Worry and intolerance of uncertainty: An empirical investigation of the symptoms and processes maintaining generalised anxiety disorder

by Emily Wilson

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

under the supervision of Dr Alice Norton, Professor Maree Abbott and Associate Professor David Berle

University of Technology Sydney
Faculty of Health

May 2025

Certificate of Original Ownership

I, Emily Wilson, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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Acknowledgements

This thesis would not have been possible without the encouragement and guidance of many people throughout my life. In particular though, I am profoundly grateful to my PhD supervisors. Professor Maree Abbott, thank you for your steadfast belief in my potential, as well as for your wisdom, pragmatism, warmth, and resilience. Dr. Alice Norton, I am appreciative of your kindness, patience, and curiosity, as well as inspiring me to take a chance and be creative. Associate Professor David Berle, thank you for your consistency, integrity, and sense of calm, which have provided me with a solid foundation throughout this thesis.

To my friends and family, I am forever grateful for your constant words of encouragement and acts of support over the many years. A special mention goes to Ruby, whose friendship throughout MCP and PhD have meant the world to me. And to Jordan, your care and love has grounded me, and your sense of humour has lifted me, thank you for coming on this journey with me.

Statement of Thesis Format

This thesis follows the Publication Manual of the American Psychological Association (APA) Seventh Edition (APA7) for both referencing and style guidelines (American Psychological Association, 2020). Australian English spelling is used throughout; apart from published articles requiring American English spelling.

List of Publications and Presentations

The format of thesis is by compilation. This thesis is comprised of six chapters. Of these six chapters, four of the chapters reflect four papers that have been published or submitted as peer-reviewed journal articles.

Peer-reviewed journal articles:

Chapter 2 (Published). Wilson, E., Abbott, M. J., & Norton, A., Berle, D., Stapinski, L., & Rapee, R. M. (2025). A comparison of the long and short forms of the Penn State Worry Questionnaire in adults with generalised anxiety disorder. *Journal of Psychopathology and Behavioural Assessment,* 47(24). doi: 10.1007/s10862-025-10200-4.

Chapter 3 (Published). Wilson, E., Abbott, M. J., & Norton, A., Berle, D., & Rapee, R. M. (2025). Exploring pathways from intolerance of uncertainty to worry in adults with generalised anxiety disorder. *Cognitive Behaviour Therapy*. doi:10.1080/16506073.2025.2478246

Chapter 4 (Published). Wilson, E., Abbott, M. J., & Norton, A. (2023). The impact of psychological treatment on intolerance of uncertainty in generalized anxiety disorder: A systematic review and meta-analysis. *Journal of Anxiety Disorders,102729*. doi:10.1016/j.janxdis.2023.102729

Manuscripts submitted for publication:

Chapter 5 (under review). Wilson, E., Abbott, M., Norton, A. R., Riley. J. A., & Berle, D. Experimenting with uncertainty: Behavioural experiments targeting intolerance of uncertainty in adults with generalised anxiety disorder. *Journal of Anxiety Disorders.*

International Conference Presentations

Wilson, E., Abbott, M. J., & Norton, A. (2023, June 1-4). *Examination of the intolerance of uncertainty models in generalised anxiety disorder: Pathways and processes*. [Open paper presentation]. Tenth World Congress of Cognitive and Behavioral Therapy (WCCBT) Seoul, South Korea

Wilson, E., Abbott, M. J., & Norton, A. (2022, September 7-10). *How well do psychological treatments for generalized anxiety disorder impact intolerance of uncertainty? A systematic review and meta-analysis* [Open paper presentation]. Fifty-second European Association of Behavioural and Cognitive Therapies (EABCT) Congress. Barcelona, Spain

National Conference Presentations

Wilson, E., Riley, J., Abbott, M. J., Berle, D., & Norton, A. (2024, October 17-19). *Experimenting with uncertainty: A brief intervention targeting negative beliefs about uncertainty for individuals with generalised anxiety disorder* [Open paper presentation]. Forty-fourth national conference for the Australian Association of Cognitive Behaviour Therapy (AACBT). Brisbane, Australia

Wilson, E., Abbott, M. J., & Norton, A. (2023, October 19-21). *How can we adapt to change when uncertainty is everywhere?* [Symposium presentation]. Forty-third national conference for the Australian Association of Cognitive Behaviour Therapy (AACBT), Sydney, Australia

Statement of Contribution of Authors

Chapter 2: Psychometric properties of the long and short versions of the Penn State Worry Questionnaire in adults with generalised anxiety disorder

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First Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Second Author Contribution:	Research conceptualisation and design. Clinical ethics, recruitment, assessment and data collection. Primary research supervision and manuscript revision.
Second Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Third Author Contribution:	Research supervision and manuscript revision.
Third Author Date and Signature:	Production Note: Signature removed prior to publication. 30/04/2025
Fourth Author Contribution:	Research supervision and manuscript revision.
Fourth Author Date and Signature:	Production Note: Signature removed prior to publication. 02/05/2025
Fifth Author Contribution:	Non-clinical ethics. Clinical and non-clinical recruitment, assessment, and data collection. Manuscript revision.
Fifth Author Date and Signature:	Production Note: Signature removed prior to publication. 05/05/2025
Sixth Author Contribution:	Manuscript revision.
Sixth Author Date and Signature:	Production Note: Signature removed prior to publication. 05/05/2025

Chapter 3: Exploring pathways from intolerance of uncertainty to worry in adults with generalised anxiety disorder.

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First Author Contribution:	Research conceptualisation and design, research ethics, statistical analysis, initial write-up of manuscript and revisions.
First Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Second Author Contribution:	Research conceptualisation and design, clinical ethics, clinical assessment and supervision. Clinical recruitment and data collection. Primary research supervision and manuscript revision.
Second Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Third Author Contribution:	Research supervision and manuscript revision.
Third Author Date and Signature:	Production Note: Signature removed prior to publication. 30/04/2025
Fourth Author Contribution:	Statistical support, research supervision, and manuscript revision.
Fourth Author Date and Signature:	Production Note: Signature removed prior to publication. 02/05/2025
Fifth Author Contribution:	Manuscript revision.
Fifth Author Date and Signature:	Production Note: Signature removed prior to publication. 05/05/2025

Chapter 4: The impact of psychological treatment on intolerance of uncertainty in generalised anxiety disorder: A systematic review and meta-analysis.

Authors: Emily Wilson, Maree Abbott, Alice Norton

First Author Contribution:	Research conceptualisation and design, data screening, data extraction, data coding, statistical analysis, initial write up of manuscript and revisions.
First Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
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Second Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Third Author Contribution:	Data coding, research supervision and manuscript revision.
Third Author Date and Signature:	Production Note: Signature removed prior to publication. 30/04/2025

Chapter 5: Experimenting with uncertainty: Behavioural experiments targeting intolerance of uncertainty in adults with generalised anxiety disorder.

Authors: Emily Wilson, Maree Abbott, Alice Norton, Jessica Riley, David Berle.

First Author Contribution:	Research conceptualisation, design and ethics. Clinical recruitment, assessment, and data collection. Statistical analysis, write-up of initial manuscript and revisions.
First Author Date and Signature	Production Note: Signature removed prior to publication. 24/04/2025
Second Author Contribution:	Research conceptualisation and design. Primary research and clinical supervision as well as manuscript revisions.
Second Author Date and Signature:	Production Note: Signature removed prior to publication. 24/04/2025
Third Author Contribution:	Research and clinical supervision, as well as manuscript revisions.
Third Author Date and Signature:	Production Note: Signature removed prior to publication. 30/04/2025
Fourth Author Contribution:	Clinical recruitment, assessment, and data collection.
Fourth Author Date and Signature:	Production Note: Signature removed prior to publication. 12/05/2025
Fifth Author Contribution:	Research supervision and manuscript revisions.
Fifth Author Date and Signature:	Production Note: Signature removed prior to publication. 02/05/2025

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Thesis Abstract

Generalised anxiety disorder (GAD) is characterised by excessive and difficult to control worry. Cognitive-behaviour therapy is recommended as a first-line treatment for GAD. However, remission rates remain modest, with approximately 40-60% of individuals continuing to meet diagnostic criteria for GAD after treatment. To improve psychological treatments, understanding the relationship between symptoms and processes maintaining the disorder is essential. One cognitive process implicated in excessive worry is intolerance of uncertainty. This thesis aims to: 1) improve measurement of worry in adults with GAD; 2) enhance understanding of the psychological mechanisms underlying the relationship between intolerance of uncertainty and worry; 3) review the effectiveness of psychological treatments on intolerance of uncertainty and worry; and 4) evaluate a brief psychological intervention targeting intolerance of uncertainty in adults with GAD. This thesis presents a mixed-methods approach with four studies: three empirical studies and a systematic review and meta-analysis.

Chapter 1 provides a literature review of the relationship between intolerance of uncertainty and worry in GAD, focusing on cognitive-behavioural models and psychological treatments targeting intolerance of uncertainty. Chapter 2 compares the psychometric properties of three versions of the Penn State Worry Questionnaire (PSWQ): the 3-item PSWQ-3, the 8-item PSWQ-Abbreviated (PSWQ-A), and the 16-item PSWQ. All versions showed good construct validity, moderate test-retest reliability, and excellent criterion validity. Chapter 3 sought 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) using path analysis in adults with GAD. Of note, neither cognitive avoidance nor positive beliefs about worry were found to indirectly effect the relationship between intolerance of uncertainty and worry,

suggesting that these processes may not be implicated in the maintenance of GAD. Chapter 4 comprises a systematic review and meta-analysis investigating the impact of psychological interventions on intolerance of uncertainty and worry in adults with GAD. The meta-analysis found that psychological interventions were effective at reducing both intolerance of uncertainty and worry. Chapter 5 evaluates a brief intervention delivered via videoconference targeting intolerance of uncertainty through behavioural experiments. Results showed that the treatment group had greater reductions in worry compared to the waitlist group. After the waitlist group received treatment, the combined group showed significant improvements in worry, intolerance of uncertainty, physiological tension, and worry behaviours. Chapter 6 synthesises the findings from all four studies, discusses theoretical and clinical implications, as well as strengths and limitations of the thesis.

