participants aged under 18 years. Participants were then given a structured questionnaire before entering the attraction and another questionnaire after they came out of the attraction.

The first questionnaire consisted of the following (translated into Danish): i) a 12-item version of the Intolerance of Uncertainty Scale (IUS-12; Carleton et al., 2007), ii) a modified 12-item version of the Positive and Negative Affect Scale for Children (PANAS-C; Ebesutani et al., 2012; Laurent et al., 1999) asking about expected emotions during the attraction and confidence in these expectations for each emotion, iii) demographic questions (age, gender), and, iv) control questions to determine whether participants had previously visited the attraction during that same season or during previous years. There was also a question designed to assess whether the participants were internally or externally motivated to attend the attraction: "Why are you visiting Dystopia today?" (internal: "Mostly because I wanted to", or external: "mostly because my friends/acquaintances/family wanted to"). This question was included because we expected that individuals high in IU may be less likely to choose to go to this type of attraction without some external pressure or motivation to do so, relative to those low in IU. This has relevance for interpreting the findings in relation to exposure and avoidance.

The second questionnaire, administered to participants immediately after they exited the attraction, consisted of the same 12-item modified version of the PANAS-C scale, asking about the extent to which they had actually felt the twelve different emotions while taking part in the attraction.

2.2. Materials

2.2.1. IUS-12 scoring and psychometric properties

A short 12-item version of the Intolerance of Uncertainty Scale (IUS-12; Carleton et al., 2007) was used. The IUS-12 is used to assess a person's tendency to experience anxiety and distress in response to uncertain situations. Participants respond to twelve statements and have to indicate the extent to which each statement is characteristic of them on a 5-point likert scale ranging from: "not at all characteristic of me" to "entirely characteristic of me". Scores from all 12 items were summed to create a total score, and then mean centered and scaled such that a change of 1 represents 1 standard deviation. The internal consistency of the IUS-12 suggests that the measure was reliable for this dataset, $\alpha = .85$.

2.2.2. Emotion rating scoring and psychometric properties

A modified 12-item version of the Positive and Negative Affect Scale for Children (PANAS-C; Ebesutani et al., 2012; Laurent et al., 1999) was created for the project. The PANAS-C is a widely used questionnaire designed to assess emotional states in school-aged children, but it can also be used with adults. The PANAS-C consists of 30 items, each asking the participant to rate the extent to which they felt a certain emotion. A shortened 10-item version of the scale was developed by Ebesutani et al. (2012). The shortened version was modified for the current study to be appropriate for the context of a horror attraction by including two additional items from the original 30-item scale: 'Excited' and 'Nervous'. The twelve emotions chosen for the study were thus Sad, Excited, Happy, Nervous, Scared, Miserable, Cheerful, Proud, Afraid, Joyful, Mad and Lively. Participants were asked to engage in affective forecasting with respect to these twelve different emotions prior to entering the attraction. For each emotion, they responded to statements such as "I expect to be sad" or "I expect to be excited" using a five-point Likert scale (1 = not at all/to a very low extent, 5 = to a very high extent). They also rated their confidence in each prediction on a scale from 0 to 10 (0 = not sure at all, 10 = completely sure), in response to the question: "How sure do you feel about your assessment?". After completing the attraction, participants completed a post-questionnaire using the same set of emotion items (e.g., "I was sad," "I was excited"), again rated on the five-point Likert scale. Confidence ratings were not collected post-experience.

Because these 12 items have not previously been used together as a scale, we conducted a principal components analysis using the forecasted emotions data to determine whether subscales could be used. The data were adequately sampled and factorable as indicated by a significant Bartlett's test of sphericity ($\chi2(66) = 4194.08$, $p < .001$), a non-zero, positive correlation matrix determinant (.017), and the Kaiser-Meyer-Olkin statistic above 0.70 for both, the overall sample (KMO = 0.82) as well as each individual item (lowest measure of sampling adequacy = 0.74). Next we entered all items into a principal components analysis that estimated weightings for the maximum number of possible components (12). Using the rule-of-thumb that the number of factors corresponds with the number of eigenvalues above one, we determined that a three-factor solution was most appropriate. These three factors explained a total of 61 % of the total variance.

