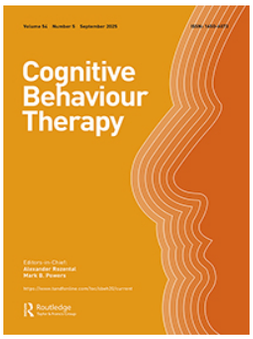

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Exploring pathways from intolerance of uncertainty to worry in adults with generalised anxiety disorder

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ABSTRACT

Three decades of research indicate that intolerance of uncertainty (IU) plays a role in the maintenance of mental health conditions. In particular, the relationship between IU and worry is especially strong. The current study aimed to conduct a partial examination of the Intolerance of Uncertainty Model (IUM) of GAD as well as the Transdiagnostic Model of Intolerance of Uncertainty (TMIU), in a clinical sample of adults with GAD using path analysis. Participants with a primary diagnosis of GAD ($N = 112$) completed a range of measures that assessed IU, cognitive avoidance (CA), positive beliefs about worry (PBW), threat estimates, worry, and anxiety, with two path analysis models constructed for the IUM and TMIU. In a preliminary analysis of the IUM, path analysis found that CA and PBW did not have an indirect effect the relationship between IU and worry, however, CA (and not PBW) had an indirect effect on the relationship between IU and anxiety. For the TMIU, the first model demonstrated a poor fit. In an alternative model, threat estimates were found to indirect effect the relationship between IU and worry as well as anxiety. This suggests that threat appraisals do play a role in the relationship between IU, worry and anxiety in individuals with GAD.

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Intolerance of uncertainty; anxiety; worry; generalised anxiety disorder; path analysis

Introduction

Generalised anxiety disorder (GAD) is a mental health disorder characterised by excessive and difficult to control worry, experienced more days than not, with accompanying anxiety and physical symptoms (American Psychiatric Association, 2022). Worry is a form of repetitive negative thinking, conceptualised as a mental act involving attempts to plan and prepare a favourable solution in the face of an uncertain and potentially negative outcome (Borkovec, 1994; Fresco et al., 2002; McEvoy, Salmon, et al., 2019). Within GAD, excessive worry is experienced as uncontrollable, with worry content often tending to be transient, determined by current life stressors, most notably characterised

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by concerns about family, finances, and work (Becker et al., 2003). Treatment based on the principles of cognitive behaviour therapy (CBT) is recommended as one of the first-line treatment options for GAD, with treatment delivered either through psychoeducational groups or through self-guided material (Kendall et al., 2011). If symptoms have not improved or functional impairment is still marked following low-intensity interventions, individual therapy focused on the principles of CBT is one of the next-line recommendations (Kendall et al., 2011). A recent meta-analysis found that evidence-based psychological therapy has a medium-to-large effect on GAD-related outcome measures, including worry and anxiety, whereas medication alone showed a small effect on these same GAD-related outcome measures (Carl et al., 2020). Despite a reduction in symptoms following psychological treatment, the results also indicate that 40–60% of the individuals who participate in psychological therapy continue to meet the diagnostic criteria for GAD (Bolognesi et al., 2014; Reinhold & Rickels, 2015). It is therefore imperative that clinical research continues to investigate the psychological processes hypothesised to underpin excessive worry and to identify opportunities for further improving theoretical models and intervention outcomes for people with GAD.

Over the past three decades, multiple conceptualisations of GAD have been proposed to explain the development and maintenance of excessive worry (Behar et al., 2009; Freeston, 2023). One prominent model is the intolerance of uncertainty model (IUM) of GAD (Dugas et al., 1998). The IUM posits that intolerance of uncertainty (IU) is the primary cognitive process initiating and driving excessive worry in GAD, with three secondary cognitive processes, namely, positive beliefs about worry (PBW), negative problem orientation (NPO) and cognitive avoidance (CA) (Dugas et al., 1998). IU is 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). In that, IU is hypothesised to have an impact on cognitive processing leading to the tendency to evaluate uncertain scenarios in a negative manner (Dugas et al., 2005; Koerner & Dugas, 2008). IU, in the IUM, is considered the primary cognitive process as it is hypothesised to directly relate to worry (Robichaud et al., 2019). Meta-analyses have consistently demonstrated a medium significant relationship between IU and worry (Gentes & Ruscio, 2011; McEvoy, Hyett, et al., 2019). Empirical research has found that experimentally manipulating IU can induce increased (or decreased) worry in community samples (Ladouceur et al., 2000; Rosen & Knäuper, 2009). More still, a recent meta-analysis found that CBT aimed at targeting components of the IUM (i.e. CBT-IU), significantly reduced both IU and worry at post-treatment and follow-up time points (Wilson et al., 2023). These empirical findings together provide evidence in support of the hypothesised primary relationship between IU and worry in the IUM for adults with GAD.

In addition, the IUM suggests that the presence of heightened IU also contributes to the individual's propensity of holding beliefs that it is useful to worry (i.e. PBW), viewing problems as negative (i.e. NPO) and engaging in thought suppression and/or substitution of images to verbal-linguistic thoughts (i.e. CA) (Behar et al., 2009; Dugas et al., 1998; Robichaud et al., 2019). Thus, these three processes are termed as secondary due to their hypothesised interaction with IU, leading to further worry and anxiety (Robichaud et al., 2019). Robichaud et al. (2019, p. 19) also highlights that the four IUM processes are "not

mutually exclusive and that they interact in complex ways that we are just beginning to understand". Correlational research has demonstrated mixed results in how the three secondary processes of the IUM relate to both IU and worry. In an undergraduate sample, all three secondary processes (i.e. CA, PBW, and NPO) were significantly related to IU and worry, with no gender differences (Robichaud et al., 2003). In contrast, research conducted in a clinical GAD sample found that although all secondary variables were related to IU (i.e. NPO, CA, PBW), only one secondary variable (i.e. NPO) was related to worry (Dugas et al., 2007).