CHAPTER 1. Literature Review and General Introduction

Generalised Anxiety Disorder (GAD)

Generalised anxiety disorder (GAD) is a mental health disorder characterised by excessive and difficult to control worry most days for at least 6 months (American Psychiatric Association, 2022). In combination with worry, individuals with GAD also experience anxiety and a range of physiological symptoms, such as restlessness, fatigue, irritability, muscle tension, difficulty concentrating, and sleep disturbance (American Psychiatric Association, 2022). Difficult to control worry, anxiety, and physiological symptoms must cause distress and/or impairment in functioning for at least 6 months to meet diagnostic criteria specified in the Diagnostic and Statistical Manual, Fifth Edition-Text Revision (DSM-5-TR) (American Psychiatric Association, 2022). The estimated 12-month prevalence of GAD in adults ranges from 1.4% to 4.2% (Kessler et al., 2012; Somers et al., 2006; Wittchen & Jacobi, 2005). A recent cross-sectional survey conducted across 26 countries, found that GAD had a lifetime prevalence of 3.7% (Ruscio et al., 2017), which is consistent with previous surveys reporting of 6.1% in the Australian (McEvoy et al., 2011) and 4.3% in the US population (Kessler et al., 2012).

Excessive Worry

Excessive and difficult to control worry is the cardinal feature of GAD. Worry content in GAD is focused on various everyday events and life domains, commonly concerning family, relationships, health, finances, work or school, the world and society, and is relatively stable over time (Constans et al., 2002). In GAD, worry is typified by statements that imply catastrophising or inflexible rule-bound interpretations (Molina et al., 1998), and adults with primary GAD will worry more about the future than individuals with other anxiety disorders (Dugas, Freeston, et

al., 1998). In particular, worry themes tend to be related to areas of high personal value (Boehnke et al., 1998).

Measurement of Excessive Worry

The Penn State Worry Questionnaire (PSWQ) is a 16-item self-report measure that is widely used to assess excessive worry and has demonstrated strong psychometric properties, including good construct validity, internal consistency, and test-retest reliability (Brown et al., 1992; Meyer et al., 1990). Despite these strengths, there have been inconsistent findings regarding its factor structure. While early studies supported a unidimensional model, later research identified a two-factor solution comprising "worry engagement" and "absence of worry," with the latter largely reflecting method effects due to negatively worded, reverse-scored items rather than a distinct construct (Fresco et al., 2002). Subsequent investigations suggested that the reverse-scored items may introduce psychometric artifacts, creating artificial factors and limiting the validity of the full scale. Dear et al. (2011) is the only study to compare four structural models of the 16-item PSWQ in adults with GAD, finding that a three-factor model, with one general factor and two method factors (absence of worry and worry engagement), best fit the data. This structure closely resembled a bifactor model, which future research could aim to model, as a bifactor model offers the added benefit of clarifying whether a unidimensional or multidimensional interpretation is most appropriate.

In response to the structural limitations, two abbreviated versions of the PSWQ were developed. The PSWQ-Abbreviated (PSWQ-A), an 8-item version using only positively worded items, was designed to reduce factorial redundancy and cognitive burden (Hopko et al., 2003). It has shown strong fit indices, internal consistency, and reliability, especially in older adults with anxiety and mood disorders. Another abbreviated version, the PSWQ-3, includes only three

items capturing key dimensions of pathological worry, that is, frequency, uncontrollability, and breadth, and excludes reverse-scored items (Berle et al., 2011). The PSWQ-3 performed with similar psychometric properties to the PSWQ in a clinical sample of adults with GAD, and thus warrants further replication and comparison to the PSWQ-A in a clinical sample of adults with GAD. Kertz et al. (2014) compared all three versions of the PSWQ in a heterogeneous clinical sample (i.e., anxiety, mood, psychotic disorders, trauma-related) of adults presenting for treatment in a partial hospital setting. Interestingly, the 16-item PSWQ was best described by a two-factor structure, however, the abbreviated version (PSWQ-A) showed the strongest fit across all fit indices (Kertz et al., 2014). While all three versions demonstrated comparable reliability and validity in a heterogenous sample of adults with clinical disorders, research is yet to directly compare all three versions in a clinical sample of adults with a principal diagnosis of GAD. Alongside psychometric properties, it is essential to consider the clinical utility of measurement scales in routine care settings. A measure may demonstrate excellent psychometric performance yet offer limited practical value in clinical contexts, particularly if it is burdensome or difficult to interpret. Further practical considerations, such as scale length and clarity, are critical when working with diverse populations; brief, clearly worded instruments are generally more suitable for individuals with varying literacy levels than longer scales with reverse-scored items (Chachamovich et al., 2009). Effective measures strike a balance between psychometric rigor and clinical applicability to support both accurate assessment and practical implementation. This is of particular importance, as excessive worry is one of the central diagnostic criteria for GAD, thus valid and reliable measurement is essential to evidence-based practice (Margison et al., 2000).

Intolerance of Uncertainty and Excessive Worry

Intolerance of uncertainty is defined as a dispositional characteristic that results from a set of negative beliefs about uncertainty and its consequences (Robichaud et al., 2019). Thus, uncertainty is interpreted as inherently negative in that the experience reflects a characterological flaw (i.e., *'Being uncertain means that I am not first rate'*) and leads to negative emotional (i.e., '*Uncertainty makes me vulnerable, unhappy, or sad')* and behavioural consequences (i.e., '*When it's time to act uncertainty paralyses me')* (Freeston et al., 1994, p. 798). Intolerance of uncertainty was first proposed as a reason people have difficulty with excessive worry by Freeston et al. (1994). Specifically, they suggested that intolerance of uncertainty represents a dysfunctional schema about uncertainty, and therefore individuals engage in excessive worry as a way to create a sense of control over uncertain events and their consequences (Freeston et al., 1994).

Since the initial conception of the construct of intolerance of uncertainty, research has burgeoned in this area. Two separate meta-analyses have found a medium correlation of 0.57 between intolerance of uncertainty and excessive worry (Gentes & Ruscio, 2011; McEvoy et al., 2011). Longitudinal research has also found that in adolescence, changes in intolerance of uncertainty partially mediate changes in worry over a 5-year period (Dugas et al., 2012). Empirical research has found that manipulations in situational uncertainty, correspond to parallel changes in worry, with individuals who are in higher situational uncertainty reporting higher levels of worry than those in lower situational uncertainty (Ladouceur, Gosselin, et al., 2000; Rosen & Knäuper, 2009). Research has also found that changes in intolerance of uncertainty are associated with changes in worry throughout the course of cognitive-behaviour therapy (Laposa et al., 2022), with one treatment study finding that reductions in intolerance of uncertainty

precede reductions in excessive worry (Bomyea et al., 2015) Taken together, this research suggests that there is strong link between intolerance of uncertainty and excessive worry.

Measurement of Intolerance of Uncertainty

The Intolerance of Uncertainty Scale-27 (IUS-27) was first developed by Freeston et al. (1994). The Intolerance of Uncertainty Scale-27 (IUS-27), initially showed strong psychometric properties, but was later found to have an unstable factor structure and item redundancy (Buhr & Dugas, 2002; Norton, 2005). This led to the development of the 12-item version (IUS-12) by Carleton et al. (2007), which includes two subscales: prospective IU (i.e., desire for predictability) and inhibitory IU (i.e., avoidance in response to uncertainty). With the IUS-12 total score used to assess overall intolerance of uncertainty. The IUS-12 demonstrated good construct validity, internal consistency, and test-retest reliability in both clinical GAD and non-clinical samples for the total score and both subscales (Carleton et al., 2007; Khawaja & Yu, 2010). Wilson et al. (2020) was the first to assess the factor structure of the IUS-12 in a clinical sample of adults with GAD. Confirmatory factor analysis determined that the bifactor type model demonstrated a significantly better fit in comparison to the unidimensional or two-factor model for the GAD sample, and the IUS-12 exhibited limited multidimensionality suggesting that only the IUS-12 total score provides meaningful interpretation (Wilson et al., 2020). The IUS-12 total score also demonstrated good construct validity, good internal consistency, good test-retest reliability over 12-weeks, as well as responsivity to treatment following cognitive behaviour therapy (CBT) and mindfulness based psychological interventions (Wilson et al., 2020). Together these results suggest the use of the total score of the IUS-12 when assessing intolerance of uncertainty in adults with GAD.

The Intolerance of Uncertainty Model of GAD

The Intolerance of Uncertainty Model (IUM) of GAD was developed by Dugas et al. (1998) based on emerging research at the time on the relationship between intolerance of uncertainty and excessive worry. The IUM posits that intolerance of uncertainty is the primary cognitive process initiating and driving excessive worry in GAD, with three secondary cognitive processes namely, positive beliefs about worry, negative problem orientation, and cognitive avoidance (Dugas et al., 1998). The IUM suggested that if uncertainty is a common trigger for worry, then holding negative beliefs about uncertainty is hypothesised to exacerbate the initial 'what if …?' questioning style (Dugas et al., 1998). Moreover, intolerance of uncertainty is thought to maintain the excessive worry cycle, as the individual attempts to reduce uncertainty in ambiguous or novel situations by worrying about all possible outcomes ahead of time (Robichaud et al., 2019). Thus, intolerance of uncertainty is considered the primary cognitive process in the IUM as it is hypothesised to directly relate to worry (Robichaud et al., 2019). In addition, the IUM suggests that the presence of heightened intolerance of uncertainty also contributes to the individual's propensity of holding beliefs that it is useful to worry (i.e., positive beliefs about worry), viewing problems as negative (i.e., negative problem orientation), and engaging in thought suppression and/or substitution of images to verbal-linguistic thoughts (i.e., cognitive avoidance) (Dugas et al., 1998; Robichaud et al., 2019). Thus, these three processes are termed as secondary due to their hypothesised interaction with intolerance of uncertainty, leading to further worry and anxiety (Robichaud et al., 2019).

Research exploring the relationship between these secondary variables and intolerance of uncertainty as well as excessive worry has been met with inconsistent findings across community and clinical GAD samples. Specifically, positive beliefs about worry encompass a range of

positive metacognitive beliefs that worrying is a helpful strategy to cope, remain organised, and solve problems (Robichaud et al., 2019). Correlational research has endorsed a significant relationship between positive beliefs about worry and excessive worry in an undergraduate sample (Hebert et al., 2014). However, research in clinical GAD samples has only found a significant relationship between positive beliefs about worry and intolerance of uncertainty (Dugas et al., 2007), with no significant relationship between excessive worry or worry intensity with a range of measures capturing positive beliefs about worry, (i.e., Metacognitions Questionnaire- positive beliefs about worry subscale, Consequences of Worrying Scale) (Dugas et al., 2007; Thielsch et al., 2015). Cognitive avoidance is another secondary process, and is conceptualised as an attempt to avoid distressing thoughts, images, or emotions via mental distraction, suppressing the thoughts, or replacing them with neutral or unrelated content (Sexton & Dugas, 2008). Research in undergraduate samples has found cognitive avoidance to be significantly related to both generalised and catastrophic worry (Sexton & Dugas, 2009). A recent meta-analysis incorporating both community and clinical samples found that cognitive avoidance had a significant moderate relationship with intolerance of uncertainty ($r = 0.47$) (Sahib et al., 2023). Whereas in a clinical GAD sample only intolerance of uncertainty, and not excessive worry, was significantly related to cognitive avoidance (Dugas et al., 2007). Negative problem orientation is the third secondary process and reflects a dysfunctional cognitive attitude towards perceived problems, with problems viewed as inherently negative (Robichaud & Dugas, 2005). Importantly, research has found that negative problem orientation, and *not* problem-solving skills, is significantly related to the level of worry in a community sample (Dugas et al., 1995). A meta-analysis including both community and clinical samples found that negative problem orientation had a significant large relationship with intolerance of uncertainty ($r = 0.71$)

and a significant moderate relationship with worry (r = 0.57) (Clarke et al., 2017). In a clinical GAD sample, negative problem orientation was significantly related to both intolerance of uncertainty as well as worry (Dugas et al., 2007).