To achieve a simple structure, we applied a varimax rotation to a principal components analysis with three factors. The root mean square of the residuals was 0.07, with values of less than 0.08 indicating a good fit. Items that loaded onto each factor with weightings greater than .50 were considered to have strong factor loadings and were included in the resulting emotion scales. The first factor contains four positive affect

items including "Excited", "Happy", "Cheerful", and "Joyful" (all loadings >.71, two positive items dropped: "Lively" and "Proud" with loadings of .46 and .49 respectively), labeled "positive affect hereafter. The other two factors contained negative items. The first, including "Nervous", "Scared", and "Afraid" (all loadings >.81) represents anxiety-related emotions, is labeled "anxious affect" hereafter and the second, weaker, factor including "Sad", "Miserable", and "Mad" represents other negative emotions (all loadings >.67), and is labeled "negative affect" hereafter. Examination of the Cronbach's alphas of these factors revealed good internal consistency for positive affect (α =.82) and anxious affect (α =.86), but questionable internal consistency for negative affect (α =.63), likely due to low variance for this subscale (see descriptives).

2.3. Missing data

Variables had a range of 0.39–12.83 % missing data. There was a 10.40 % attrition rate from the pre to the post-event survey. Mean proportion of missing items across the study components are as follows: IUS-12 items, mean = 1.07 %; expected affect ratings, mean = 1.19 %; expected confidence ratings, mean = 2.18 %; experienced affect ratings, mean = 11.18 %). The validity of multiple imputation relies on the assumption that data are missing at random. Little's missing completely at random test suggests that missingness was unrelated to any variable in our study: $\chi2(4652) = 976.93$, $p = 1.00$, however, this should be treated with caution when there are many variables in the dataset. Given this, we also explored whether expected affect and the control variables included in the models specifically predicted attrition from the study after the event. We found that those who expected higher negative affect were more likely to drop out of the study than those who expected lower negative affect. In contrast, those who expected higher anxious affect were less likely to drop out of the study. Participants who were internally motivated to attend the event were marginally less likely to drop out of the study than those who were externally motivated. No other variables predicted attrition from the study. The number of missing items from the pre-event survey was not predicted by expected emotions or any of the control variables. Missing data were imputed at item level for the regression analyses using multiple imputation with the R package `mice`. Twenty imputed datasets were created using predictive mean matching for interval data and logistic regression and polynomial regression for dichotomous and categorical variables respectively.

2.3.1. Data analysis

To address each research question, we ran regression analyses with IU (normalised IUS-12 scores) predicting the outcome variable of interest: RQ1 - expected emotion ratings measured before entering the attraction; RQ2 - experienced emotion ratings measured after leaving the attraction; RQ3 - bias in affective forecasting, operationalised as the directional difference between pre-event expectancy ratings and the post-event experienced affect ratings (post-pre, larger scores represented higher than expected emotions); RQ4 - confidence in expected emotion ratings. For RQ5, we sought to explore metacognitive awareness by determining the extent to which confidence in expected emotions related to accuracy of affective forecasting, and whether this was moderated by IU. To capture accuracy, we took the absolute (unsigned) difference between expected and experienced emotions and reversed this value so that more negative values represent less accurate forecasts. We then ran regression models with accuracy as the outcome variable and both IU and confidence in expected emotion as predictors (both as main effects and in interaction with one another); a positive relationship between confidence and accuracy suggests that people who were more confident had better forecasting accuracy, and vice versa; the stronger this association, the better the metacognitive awareness.

The regression models were conducted for each affect subscore (positive, anxious, or negative) and controlled for the following demographic and situational factors: participants' age and gender; whether the participant had visited the attraction in a previous year; and whether the participants' motivation for attending the attraction was internal or external.

Pooled summary statistics and regression estimates from the twenty multiply imputed datasets are reported in the manuscript along with the Fraction of Missing Information (FMI) statistic which describes the proportion of total variance due to missingness. Model results without imputing missing data (casewise removal) were consistent with the results of the pooled analysis. These results as well as the full model tables for each analysis are provided with the data and analysis code here: https://osf.io/3b7hz/?view_only=4e30e36ee9e143df9730447b5764f52f. Figs. 1 and 2 are plotted using raw (unimputed) data.