Research has begun to explore how these secondary processes may interact within the relationship between IU and worry, beyond correlational research in undergraduate samples. Bottesi et al. (2016) used a cross-sectional design to determine whether the secondary processes of the IUM have an indirect effect on the relationship between IU and worry, as well as between IU and somatic anxiety, with undergraduate participants from the United Kingdom (UK) and Italy. Results from the UK sample indicated that only NPO (but not CA, nor PBW) had a significant indirect effect on the relationship between IU and worry, whereas, in the Italian sample, both NPO and PBW were found to have a significant indirect effect on the relationship between IU and worry in the Italian sample. In relation to anxiety, none of the secondary processes (i.e. CA, PBW, NPO) were found to have an indirect effect on the relationship between IU and anxiety in the UK sample; however, CA did have an indirect effect on the relationship between IU and anxiety in the Italian undergraduate sample. Bottesi et al. (2018) replicated the study using a cross-sectional design, but this time separating an Italian undergraduate sample by gender (i.e. female and male). The study found no gender differences, with both NPO and PBW showing a significant indirect effect in the relationship between IU and worry. Given the disparity in findings for undergraduate samples between cultures when testing the model with path analysis, as well as the paucity of studies in clinical GAD samples, it remains important to investigate whether the secondary processes within the IUM impact the relationship from IU to excessive worry in a clinical sample of individuals with GAD.

The IUM is a cognitive conceptualisation that attempts to explain the underlying processes driving excessive worry. The transdiagnostic model of intolerance of uncertainty (TMIU) also aims to explain how IU may be implicated in psychopathology in mental health disorders (Einstein, 2014). Einstein (2014) proposes that when individuals are faced with uncertainty, they make a threat estimate. A threat estimate is an imagined aversive consequence to a negative situation, involving one or more components: 1) the *probability* of a dangerous incident occurring, 2) the *cost* this event would result in if it actually happened, 3) the person's ability to *cope* (Salkovskis, 1997). The degree of anxiety an individual experiences is not dependent on one individual component of the threat appraisal (i.e. probability, cost, or coping), but, the over-estimation of probability and severity of potential danger, alongside an estimate of their ability to cope and buffer this threat (Beck et al., 1985). Within the TMIU, IU is comprised of two components, the need for predictability and uncertainty arousal, with the need for predictability encapsulating the meta-belief that uncertainty spoils everything and that certainty should be achievable (Birrell et al., 2011; Carleton et al., 2007). Whereas uncertainty arousal is conceptualised as the emotional and behavioural difficulties an individual experiences if they have a high need for predictability including difficulty functioning and a feeling of

paralysis in the face of uncertainty (Carleton et al., 2007; Einstein, 2014). In the TMIU, if the threat estimate is low, IU cannot be activated. Whereas, if the threat appraisal is elevated (i.e. higher probability, cost, coping with negative consequences) two paths emerge depending on the person's IU. If the individual possesses a high IU, the TMIU suggests that the individual will have a negative-outcome-focused state and consequently engage in behaviours that focus on eliminating the threat estimates such as worrying, safety behaviours, or avoidance (Carr, 1974; Einstein, 2014; Klenk et al., 2011). Whereas, when a threat estimate is elevated, and the person does not have heightened IU, the individuals can reflect on their goals and reorganise them in a way that focuses on their advancement and accomplishment (Einstein, 2014; Klenk et al., 2011).

Within the TMIU, IU is hypothesised to impact the relationship between threat estimates and worry (Einstein, 2014). Butler and Mathews (1983) found that adults with GAD made significantly higher probability and cost estimations of future negative events than control participants. Research exploring the interplay of threat reappraisal and anxiety in the context of CBT has demonstrated large effects, whereas specific research on the relationship between threat reappraisal and worry has been sparse in GAD (Draheim & Anderson, 2021). Smits et al. (2012) conducted a systematic review exploring the impact of CBT on threat re-appraisal in anxiety disorders. The study established CBT as a cause of threat re-appraisal, as well as threat re-appraisal as a cause of anxiety reduction, but no studies included a GAD sample (Smits et al., 2012). More recently, Draheim and Anderson (2021) conducted a meta-analysis on 19 randomised control trials and found that CBT produced significant medium effect (Hedge's $g = .76$) on threat re-appraisal for a range of anxiety disorders (e.g. GAD, panic disorder, social anxiety disorder, specific phobia) relative to comparison condition. However, of the 19 studies, only 3 studies were specific to GAD and found a significant, yet small effect (Hedge's $g = .35$) (Draheim & Anderson, 2021). Together, these results suggest that the threat estimate is impacted by psychological treatment, suggesting that there is a relationship between threat estimate and worry.

Einstein's (2014) model proposes that uncertainty in the context of threat estimations is aversive and not uncertainty in and of itself. Milne et al. (2019) highlights that this view sits in opposition with other conceptualisations of IU (Carleton, 2016; Hebert & Dugas, 2019), in that, uncertainty is, in and of itself, threatening, and as a result IU predicts negative biases in processing, particularly in uncertain situations. Most of the research has focused on exploring the latter conceptualisation of IU, which aligns with the IUM (Dugas et al., 1998). However, some research has found that individuals high in IU found not only ambiguous but also negative and positive situations as more concerning (i.e. cost estimate) (Koerner & Dugas, 2008). If individuals high in IU find negative situations more concerning, this suggests that a threat estimate may be being made. In addition, Anderson et al. (2012) found that individuals with anxiety disorders (i.e. GAD, panic disorder, social anxiety disorder, obsessive-compulsive disorder) reported more concern regarding negative, positive, and ambiguous situations than non-clinical participants. Furthermore, the study combined the anxiety disorder and non-clinical participants ($N = 108$), and after controlling for anxiety and depression, scores on a measure of IU (i.e. uncertainty is unfair) were a significant predictor of concern in both ambiguous and negative situations (i.e. cost estimate) in regression analysis (Anderson et al., 2012). This could suggest that IU is not only associated with negative interpretation bias regarding ambiguous situations but also

increased concern regarding negative situations, suggesting that threat estimates (i.e. probability, cost and coping) may be involved. In the study by Koerner and Dugas (2008), they conducted further path analysis using a cross-sectional design, only for the ambiguous situations, and found that appraisals about ambiguous situations had a significant indirect effect on the relationship between IU to worry in individuals with high IU. The study did not explore whether concern about negative situations also had an indirect effect on the relationship from IU to worry in individuals high in IU, as after controlling for demographics, GAD symptoms, and mood variables, only the high IU group differed in their appraisals of ambiguous situations when compared to the low IU group. Therefore, research is yet to explore if threat estimates indirectly effect the relationship between IU and worry in adults with GAD. Contrastingly, research is also yet to explore whether IU indirectly effects the relationship between threat estimates and worry, as suggested in the TMIU for adults with GAD.

