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Uncertainty and test anxiety: Psychometric properties of the Intolerance of Uncertainty Scale – 12 (IUS-12) among university students

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Abstract

Test anxiety is common among university students and more effective interventions are needed. The Intolerance of Uncertainty (IU) model underpins an effective intervention for anxiety. IU is the propensity to react negatively to uncertainty. The Intolerance of Uncertainty Scale – 12 (IUS-12) is the most common scale for measuring IU. This study examined for the first time the factor structure of the IUS-12 in UK samples, and explored the relationship between IU and trait and state test anxiety. Factor analyses supported a bifactor model with a robust and reliable general IU factor, which was replicated across two samples. IU was strongly associated with both trait and state test anxiety.

Keywords: Test anxiety; intolerance of uncertainty; IUS-12; university students; psychometric; bifactor model.

Uncertainty and test anxiety: Validation of the Intolerance of Uncertainty Scale – 12 (IUS-12)

Anxiety about examinations or *test anxiety* is increasingly recognized as important in higher education settings due to its impact upon student academic achievement (von der Embse, Jester, Roy, & Post, 2018) and student mental health (Kitzrow, 2003). It is estimated that 25% of students are highly test anxious (Hill & Wigfield, 1984; Hahne, 1999 cf. Neuderth, Jabs, & Schmidtke, 2009). Highly test anxious students report poorer mental health (Depreeuw & De-Neve, 1992), are more likely drop out or repeat a year of study (Schaefer, Matthess, Pfitzer, & Kohle K, 2007 cf. Neuderth et al., 2009), and are more likely to abuse alcohol (Tektaş, Paulsen, & Sel, 2013) and use prescription stimulants for non-medical reasons (Ne'Eman-Haviv & Bonny-Noach, 2019; Sattler & Wiegel, 2013) than their low-test-anxious peers. Moreover, test anxiety is associated with non-suicidal self-injury (Kiekens et al., 2016).

Test anxiety concerns anxiety about tests and their consequences, and refers to both transitory states of distress in test situations (i.e., state test anxiety) and to the traits that predispose the person to experience test anxiety (i.e., trait test anxiety) (Zeidner, 1998). Test anxiety consists of worry and somatic symptoms experienced in test contexts (Liebert & Morris, 1967; Spielberger, 1980). Worry, which consists of repetitive negative thinking of the consequences of failure, is the defining characteristic of test anxiety, with meta-analyses consistently finding this dimension is much more strongly associated with poorer academic and test performance than the somatic dimension (Hembree, 1988; Seipp, 1991; von der Embse et al., 2018).

Many interventions have been developed to treat test anxiety in university students. However, a meta-analysis of randomized controlled trials found only medium effects for reducing test anxiety (*g* = -0.64) and weak effects for improving academic and test performance (*g* = 0.28), when outliers were removed (Huntley et al., 2019). Most interventions were based upon behavioral techniques (e.g., progressive muscle relaxation) that primarily target the somatic symptoms of test anxiety, and it may be that interventions that specifically target worry for therapeutic modification produce better outcomes. One contemporary intervention that does target worry and anxiety symptoms is a cognitive-behavioral therapy based upon the Intolerance of Uncertainty model (IUM; Dugas, Gagnon, Ladouceur, & Freeston, 1998). This intervention is effective in alleviating anxiety (Fisher, 2006) and treating other emotional disorders (Shihata, McEvoy, Mullan, & Carleton, 2016).

Intolerance of Uncertainty (IU) is the key component of the IUM and is defined as the tendency to view uncertain situations or outcomes as intolerable and threatening, irrespective of the actual probability of the events occurring (Dugas et al., 1998). In test anxiety, high IU individuals may see failing as intolerable and threatening. The IUM proposes that individuals with high IU experience difficulty coping with the experience of not knowing, which gives rise to range of responses aimed at minimizing or resolving uncertainty (Dugas et al., 1998; Ladouceur, Talbot, & Dugas, 1997). Worry is particularly important in the IUM, and it is posited that individuals with high IU frequently engage in worry as a subjective means of ameliorating uncertainty. For example, in test anxious students may worry about the possible negative consequences of failure and how they would deal with them. IU is highly correlated with worry in both clinical (Dugas et al., 1998; Ladouceur et al., 1999) and non-clinical (Dugas, Freeston, & Ladouceur, 1997; Dugas, Gosselin, & Ladouceur, 2001) samples. In experimental manipulations of IU, increasing IU results in increased worry (Dugas et al., 2005; Ladouceur, Gosselin, & Dugas, 2000).