Thus, correlational research for cognitive avoidance and positive beliefs about worry has shown mixed results in clinical samples of individuals with GAD, despite largely demonstrating significant relationship in community samples. Hence, it is important to determine how these secondary processes may interact within the relationship between intolerance of uncertainty and worry, beyond correlational research in a clinical sample of individuals with GAD. One potential format to test these theoretical hypotheses is through path analysis, which is yet to be investigated. Thus, a current gap in the literature regards modelling of the manner in which secondary processes within the IUM impact the relationship between intolerance of uncertainty and worry in a clinical GAD sample.

Transdiagnostic Model of Intolerance of Uncertainty

The IUM is one cognitive-behavioural framework designed to explain the underlying mechanisms that contribute to excessive worry in GAD. The Transdiagnostic Model of Intolerance of Uncertainty (TMIU) is another cognitive-behavioural theory that attempts to clarify how intolerance of uncertainty may play a role in the development and maintenance of various mental health disorders (Einstein, 2014). According to the TMIU, when individuals encounter uncertainty, they generate a threat estimate, that is, an imagined negative outcome in response to a potential adverse situation (Einstein, 2014), encompassing the *probability*, the potential *cost*, and perceived ability to *cope* with the outcome (Salkovskis, 1997). Neuropsychologically, Einstein (2014) suggests that threat estimates are processed by the comparator system, starting at the dorsal anterior cingulate cortex (dACC) that detects a

mismatch between expectation and actual events (McNaughton & Gray, 2000). In particular, in a situation of uncertainty, both dACC and amygdala may be activated (Einstein, 2014). This is then hypothesised to lead to a 'premotion' by simulating a forward representation in response to the mismatch in expectations occurs in anterior insula, leading to uncertainty arousal – somatic arousal due to uncertainty (Einstein, 2014). Intolerance of uncertainty is conceptualised to consist of two key components in the TMIU: uncertainty arousal and the need for predictability. Uncertainty arousal refers to the emotional and behavioural distress triggered in individuals with a strong desire for predictability, manifesting as difficulty functioning and behavioural paralysis when confronted with uncertain situations (Carleton et al., 2007; Einstein, 2014). In contrast, need for predictability reflects a meta-belief that uncertainty is inherently disruptive, and that certainty is both desirable and attainable (Birrell et al., 2011; Carleton et al., 2007).

According to the TMIU, intolerance of uncertainty cannot be activated if the threat estimate is low. When the threat estimate is high, and individual's level of intolerance of uncertainty is also high, a negative-outcome-focused mindset occurs, prompting maladaptive coping strategies (Einstein, 2014; Klenk et al., 2011). Conversely, individuals with lower intolerance of uncertainty are more likely to respond by reevaluating their goals and adapting their behaviour in ways that promote personal growth and goal attainment, despite the uncertainty (Einstein, 2014; Klenk et al., 2011).

Einstein's (2014) model suggests that uncertainty, can only be activated under the pretext of an elevated threat estimate. In contrast, Milne et al. (2019) notes that this perspective diverges from other interpretations of intolerance of uncertainty (Carleton, 2016; Hebert & Dugas, 2019), which argue that uncertainty alone can trigger IU. According to these alternative views, intolerance of uncertainty contributes to negative cognitive biases, particularly when individuals

are faced with ambiguous or uncertain situations. However, some research has found that individuals high in intolerance of uncertainty found not only ambiguous, but also negative and positive situations as more concerning (i.e., severe/costly) (Koerner & Dugas, 2008). If individuals high in intolerance of uncertainty find negative situations more concerning, this suggests that a threat estimate, may be occurring. In addition, Anderson et al. (2012) found that individuals with anxiety disorders, and anxiety-related disorders (i.e., GAD, panic disorder, social anxiety disorder, obsessive-compulsive disorder (OCD)) reported more concern regarding negative, positive, and ambiguous situations than non-clinical participants suggesting that threat estimates (i.e., probability, cost, coping) may be involved. Regarding understanding the potential pathways in which intolerance of uncertainty and worry may work, the TMIU may offer a different understanding for how this process leads to worry in adults with GAD. In their 2009 study, Koerner and Dugas conducted a path analysis using a cross-sectional design focused specifically on ambiguous situations. After accounting for demographic variables, GAD symptoms, and mood factors, only the high intolerance of uncertainty group showed significant differences in their interpretations of ambiguous scenarios compared to those with low intolerance of uncertainty. They found that individuals with high levels of intolerance of uncertainty demonstrated a significant indirect relationship between intolerance of uncertainty and worry, mediated by their appraisals of ambiguity. However, the study did not investigate whether appraisals of clearly negative situations might also play a mediating role in the intolerance of uncertainty–worry relationship among those with high intolerance of uncertainty. As a result, it remains unclear whether threat estimates also serve as an indirect pathway between intolerance of uncertainty and worry in adults with GAD. Conversely, it is also not yet known

whether intolerance of uncertainty functions as an indirect factor influencing the relationship between threat estimates and worry, as proposed by the TMIU in the context of GAD.

Thus, several methodological limitations are evident in the existing literature regarding the IUM and TMIU, most studies have been conducted with samples of university students, and studies that have been conducted in adults GAD sample have found partial evidence of the IUM and TMIU predictions in this clinical sample. Further, no studies appear to have employed path analysis to evaluate the relationships between intolerance of uncertainty and worry in the IUM and TMIU.

Psychological Treatment in GAD

Psychological treatment utilising principals of CBT are recommended as one of the first line treatments for GAD using a stepped care approach (Kendall et al., 2011). Within a stepped care approach, treatment is first delivered either through low intensity psychoeducational groups or through self-guided material based on CBT principles (Kendall et al., 2011). If symptoms have not improved following low intensity interventions, individual therapy focused on the principles of CBT or medication (with preference to start on a selective serotonin reuptake inhibitor (SSRI)) as the next-line of treatment (Kendall et al., 2011). Meta-analyses exploring the effects of evidence-based psychological interventions (i.e., CBT or applied relaxation) have demonstrated large effect size for GAD symptoms (Hedges' $g = 0.84$) and a medium effect for depression (Hedges' $g = 0.71$) (Cuijpers et al., 2014). These findings were replicated in a recent meta-analysis with psychological interventions (i.e., CBT or applied relation) for GAD showing a medium to large effect on GAD symptom measures (Hedges' g = 0.76) and medium effects on depression outcomes (Hedges' g = 0.64) (Carl et al., 2020). In contrast, the same meta-analysis only found small effect sizes for pharmacological interventions for GAD symptoms (Hedges' $g =$

0.38) and moderate effect on depression symptoms (Hedges' $g = 0.59$), suggesting that psychological treatment is more effective in relation to reduction of specific GAD symptoms (Carl et al., 2020). Despite a reduction in symptoms following psychological treatment, results also indicate that 40-60% of individuals who participate in psychological therapy continue to meet diagnostic criteria for GAD (Bolognesi et al., 2014; Reinhold & Rickels, 2015). A recent meta-analysis estimating mean remission rates following CBT for adults with GAD found that 56.3% of adults with GAD at post-treatment and 65.2% of adults at follow-up achieved remission (Springer et al., 2018). Thus, CBT appears to be an effective form of treatment for the majority of adults with GAD, however, there is still substantial room for improvement.

One way to improve psychological treatment is to systematically examine the impact that CBT has on cognitive processes hypothesised to underlie disorder specific psychopathology to determine whether psychological treatments *do indeed* impact these cognitive processes. For adults with GAD, intolerance of uncertainty is one such cognitive vulnerability. To date, no studies have used systematic review or meta-analytic techniques to explore the impact CBT-based psychological treatment has on intolerance of uncertainty as well as symptoms of GAD, including worry, anxiety, and depression. In addition, research is yet to systematically perform sub-groups analysis to determine whether specific forms of CBT may be more effective at reducing intolerance of uncertainty and worry for adults with GAD. This is of relevance as one of the evidence-based CBT protocols aims to directly target intolerance of uncertainty: CBT – Intolerance of Uncertainty (CBT-IU).

Cognitive Behaviour Therapy for Intolerance of Uncertainty (CBT-IU)

CBT-IU was developed to target intolerance of uncertainty and address the three secondary variables hypothesised to impact the relationship between intolerance of uncertainty

and worry in GAD (Ladouceur, Dugas, et al., 2000). Earlier forms of the manual comprise of a number of modules, including psychoeducation and worry awareness training, re-evaluation of the usefulness of worry, problem solving training, imaginal exposure, and relapse prevention (Dugas et al., 2003; Dugas & Ladouceur, 2000; Ladouceur, Dugas, et al., 2000). Later iterations of CBT-IU include behavioural experiments that directly target intolerance of uncertainty (Ladouceur et al., 2004; Robichaud et al., 2019). The modules in CBT-IU directly correspond to specific aspects of the IUM with positive beliefs about worry, negative problem orientation, cognitive avoidance, and intolerance of uncertainty targeted through the following therapeutic techniques respectively; re-evaluation of the usefulness of worry, problem solving training, imaginal exposure, and behavioural experiments targeting intolerance of uncertainty.

Research has shown that CBT-IU is significantly more effective than waitlist control at reducing intolerance of uncertainty and worry in adults (Dugas et al., 2003; Ladouceur, Dugas et al., 2000b) and older adults with GAD (Hui & Zhihui, 2017). Additionally, a trial comparing CBT-IU to a pharmacological intervention (i.e., SSRIs), found CBT-IU to be significantly more effective at reducing intolerance of uncertainty and worry (Zemestani et al., 2021). Two studies comparing CBT-IU to metacognitive therapy, found that metacognitive therapy was significantly more effective at reducing worry and depression than CBT-IU (af Winklerfelt Hammarberg et al., 2023; van der Heiden et al., 2012). van der Heiden et al. (2012) also collected measures on intolerance of uncertainty and anxiety (whereas af Winklerfelt Hammarberg et al., 2023 did not) and found that metacognitive therapy demonstrated a significantly greater reduction in intolerance of uncertainty and anxiety. This further speaks to the need to systematically perform sub-groups analysis to determine if specific forms of CBT may be more effective at reducing intolerance of uncertainty and worry for adults with GAD.