3. Results

3.1. Descriptives

Descriptive statistics are calculated by taking the average across the 20 imputed datasets. The mean IUS-12 score was 29.71 (SD = 8.21), which is comparable to previous studies with non-clinical samples (Carleton et al., 2007; Huntley et al., 2020; Khawaja & Yu, 2010). Descriptive statistics for the positive affect, anxious affect, and negative affect scales for expected affect, confidence in the expected affect, and experienced affect are presented in Table 1.

3.2. Analysis

3.2.1. How is IU associated with affective forecasting?

To determine whether IU is associated with expectations of positive, anxious, and negative affect (RQ1), we ran regression models predicting expected affect from IU, while controlling for other relevant factors (see Data Analysis section). Those with higher IU expected lower positive affect, b = -0.13, CI = -0.18 – −0.07, t = -4.46, p < .001, FMI = 0.01, higher anxious affect, b = 0.20, CI = 0.15 – 0.25, t = 7.54, p < .001, FMI = 0.01, and higher negative affect, b = 0.27, CI = 0.22 – 0.31, t = 11.52, p < .001, FMI = 0.03, relative to those lower in IU (see Fig. 1a).

We ran regression models to determine whether IU is associated with actual experiences of positive, anxious, and negative affect (RQ2). Those with higher IU also actually experienced lower positive affect, b = -0.13, CI = -0.19 – −0.06, t = -4.04, p < .001, FMI = 0.06, and higher anxious affect, b = 0.24, CI = 0.17 – 0.32, t = 6.40, p < .001, FMI = 0.08, and higher negative affect, b = 0.15, CI = 0.10 – 0.19, t = 6.89, p < .001, FMI = 0.08, relative to those lower in IU (see Fig. 1b).

We ran regression models to determine whether IU is associated with biases in forecasting of positive, anxious, and negative affect (RQ3). For these models, the difference between expected affect and experienced affect was entered as the dependent variable (experienced – expected), such that positive values indicate that the emotion was experienced more than expected (underestimated), and negative values indicate that the emotion was experienced less than expected (overestimated). Inspecting the intercepts of the regression models of affective-forecasting bias, overall, participants significantly underestimated their positive affect, b = 0.37, CI = 0.30 – 0.44, t = 10.81, p < .001, FMI = 0.08, and overestimated both their anxious affect, b = -0.75, CI = -0.82 – −0.67, t = -19.62, p < .001, FMI = 0.12, and negative affect, b = -0.42, CI = -0.47 – −0.36, t = -15.35, p < .001, FMI = 0.08. This overestimation for negative affect was greater in those higher in IU relative to those lower in IU, with those higher in IU experiencing less negative affect relative to what they expected, compared to those lower in IU, b = -0.12, CI = -0.17 – −0.07, t = -5.06, p < .001, FMI = 0.07. IU was not related to affective-forecasting bias for positive, 0.00, CI = -0.06 – 0.06, t = -0.01, p = .991, FMI = 0.07, or anxious affect, b = 0.04, CI = -0.02 – 0.11, t = 1.33, p = .183, FMI = 0.10 (see Fig. 2a).