Meta-analyses have found IU is associated with anxiety in adults (Gentes & Ruscio, 2011), and children and adolescents (Osmanagaoglu, Creswell, & Dodd, 2018). IU is also a transdiagnostic risk factor across emotional disorders (McEvoy, Hyett, Shihata, Price, & Strachan, 2019; Rosser, 2019), with moderate effects ($r = 0.51$) between IU and psychopathology symptoms, based on 181 studies and 52,402 participants (McEvoy et al., 2019). However, as yet, no study has examined IU in test anxiety. Current best practice for the development and evaluation of complex interventions suggests the first phase of programmatic research should examine the validity of a theoretical model in the population of interest (Craig et al., 2008). This study will be the first to examine the relationships between IU and both trait and state test anxiety in a high stake's situation (i.e., summative examinations). However, prior to investigation of IU in test anxiety among university students, an important first step is to examine the psychometric properties of the most commonly used measure that assesses IU; the Intolerance of Uncertainty Scale – 12 (IUS-12; Carleton, Norton, & Asmundson, 2007). The *Standards for Educational and Psychological Testing* (AERA, APA, NCME; 2014) state that evidence to support validity is required for each new usage of an instrument or assessment (i.e., in new contexts or populations of interest). In this context, validity refers to the evidence that supports the meaningful interpretation of IUS-12 instrument scores (Downing, 2003). Evidence to support validity of usage can be derived from investigations of internal structure and relations to other measures or constructs (AERA, APA, NCME; 2014). The IUS-12 was primarily created to address the inconsistent factor structure of the original 27-item IUS, in addition to removing some redundant and Generalized Anxiety Disorder specific items in order to improve generalizability of use of the instrument as a measure of IU (Carleton et al., 2007). Initial psychometric investigation revealed the IUS-12 to have a stable two-factor structure, excellent internal consistency, and be highly correlated with worry and anxiety (Carleton et al., 2007). The two IUS-12 factors were labeled 'Prospective IU' and 'Inhibitory IU'. 'Prospective IU' refers to the desire for predictability and the propensity to actively seek out information to help reduce uncertainty, while ‘Inhibitory IU’ refers to reticence in the face of uncertainty (Carleton et al., 2007). ‘Prospective IU’ and ‘Inhibitory IU’ were highly correlated (r = .73), which led Carleton and colleagues to suggest that either total score or subscales could be computed. However, highly correlated factors does not provide empirical justification for use of a total score (Reise, Moore, & Haviland, 2010). Thus, although the two-factor structure of the IUS-12 was initially replicated in student, clinical, and community samples (Carleton, Collimore, & Asmundson, 2010; Fergus & Wu, 2013), subsequent research applying more sophisticated bifactor measurement models found the IUS-12 to have a strong and reliable general IU factor that explains the majority of common variance, leading to conclusions that the IUS-12 is essentially a unidimensional instrument and that total scores should be used (Bottesi, Noventa, Freeston, & Ghisi, 2019; Hale et al., 2016; Saulnier, Allan, Raines, & Schmidt, 2019; Shihata, McEvoy, & Mullan, 2018). As yet, no study has examined the factor structure of the IUS-12 in UK student samples or investigated the relationships between IU and test anxiety.

The aims of this study are: (i) to examine the validity of the IUS-12 by examining if a bifactor or correlated two-factor measurement model provides best fit in UK student samples, and (ii) to examine the relationship between IU and test anxiety. To ensure robustness and generalizability of our findings, we investigate IUS-12 validity and relationships between IU in both trait test anxiety that is assessed during term time, and state test anxiety, assessed immediately prior to summative examinations. We hypothesized that a bifactor measurement model of the IUS-12 will best fit the data, and that IU will be significantly and positively associated with both state and trait test anxiety.

Method

Participants and procedure

Participants were university students from a large UK university. Convenience sampling was used to collect data from two different cohorts. Emails and a university student intranet announcement advertised the study.

The first sample ('trait sample' dataset) consisted of students from across all degree programs at the university who completed the IUS-12 and a trait measure of test anxiety, the Test Anxiety Inventory (TAI; Spielberger, 1980), online during term time.

The second sample ('state sample' dataset) consisted of medical students who completed paper copies of the IUS-12 and a state measure of anxiety, the State-Trait Inventory for Cognitive and Somatic Anxiety – State (STICSA-S; Ree, French, MacLeod, & Locke, 2008), approximately 30 minutes before their summative Objective Structured Clinical Examinations (OSCEs). OSCEs require students to complete a series of simulated clinical tasks whilst being observed and evaluated by examiners (Harden, 1988).

An information sheet advised both cohorts of students about the voluntary nature of the study and that they were free to leave the study at any time without impact upon their studies. Participants in both cohorts were offered the opportunity to be entered into a prize draw for Amazon vouchers. Ethical approval for this study was received. Informed consent was obtained from all participants.