One potential reason that metacognitive therapy may have outperformed CBT-IU, pertains to the use of the earlier CBT-IU protocol that did not incorporate behavioural experiments targeting intolerance of uncertainty. Both first and second editions of the CBT-IU treatment protocol highlight behavioural experiments targeting intolerance of uncertainty as an essential component of CBT-IU (Dugas & Robichaud, 2007; Robichaud et al., 2019). In comparison, the metacognitive therapy protocol incorporated behavioural experiments to target core processes within the metacognitive model, including negative beliefs about the uncontrollability/danger of worrying and well as positive beliefs about worry (Wells, 2010).

Behavioural Experiments Targeting Intolerance of Uncertainty

Behavioural experiments are set up to impact both cognitive and behavioural components of a disorder, rather than just behavioural components when doing exposure alone, that are in turn hypothesised to elicit greater experiential learning (McMillan & Lee, 2010). Behavioural experiments, require participants to formulate specific predictions prior to, and compare their predictions to actual outcomes, following an exposure-type situation (Bennett-Levy et al., 2004). In addition, behavioural experiments can be designed to maximally violate expectations, a strategy essential for enhanced inhibitory learning and retrieval (Craske et al., 2014).

Behavioural experiments targeting intolerance of uncertainty are seen as crucial to CBT-IU, so much so that Herbert and Dugas (2019) suggested a new treatment protocol based on strong links between intolerance of uncertainty and worry that exclusively utilised behavioural experiments to target intolerance of uncertainty. Hebert and Dugas (2019) conducted a preliminary evaluation of efficacy with a small sample size (n = 7) and found a large effect size on measures of intolerance of uncertainty, worry, anxiety, and depression from pre- to post-treatment. Dugas et al. (2022) extended upon this research utilising a randomised controlled trial

(RCT) design demonstrating that behavioural experiments were significantly more effective than the waitlist control condition.

A recent study aimed to explore the impact of a 50-minute self-guided online psychoeducation session regarding intolerance of uncertainty and maladaptive avoidance for individuals high in intolerance of uncertainty (Shapiro et al., 2023). The content provided education on the nature of intolerance of uncertainty, as well as taught individuals to recognise behaviours that they engage in to gain a sense certainty or avoid uncertainty, with prompts guiding the replacement of these behaviours with more adaptive behaviours to increase tolerance of uncertainty (i.e., send an email at work without checking it) (Shapiro et al., 2023). Path modeling found the intolerance of uncertainty psychoeducation condition (compared to the control health psychoeducation condition) led to significant reductions in intolerance of uncertainty at week 4 follow-up (Shapiro et al., 2023). Though this was not a clinical sample, the findings provide evidence that techniques targeted at reducing intolerance of uncertainty and maladaptive behaviours can be effective in the short term at reducing intolerance of uncertainty.

Within Australia, the government currently provides financial rebates for CBT through the Medicare benefits scheme. Despite this, the uptake for 10 sessions of psychological therapy remains low, with close to half of Australian’s accessing the rebated psychological therapy using three or fewer sessions (Productivity Commission, 2020). In a recent study conducted within Australia, adults with clinically significant GAD symptoms reported that the primary barrier to accessing care was a desire to solve one's own problems, followed by financial affordability and then, feeling embarrassed or ashamed about seeking treatment (Basile et al., 2024). These barriers to treatment could be addressed via low-intensity internet-delivered CBT, however, the study also found that the majority of individuals with GAD symptoms would prefer real-time

contact with an individual therapist, through face-to-face and video-conference (Basile et al., 2024). Currently there is a lack of research regarding the efficacy and acceptability of briefer interventions delivered by a therapist for individuals with GAD that could overcome some of the identified barriers to treatment. A brief intervention using behavioural experiments targeting intolerance of uncertainty may be one way to overcome some of these barriers.

Thesis Aims

The broad aims of this thesis are to address gaps identified in the empirical literature on the measurement of worry as well as the relationship and pathways between intolerance of uncertainty and worry in adults with GAD, with the aim to improve psychological treatment outcomes for adults with GAD. Specifically, there are four aims to be addressed through a mixed-method series of four studies in this thesis, comprising of a systematic review and meta-analysis, and three empirical studies.

Chapter 2 (Empirical Study 1) will aim to assess the psychometric properties of three different versions of the most widely used measure of excessive worry, the Penn State Worry Questionnaire (PSWQ). Specifically, Chapter 2 will compare the 3-item PSWQ, 8-item PSWQ, and the 16-item PSWQ in terms of factor structure, construct validity, test-retest reliability, criterion validity, floor and ceiling effects, as well as sensitivity and specificity for screening GAD.

Chapter 3 (Empirical Study 2) will aim to explore the potential pathways from intolerance of uncertainty to excessive worry and anxiety in adults with GAD using path analysis. Specifically, the processes that will be selected from the literature will include positive beliefs about worry and cognitive avoidance from the IUM of GAD, as well as threat appraisals as outlined in the TMIU.

Chapter 4 (Systematic Review and Meta-Analysis) will aim to systematically review the impact of current evidence-based psychological treatment on intolerance of uncertainty and excessive worry, using systematic review and meta-analytic techniques. Chapter 4 will aim to determine whether psychological treatment demonstrates a significant within-group effect from pre- to post-treatment as well as pre-treatment to follow-up on intolerance of uncertainty and worry. Chapter 4 will also seek to establish whether psychological treatment performs significantly better than a waitlist control in reducing intolerance of uncertainty and worry. Furthermore, Chapter 4 will aim to investigate whether treatments that directly target intolerance of uncertainty (i.e., CBT-IU) are significantly more effective at reducing intolerance of uncertainty and worry than treatments that indirectly target intolerance of uncertainty (i.e., general CBT, metacognitive therapy).

Chapter 5 (Empirical Study 3) will aim to evaluate a brief two-session intervention targeting intolerance of uncertainty via behavioural experiments for adults with GAD via a telehealth platform. Chapter 5 will determine whether behavioural experiments can lead to a significant reduction in worry, intolerance of uncertainty, and maladaptive worry behaviours (i.e., safety behaviours and avoidance).

Thus, it is hoped that the research presented in this thesis may contribute to improvements in the assessment of worry as well as treatment for adults with GAD, through better understanding the relationship between worry and intolerance of uncertainty.

CHAPTER 2. Empirical Study 1

Abstract

The Penn State Worry Questionnaire (PSWQ) is a 16-item self-report measure designed to assess pathological worry. The PSWQ has, however, demonstrated inconsistent factor structure in adults and older adults leading to the development of the 8-item PSWQ-A and the ultra-brief 3-item PSWQ-3. The PSWQ is yet to be compared to the PSWQ-A and PSWQ-3 in adults with GAD. Thus, the current study aimed to evaluate the psychometric properties of these three versions. Participants were screened using the Anxiety Disorders Interview Schedule for DSM-IV-TR to ascertain clinical principal diagnosis of GAD (n = 140) or non-clinical status (n = 76). Four different confirmatory factor models were fit to the 16-item PSWQ, with a unidimensional model fit to the 8-item PSWQ-A and to the PSWQ-3. A bifactor model fitted the data best for the PSWQ, and a unidimensional PSWQ-A model fitted the data best for the GAD sample. Results found that all three versions of the PSWQ demonstrated good construct validity, moderate test-retest reliability, and excellent criterion validity. ROC curve analysis indicated that all three versions demonstrated comparable levels of sensitivity and specificity for screening GAD. Both the PSWQ-A and PSWQ demonstrated no floor or ceiling effects and good internal consistency, whereas the PSWQ-3 demonstrated floor effects with adequate internal consistency. Overall, all three versions of the PSWQ share comparable psychometric properties. As such, the brevity of the PSWQ-A and its comparable performance to the 16-item PSWQ, warrant recommendations for use of this version to researchers and clinicians.

Please see Appendix A for Ethics Approval Letter for Chapter 1 and 2.

Please see Appendix B for published peer-reviewed journal article

Introduction

Worry is a form of repetitive negative thinking (McEvoy, Salmon, et al., 2019) that is conceptualised as a mental process involving attempts to plan and prepare a favourable solution in the face of an uncertain and potentially negative outcomes (Borkovec, 1994; Fresco et al., 2002). Though worry is experienced to some extent by everyone, excessive, multi-focal, and difficult to control worry is a cardinal feature of GAD. In GAD, worry is typified by statements that imply catastrophising or inflexible rule-bound interpretations (Dugas, Freeston, et al., 1998; Molina et al., 1998). Worry content centres around life domains such as family, interpersonal relationships, finances, personal health, health of loved ones, work, education, everyday tasks, the world and society, and is relatively stable over time (Constans et al., 2002). In particular, worry themes tend to be related to areas of high personal value (Boehnke et al., 1998).

The Penn State Worry Questionnaire is a 16-item self-report questionnaire that is one of the most widely used measures of excessive worry (McEvoy, Hyett, et al., 2019). The PSWQ has demonstrated good construct validity, internal consistency, and test-retest reliability (Brown et al., 1992; Dear et al., 2011; Hazlett-Stevens et al., 2004; Meyer et al., 1990). Despite these favourable psychometric properties, there has been inconsistent findings in relation to factor structure. The PSWQ was originally found to have a unidimensional factor structure in both undergraduates (Meyer et al., 1990) and in a heterogenous anxiety disorder sample (Brown et al., 1992). In contrast, Fresco et al. (2002) found that a two-factor solution provided superior fit when compared to a unidimensional solution in undergraduate students, with these two factors comprising of 1) worry engagement and 2) absence of worry. This same study found that higher order and lower order factors, general worry and worry engagement respectively, explained the majority of variance in symptom measures (Fresco et al., 2002). Thus, the second factor, absence

of worry, appeared to represent methodological variance, as the items loaded onto this factor were negatively worded (i.e., *'I do not tend to worry about things')* and thus reverse scored, rather than representing a conceptually orthogonal construct. Further investigation in a mixed sample of people with anxiety and mood disorders found that a unidimensional model accounting for method effects (i.e., covariance among errors of reverse-scored items) provided significantly better fit compared to the two-factor solution (Brown et al., 2003). Therefore, it appears that the negatively phrased items may have an aberrant function producing an artificial factor, creating a limitation of the 16-item PSWQ. These findings also parallel literature that discourages the intermixing of negatively worded items in scales as they create psychometric artefacts, rather than reducing respondent bias (Chyung et al., 2018; Roszkowski & Soven, 2010), with evidence indicating that reverse-scored items hinder psychometric performance in other anxiety disorder questionnaires (Rodebaugh et al., 2007).