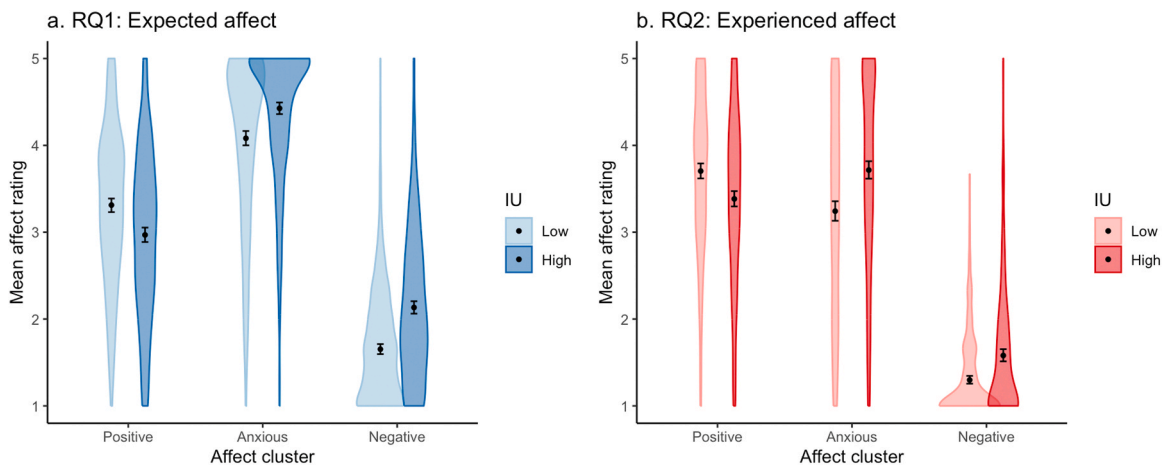

Fig. 1. a. Expected affect ratings for positive, anxious, and negative affect by IU (split by median split for visualization only). b. Experienced affect ratings for positive, anxious, and negative affect by IU (split by median split). violins represent the density of the ratings, points represent the mean for each group, error bars represent the bootstrapped 95 % confidence intervals around the means. Plots are based on raw, unimputed data.

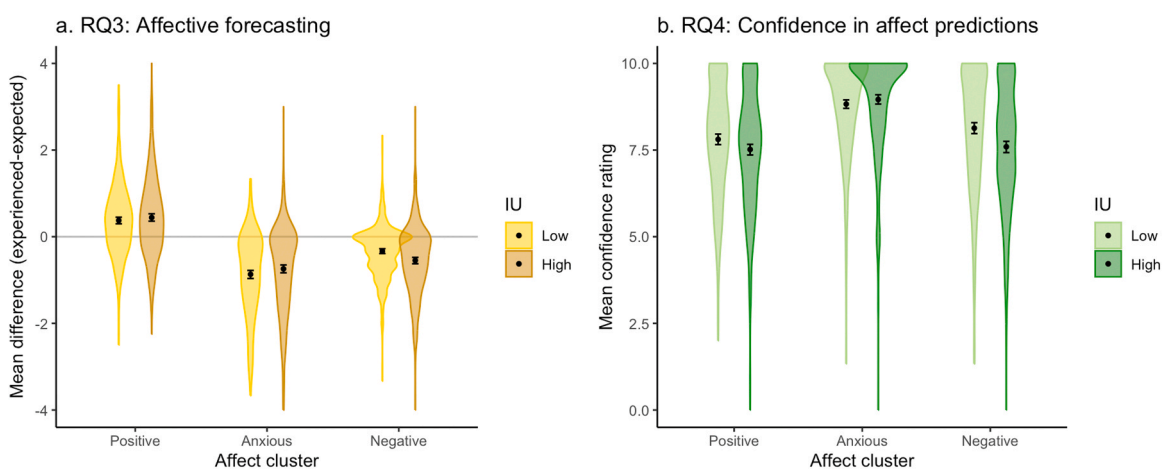

Fig. 2. a. Affective forecasting bias for positive, anxious, and negative affect by IU (split by median split). affective forecasting bias is operationalised as the difference between expected and experienced affect ratings such that positive numbers represent experienced affect ratings that are higher than expected affect ratings (underestimation of affect) and negative values represent experienced affect ratings that are lower than expected affect ratings (overestimation of affect). b. Confidence in expected affect ratings for positive, anxious, and negative affect by IU (split by median split for visualization purposes only. Violins represent the density of the ratings, points represent the mean for each group, error bars represent the bootstrapped 95 % confidence intervals around the means. Plots are based on raw, unimputed data.

Table 1
Descriptive statistics for expected and experienced positive, anxious, and negative affect and confidence in expected positive, anxious, and negative affect. Estimates are pooled across imputations.

	Positive		Anxious		Negative	
	M	***(SD)***	***M***	***(SD)***	***M***	***(SD)***
Expected (1−5)	3.14	(0.96)	4.25	(0.88)	1.90	(0.81)
Experienced (1−5)	3.54	(0.98)	3.45	(1.22)	1.45	(0.67)
Confidence (1−10)	7.64	(1.74)	8.86	(1.47)	7.84	(1.84)

3.2.2. Is IU associated with metacognitive differences in affective forecasting?

We ran regression models to determine whether IU is associated with confidence in expectations of positive, anxious, and negative affect (RQ4). Those with higher IU were less confident in expected negative affect than those with lower IU, b = -0.19, CI = -0.31 – −0.08, t = -3.32, p < .001, FMI = 0.03. IU was not related to confidence in expected positive, b = -0.09, CI = -0.20 – 0.02, t = -1.66, p = .096, FMI = 0.02, or anxious affect, b = 0.07, CI = -0.02 – 0.16, t = 1.61, p = .109, FMI = 0.02 (see Fig. 2b).