Measures

Intolerance of Uncertainty Scale – 12 (IUS-12; Carleton et al., 2007). The IUS-12 consists of 12 items assessing IU. It has two subscales: (i) 'Prospective IU' (e.g. "One should always look ahead so as to avoid surprises") and (ii) 'Inhibitory IU' (e.g. "When it's time to act, uncertainty paralyses me"). Items are scored on a 5-point scale from 1 ("*Not at all characteristic of me*") to 5 ("*Very Characteristic of me*"). Subscales scores range from 7-35 for 'Prospective IU', and 5-25 for 'Inhibitory IU', with higher scores indicating greater IU.

The IUS-12 has good internal reliability (subscales Cronbach alphas of .85), stable factor structure, and convergent validity with other measures of IU (Carleton et al., 2007; Roma & Hope, 2017).

Test Anxiety Inventory (TAI; Spielberger, 1980). The TAI consists of 20 items assessing trait test anxiety. It has two subscales: (i) Worry (e.g. "Thoughts of doing poorly interfere with my concentration on tests"), and (ii) Emotionality (e.g. "I feel very jittery when taking an important test"). Items are scored on a 4-point scale from 1 ("*Almost never*") to 4 ("*Almost always*"). Subscale scores range from 8-32, with higher scores indicating greater trait test anxiety. The TAI has excellent internal reliability (subscale Cronbach alphas ranging from .90 – .91), stable factor structure, and convergent validity with other measures of trait test anxiety (Spielberger, 1980; Szafranski, Barrera, & Norton, 2012).

State-Trait Inventory for Cognitive and Somatic Anxiety – State Subscale (STICSA-S; Ree et al., 2008). The STICSA-S consists of 21 items assessing an individual's state anxiety. It has two subscales: (i) S-Cognitive Anxiety (e.g. "I think the worst will happen"), and (ii) S-Somatic Anxiety (e.g. "My breathing is fast and shallow"). Items are scored on a 4-point scale from 1 ("*Not at all*") to 4 ("*Very much so*"). Subscale scores range from 10-40 for Cognitive Anxiety and 11-44 for Somatic Anxiety, with higher scores indicating greater state anxiety. The STISCA-S has good internal reliability (subscale Cronbach alphas of .85 – .86), stable factor structure, and convergent validity with other measures of state anxiety, and the scale has previously been used to measure state anxiety in examination contexts (Gros, Antony, Simms, & McCabe, 2007; Ree et al., 2008). For consistency of terms, in this study, we refer to S-Cognitive Anxiety as S-Worry, and to S-Somatic Anxiety as S-Emotionality.

Data analytic strategy

Measurement models and evaluation. Confirmatory factor analyses (CFA), using the weighted least squares estimator (WLSMV) recommended for analyses of ordinal data (Brown, 2006), were used to compare unidimensional, 2-factor correlated traits, and bifactor models of the IUS-12. CFA was conducted in both the trait and state datasets separately. CFA model fit was assessed using chi-square goodness of fit, the Comparative Fit Index (CFI) where values ≥ .95 indicate adequate fit (Hu & Bentler, 1999), and the Root Mean Square Error of Approximation (RMSEA), where values < .05 indicate good fit and values between 0.5 – 0.8 indicate adequate fit (Browne & Cudeck, 1992), and Weighed Root Mean Square Residual (WRMR), where values < 1.00 indicate good fit (DiStefano, Liu, Jiang, & Shi, 2018).

Additional statistical indices were conducted, consistent with current best practice (Rodriguez, Reise, & Haviland, 2016), to assess the bifactor model, which assess the dimensionality of the instrument and the reliability of the general and specific factors. Dimensionality of the IUS-12 within the bifactor model was assessed with the following indices: Explained Common Variance (ECV), Percent of Uncontaminated Correlations (PUC), and assessment of standardized factor loadings for the general and specific factors. ECV and PUC inform whether a bifactor model with a strong general factor should be modelled as unidimensional or multidimensional (general and specific factors) in structural equation modelling (SEM). ECV is the proportion of common variance across items explained by the general factor relative to the specific factors, where values greater than .70 indicates support for a strong general factor (Rodriguez et al., 2016). Additionally, the proportion of common variance explained in each item by the general factor is examined by item-explained common variance (I-ECV), where values greater than .80 suggest items primarily reflect the general factor (Stucky & Edelen, 2015). PUC is the proportion of covariance terms which reflect variance from the general dimension and values greater than .70 reflect unidimensionality (Rodriguez et al., 2016).