In light of the inconsistent factor structure of the full PSWQ, the 8-item PSWQ-Abbreviated (PSWQ-A) was constructed by Hopko et al. (2003). The PSWQ-A was developed from the full PSWQ items that were only positively worded (i.e., *'I worry all the time'*) to address factorial redundancy as well difficulties that had been previously reported for older adults with answering negatively worded questions due to increased cognitive load. Hopko et al. (2003) demonstrated that the PSWQ-A has strong fit indices, good convergent validity, high internal consistency, and adequate test–retest reliability in a sample of older adults with a principal or co-principal diagnosis of GAD. Wuthrich et al. (2014) went on to reproduce this methodology and compare the PSWQ to the PSWQ-A with a clinical sample of older adults with depression and an anxiety disorder. Wuthrich et al. (2014) again found poor fit across absolute and incremental fit indices for both the one-factor and two-factor models for the 16-item PSWQ,

whereas the unidimensional PSWQ-A was found to have good fit across all indices. Further, the PSWQ-A was found to have good construct validity and internal consistency, with adequate test-retest reliability. In addition to the PSWQ-A, another 3-item version of the PSWQ has also been developed by Berle and colleagues (2011). The PSWQ-3 was created to incorporate the essential features of pathological worry (i.e., high frequency, high uncontrollability, multiple worry domains) as well as to exclude any reverse-scored items (Berle et al., 2011). Psychometric properties of the PSWQ-3 were explored with a mixed sample of adults with a principal anxiety or related disorder, and the results indicated similar psychometric properties for the 16-item PSWQ and PSWQ-3. Berle et al. (2011) found comparable construct validity, as well as sensitivity to treatment for individuals with GAD with equivalent large effect sizes following individual cognitive-behaviour therapy (CBT). Participants with GAD also scored higher than participants with another principal anxiety disorder on both the PSWQ and PSWQ-3.

Kertz et al. (2014) aimed to compare all three versions of the PSWQ in a heterogeneous clinical sample (i.e., mood, anxiety, trauma-related, and psychotic disorders) of adults presenting for treatment in a partial hospital setting. The underlying factor structure of the 16-item PSWQ was represented by a two-factor model, although, when compared to the PSWQ-A, the PSWQ-A exhibited the best fit across all fit indices. In addition, all three versions demonstrated similar psychometric properties, with good construct validity for the briefer versions and excellent internal consistency for the full PSWQ. All three versions showed comparable sensitivity to treatment, demonstrating medium effects following an assorted program of group and individual therapy informed by CBT. In adults with GAD, only Dear et al. (2011) has compared four model iterations of the 16-item PSWQ (i.e., unidimensional, two-factor, one-factor with method effects, and a three-factor model) and investigated the psychometric properties in adults with GAD.

Interestingly, Dear et al. (2011) found a three-factor solution, with all items loading onto one general factor as well as two separate method factors (i.e., absence of worry and worry engagement), provided the best fit to the data. The path diagram of the three-factor model from Dear et al. (2011, p.20), demonstrated a similar structure to a bifactor model. Bifactor modelling has an advantage (over the three-factor solution) as bifactor indices can determine the extent to which a unidimensional (or multidimensional) interpretation is supported by the data. In addition, research has yet to compare the 16-item PSWQ to the two shortened versions, PSWQ-A and PSWQ-3, in a clinical sample of *adults* with a *principal diagnosis of GAD*.

The current study aimed to extend previous research by comparing the psychometric properties of the 16-item PSWQ, 8-item PSWQ-A, and 3-item PSWQ-3 in a sample of adults with a principal diagnosis of GAD. It was hypothesised that the shorter PSWQ-A unidimensional model would provide the best fit for the data, when compared to the 16-item PSWQ and 3-item PSWQ-3 (Kertz et al., 2014). In addition, we hypothesised that both PSWQ-A and PSWQ-3 would demonstrate comparable psychometric properties to the longer PSWQ-16. Specifically, we predicted that all three versions would demonstrate no floor or ceiling effects. All three versions were predicted to demonstrate good construct validity though significant correlations with GAD symptom measures (i.e., physiological tension) and processes hypothesised to maintain pathological worry in cognitive-behavioural models of GAD (i.e., intolerance of uncertainty and negative metacognitive beliefs about worry). Significant moderate positive correlations were predicted for these aforementioned variables in line with previous research in mixed clinical and undergraduate samples (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004). We also predicted significant low correlations with distinct, yet overlapping psychopathology constructs, including depression and autonomic anxiety, as well as a range of metacognitive

beliefs (i.e., positive beliefs about worry, lack of cognitive confidence, cognitive self-consciousness, and need for control of thoughts) in line with previous research (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004). Further, all three versions were predicted to demonstrate good internal consistency as well as reproducibility through adequate test-retest reliability over a 12-week period. Finally, we also predicted that the measure would significantly discriminate participants with GAD from non-clinical participants, with high sensitivity and specificity.

Method

Participants

A total of 216 participants were included in the study, with the combined group being predominantly female (73.6%), with an age range from 18-70 years (*M* = 36.58 years, *SD* = 13.07). All participants were assessed using the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Brown et al., 1994). Participants needed to be at least 18 years old, living in Australia and fluent in English to participate. Individuals who were experiencing active psychosis or active suicidal ideation were excluded from the study and referred to appropriate mental health services.

Non-clinical participants (*N* = 76) were predominantly female (65.8%) and aged between 18 and 70 years (*M* = 35.55; *SD* = 14.08). Non-clinical participants were screened using the using the ADIS-IV and did not meet diagnostic criteria for any mental health disorder. Non-clinical participants were recruited via community notices in local newspapers.

The clinical sample was recruited from a specialist university-based clinical research unit for the assessment and treatment of anxiety disorders. All clinical participants met criteria for a principal diagnosis of GAD (*N* = 140) and were aged between 18 and 70 years old (*M* = 37.14;

SD = 12.50), with the majority identifying as female (77.9 %). The clinician severity rating (CSR) was assigned by the clinician who administered the ADIS-IV and reflects the severity of symptoms and related interference or distress. Ranging from zero to eight, a CSR of four or higher suggests a clinical level of severity. The average CSR for the principal diagnosis of GAD in this study was 6.15 (*SD* = 0.93). Regarding co-morbidity within the clinical sample, 73.6% of participants satisfied criteria for at least one additional diagnosis (i.e., secondary diagnosis), including social anxiety disorder (41.4%), major depressive disorder (12.9%), dysthymia (5.0%), panic disorder with agoraphobia (5%), panic disorder without agoraphobia (1.4%), OCD (1.4%), specific phobia (2.9%), and other (3.6%). At the time of assessment, 41.4% reported that they were taking some form of psychotropic medication.

There were no significant differences between the two groups on age, t (214) = 0.82, p = 0.41, gender χ^2 (1) = 3.69, p = 0.06, employment status, χ^2 (7) = 4.76, p = 0.68 and education, χ^2 (2) = 57, p = 0.06. There was a significant difference between groups in terms of marital status, χ^2 (4) = 24.56, $p < 0.01$. A greater proportion of the non-clinical group were single (52.6 %) or had been divorced (18.4%), compared to the clinical group who were single (38.7%) or divorced (6.4%). Whereas in the clinical group the majority were married/de facto (54.9%) compared to the non-clinical group (27.6%). With only a small percentage of people widowed in the non-clinical sample (1.4%).

Procedure

The original research study 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). All participants (N = 140) completed the measures as part of a clinical trial at the initial

assessment session (Abbott, 2007). At the initial assessment session, all participants signed the consent form and were administered the ADIS-IV by a clinical psychologist or doctoral-level graduate student, supervised by senior clinical psychologists. A subsample (N = 22) of the participants were in a waitlist condition for the clinical trial. These participants re-completed the PSWQ after a 12-week waitlist period (with no treatment). Participants in the waitlist condition were offered either group CBT or group mindfulness-based therapy after the 12-week waitlist.

Measures

Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV)

The ADIS-IV is a semi-structured interview designed to evaluate anxiety and mood disorders in accordance with DSM-IV diagnostic criteria (Brown et al., 1994). Extensive research has demonstrated good to excellent inter-rater reliability for this interview (Brown et al., 1994). In the current study, blind raters exhibited high agreement ($\kappa = 0.84$), underscoring strong inter-rater reliability in assessing diagnostic consistency.

Penn State Worry Questionnaire (PSWQ)

The PSWQ is a measure of excessive worry (Meyer et al., 1990). The PSWQ is a 16-item inventory created to capture the excessive and uncontrollable nature of pathological worry. The PSWQ is rated on a 5-point Likert scale, with scores ranging from 16 to 80. There are 12 items that are positively worded (i.e., '*I worry all the* time') and the remaining five items are negatively worded (i.e., '*I never worry about* anything') and need to be reverse scored. The PSWQ has been found to have good construct and internal reliability in a sample of participants with GAD (Brown et al., 1992; Dear et al., 2011). Internal consistency for the combined sample was $\alpha = 0.97$.

Penn State Worry Questionnaire – Abbreviated (PSWQ-A)

The PSWQ-A is an abridged version of the PSWQ, incorporating only eight positively worded items from the original PSWQ (Hopko et al., 2003). The PSWQ-A has been found to have a stable one-factor structure in older adult samples with mixed anxiety as well as undergraduate samples (Crittendon & Hopko, 2006; Wuthrich et al., 2014). The PSWQ-A was derived from the PSWQ and was not provided as a separate measure to participants. Cronbach's α for the combined sample was 0.95.

Penn State Worry Questionnaire – 3 (PSWQ-3)

The PSWQ-3 is an ultra-brief version on the PSWQ, with three items selected from the original PSWQ (Berle et al., 2011). The three items reflect the cardinal features of pathological worry (i.e., high frequency, perceived uncontrollability and multiple domains of worry). The PSWQ-3 has been found have good psychometric properties in both adults with GAD, as well as heterogenous mental health samples (Berle et al., 2011; Kertz et al., 2014). Like the PSWQ-A, the PSWQ-3 was extracted from the PSWQ and was not provided as a separate measure to participants. Cronbach's α for the combined sample was 0.93.

Intolerance of Uncertainty Scale – 12 (IUS – 12)

The IUS-12 was used as a measure of intolerance of uncertainty (Carleton et al., 2007; Freeston et al., 1994). There are 12 items that assess specific negative beliefs about uncertainty that someone may hold, such as '*When it is time to act, uncertainty paralyses me*' or '*I always want to know what the future has in store for me*'. The IUS-12 has a bifactor structure, with the total score to be utilised in the clinical sample of individuals with GAD (Wilson et al., 2020). It has also demonstrated good construct validity, treatment sensitivity, test-retest reliability as well as good internal consistency in a sample of individuals with GAD (Wilson et al., 2020). Internal consistency for the combined sample was excellent (α = 0.90).