The current study aimed to test potential theoretical pathways that lead to excessive worry and anxiety, in a clinical sample of people with GAD using path analysis. The study aimed to create four path analysis models to test aspects of the IUM as well as TMIU. Specifically, the study sought to create two path analysis models to partially test the IUM and determine if CA and PBW have an indirect effect on the relationship between IU and worry, as well as IU and anxiety. The study also aimed to test aspects of the TMIU, with a model created to determine if IU has an indirect effect on the relationship between threat estimates and worry as well as anxiety. An alternate model was also created based on contrasting theory and research that IU predicts biases in processing, and therefore IU may contribute to a threat estimate. Significant positive bivariate correlations were hypothesised to be present between measures of worry, IU, PBW, CA, threat estimates, and anxiety. It was predicted that all models would provide an acceptable fit to the data across most, if not all indices, for adults with GAD. For the IUM, IU was modelled as the predictor variable, as it was hypothesised that CA and PBW would demonstrate a significant indirect effect between IU and worry (first model) and IU and anxiety (second model). It was predicted that IU would have a significant direct effect on worry (first model) and anxiety (second model). For the TMIU (third model), a threat estimate was modelled as the predictor variable, to determine if IU would demonstrate a significant indirect effect between threat estimate and worry as well as anxiety. A fourth exploratory model was also fit to the data based on contrasting theory, in that, IU predicts biases in processing (rather than threat estimate predicting IU). The fourth model was created with IU as a predictor variable (rather than a threat estimate), to determine whether this would provide a better fit to the data and determine if threat estimates play a role in the relationship between IU and worry as well as anxiety.

Method

Participants

This study involved 112 participants aged between 19 and 65 years ($M = 36.85$; $SD = 11.99$) with the majority of participants identifying as female (75.9%). These participants were part of a larger clinical trial (Abbott, 2007). All participants had a primary diagnosis of GAD and were assessed using the Anxiety Disorders Interview

Schedule for DSM-IV (ADIS-IV; Brown et al., 1994). The ADIS-IV interviews were conducted by clinical psychologists or doctoral-level graduate students under the supervision of senior clinical psychologists. The clinician severity rating (CSR) is a rating allocated by the clinician administering the ADIS-IV based on the severity of symptomology and associated interference and/or distress. The CSR ranges from 0 to 8, with a CSR of four or greater indicating a clinical level of severity. The mean CSR for the primary diagnosis of GAD in this sample was 6.01 ($SD = 0.89$). With regard to co-morbidity of the total sample, 71.4% of the participants also met criteria for at least one secondary diagnosis, including social anxiety disorder (40.2%), major depressive disorder (14.3%), dysthymia (6.3%), panic disorder with agoraphobia (3.6%), panic disorder without agoraphobia (1.8%), obsessive-compulsive disorder (1.8%), specific phobia (0.9%), and other (2.7%). In terms of relationship status, a proportion of participants reported that they had never married (39.3%), approximately half indicated that they were married or in a de facto relationship (54.4%), and the remaining participants stated they were separated or divorced (6.3%). All participants had completed secondary school education, with a large proportion also completing either an undergraduate degree or higher (48.2%) or a trade certificate or diploma qualification (38.5%). At the time of assessment, 43.8% reported that they were taking some form of medication for their mental health.

Measures

Anxiety disorders interview schedule for DSM-IV (ADIS-IV)

The ADIS-IV (Brown et al., 1994) is a semi-structured interview that assesses for the presence of anxiety and mood disorders based on DSM-IV diagnostic criteria. Inter-rater reliability for this interview has been demonstrated to be good to excellent (Brown et al., 1994). The agreement of blind raters assessing diagnostic reliability was high for the current study ($\kappa = 0.84$), indicating strong inter-rater reliability.

Intolerance of uncertainty scale – 12 (IUS – 12)

IU was measured using the IUS-12 (Carleton et al., 2007; Freeston et al., 1994). The IUS-12 is a 12-item measure that captures negative beliefs that someone may hold about uncertainty, such as "*When I'm uncertain I can't function very well*" or "*I must get away from all uncertain situations*". Within the TMIU, IU is hypothesised to be comprised of two components, i.e. 1) need for predictability and 2) uncertainty arousal (Einstein, 2014). These components were hypothesised to correspond to the two subscales on the IUS-12, in the original psychometric paper, namely prospective factor and inhibitory factor, respectively (Carleton et al., 2007). A recent psychometric study in a clinical sample of adults with GAD found that a bifactor (two-factor testlet) model fits the data best when compared to a unidimensional and two-factor model (Wilson et al., 2020). Bifactor indices suggested that the IUS-12 should be treated as unidimensional, with further inspection of multidimensionality suggested that only the interpretation of the total score is advised and not the two subscales (Wilson et al., 2020). Thus, the current study chose to combine the prospective and inhibitory subscales informed by recent confirmatory factor analysis and used the total score of the

IUS-12 for both the IUM and TMIU. The IUS-12 total score demonstrated good construct validity, good internal consistency, good test re-test reliability, as well as treatment sensitivity for adults with GAD (Wilson et al., 2020). Internal consistency for the current sample was excellent $\alpha = 0.90$.