Model-based reliability of total and specific factors was assessed using the following indices: Omega Hierarchical General (ωH) and Specific (ωHS), construct reliability (*H*), and Factor Determinacy (*FD*). The coefficient ωH represents the proportion of systematic variance that can attributed to the general factor, while ωHS reflects the proportion of systematic variance explained by specific factors after partitioning out variance attributable to the general factor. If ωH values are greater than .80 then total scores are considered essentially unidimensional (Rodriguez et al., 2016). Coefficient *H* represents the proportion of variance explained by the latent variable (i.e., a unidimensional IU factor in this case) relative the variance unexplained by the latent variable. High *H* values (> .80) suggest a well-defined latent variable that is replicable across studies (Rodriguez et al., 2016). *FD* represents the correlation between factor scores and factors, and it is recommended that factor scores are only used for *FD* greater than .90 (Gorsuch, 1983 cf. Rodriguez et al., 2016).

Exploratory data analyses. Inter-correlations amongst IUS-12 and other study variables (TAI, STICSA, age) were examined. Internal consistency of IUS-12 was assessed using Cronbach’s alpha. Independent *t*-tests examined gender and year of study differences in IUS-12 and other study variables.

Structural modelling of the associations between IU and trait and state test anxiety. Associations between IU and test anxiety was assessed in both trait and state sample datasets by fitting structural models in which latent variables for test anxiety Worry and Emotionality were regressed onto IUS-12. Model fit was assessed using chi-square, CLI, RMSEA, and WRMR fit indices using the same criteria as detailed for CFA measurement models above.

Measurement and structural modelling analyses were conducted using Mplus version 8 (Muthén & Muthén, 2008-2017). Exploratory data analyses were conducted using SPSS version 25 (IBM, 2017).

Results

The participant response rates were 53% (288 out of 541) and 52% (463 out of 882) for the trait and state sample datasets respectively, based upon the number of students who accessed the study website (for trait sample) or had access to the study information (state sample), with these figures including only participants who supplied sufficient data to be included in data analyses.

For the trait sample (*n* = 288), the mean age of participants was 20.79 years (SD = 3.46), with 201 (70%) female and 82 (29%) male respondents (and two respondents did not state their age or gender). One hundred and nineteen participants (41%) were in Year 1 of their studies, with 87 (30%) in Year 2, 52 (18%) in Year 3, and 28 (10%) in Year 4. The ethnic composition of the sample was as follows: 225 (79%) White British, Irish, or other, 18 (6%) Chinese, 12 (4%) from the Indian subcontinent, 9 (3%) as Black, 10 (3%) as of mixed heritage, and 11 (4%) as from another ethnic group, with one participants not stating their ethnicity.

For the state sample (*n* = 463), the mean age of participants was 21.87 years (SD = 2.52), with 259 (56%) female and 204 (44%) male respondents. Two hundred participants, 200 (43%) were in Year 2 of their studies, with 144 (31%) in Year 3, and 119 (26%) in Year 4. The ethnic composition of the sample was as follows: 313 (68%) White British, Irish, or other, 15 (3%) Chinese, 92 (20%) from the Indian subcontinent, 12 (3%) as Black, 13 (3%) as of mixed heritage, and 14 (3%) as from another ethnic group, with two participants not stating their ethnicity.

In summary, the mean age of participants in both samples was similar, and both samples were constituted of more females than males, and where the largest ethnic group in both was White British. The demographic composition of the samples was similar to the university (trait dataset) and School of Medicine (state dataset) populations from which they were drawn.

There no missing data points in the trait dataset but there were 27 missing data points in the State dataset (< 0.2% of total data points). Little's MCAR test confirmed these data points as missing completely at random ($\chi^2(2583) = 2655.44$, $p = .157$) and expectation-maximization was used to impute values.

Factor Structure of the IUS-12

CFA of unidimensional, correlated factors, and bifactor measurement models were first examined for trait (Table 1) and state test anxiety (Table 2).

Model fit statistics for IUS-12 in trait test anxiety dataset revealed all measurement models fit data adequately. Rescaled χ^2 difference tests found the bifactor model fit the data significantly better than the correlated factors model $\Delta\chi^2(11) = 46.18$, $p < .001$ and unidimensional models $\Delta\chi^2(12) = 127.32$, $p < .001$. Assessment of the bifactor model found a strong general factor, indicated by higher standardized loadings for all general factor items compared to specific factors and the general factor explained 82% of the common variance (ECV) compared to just 8% and 10% explained by 'Prospective IU' and 'Inhibitory IU' specific factors respectively. The mean I-ECV value was .81 (range .65 to .99), with 50% of IUS-12 items having I-ECV greater than .80, indicating that these items are stronger indicators of the general factor than their specific factors. The PUC value of .53 indicated the general factor accounted for approximately half of item correlations. Bifactor reliability indices support the construct reliability of the general factor ($\omega H = .87$, $H = .92$, $FD = .94$).