To determine whether IU is associated with metacognitive awareness around affective forecasting accuracy (RQ5), we ran regression models predicting the absolute difference between expected and experienced affect from IU, self-reported confidence in expected affect, and the interaction between IU and confidence, as well as the control variables used across all models. The outcome variable was reversed such that a positive relationship between confidence and accuracy indicates good metacognitive awareness. Indeed, the more confident people were about their expected negative affect, the higher their accuracy, b = 0.05, CI = 0.02 – 0.09, t = 2.79, p = .005, FMI = 0.10. There was no relationship between confidence and accuracy for positive affect, b = 0.01, CI = -0.03 – 0.06, t = 0.56, p = .577, FMI = 0.16, or anxious affect, b = -0.04, CI = -0.09 – 0.02, t = -1.26, p = .208, FMI = 0.09. However, there was a significant interaction between IU and confidence for positive affect, b = -0.05, CI = -0.09 – −0.01, t = -2.56, p = .011, FMI = 0.12.

To explore this interaction, the effect of confidence was explored separately for those with high and low IU, separated by a median split. For those with low IU, confidence about expected affect had a positive

relationship with accuracy, b = 0.07, CI = 0.01 – 0.13, t = 2.16, p = .032, FMI = 0.23, however, this effect does not withstand Bonferroni correction of alpha to the.025 level. In contrast, for those with high IU, there was no relationship between confidence about expected affect and accuracy, b = -0.05, CI = -0.11 – 0.01, t = -1.60, p = .110, FMI = 0.04. This suggests that those lower in IU had better metacognitive awareness of their accuracy for forecasting positive affective states than those high in IU. Fig. 3 visualises these trends for high and low IU participants.

4. Discussion

The present study examined how IU is related to affective forecasting about negative, positive, and anxiety-related affect in a field-study conducted at a horror attraction, which provides an uncertain, threat-related experience. The findings provided some support for the hypotheses. Participants higher in IU anticipated more negative and anxious affect, and less positive affect, compared to those lower in IU. IU was also associated with accuracy of forecasting, but for negative affect only, with those higher in IU being more biased in their estimations of negative affect. The results further showed that participants higher in IU experienced less positive and more negative and anxiety-related affect, compared to those lower in IU. There was also some evidence of associations between IU and confidence judgements, with participants higher in IU significantly less confident about their expectations, but only for negative affect. Finally, higher IU was associated with poorer metacognitive ability, but for positive affect only. Overall, these findings suggest that IU is associated with anticipated emotions and emotional experience across a range of emotions, and also with biased forecasting, but for negative affect only. These findings have clear implications for transdiagnostic models of psychopathology and their treatment, in particular in relation to exposure therapy and motivating approach behaviours (see below).

Our novel findings demonstrate that IU is not only associated with anticipated emotion, but also related to experienced emotions. Higher IU, compared to lower IU, was associated with anticipation of greater negative and anxiety-related affect, as well as anticipation of less positive affect. Similarly, in relation to experienced emotions, higher IU was associated with more negative and anxiety-related affect and less positive affect. This finding is in line with previous research that has examined individual differences in IU and hypothetical scenarios with uncertain negative and positive outcomes (Morriss et al., 2023; Pepperdine et al., 2018) but in the current study, the results were observed for actual affective states rather than hypothetical ones. The study clearly demonstrates that individual differences in IU relate to both positive and negative affective experiences.