Metacognitions Questionnaire – 30 (MCQ-30)

The MCQ-30 is 30-item inventory, developed to assess metacognitive beliefs and cognitive monitoring tendencies (Wells & Cartwright-Hatton, 2004). There are five subscales in the MCQ-30: 1) cognitive self-consciousness; 2) beliefs about the need to control thoughts; 3) positive beliefs about worry; 4) cognitive confidence; and 5) negative beliefs about the uncontrollability and danger of worry. The MCQ-30 has demonstrated acceptable fit within a five-factor model, as well as good construct validity and internal consistency for each subscale (Huntley et al., 2020; Nordahl, Anyan, et al., 2023). In the current sample, internal consistency ranged from adequate to excellent in the combined sample: cognitive confidence, $\alpha = 0.90$; positive beliefs about worry, $\alpha = 0.90$; cognitive self-consciousness, $\alpha = 0.85$; uncontrollability of thoughts and danger, $\alpha = 0.91$; and beliefs about need to control thoughts, $\alpha = 0.77$.

Depression Anxiety Stress Scales – Short Form (DASS-21)

The DASS-21 (Lovibond & Lovibond, 1995) includes 21-items aimed at assessing current symptoms of depression, anxiety (e.g., autonomic arousal and situational anxiety), and stress (e.g., agitation, impatience and nervous tension). Factor analysis has consistently demonstrated a three-factor solution, as well as adequate construct validity, internal consistency, and test-retest reliability in a variety of clinical samples (Brown et al., 1997; Lovibond & Lovibond, 1995; A. C. Page et al., 2007). Cronbach's α for each of the subscales was good to excellent for the combined sample: depression $\alpha = 0.91$; anxiety $\alpha = 0.82$; and stress $\alpha = 0.92$.

Data analysis

Confirmatory factor analysis (CFA) was performed to ascertain the best model that fit the data for the 16-item PSWQ, and 8-item PSWQ-A. CFA was selected (over EFA) as there are strong a priori hypotheses regarding the different factor structures from previous research (Flora

& Flake, 2017). Models tested for the 16-item PSWQ were informed by previous research (Brown et al., 1997; Dear et al., 2011) and included: 1) a one-factor model with all items loaded onto one general worry factor; 2) a one-factor model accounting for method effects, with all items loaded onto one general worry factor, with an additional method factor to account for the residual covariations among responses to five negatively worded items (i.e., reverse-scored items were permitted to covary with one another, items 1, 3, 8, 10 and 11); 3) a two-factor model with the positively-worded items loaded onto one factor, and the five negatively worded items loaded onto a second factor; 4) bifactor model (i.e., similar to the three factor model tested by Dear et al. 2011) with one general factor (shared variance between items) and two group factors, positive-scored factor and negatively scored (indicative of the covariance not explained by the general factor). The correlations between the general worry factor and the two factors (i.e., positively scored and reverse-scored factors) were constrained to zero. A unidimensional model was fit to the 8-item PSWQ-A.

Each confirmatory factor model was created using polychoric correlation coefficients in Mplus, version 6.1 (Muthen & Muthen, 1998-2022). For each confirmatory factor model absolute and incremental goodness-of-fit indices were used to evaluate fit (Hu & Bentler, 1999). Missing data was managed using the full information maximum likelihood method (FIML) with a bootstrap resample of 1000 (Hayes, 2009). Absolute goodness-of-fit was evaluated using the chi-squared statistic, where a non-significant value indicates acceptable fit (Tabachnick & Fidell, 2013). Further absolute goodness-of-fit was indicated with the standardised root mean square residual (SRMR), 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 both, SRMR and RMSEA values $\leq .08$ are indicative of acceptable fit, and values $< .06$ have been suggested as

indicative of good fit (Bentler, 1995; Hu & Bentler, 1999). A non-significant PCLOSE and lower limit of the RMSEA 90% CI close to zero indicate good model fit (Kenny et al., 2014). Incremental fit was evaluated with the Tucker-Lewis index (TLI; Tucker & Lewis, 1973), incremental fit index (IFI) (Bollen, 1989) and comparative fit index (CFI; Bentler, 1990). Values ≥ 0.90 for the TLI, IFI and CFI are suggestive of good fit, with values for the TLI and CFI ≥ 0.95 suggestive of excellent model fit (Hu & Bentler, 1999). Standardised factor loadings were also reported.

The bifactor indices were computed using the Bifactor Indices Calculator (Dueber, 2017) to determine the extent to which a unidimensional interpretation of PSWQ is supported by the data. Coefficient omega (ω) and omega subscale (ω_S) is a model-based estimate of internal reliability that can be applied to the general factor and group factors, and represents the proportion of variance in raw scores for the total score (ω) and each subscale (ω_S) that is explained by all sources of common variance i.e., both general and each subscale factor (Rodriguez et al., 2016). OmegaH (ω_H) represents the proportion of variance in the total score explained by the general factor. When OmegaH ≥ 0.80 the total score reflects a single construct sufficiently well (Rodriguez et al., 2016). OmegaHS (ω_{HS}), is an index reflecting the reliability of a subscale score (or the unique variance of each group factor) after controlling for the variance accounted for by the general factor (Reise et al., 2013). H is a measure of construct replicability conceptualized by and represents the correlation between a factor and an optimally-weighted item composite (Hancock & Mueller, 2001), thus high H values (> 0.80) suggest a well-defined latent variable. Specifically, explained common variance (ECV) reflects the proportion of all common variance explained by the general factor relative to the group factors. ECV > 0.70 indicates that a measure is sufficiently unidimensional to be treated as such in a latent variable modeling framework (Rodriguez et al., 2016). The Percent of Uncontaminated Correlations (PUC) represents the percentage of covariance

terms which only reflect variance from the general dimension, thus the higher the PUC, the more the correlation matrix reflects the general factor (Rodriguez et al., 2016).

Subsequent psychometric analyses were conducted in SPSS 28.0.0 across all three measures. Data was screened for missing values Little's Missing Completely at Random Test and indicated that the data was missing completely at random, $\chi^2(45) = 46.03$, $p = 0.43$. Missing data was handled using a multiple imputation method. The Shapiro-Wilk statistic was non-significant ($p > 0.05$) for the 16-item PSWQ, the 8-item PSWQ-A and PSWQ-3, indicating normality of data. Inspection of data and histograms indicated acceptable levels of skewness (i.e., < 2) and kurtosis (i.e., < 7). Group mean differences were calculated between the GAD and non-clinical samples using a one-way ANOVA. Floor and ceiling effects were considered to be present if 15% or more of participants scored the lowest or highest score, respectively (Terwee et al., 2007). Construct validity was assessed for the clinical sample using Pearson's *r* correlations, with descriptors used as per the following ranges: low = 0.10 - 0.39; moderate = 0.40-0.69; strong = 0.70 - 0.90. (Akoglu, 2018). Internal consistency was examined using Cronbach's alpha, with a score between 0.70 and 0.95, deemed as adequate for quality criteria (Mokkink et al., 2010). Test-retest reliability was assessed using a subsample of the participants with GAD (N = 22) who were in a waitlist condition for the clinical trial. Specifically, scores taken at the initial assessment were compared to scores taken at the end of the waitlist period (i.e., 12-weeks after the initial assessment). Test-retest reliability was assessed using the intraclass correlation coefficient (ICC). For the ICC (calculated for absolute agreement using the two-way random effects model) a value lower than 0.5 indicates poor reliability, a value between 0.50 to 0.75 suggests moderate reliability, a value between 0.75 to 0.90 indicates good reliability, with values greater than 0.9 suggesting excellent reliability (Koo & Li, 2016; McGraw & Wong, 1996). To

assess criterion validity, the 16-item PSWQ will be correlated with the two briefer versions, PSWQ-A and PSWQ-3, using a split-half sample of participant with GAD. A Pearson's *r* correlation > 0.70 with the gold-standard measure (i.e., 16-item PSWQ) is suggested to meet quality criteria for criterion validity (Terwee et al., 2007). In addition, Receiver Operating Characteristic (ROC) curve analyses were conducted to determine if the measure could distinguish individuals with GAD from non-clinical participants. Specifically, for these analyses we reported the Youden-Index for the Area Under the Curve (AUC) which provides a cut-off score that maximises both sensitivity (proportion of true positive) and specificity (proportion of false negatives) (Fluss et al., 2005; Youngstrom, 2014). An accurate cut-off score should have an AUC close to 1.0, with scores above 0.85 classified as convincing evidence, scores between 0.75-0.85 classified as partially convincing, and AUC < 0.75 as unconvincing evidence for the accuracy of the cut-off score (Bowers & Zhou, 2019).

Results

Confirmatory Factor Analysis

Fit Indices

The results of the testing goodness of fit for the separate CFA models can be found in Table 1. See Table 2 for standardised factor loadings. The absolute and incremental fit indices were inconsistent for all four separate CFA models for the 16-item PSWQ. The bifactor model, though exhibited the most reliable fit for the 16-item PSWQ, however, there was room for improvement as the TLI < 0.90 and χ^2 *p* value was < 0.05. The PSWQ-A fit the data well across all absolute and incremental fit indices. A unidimensional model was also estimated for the 3-item PSWQ-3, however, the model was fully saturated, which was similar to (Kertz et al., 2014). As a result, goodness of fit indices could not be interpreted for the PSWQ-3.

Table 1

Fit indices for the PSWQ and PSWQ-A for adults with GAD.

Fit Indices	PSWQ One Factor	PSWQ One Factor with method effects†	PSWQ Bifactor	PSWQ Two Factor	PSWQ-A One Factor
χ^2 / (*df*)	187.34 / 104	166.73 / 94	138.24 / 88	176.92 / 103	27.40 / 20
χ^2 *p* value	< 0.01	< 0.01	< 0.01	< 0.01	0.12
RMSEA [90% CI]	0.08 [0.06- 0.09]	0.07 [0.06- 0.09]	0.06 [0.04- 0.08]	0.07 [0.05- 0.09]	0.05 [<0.01 -0.01]
PCLOSE	0.01	0.02	0.13	0.03	0.44
SRMR	0.07	0.06	0.05	0.06	0.05
CFI	0.86	0.88	0.92	0.88	0.97
TLI	0.84	0.84	0.88	0.86	0.95

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *RMSEA* root mean square error of approximation, *PCLOSE* significance of the RMSEA close fit, *SRMR* standardised root mean square residual, *CFI* comparative fit index, *TLI* Tucker-Lewis index.

† Method effects indicate that the reverse-scored items were permitted to covary with one another (items 1, 3, 8, 10 and 11)

TABLE 2

Standardised factor loadings for PSWQ, PSWQ-A, and PSWQ-3 as well as bifactor indices for the PSWQ for adults with GAD.