Model fit statistics for IUS-12 in state test anxiety dataset also found all measurement models fit data adequately. Rescaled $\chi 2$ difference tests found the bifactor model fit the data significantly better than the correlated factors model $\Delta\chi 2(11) = 282.97$, $p < .001$ and unidimensional models $\Delta\chi 2(12) = 312.14$, $p < .001$. Assessment of the bifactor model found a strong general factor, indicated by higher standardized loadings for all general factor items compared to specific factors and the general factor explained 80% of the common variance (ECV) compared to just 10% and 10% explained by 'Prospective IU' and 'Inhibitory IU' factors respectively. The mean I-ECV value was .82 (range .56 to .99), with 58% of IUS-12 items having I-ECV greater than .80, indicating that these items are stronger indicators of the general factor than their specific factors. The PUC value of .53 indicated the general factor accounted for approximately half of item correlations. Bifactor reliability indices support the construct reliability of the general factor ($\omega H = .88$, $H = .93$, $FD = .95$).

Overall bifactor indices of the IUS-12 in both samples show that specific factors, despite explaining a small proportion of variance, do not possess sufficient reliable variance to enable interpretation, whereas the general factor does have construct reliability. Evidence here supports deriving only total IUS-12 scores.

// Tables 1 and 2 about here //

Descriptive statistics and intercorrelations

Descriptive statistics were for IUS-12 and intercorrelations with TAI and STICSA-S are presented in Table 3. Internal consistency of IUS-12 was excellent (Cronbach's alphas of .91) across trait and state datasets.

IU was significantly positively correlated with trait and state test anxiety (Pearson's *r* from .34 to .57). Age did not correlate with IUS-12 or any TAI, or STICSA subscale.

In the ‘trait’ dataset, gender differences were found in trait test anxiety, with females reporting greater Worry (M_{Female} = 19.22 vs. M_{Male} = 16.18; $t(281) = 3.68$, $p < .001$) and Emotionality (M_{Female} = 23.64 vs M_{Male} = 19.11; $t(281) = 5.80$, $p < .001$) but no gender differences in IU were found. No differences were found in IU, test anxiety Worry and Emotionality based on students’ year of study.

In the ‘state’ dataset, gender differences were found in state test anxiety and IU, with females reporting greater Worry (M_{Female} = 21.84 vs. M_{Male} = 19.30; $t(461) = 4.00$, $p < .001$), Emotionality (M_{Female} = 24.67 vs. M_{Male} = 21.55; $t(461) = 5.23$, $p < .001$), and IU (M_{Female} = 29.90 vs. M_{Male} = 27.20; $t(461) = 3.09$, $p = .002$). With regard to differences in test anxiety and IU scores due to year of study, no significant differences were found, except for a significant difference in state test anxiety Worry scores ($F(2, 460) = 3.71$, $p = .025$), with Year 2 students reporting significantly less Worry than Year 3 students ($M_{difference}$ = -2.03).

// Table 3 about here //

Associations between IU and trait and state test anxiety

Prior to examining the relationships between IU and test anxiety in the ‘trait’ and ‘state’ datasets, measurement models of the TAI and STICSA-S were examined, with correlated two-factor models for the TAI ($\chi 2$ (103) = 268.80 $p < .0001$, CFI = .98, RMSEA = .08 (90% CIs .06 - .09), WRMR = .04) and STICSA ($\chi 2$ (188) = 647.15 $p < .0001$, CFI = .95, RMSEA = .07 (90% CIs .07 - .08), WRMR = .05) having acceptable fit.

The relationships between IU and test anxiety Worry and Emotionality are presented in Figure 1 for the trait dataset and Figure 2 for the state dataset. We included gender as a covariate of Worry and Emotionality in both ‘trait’ and ‘state’ structural models, as gender differences in test anxiety are well known (Hembree, 1988; Seipp, 1991; von der Embse et al., 2018). We also included Year of Study as a covariate of Worry in the 'state' model, as a significant difference between year groups was found suggesting that past examination experience has induced more worry, and so including for this variable will permit examination of this conjectured relationship. For simplicity, relationships between gender and Year of Study and study variables are not shown in Figures 1 and 2.

Fit indices indicated acceptable model fit in the 'trait' dataset: $\chi 2$ (373) = 647.82 $p <$ .0001, CFI = .97, RMSEA = .051 (90% CIs .044 - .057), WRMR = .10. IU was significantly and positively associated with test anxiety Worry and Emotionality dimensions. Gender was not significantly associated with Worry or Emotionality.