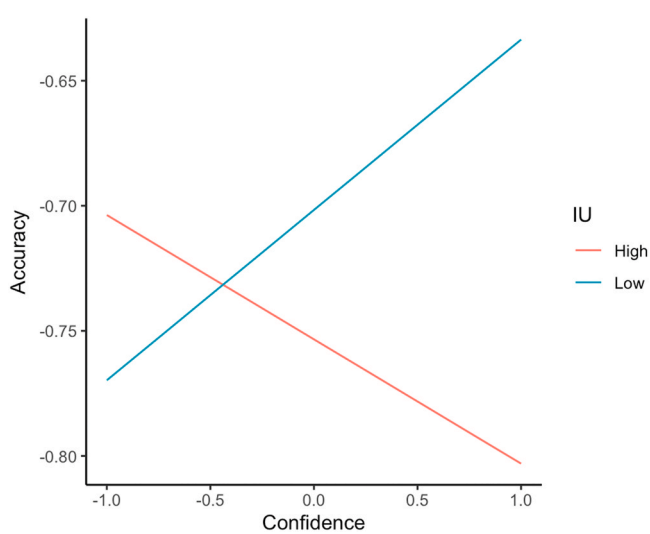

Fig. 3. Visualisation of the interaction between IU and confidence for positive affect. Lines show regression estimates for the association between confidence and forecasting accuracy by participants high and low in IU, using a median split.

With regards to confidence ratings for expected affective states, higher IU, compared to lower IU, was associated with lower confidence for negative affect but not anxiety-related or positive affect. These findings suggest that individuals higher in IU do not feel less confident about their anticipated future emotional experience in general, relative to those lower in IU. The negative affect scale (mad, miserable, sad) is arguably the least relevant to the horror experience and both anticipated and experienced affect scores were lower for this scale than the other two scales. Based on this, there may have been more uncertainty around what to expect in relation to negative affect. The presence of this uncertainty may have affected confidence more strongly in those higher in IU than those lower in IU, leading to associations between confidence and IU for negative affect specifically.

Exploratory analyses showed that confidence ratings for negative affect were associated with poorer accuracy across the sample as a whole (no interactions with IU were found), suggesting some metacognitive awareness. For positive affect, there was an interaction between IU and confidence ratings in predicting accuracy. The results of this interaction suggest that those with higher IU have poorer metacognitive awareness of their affective forecasting ability for positive affective states, relative to those with lower IU. Caution is warranted in interpreting this novel finding, given that it did not retain significance following correction for multiple comparisons. However, it is particularly interesting in the context of participants underestimating in general how much positive affect they would experience. Furthermore, we can speculate that individuals higher in IU may be less open to the possibility that an experience, at least one that involves uncertainty and fear, might be more enjoyable than they expect. Positive affect plays a key role in adaptive responses to threat (see Taylor et al., 2023). Of particular relevance, positive affect activates approach motivation and supports engagement in exposure to fear stimuli (Berman et al., 2019). Some metacognitive understanding that an experience might be more enjoyable than anticipated may be particularly important in motivating approach, as opposed to avoidance, in situations that involve facing uncertainty and fear. If individuals high in IU underestimate the possibility of positive affect and have poorer metacognitive awareness that their expectations may be wrong, then this may increase the likelihood of avoidance behaviour.

Although the primary aims of the research were related to IU, the results showed that for affective forecasting, participants in general overestimated the experience of negative affect and anxiety-related affect, and underestimated the experience of positive affect. The findings for both negative and anxious affect mirror well-established findings from the affective forecasting literature (e.g., Dunn et al., 2003; Gilbert et al., 1998). It is less common however to find that participants underestimate their positive affect; typically both positive and negative future emotions are overestimated. It seems likely that this may be due to the context of the present study being a horror experience designed to invoke enjoyable fear. The majority of affective forecasting research has focused on events that are more clearly positively or negatively valenced.

The findings have relevance for theory and for evidence-based therapies for anxiety and mood-related conditions (Shihata et al., 2016). In relation to theory, the key contribution of this paper is to highlight that IU may be related to biases in anticipated affect that extend beyond inflated estimates of threat and include positive and negative affect more broadly. This aligns with the overall conclusions of a recent review that a negative intensity bias, as well as a blunted positive intensity bias, were associated with affective psychopathology (Rizeq, 2024), but this is the first study to demonstrate associations with IU. Theories focused on the role of uncertainty in anxiety and mood

related disorders (e.g. Grupe & Nitschke, 2013) may therefore need to be extended to accommodate these broader emotional biases. With regards to treatment implications, the study shows that IU may be associated with meta-cognitive differences in relation to confidence about their future positive affect. Given recent findings regarding the role of positive affect in effective exposure treatment for anxiety (e.g., Berman et al., 2019; Taylor et al., 2023) these findings are of particular relevance for therapies that focus on overcoming avoidance behaviours, including exposure therapy. Those with higher IU may benefit from cognitive restructuring work that focuses on modifying the overestimation of negative affective states and increasing awareness of possible positive affective states, prior to exposure exercises. This builds on research related to savouring positive affective states (for discussion, see LaFreniere & Newman, 2023; Malivoire et al., 2022), which focuses on emotions after an exposure.