Items	PSWQ One Factor	PSWQ One Factor †	PSWQ Two Factor		PSWQ Bifactor			PSWQ-A	PSWQ-3
			Positive	Negative	General	Positive	Negative		
1. If I do not have enough time to do everything, I do not worry about it.	0.40	0.39	-	0.47	0.38	-	0.22	-	-
2. My worries overwhelm me.	0.58	0.58	0.58	-	0.58	0.01	-	0.55	-
3. I do not tend to worry about things.	0.23	0.20	-	0.41	0.17	0.28	0.60	-	-
4. Many situations make me worry.	0.70	0.70	0.70	-	0.67	0.28	-	0.75	0.64
5. I know I should not worry about things; but I just cannot help it.	0.55	0.55	0.55	-	0.54	0.12	-	0.61	-
6. When I am under pressure I worry a lot.	0.55	0.55	0.55	-	0.53	0.21	-	0.60	-
7. I am always worrying about something.	0.81	0.81	0.81	-	0.76	0.30	-	0.79	-
8. I find it easy to dismiss worrisome thoughts.	0.30	0.29	-	0.32	0.32	-	0.10	-	-
9. As soon as I finish one task, I start to worry about everything else I have to do.	0.61	0.61	0.61	-	0.59	0.19	-	0.59	-
10. I never worry about anything.	0.50	0.47	-	0.66	0.45	-	0.50	-	-
11. When there is nothing more I can do about a concern, I do not worry about it anymore.	0.36	0.34	-	0.43	0.35	-	0.21	-	-
12. I have been a worrier all my life.	0.38	0.38	0.38	-	0.37	0.06	-	0.32	-
13. I notice that I have been worrying about things.	0.48	0.48	0.48	-	0.48	0.02	-	0.44	-
14. Once I start worrying; I cannot stop.	0.63	0.63	0.62	-	0.91	0.85	-	-	0.62
15. I worry all the time.	0.82	0.83	0.83	-	0.80	0.20	-	-	0.98
16. I worry about projects until they are all done.	0.61	0.62	0.62	-	0.58	0.25	-	-	-
Bifactor Indices									
Omega					$\omega = 0.90$	$\omega_S = 0.91$	$\omega_S = 0.60$		
OmegaH					$\omega_H = 0.80$	$\omega_{HS} = 0.13$	$\omega_{HS} = 0.29$		
H					0.92	0.79	0.50		
ECV					0.72				
PUC					0.37				

Note. PSWQ Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated*, ECV* Explained Common Variance, *PUC* Percent of Uncontaminated Correlations.

† Method effects indicate that the reverse-scored items were permitted to covary with one another (items 1, 3, 8, 10 and 11)

Bifactor Indices

The omega coefficients for the general worry factor, and the positive worded factor were high. OmegaH for the general factor (ω_H) suggested that 80% of the variance in PSWQ scores can be explained by individual differences on the general factor. Whereas the omegaHS for the group factors (ω_{HS}) suggested only 13% and 29% of the variance in PSWQ scores can be attributed to the positively worded and negatively worded factors, respectively. Regarding the *H* construct, general factor had a high value (0.92), suggesting a well-defined latent construct. Whereas, both positively worded and negatively worded factors were <0.80, suggesting that they are poorly defined latent constructs. The ECV indicates that the general factor explained 72% of the common variance, whereas only 27% was shared among the positively worded and negatively worded factors. The PUC indicated that 37% of the correlation matrix reflected the general factor.

Group Differences

Three separate independent samples *t*-test were performed on all three versions of the PSWQ, with each on finding that the clinical GAD group scored significantly higher those in the non-clinical group: PSWQ, t (214) = 26.76, p <0.01; PSWQ-A, t (214) = 24.51, p <0.01. PSWQ-3, t (214) = 23.98, p <0.01. See Table 3 for descriptives.

TABLE 3

Group differences for the three versions of the PSWQ.

	PSWQ	PSWQ-A	PSWQ-3
GAD (*N* = 140)	66.98 (8.68)	32.84 (5.20)	11.57 (2.38)
Non-clinical (*N* = 78)	32.46 (9.70)	13.97 (5.75)	4.24 (1.62)

Note. PSWQ Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated.

Floor and Ceiling Effects

Across all 216 participants, scores on the 16-item PSWQ ranged from 16 to 80, with 0.5% achieving the lowest score of 16, and 1.4% achieved the highest possible score of 80. Across the combined sample, the 8-item PSWQ-A scores ranged from 8 to 40, with 3.2% achieving the lowest score of 8, and 2.8% achieved the highest possible score of 40. Together these results indicate no floor or ceiling effects for the 16-item PSWQ and for the 8-item PSWQ-A. For the PSWQ-3, scores ranged from 3 to 15 in the combined sample, with 16.7% achieving the lowest score of 3, and 6% achieved the highest possible score of 15. These results indicate a presence of floor effects but not ceiling effects for the PSWQ-3.

Internal Consistency

For participants with GAD, the Cronbach's alpha for the 16-item PSWQ ($\alpha = 0.86$) and the 8-item PSWQ-A ($\alpha = 0.80$) was good. The Cronbach's alpha for the PSWQ-3 ($\alpha = 0.74$) was adequate.

Test-Retest Reliability

The ICC for all three versions indicated moderate reliability over a 12-week period: PSWQ ICC r (19) = 0.66, $p < 0.01$, PSWQ-A ICC (19) = 0.66, $p < 0.01$ and PSWQ-3 ICC (19) = 0.56, $p = 0.04$.

Construct Validity

For adults with a diagnosis of GAD, all three versions of the PSWQ were found to moderate correlations with DASS-stress, IUS-12 and MCQ-30 negative metacognitive beliefs subscale, in line with hypotheses. The remaining questionnaires demonstrated a significant but low correlation with all three versions of the PSWQ, again in line with hypotheses. See Table 4 for correlations.

Criterion Validity

The 16-item PSWQ was correlated using a spilt-half sample, and the strength was excellent for the PSWQ-A (r (140) = 0.95, $p < 0.01$) and good for the PSWQ-3 (r (140) = 0.89 $p < 0.01$). Criterion validity was also assessed using ROC curve analysis. Table 5 summarises the cut-off criteria and associated test performance indicators for the comparison of participants with GAD versus those without a mental health condition (i.e., non-clinical participants) for all three versions of the PSWQ. Of note, the AUC for the 16-item PSWQ, the PSWQ-A, and PSWQ-3 were all close to 1.0 (i.e., 0.99-0.98), indicating high accuracy for each of the respective cut-off scores.

TABLE 4

Construct validity indicated by Pearsons' r correlations between the three versions of the PSWQ and associated GAD symptoms and processes in adults with GAD (N = 140)

Measures	PSWQ	PSWQ-A	PSWQ-3
IUS – 12	0.43**	0.43**	0.40**
DASS – 21: Stress	0.57**	0.53**	0.55**
DASS – 21: Depression	0.26**	0.24**	0.28**
DASS – 21: Anxiety	0.32**	0.32**	0.34**
MCQ – 30: Negative beliefs about worry	0.55**	0.50**	0.59**
MCQ – 30: Positive beliefs about worry	0.29**	0.26**	0.18*
MCQ – 30: (Lack of) cognitive confidence	0.23**	0.21*	0.24**
MCQ – 30: Need for control of thoughts	0.32**	0.27**	0.31**
MCQ – 30: Cognitive self-consciousness	0.34**	0.28**	0.31**

Note. PSWQ Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *IUS-12* Intolerance of Uncertainty Scale - 12, *DASS-21* Depression Anxiety Stress Scales-21, *MCQ-30* Metacognitive Beliefs Questionnaire-30.
* $p < 0.05$. ** $p < 0.01$.

TABLE 5

Receiver Operating Characteristic (ROC) Curve analysis comparing adults with GAD (n = 140) to non-clinical participants (n = 78)

	PSWQ	PSWQ-A	PSWQ-3
Cut-Off Score	> 50	> 22	> 7
Area Under the Curve (AUC) (95 % CI)	0.99 ** (0.97 – 0.99)	0.98** (0.95 - 0.99)	0.99 ** (0.96 - 0.99)
Sensitivity (95% CI)	97.14 (92.8 – 99.2)	96.43 (91.9 – 98.8)	94.29 (89.1 - 97.5)
Specificity (95 % CI)	94.74 (87.1 - 98.5)	90.79 (81.9 – 96.2)	93.42 (85.3 – 97.8)
Positive Predictive Value (95 % CI)	97.12 (92.9 – 98.9)	95.16 (90.5 - 97.5)	96.48 (91.9 - 98.4)
Negative Predictive Value (95 % CI)	94.75 (87.2 – 97.9)	93.23 (85.3 – 97.0)	89.95 (81.9 – 94.6)

Note. PSWQ Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *95% CI* 95% Confidence Interval.
** $p < 0.01$

Discussion

The current study compared the psychometric properties of the 16-item PSWQ, 8-item PSWQ-A and 3-item PSWQ-3 in a clinical sample of adults with GAD. Findings demonstrated that all three versions of the PSWQ possess good psychometric properties across a range of indicators. Despite their brevity, the 8-item PSWQ-A and PSWQ-3 uphold their psychometric properties in comparison to the longer form and can be endorsed for use in both clinical and research settings for adults with GAD.

Initially six different confirmatory factor models were fit to the data, with four models incorporating 16-items from the PSWQ (i.e., unidimensional, bifactor, two factor, one factor with method effects), a unidimensional model for the 8-item PSWQ-A, and a unidimensional model for the PSWQ-3. The bifactor model appeared to fit the 16-item PSWQ better than the other PSWQ model iterations, though there was some room for improvement in absolute (i.e., χ^2 test) and incremental (TLI) fit indices. This finding endorses previous research that compared different versions of the 16-item PSWQ showing that the three-factor solution (i.e., one general factor and two method factors) provided the best fit to the data, mirroring current findings indicating that the longer form can be further improved, in a clinical GAD sample (Dear et al.,

2011). Regarding bifactor indices from the current study, the general PSWQ factor represented the dominant source of variance (ω_H) in the total PSWQ score, with the *H* value indicating that the general factor was a well-defined latent variable (H). In addition, the ECV was greater than 0.70, suggesting that the general worry factor is sufficiently unidimensional to be treatment as a latent variable, thus using a total score for the PSWQ is recommended. Together, these results provide support for a strong general PSWQ factor, and unidimensionality (over multidimensionality) for the PSWQ. The unidimensional model also demonstrated the best fit the 8-item PSWQ-A across all absolute and incremental indices. This is perhaps unsurprising, as the PSWQ-A was developed by removing the negatively worded items. Regarding the PSWQ-3, comparable analyses could not be conducted on the PSWQ-3 because the model was saturated.