Penn State worry questionnaire (PSWQ)

Excessive worry was measured using the PSWQ (Meyer et al., 1990). The PSWQ is a 16-item inventory created to capture the excessiveness, uncontrollability and generality of pathological worry, cardinal to GAD. The PSWQ has been found to have a stable unidimensional fit, as well as good construct validity and internal reliability in a sample of participants with GAD (Brown et al., 1992; Dear et al., 2011). Internal consistency in this study was good, $\alpha = 0.85$

Metacognitions Questionnaire-30 Positive Beliefs about worry (MCQ-30-PBW)

Positive beliefs about worry were measured using the MCQ-30-PBW subscale (Wells & Cartwright-Hatton, 2004). The MCQ-30 was designed to measure different metacognitive beliefs, judgements, and monitoring tendencies. The MCQ-30 consists of five subscales: 1) positive beliefs about worry; 2) negative beliefs about the uncontrollability and danger of worry; 3) cognitive self-consciousness; 4) cognitive confidence; and 5) beliefs about the need to control thoughts. The MCQ-30 has demonstrated acceptable fit within a five-factor model, as well as good construct validity and internal consistency for each subscale, including PBW, in adults with GAD (White et al., 2024). In the current sample, the internal consistency was good for the MCQ-30 PBW subscale, $\alpha = 0.88$.

White bear suppression inventory (WBSI)

Cognitive avoidance was measured using the WBSI (Wegner & Zanakos, 1994). The WBSI is a 15-item questionnaire that measures the tendency to suppress thoughts and to engage in cognitive avoidance (i.e. *"I often do things to distract myself from my thoughts"*). The WBSI has a stable one-factor structure, with good internal consistency and test–retest reliability (Muris et al., 1996). The WBSI has been shown to have good divergent validity and to negatively correlate with effective/successful suppression (van Schie et al., 2016). Internal consistency among the clinical sample for this measure was good, $\alpha = 0.88$.

The probability cost coping questionnaire (PCCQ)

Threat estimates were measured with the PCCQ (Stapinski et al., 2010). The PCCQ assesses participants' probability, cost, and coping expectations in relation to a hypothetical future threat. The PCCQ is comprised of 11 scenarios that detail hypothetical situations (e.g. *"You make a big mistake at work, and everyone thinks badly of you . . . ", "You will forget a close friend's birthday and they will feel very upset")*. For each scenario, participants are asked to rate 1) the likelihood, 2) the consequence (how bad or distressing), and 3) how difficult it would be to cope if this situation happened, on a 9-point Likert scale from 0 to 8. A total score for this measure comprised a total of all items, with higher scores indicating increased belief that the situation would happen, it

would be bad, and that it would be difficult to cope. Internal consistency for the PCCQ total score for the current sample was excellent, α = 0.91.

Depression anxiety stress scales – 21 (DASS-21)

Anxiety was measured using the anxiety subscale of the DASS-21 (Lovibond & Lovibond, 1995). The DASS-21 includes 21 items across three subscales, aimed at assessing current symptoms of depression and anxiety (i.e. physical arousal) and stress (i.e. psychological tension and agitation), with all subscales demonstrating adequate construct validity and internal consistency in a variety of clinical samples (Antony et al., 1998). Cronbach's α for the anxiety subscale was adequate: α = 0.73.

Procedure

Participants were referred to a specialist university-based clinical research unit for the assessment and treatment of anxiety disorders. At the initial assessment session, participants signed a consent form, were administered the ADIS-IV and completed a battery of standardised self-report measures as part of a clinical trial for individuals with GAD (Abbott, 2007). The current study only used measures from the initial assessment session and is therefore cross-sectional in design. Participants who endorsed symptoms of active psychosis or active suicidality in the ADIS-IV were excluded from the current study. The original treatment trial methodology was approved by the Macquarie University Human Research Ethics Committee (Project HE-R02594), and the methodology of this study was approved by The University of Technology Sydney Human Research Ethics Committee (Project: ETH22–7702).

Data analyses

Preliminary analyses were conducted in SPSS 26. Data were screened for missing values and distribution properties, with analyses to determine descriptive statistics, bivariate correlations and internal reliability also performed on each measure. Path analysis models were created using polychoric correlation coefficients for each hypothesised model, following a strategic framework (Byrne, 2011) in Mplus, version 8.8 (Muthen & Muthen, 1998–2022). Missing data was managed using the full information maximum likelihood method (FIML) with a bootstrap resample of 1000 to attenuate for any non-normality of the sampling distribution (Hayes, 2009). Research has found the FIML to be well suited for data with varying levels of normality, including non-normality (Enders, 2001). Absolute and incremental goodness-of-fit indices were used to evaluate the fit (Hu & Bentler, 1999; West et al., 2012). Absolute goodness-of-fit was evaluated using the chi-squared p value, the standardised root mean square residual (SRMR) (Bentler, 1995), the root mean square error of approximation (RMSEA), as well as the accompanying RMSEA 90% confidence interval (RMSEA 90% CI) and p of close fit (PCLOSE). For the cutoff criterion, a non-significant chi-squared statistic was suggestive of an acceptable fit (Tabachnick & Fidell, 2013; West et al., 2012), with both SRMR and RMSEA values ≤ .08 indicative of an acceptable fit, with SRMR and RMSEA values < .06 suggested to be of a good fit (Hu & Bentler, 1999). A non-significant PCLOSE and a lower limit of the RMSEA 90% CI are close to zero indicative of a good model fit (Kenny et al., 2015).

Incremental fit was evaluated with the Tucker-Lewis index (TLI) (Tucker & Lewis, 1973) and comparative fit index (CFI) (Bentler, 1990), and CFI and TLI cutoff criterion stated values ≥ .90 are indicative of a good fit, with values ≥ .95 to be indicative of an excellent model fit (Hu & Bentler, 1999). Standardised path coefficients (i.e. regression weight) were used to assess the strength of pathways, with paths above .30 considered as meaningful (Chin, 1998).

Path analysis models were developed to test aspects of the IUM (Dugas et al., 1998) and the TMIU (Einstein, 2014) in a clinical GAD sample. For the IUM, two path analysis models were created to incorporate components of the model. For the first IUM, the predictor variable was IU, and the outcome variables were worry, CA and PBW. For the second IUM path analysis model, the predictor variable was IU, and the outcome variables were anxiety, CA, and PBW. This was constructed based on the configuration by Bottesi et al. (2016, 2018) in undergraduate samples. A measure of NPO was not administered to participants in the present study and therefore was not able to be included in the analyses. Thus, this study must be considered a preliminary investigation of the IUM but is also novel due to its application in adults with GAD.