4.1. Strengths and limitations

The study had a number of strengths and some limitations. The main strengths include the unique setting where uncertainty was used creatively to elicit a range of strong emotions from attendees, the large sample size, and the pre and post data which allowed for actual emotional experience to be assessed in relation to the experience itself rather than just anticipated emotion (Aitken et al., 2023). There are six main limitations. Firstly, only self-report data were collected, and only at two time points. Future research may wish to expand on this by examining how self-reported expectations, confidence, and experiences map onto psychophysiological markers of emotional phenomena during the uncertain event (e.g. pulse, movement patterns). Secondly, the self-reported negative affect scale showed suboptimal reliability. This indicates that the items in the negative affect scale are not strongly related to one another but this may also be caused by low variance on the three items. Future research may wish to examine these negative emotions separately. Thirdly, we were unable to assess the specificity of IU in relation to other broader negative affective traits, such as neuroticism or anxiety sensitivity. Further addressing this will lead to advancements in our understanding of the specificity and relevance of IU and affective forecasting in transdiagnostic models of psychopathology (Morriss, 2023). Fourthly, whilst the descriptive statistics for the IU scale suggest that the sample had typical levels of IU, the sample necessarily only includes individuals who were willing to attend a horror attraction. It is relevant to highlight, though, that approximately half of participants were there because of other people and had not sought out the attraction themselves. Follow up studies could attempt to capture the IU scores and affective forecasting from those willing to go (e.g. bought tickets), but who did not attend, or those who exited the attraction before the end. This would allow for an assessment of how IU and affective forecasting link to avoidance behaviour. Fifthly, participants were instructed not to discuss their responses with others while completing the pre- and post-experience questionnaires. However, we did not collect detailed information about the social composition of participant groups (e.g., whether individuals attended with friends or strangers), nor did we assess group-level dynamics. Groups typically consisted of a mix of people that participants knew and did not know, due to the attraction's ticketing and scheduling practices. As a result, we are unable to evaluate potential social influences on participants' predictions or emotional responses—such as emotional contagion or social appraisal processes—which may be especially relevant in socially shared environments like horror attractions. Future research could directly examine how group context shapes individual experience under uncertainty. Lastly, due to the field study design, minimal demographic information could be collected. The sample were limited to a community sample from Denmark and no information is available regarding participants' ethnicity/culture, income, education, or socioeconomic status, nor how representative they were of the population of visitors to the attraction. To assess the generalisability and reproducibility of these IU-related effects, further replication is required in diverse samples (e.g. age, ethnicity, nationality, psychiatric diagnosis history).

5. Conclusion

This study examines for the first time whether IU is related to biases in affective forecasting. The study is highly novel, with data collected at a horror attraction, which allowed anticipated and experienced affect to be explored within a highly uncertain, threat-related environment. The results showed that individuals high in IU *anticipated* more negative and anxious affect, and less positive affect before entering the experience, compared to those lower in IU. Similarly, participants higher in IU also *experienced* less positive and more negative and anxiety-related affect, compared to those lower in IU. Higher IU predicted more biased forecasting but only for negative affect, suggesting that IU is not associated with a general bias in affective forecasting. Interestingly, higher IU was associated with poorer metacognitive ability for positive affect, which may be important because positive emotions activate approach motivation and support engagement in exposure to fear stimuli. Overall, these findings suggest that IU is associated with anticipated emotions and emotional experience across a range of emotions, and also with biased forecasting, but for negative affect only. The findings have implications for transdiagnostic models of psychopathology and their treatment, in relation to exposure therapy and motivating approach behaviours in particular.

CRediT authorship contribution statement

MMA, MC, SW, RN, HD, LF Data curation: MMA, MC, SW, LF Formal analysis: SW, LF Funding acquisition: MC Methodology: MMA, MC, SW, RN, HD, LF Project administration: MC and MMA Resources: All Validation: SW and LF Visualization: LF Writing – original draft: HD, JM, LF Writing – review and editing.

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Declaration of Competing Interest

The authors have no declarations of interest to declare.

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