In the 'state' dataset, the structural model also had acceptable fit: $\chi 2$ (554) = 1363.20 $p < .0001$, CFI = .95, RMSEA = .056 (90% CIs .052 - .060), WRMR = 0.06. IU was significantly and positively associated with test anxiety Worry and Emotionality dimensions, with a stronger association with Worry exhibited. Gender was significantly associated with Worry (-.10, $p < .05$) and Emotionality (-.18, $p < .05$), and Year of Study was significantly and positively associated with Worry (-.08, $p < .05$).

// Figures 1 and 2 about here //

Discussion

Factor analyses of the IUS-12 in both trait and state test anxiety samples found a bifactor model provided best fit to data, with a strong and reliable general IU factor that accounted for the majority of variance in total IUS-12 scores. Practically, the IUS-12 can be considered a unidimensional representation of IU, and users of the instrument in UK university student contexts should compute total scores. Examination of the associations between IU and test anxiety found IU was significantly and positively correlated with Worry and Emotionality dimensions in both trait and state test anxiety, indicating IU may represent an important factor in the manifestation of test anxiety.

Measurement model results from this study are consistent with previous studies examining the factor structure of the IUS-12, which found that a bifactor measurement model provides best fit (Bottesi et al., 2019; Hale et al., 2016; Saulnier et al., 2019; Shihata et al., 2018). In the current study, the strong general IU factor was found to account for much of the reliable variance in the IUS-12 total score and also account for the majority of reliable variance of the specific ‘Prospective IU’ and ‘Inhibitory IU’ subscale scores too. The weak construct reliability of ‘Inhibitory IU’ and ‘Prospective IU’ factors argue against their scoring and interpretation. Thus, the robustness of a bifactor measurement model was confirmed in UK samples for the first time, and the IUS-12 factor structure was demonstrated in both trait and state test anxiety contexts, increasing generalizability of findings, and providing confidence to researchers in this field who wish to use the scale.

Structural models found IU is significantly associated with both trait and state test anxiety, with IU showing marginally stronger associations with the test anxiety Worry dimension compared to Emotionality. This suggests that IU is an important factor in test anxiety and that reducing IU might effectively alleviate test anxiety. Gender was not associated with trait test anxiety but was significantly associated with state test anxiety, and given females reported higher state anxiety, suggests that females react with greater anxiety in high stakes examination contexts than males. Year of study was associated with the Worry dimension of test anxiety suggesting prior examination experience influences the degree of worry in the present examination.

There are several limitations to this study. Firstly, sample size for the trait dataset was relatively small, potentially reducing the reliability of estimates, particularly for the structural modelling. Secondly, females were overly represented in both trait and state samples, and given females reported higher trait and state test anxiety, this may bias estimates. Thirdly, all data were cross-sectional and longitudinal designs are needed to elicit predictive associations between IU and test anxiety.

In summary, the IUS-12 is a valid scale for measuring IU in among UK university students, with results suggesting researchers and clinicians should compute total but not subscale scores. IU was significantly and positively associated with both trait and state test anxiety, which suggests IU plays an important contributory role in test anxiety. Further examination of the IUM as applied to test anxiety is now warranted, particularly studies that can determine if IU predicts test anxiety

Compliance with Ethical standards

Conflict of interest

The authors declare that they have no conflicts of interest.

Research involving human participants and/or animals

This study collected self-report data from human participants. All participants were presented with a detailed participant information sheet. Participation was voluntary. Informed consent was obtained from all participants in this study.

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Table 1

Standardized factor loadings and confirmatory factor analysis goodness-of-fit indices for measurement models of the Intolerance of Uncertainty Scale – 12 in trait test anxiety sample (n = 288)

	Unidimensional	**Correlated factors model**		**Bifactor model**		
Item	**model**	**Inhibitory**	**Prospective**	**General**	**Inhibitory**	**Prospective**
3. Uncertainty keeps me from living a full life.	.33	.35		.39	-.27	
6. When it is time to act, uncertainty paralyzes me.	.75	.79		.68	.49	
7. When I am uncertain I can't function very well.	.75	.80		.70	.44	
10. The smallest doubt can stop me from acting.	.73	.77		.69	.35	
12. I must get away from all uncertain situations.	.76	.81		.75	.24	
1. Unforeseen events upset me greatly.	.79		.81	.78		.19
2. It frustrates me not having all the information I need.	.78		.80	.72		.41
4. One should always look ahead so as to avoid surprises.	.62		.63	.57		.32
5. A small unforeseen event can spoil everything, even with the best of planning.	.76		.78	.78		.06
8. I always want to know what the future has in store for me.	.77		.81	.76		.27