For the TMIU, two path analysis models were also created to test aspects of the model using variables salient to GAD (i.e. worry and anxiety). For the first TMIU, threat estimate was entered as the predictor variable, and IU, worry and anxiety were entered as outcome variables. A direct effect was modelled exclusively from threat estimate to worry, as there were not enough free parameters to model both worry and anxiety. Worry was selected over anxiety as it is the cardinal feature of GAD. In addition, due to previous data showing a relationship between heightened IU and increased concern (i.e. cost) in negative situations (Anderson et al., 2012; Koerner & Dugas, 2008), the study also sought to explore whether threat estimates would indirectly impact the relationship between IU and worry as well as anxiety. Thus, IU was entered as the predictor variable and threat estimates, worry and anxiety were entered as outcome variables. It should be noted that unidirectional relationships were specified between variables to enable testing of indirect paths within the models.

Results

Preliminary analyses

All participants had more than 95% of their data complete (i.e. less than 5% was missing). Missing data appeared to be missing completely at random (MCAR), Little's MCAR test

Table 1. Descriptive statistics for measures included in path analyses for adults with GAD ($N = 112$).

Scale	Mean	SD	Skewness (SE)	Kurtosis (SE)	Min (%)	Max (%)
IUS-12	35.77	10.65	−0.04 (0.23)	−0.55 (0.45)	12 (0.89)	59 (0.89)
PSWQ	66.65	8.68	−0.72 (0.23)	−0.25 (0.45)	41 (0.89)	80 (0.89)
MCQ-30 PBW	11.34	4.70	0.81 (0.23)	−0.04 (0.45)	6 (15.18)	24 (1.79)
WBSI	56.63	10.77	−0.81 (0.23)	1.15 (0.45)	15 (0.89)	75 (0.89)
PCCQ Total	152.53	30.46	−0.83 (0.23)	2.05 (0.45)	38 (0.89)	225 (0.89)
DASS-21 Anxiety	14.41	7.56	0.38 (0.23)	−0.30 (0.45)	0 (2.7%)	34 (0.89)

Note. % Percent of participants with score, *IUS-12* Intolerance of Uncertainty Scale – 12, *PSWQ* Penn State Worry Questionnaire, *MCQ-30 PBW* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *WBSI* White Bear Suppression Inventory, *PCCQ* Probability Cost Coping Questionnaire, *DASS-21 Anxiety* Depression Anxiety Stress Scale-21 Anxiety

Table 2. Spearman's rho correlation coefficients between measures for adults with GAD ($N = 112$).

Measure	IUS-12	PSWQ	MCQ-30 PBW	WBSI	PCCQ Total
PSWQ	0.36**				
MCQ PBW	0.43**	0.19*			
WBSI	0.34**	0.25**	0.05		
PCCQ	0.45**	0.40**	0.15	0.51**	
DASS-21 Anxiety	0.32**	0.30**	−0.03	0.41**	0.37**

Note. *IUS-12* Intolerance of Uncertainty Scale – 12, *PSWQ* Penn State Worry Questionnaire, *MCQ-30 PBW* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *WBSI* White Bear Suppression Inventory, *PCCQ* Probability Cost Coping Questionnaire, *DASS-21 Anxiety* Depression Anxiety Stress Scale-21 Anxiety.
*$p < 0.05$, **$p < 0.01$.

($p = 0.89$). Descriptive statistics for each of the measures are presented in Table 1. Inspection of data and histograms indicated acceptable levels of skewness (i.e. <2) and kurtosis (i.e. <7) (Curran et al., 1996). Scores on the PSWQ and WBSI appeared negatively skewed, whereas the IUS-12, PCCQ and DASS-21 Anxiety, scale appeared normally distributed. The MCQ-30 PBW subscale appeared positively skewed, with 15.1% of participants endorsing the minimum possible score. Bivariate relationships between each measure were assessed using Spearman's rho non-parametric correlations given that most scales did not appear to be normally distributed. Correlations are reported in Table 2. The MCQ-30PBW subscale was not significantly correlated with the following measures: WBSI, PCCQ and DASS-21 Anxiety. All other correlations were significant, with a small to moderately positive direction.

Path analyses

The first and second models were created to explore aspects of the IUM model (Dugas et al., 1998) to determine if CA and PBW would have an indirect effect on the relationship between IU and worry as well as IU and anxiety.

The first model represented a good fit for the data across all indices, χ^2 (1) = 0.12, p = 0.73; CFI = 1.00; TLI = 1.00; SRMR = 0.01; RMSEA (90% CI) = < 0.01 (<0.01–0.18) and PCLOSE = 0.76. Tests of indirect effects were conducted for both paths in the model and neither reached a statistical significance : 1) IU to worry via CA (β = 0.04, SE = 0.04, $p = 0.22$), 2) IU to worry via PBW (β = 0.04, SE = 0.04, $p = 0.28$). See Figure 1 for visual representation of model and significance of direct effects

The second model represented a good fit for the data across all indices: χ^2 (1) = 0.14, p = 0.76; CFI = 1.00; TLI = 1.00; SRMR = 0.01; RMSEA (90% CI) = <0.01 (<0.01–0.20) and PCLOSE = .76. Tests of indirect effects indicated that the path from IU to anxiety via CA was significant ($\beta = 0.11$, SE = 0.04, $p = 0.01$). The path from IU to anxiety via PBW was not significant ($\beta = -0.04$, SE = 0.04, $p = 0.27$). See Figure 2 for visual representation of the second model and significance of direct effects.

A third model was created to explore the hypothesised relationships suggested in the TMIU, with threat estimate as a predictor variable, and IU, worry, and anxiety as outcome variables. See Figure 3 for visual representation. Fit indices for the third model were: χ^2 (1) = 8.39, $p < 0.01$; CFI = 0.90; TLI = 0.38; SRMR = 0.07; RMSEA (90% CI) = 0.26 (0.12–0.43) and PCLOSE = 0.01. For the third model, both absolute (i.e. chi-squared

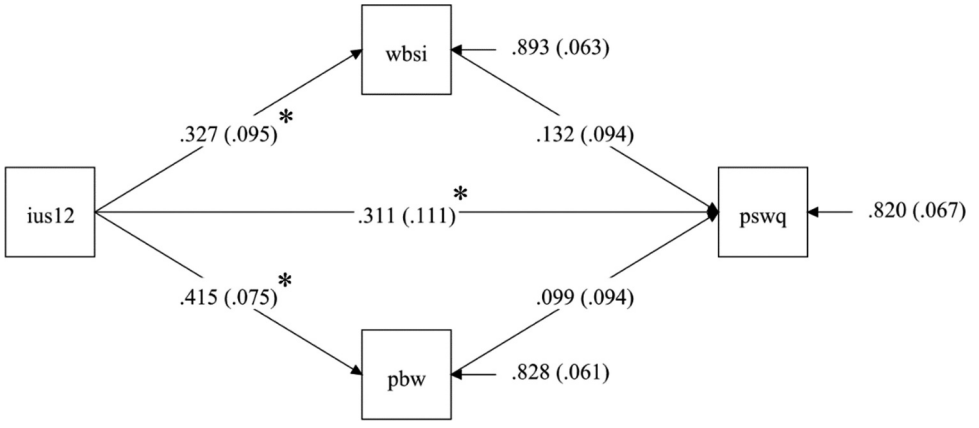

Figure 1. Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and worry in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White Bear Suppression Inventory, pswq Penn State Worry Questionnaire *$p < 0.05$.

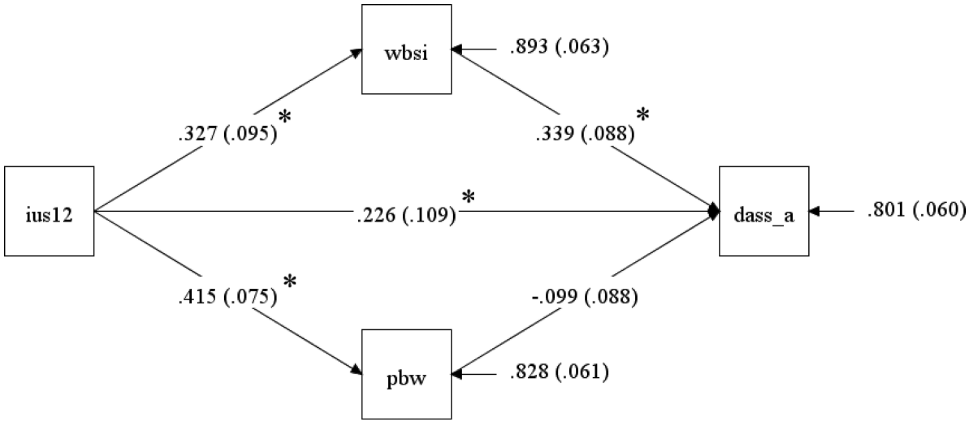

Figure 2. Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and anxiety in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White Bear Suppression Inventory, *dass_a* Depression Anxiety Stress Scale-21 Anxiety *$p < 0.05$.

test, RMSEA, RMSEA 90% CI, PCLOSE) and incremental (i.e. TLI) indices did not meet the cutoff criteria, suggesting that this model had inadequate fit for the data. Tests of indirect effects were significant for both paths tested: 1) threat estimates to worry via IU ($\beta = 0.11$, SE = 0.04, $p < 0.01$), 2) threat estimates to anxiety via IU ($\beta = 0.12$, SE = 0.05, $p = 0.03$).

A fourth model was created to examine an alternative pathway based on research that identified that IU may lead to more concern in negative situations (Anderson et al., 2012). Specifically, the fourth model identified IU as the predictor variable, with threat estimate, worry, and anxiety as outcome variables. Fit indices for the fourth model were: χ^2 (1) = 3.61, $p = 0.06$; CFI = 0.93; TLI = 0.78; SRMR = 0.05; RMSEA

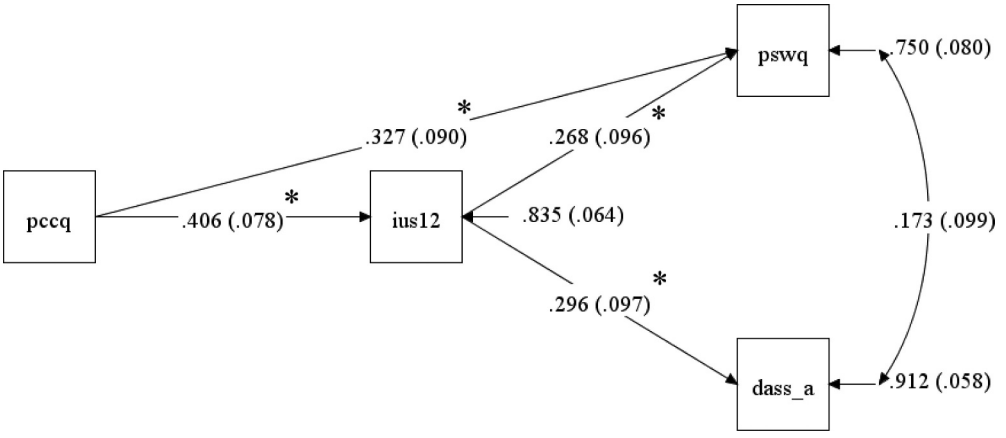

Figure 3. Standardised path coefficients and errors between threat appraisal, intolerance of uncertainty, worry, and anxiety in adults with GAD. Note. *pccq* Probability Cost Coping Questionnaire, *ius12* Intolerance of Uncertainty Scale – 12, *pswq* Penn State Worry Questionnaire, *dass_a* DASS-21 Anxiety subscale *$p < 0.05$.