9. I can’t stand being taken by surprise.	.78		.80	.73		.33
11. I should be able to organize everything in advance.	.68		.70	.64		.29
Model fit statistics						
χ^2 *(df)*	253 (54)	172 (53)		126 (42)		
CFI	.95	.97		.98		
RMSEA [90% CI]	.11 (.10 - .13)	.09 (.07 - .10)		.08 (.07-.10)		
WRMR	.05	.04		.03		
Bifactor model ancillary statistics						
% Explained Common Variance (ECV)	-	-	-	0.82	0.08	0.10
% Omega hierarchical	-	-	-	0.87	0.11	0.11
Construct reliability (*H*)	-	-	-	0.92	0.13	0.45
Factor Determinacy (*FD*)	-	-	-	0.94	0.62	0.74

Note. CFI = Comparative Fit Index; RMSEA = Root mean square error of approximation; WRMR = Weighted Root Mean square Residual.

Table 2

Standardized factor loadings and confirmatory factor analysis goodness-of-fit indices for measurement models of the Intolerance of Uncertainty Scale – 12 in state test anxiety sample (n = 463)

	Unidimensional	**Correlated factors model**		**Bifactor model**		
Item	**model**	**Inhibitory**	**Prospective**	**General**	**Inhibitory**	**Prospective**
3. Uncertainty keeps me from living a full life.	.65	.64		.70	.17	
6. When it is time to act, uncertainty paralyzes me.	.79	.77		.70	.49	
7. When I am uncertain I can't function very well.	.80	.79		.69	.60	
10. The smallest doubt can stop me from acting.	.78	.77		.71	.28	
12. I must get away from all uncertain situations.	.67	.66		.80	.10	
1. Unforeseen events upset me greatly.	.30		.29	.77		-.08
2. It frustrates me not having all the information I need.	.72		.71	.62		.20
4. One should always look ahead so as to avoid surprises.	.70		.70	.60		.45
5. A small unforeseen event can spoil everything, even with the best of planning.	.67		.67	.81		.01

8. I always want to know what the future has in store for me.	.80		.79	.70		.48
9. I can't stand being taken by surprise.	.77		.76	.79		.20
11. I should be able to organize everything in advance.	.73		.72	.61		.48
Model fit statistics						
χ^2 (df)	465 (54)	451 (60)		168 (42)		
CFI	.93	.93		.98		
RMSEA [90% CI]	.13 (.12 - .14)	.13 (.12 - .14)		.08 (.07-.09)		
WRMR	.06	.06		.03		
Bifactor model ancillary statistics						
% Explained Common variance (ECV)	-	-	-	0.81	0.10	0.10
% Omega hierarchical	-	-	-	0.88	0.10	0.16
Construct reliability (*H*)	-	-	-	0.93	0.48	0.50
Factor Determinacy (*FD*)	-	-	-	0.95	0.76	0.81

Note. CFI = Comparative Fit Index; RMSEA = Root mean square error of approximation; WRMR = Weighted Root Mean square Residual.

Table 3

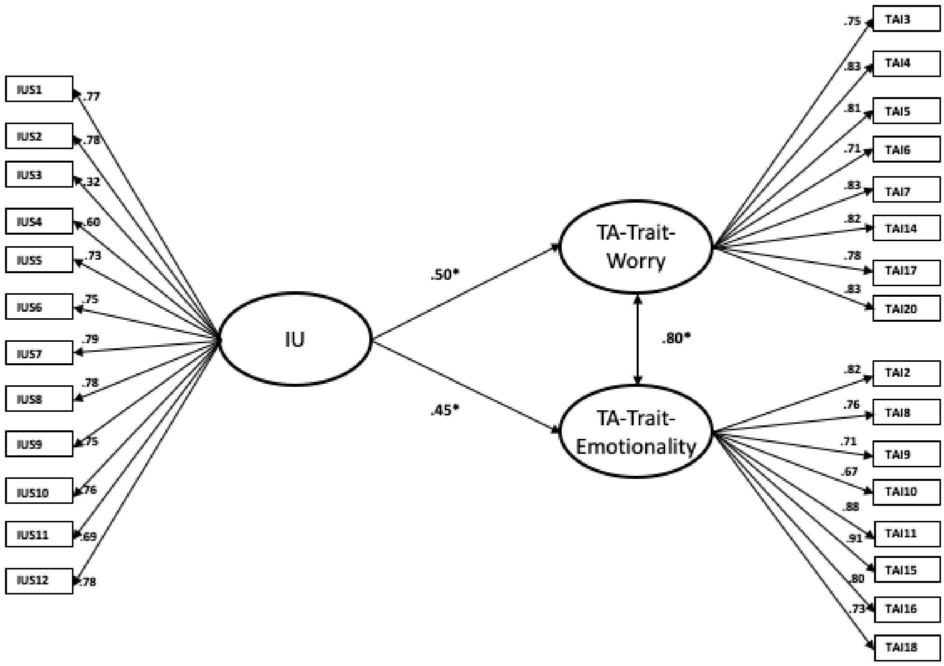
Descriptive data and Pearson's r correlations between IUS-12 and test anxiety (Trait = TAI; State = STICSA) subscales