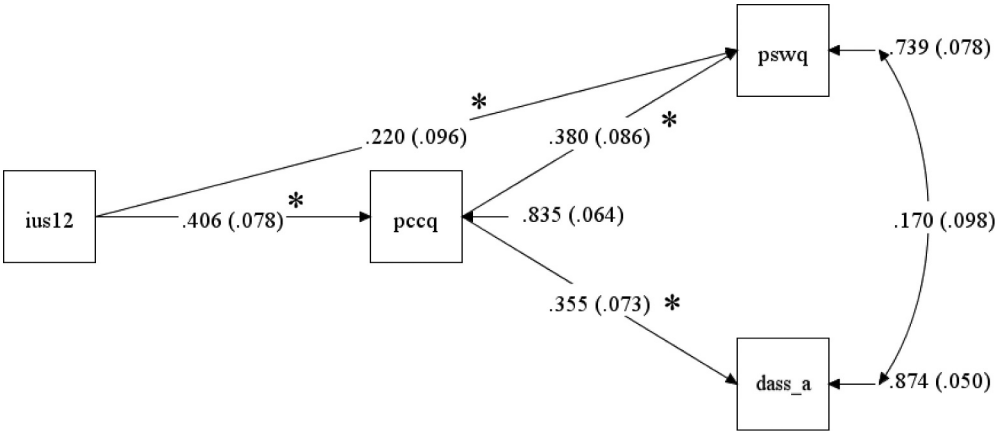

Figure 4. Standardised path coefficients and errors between intolerance of uncertainty, threat appraisals, worry and anxiety in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pccq* Probability Cost Coping Questionnaire, *pswq* Penn State Worry Questionnaire, *dass_a* DASS-21 Anxiety subscale *$p < 0.05$.

(90% CI) = 0.15 (<0.01–0.34) and PCLOSE = 0.09. Only, TLI and RMSEA did not meet the cutoff criteria, suggesting a reasonable fit. See Figure 4 for visual representation of the model, with standardised estimates, standard errors, and significance of direct effects. Tests of indirect effects were significant for both paths tested: 1) IU to worry via threat estimate ($\beta = 0.15$, SE = 0.05, $p < 0.01$), 2) IU to anxiety via threat estimate ($\beta = 0.14$, SE = 0.05, $p < 0.01$).

Discussion

IU is understood to be an important transdiagnostic factor associated with a range of emotional disorders, with particular salience to individuals with GAD (McEvoy, Hyett, et al., 2019). Potential mechanisms through which the relationship between IU and worry operate have been explored with correlational and regression analysis, however, research is yet to utilise path analysis in a sample of adults with GAD. Thus, current study aimed to conduct a preliminary and partial examination of certain processes suggested to impact the pathways from IU to worry suggested in theoretical models (i.e. IUM and TMIU) using path analysis in a clinical sample of adults with GAD.

Initial correlational analysis found that IU, worry and anxiety were all found to be significantly related to each other. Further IU, worry and anxiety were found to have a significant positive small-to-medium association with each process (i.e. CA, PBW, and threat estimates), except for anxiety and PBW, where there was no significant relationship. These results were largely consistent with extant correlational literature, confirming the relationship between IU and worry to each of these processes and symptoms in a clinical GAD sample.

The study sought to conduct a partial examination of the IUM (Dugas et al., 1998), with two path analysis models constructed to explore the relationship between IU and worry (model 1) and IU and somatic anxiety (model 2). Both models were found to have good fit across all indices, suggesting that both models fit the data well. As expected, IU demonstrated a significant and direct path to excessive worry in the first model, and from IU to anxiety in the second model. The direct path from IU to PBW had the largest standardised coefficient in both models for the IUM. Though the path from IU to PBW had the strongest predictive power, PBW did not indirectly effect the relationship between IU and worry, nor indirectly effect the relationship between IU and anxiety. Of note, the direct path from PBW to worry as well as the path from PBW to anxiety had the least predictive power for each of the preliminary IUM models. These findings mirror previous research in undergraduate samples in similar cultural backgrounds. Bottesi et al. (2016) found that PBW and CA did not have an indirect effect on the relationship between IU and worry in a UK undergraduate sample, despite all variables sharing significant zero-order correlations. Contrastingly, in two different Italian undergraduate samples (Bottesi et al., 2016, 2018), found that PBW and NPO (not CA) had an indirect effect on the relationship between IU and worry. Though there have been inconsistent findings cross-culturally in undergraduate samples regarding the nature of the relationship between IU, worry and PBW, the current study utilised a clinical GAD sample, suggesting that PBW does not play a role in the relationship between IU and pathological worry. The metacognitive model is an alternative cognitive model of GAD, which argues that people who have PBW will likely have higher levels of worry; however, what sets worriers apart from individuals with GAD is negative metacognitive beliefs about worry (Wells, 2010). Previous research has found that non-GAD high worriers and clinical GAD participants report equivalent ratings on PBW, whereas, negative metacognitive beliefs about worry (not PBW) distinguished participants with clinical GAD from non-GAD high worriers (Ruscio & Borkovec, 2004). In addition, the study aimed to determine whether CA impacted the relationship between IU and worry, as well as with anxiety in line with the IUM. Consistent with previous research, the current study found

that CA did not have an indirect effect on the relationship between IU and worry. Whereas, CA was found to indirectly effect the relationship between IU and anxiety, mirroring previous research in Italian undergraduate samples (Bottesi et al., 2016, 2018). Overall, these results suggest that suppressing mental imagery as well as PBW are not implicated in pathological worry, whereas engaging in CA is implicated to increased somatic anxiety in adults with GAD.

The current study also sought to conduct a partial examination of the TMIU (Einstein, 2014). The third model was constructed to determine if IU had an indirect effect on the relationship between threat estimates (i.e. predictor variable) and worry as well as anxiety as suggested by the TMIU. The third model was found to have a poor fit across most fit indices (i.e. chi-squared *p* value, RMSEA, RMSEA 90% CI, PCLOSE, TLI) suggesting that the path configuration suggested by the TMIU does not adequately explain the data for adults with GAD. An alternative fourth model was fit to the data and constructed on the conceptualisation that IU is a predictor of subsequent psychological processes and symptoms. This model fits the data well across most indices except for RMSEA and TLI, suggesting an adequate fit. This data suggests that IU and threat estimates do play an interactive role in the maintenance of worry and anxiety, however, due to the poor fit of the third model, and reasonable fit of the fourth model, the data suggests that IU modelled as a predictor variable provides a better explanation for these relationships for adults with GAD. Of interest for the fourth model, threat estimates were found to have a significant indirect effect on the relationship between IU and worry, as well as on IU and anxiety, with a significant direct effect from IU to worry. Thus, these findings suggest that IU impacts the extent to which an individual is going to appraise threats in state-based negative situations leading to worry and anxiety and not vice versa as suggested in the TMIU.