	IU	**TA-W**	**TA-E**	***M* (*SD*)**	**Cronbach's α**
Trait					
IU	-	.44***	.40***	33.23 (10.56)	.91
TA-W		-	.74***	18.37 (6.42)	.91
TA-E			-	22.37 (6.29)	.90
State					
IU	-	.55***	.43***	28.71 (9.41)	.91
TA-W		-	.71***	20.72 (6.90)	.90
TA-E			-	23.29 (6.53)	.88

Note. IU = Intolerance of Uncertainty Scale – 12 total score; TA-W = Test Anxiety – Worry; TA-E = Test Anxiety – Emotionality; M = mean, SD = standard deviation. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 1

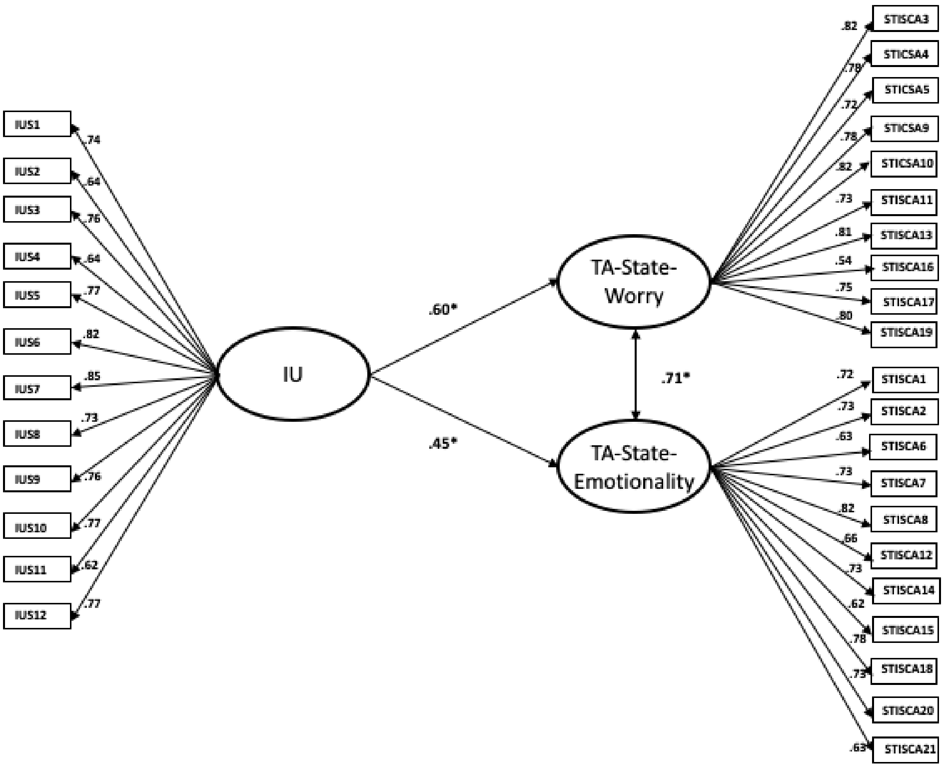
Structural equation modeling of the relationships between latent factors of the IUS-12 and dimensions of (trait) test anxiety



Note. Ellipses indicate latent factors, rectangles indicate observed variables. IU = Intolerance of Uncertainty Scale – 12; TA = Test Anxiety (Test Anxiety Inventory). Figures show standardized path coefficients. Dotted lines indicate non-significant relationships. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 2

Structural equation modeling of the relationships between latent factors of the IUS-12 and dimensions of (state) test anxiety



Note. Ellipses indicate latent factors, rectangles indicate observed variables. IU = Intolerance of Uncertainty Scale – 12; TA = Test Anxiety (as measured by STICSA-S); STISCA-S = State-Trait Inventory for Cognitive and Somatic Anxiety – State. Figures show standardized path coefficients. Dotted lines indicate non-significant relationships. * $p < .05$, ** $p < .01$, *** $p < .001$.