The current study suggests that increased negative probability, cost, and coping appraisals (i.e. threat estimates) regarding negative scenarios impact the relationship between IU and worry, as well as anxiety. However, it is yet to be explored whether increased negative appraisals in ambiguous scenarios also impact the relationship between IU and worry in adults with GAD.

Milne et al. (2019) highlights that research is yet to empirically determine whether there are situations where individuals are unable to identify negative outcomes but still are distressed due to IU. A study by Anderson et al. (2012) found that IU predicted appraisals in both negative and ambiguous situations using a combined clinical anxiety disorder (i.e. GAD, social anxiety disorder, obsessive-compulsive disorder, panic disorder) and non-clinical samples. Beyond the study by Anderson et al. (2012) there is a paucity of evidence in clinical GAD samples, exploring the interplay of IU and appraisals in negative and ambiguous situations. Therefore, given that IU appears to provide a predictive relationship to state-based threats in negative situations, future research is needed to explore whether IU is a predictor in ambiguous situations in a clinical GAD sample.

The current study also utilised a measure that included all components of the threat estimate in the context of hypothetical negative vignettes. Previous research exploring the relationship between appraisals, IU, and worry has focused on the cost component in different negatives (Anderson et al., 2012; Dugas et al., 2005; Koerner & Dugas, 2008). Whereas the PCCQ not only considers perceptions of cost but also perceptions of

probability as well as coping. Indeed, including appraisals related to coping is of particular relevance to individuals with GAD, as research has found that perceived control over worrying (and not whether it is realistic or likely) explained a significant amount of variability between adults with GAD and non-anxious controls (Craske et al., 1989). In addition, future research should endeavour to explore whether specific threat appraisal components (e.g. coping) are of particular relevance to the relationship between IU and worry in GAD.

Findings from the models exploring components of the TMIU highlight the importance of targeting threat appraisals (i.e. probability, cost, and coping) when working with individuals with GAD. These findings complement the treatment protocol proposed by Hebert and Dugas (2019) that focuses exclusively on behavioural experiments targeting IU over the course of 12 sessions. Indeed, the treatment manual asserts that behavioural experiments must endeavour to target negative expectations of uncertainty, in relation to probability, cost, and coping (Hebert & Dugas, 2019; Robichaud et al., 2019). Dugas et al. (2022) recently performed a large-scale randomised control trial with a sample of individuals with GAD utilising the 12-session behavioural experiment protocol. The study found that the exclusive use of behavioural experiments performed significantly better than waitlists, however, the protocol is yet to be compared to another active psychological treatment (Dugas et al., 2022). This evaluation is of particular importance as the two studies that have compared the CBT-IU to another form of psychological therapy (i.e. metacognitive therapy) found that metacognitive therapy yielded a significantly greater reduction in worry and depression at post-treatment when compared to CBT-IU (van der Heiden et al., 2012; Winklerfelt Hammarberg et al., 2023). van der Heiden et al. (2012) also found that metacognitive therapy demonstrated a significantly greater reduction in IU and anxiety. The CBT-IU protocol used in comparison to metacognitive therapy aimed to target all four processes in the IUM model, including CA, PBW, NPO, and IU, with four different therapeutic strategies (i.e. worry exposure, re-evaluating positive beliefs, problem solving training, and behavioural experiments targeting IU, respectively). Given that threat appraisals, and neither CA nor PBW, were found to have an indirect effect on the relationship between IU and worry, comparing a treatment utilising the 12-session behavioural experiment protocol that predominantly targets negative expectations related to uncertainty may be a more effective treatment than the original CBT-IU protocol.

The current findings should be interpreted in light of the study limitations, which also denote future directions for prospective research. The first limitation is the partial testing of the IUM, as a measure capturing NPO was omitted from the first and second models. This is a major limitation, as previous research found NPO to be the only significant process to demonstrate a significant indirect effect between IU and worry in both the UK and Italian undergraduate samples (Bottesi et al., 2016, 2018). It is therefore important that path analysis including NPO be investigated in the future research in a clinical sample of adults with GAD. Another limitation was the cross-sectional design, as it prevented the ability to infer causality with directional pathways. This, is of particular interest in the future research as previous research exploring the process (i.e. IU) and symptom (worry) change over the course of psychological treatment for adults with GAD have had mixed results. One study found that IU preceded reductions in worry and not vice versa, during individual

psychological treatment (Bomyea et al., 2015). In contrast, recent research found that changes in IU did not predict change in worry (nor vice versa) over the course of group psychological treatment for adults with GAD (Laposa et al., 2022). Therefore, future research should aim to test the hypothesised pathways in both the IUM and TMIU using a prospective design to explore the directionality of the relationship between IU and worry. Another limitation of the current study was the inability to report on ethnicity and race. The current sample had a large proportion of missing data for ethnicity, with only 15.4% reporting their ethnicity. Future research should endeavour to capture ethnicity and race in samples, so that cultural differences can be explored and understood. Furthermore, though the participants in the study were predominantly female, the study did not explore gender differences. On the basis of previous research in undergraduate samples, the relationship between the secondary variables and IU and worry as hypothesised by the IUM was not different for the female or male group (Bottesi et al., 2018). However, future research should seek to replicate these findings in a gender diverse GAD sample, to conclusively determine that there are no gender differences.

In conclusion, the present study sought to understand potential mechanisms through which the relationship between IU and worry operates in adults with GAD. The study conducted a partial examination of certain processes in the IUM (Dugas et al., 1998) and TMIU (Einstein, 2014). Regarding the IUM, the study found that PBW and CA did not have an indirect effect on the relationship between IU and worry. However, CA was found to indirectly effect the relationship between IU and anxiety (but not anxiety). For the TMIU, the study found that IU and threat estimates play an interactive role in the maintenance of worry and anxiety in adults with GAD. Though the TMIU suggests that threat estimates are the predictor of consequent worry and anxiety in the context of IU, the data suggests that this relationship is better explained when IU is modelled as a predictor variable for adults with GAD. Overall, these findings support the use of techniques that target IU and threat appraisals, such as behavioural experiments, when working clinically with individuals with GAD.

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