The psychometric properties of the 16-item PSWQ, 8-item PSWQ-A, and 3-item PSWQ-3 were largely comparable in their results and supported most hypotheses. Of note, all three versions showed moderate positive correlations with physiological stress/tension. This demonstrated construct validity as physiological tension and vigilance symptoms are part of the diagnostic criteria for GAD. All three measures also demonstrated moderate positive relationship with 1) negative metacognitive beliefs and 2) intolerance of uncertainty. These processes of are particular importance as they relate to two dominant models of GAD (Freeston, 2023). The metacognitive model proposes that excessive, pathological worry is primarily the result of negative metacognitive beliefs about worrying (i.e., that worry is uncontrollable and dangerous), in combination with positive beliefs about worry and subsequent ineffective mental control strategies (Wells, 2010). Whereas the intolerance of uncertainty model of GAD suggests that uncertainty is a natural trigger for worry, and therefore individuals experience increased intolerance of uncertainty are more likely to experience excessive and difficult to control worry

(Dugas, Freeston, et al., 1998; Hebert & Dugas, 2019). The hypotheses also predicted, in keeping with previous research (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004), that less salient components of the metacognitive model, as well as distinct yet overlapping psychopathology constructs (i.e., depression and autonomic anxiety), would show positive relationships with the excessive worry. Together these findings are supported by the broader literature (Freeston, 2023), and highlight the importance for clinicians to target negative metacognitive beliefs about worry, as well as intolerance of uncertainty in psychological treatment, given that these processes were most strongly related to worry in the present study.

In terms of equivalence, all three versions demonstrated moderate test-retest reliability, excellent criterion validity, as well as the ability to distinguish adults with GAD from those with no mental health conditions in the non-clinical group. Criterion validity was assessed using a split-half sample analysis and demonstrated a strong correlation between the PSWQ and each of the two briefer versions (PSWQ-A and PSWQ-3). Though this result is not surprising, it strongly indicates that all three versions are measuring the same construct of excessive worry. One discrepancy between the three versions related to internal consistency, with the PSWQ-3 demonstrating adequate internal consistency, which was slightly lower than that for the PSWQ-A and PSWQ. This may be partly accounted for by the PSWQ-3's substantial reduction in items, while still falling within an acceptable range (i.e., $r > 0.70$) to meet quality criteria for measurement properties set out by Terwee et al. (2007). All three versions showed a statistically significant difference between the clinical GAD group and the non-clinical group. The PSWQ and PSWQ-A demonstrated no floor or ceiling effects, however, the PSWQ-3 demonstrated a propensity for floor effects suggesting a lack of specificity. Though floor effects were found for the PSWQ-3, ROC curve analysis demonstrated that all three versions showed an AUC close to

1.0, indicating high accuracy for each of the respective cut-off scores that maximises both sensitivity and specificity to distinguish adults with GAD from non-clinical adults. It is noteworthy that despite the substantial reduction in items, the psychometric properties of the briefer versions are largely equivalent to the 16-item PSWQ.

The two briefer versions (i.e., PSWQ-A and PSWQ-3) appear to have relatively comparable psychometric properties to the original 16-item PSWQ in a GAD sample. Researchers and clinicians who need to measure pathological worry while accounting for time constraints may consider the two shorter versions of the PSWQ: the PSWQ-A and PSWQ-3. These briefer forms are particularly beneficial in clinical assessments where a broad range of symptoms is being evaluated, as they help mitigate client questionnaire fatigue. Both the PSWQ-A and PSWQ-3 demonstrate psychometric properties comparable to the full PSWQ, making them effective and efficient options for inclusion in assessment batteries. Another instance where time constraints may favour the use of a briefer version is in tracking weekly treatment progress for adults with GAD. The ultra-brief PSWQ-3 is particularly advantageous in this context due to its quick administration time and its resistance to floor effects within a GAD sample. Another consideration for researchers and clinicians to consider when using the 16-item PSWQ is that not only do the negatively worded items appear to increase the cognitive load when completing the 16-item PSWQ, they can make real-time scoring on pen and paper forms difficult for clinicians. As without a reverse-score template, clinicians are not able to quickly inspect whether the general pattern of worry is decreasing (or increasing) over the course of treatment. One way to overcome this difficulty for clinicians, would be to automate scoring for the 16-item PSWQ through a secure survey platform (i.e., REDCap). However, for clinicians who prefer to stick to pen and paper forms, the briefer versions of the PSWQ provide a readily available solution, that

is psychometrically comparable. Thus, not only do the briefer versions avoid the methodological problems related to the reverse scored items on the 16-item PSWQ, but they also increase the speed of completion for participants or consumers in clinical practice.

It is important to highlight potential limitations of the study. First, the PSWQ-A and PSWQ-3 were not administered separately from the 16-item PSWQ, similarly to the methodology used in Wuthrich et al. (2014). Though this avoids potential problems with repeated measure effects, it prevents direct comparison of the measure's performance outside of the context of the full version. This limitation may also mean that there is an overestimation of the correlation between the versions, as the items on the 8-item and 3-item form are counted in both sides of the correlation (Smith et al., 2000). Item position has also been shown to impact questionnaire results (Podsakoff et al., 2012), which may have influenced the current findings. In addition, treatment sensitivity was not examined in the current study, previous research has found that the PSWQ (Dear et al., 2011) and the PSWQ-3 (Berle et al., 2011) were sensitive to evidence-based treatment with significant reductions following CBT, however, the PSWQ-A is yet to be assessed in adults with GAD. Another limitation of the current study was the inability to report on ethnicity and race for both clinical and non-clinical groups. The current sample had a large proportion of missing data for ethnicity in the GAD sample, with only 18.6% of the clinical group reporting their ethnicity. Future research should endeavour to capture ethnicity and race in samples, so that cultural differences can be explored and understood in the reporting of the short and longer forms of the PSWQ. In addition, a relatively small sub-sample of participants with GAD to assess test-retest reliability. This is a methodological limitation as quality criteria set out by Terwee et al. (2007) suggests that a sample size of at least 50 participants is required to meet adequate quality criteria for assessing psychometric properties of a questionnaire. Thus, the

current study provides preliminary evidence that all three versions of the PSWQ demonstrate adequate test-retest reliability in adults with GAD, and future research should attempt to replicate this in a larger sample.

Overall, the shorter versions (PSWQ-A and PSWQ-3) performed with psychometric equivalence to the full 16-item PSWQ in a sample of individuals with GAD. Therefore, clinicians and researchers may prefer to utilise these self-report instruments, since they are both quicker to complete and score, and avoid scoring and psychometric issues caused by reverse-scored items, thereby potentially easing questionnaire burnout in the research space as well as facilitating real-time discussions in clinical practice.

CHAPTER 3. Empirical Study 2

Abstract

Three decades of research indicates that intolerance of uncertainty plays a role in the maintenance of mental health conditions. In particular, the relationship between intolerance of uncertainty 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 intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, 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 cognitive avoidance and positive beliefs about worry did not indirectly effect the relationship between intolerance of uncertainty and worry, however, cognitive avoidance (and not positive beliefs about worry) had an indirect effect on the relationship between intolerance of uncertainty and anxiety. For the TMIU, the first model demonstrated poor fit. In an alternative model, threat estimates were found to indirectly effect the relationship between intolerance of uncertainty and worry as well as anxiety. This suggests that threat appraisals do play a role in the relationship between intolerance of uncertainty, worry and anxiety in individuals with GAD.

Please see Appendix A for Ethics Approval Letter for Chapter 2 and 3.

Please see Appendix C for published peer-reviewed journal article.

Introduction

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 by concerns about family, finances, and work (Becker et al., 2003). Treatment based on the principles of 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, results also indicate that 40-60% of individuals who participate in psychological therapy continue to meet 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, 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, Gagnon, et al., 1998). The IUM posits that intolerance of uncertainty is the primary cognitive process initiating and driving excessive worry in GAD, with three secondary cognitive processes namely, positive beliefs about worry, negative problem orientation, and cognitive avoidance (Dugas, Gagnon, et al., 1998). Intolerance of uncertainty 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' (p. 31, Carleton, 2016). In that, intolerance of uncertainty is hypothesised to impact on cognitive processing leading to the tendency to evaluate uncertain scenarios in a negative manner (Dugas et al., 2005; Koerner & Dugas, 2008). Intolerance of uncertainty, 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 intolerance of uncertainty and worry (Gentes & Ruscio, 2012; McEvoy et al., 2019). Empirical research has found that experimentally manipulating intolerance of uncertainty can induce increased (or decreased) worry in community samples (Ladouceur, Gosselin, et al., 2000; Rosen & Knäuper, 2009). These empirical findings together provide evidence in support of the hypothesised primary relationship between intolerance of uncertainty and worry in the IUM for adults with GAD.

In addition, the IUM suggests that the presence of heightened intolerance of uncertainty also contributes to the individual's propensity of holding positive beliefs about worry, engaging in cognitive avoidance, as well as having a negative orientation to problems (Behar et al., 2009;

Dugas, Gagnon, et al., 1998; Robichaud et al., 2019). Thus, these three processes are termed as secondary due to their hypothesised interaction with intolerance of uncertainty, 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 intolerance of uncertainty and worry. In an undergraduate sample, all three secondary processes were significantly related to intolerance of uncertainty and worry, with no gender differences (Robichaud et al., 2003). In contrast, research conducted in a clinical GAD sample found that though all secondary variables were related to intolerance of uncertainty, only one secondary variable (i.e., negative problem orientation) was related to worry (Dugas et al., 2007).

Research has begun to explore how these secondary processes may interact within the relationship between intolerance of uncertainty 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 intolerance of uncertainty and worry, as well as between intolerance of uncertainty and somatic anxiety, with undergraduate participants from the United Kingdom (UK) and Italy. Results from the UK sample indicated that only negative problem orientation (but not cognitive avoidance, nor positive beliefs about worry) had a significant indirect effect on the relationship between intolerance of uncertainty and worry, whereas, in the Italian sample, both negative problem orientation and positive beliefs about worry were found to have a significant indirect effect on the relationship between intolerance of uncertainty and worry in the Italian sample. In relation to anxiety, none of the secondary processes were found to have an indirect effect on the relationship

between intolerance of uncertainty and anxiety in the UK sample, however, cognitive avoidance did have an indirect effect on the relationship between intolerance of uncertainty 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 negative problem orientation and positive beliefs about worry showing a significant indirect effect in the relationship between intolerance of uncertainty and worry. Given the disparity in findings for undergraduate samples between cultures when testing the model with path analysis, as well as paucity of studies in clinical GAD samples it remains important to investigate whether the secondary processes within the IUM impact the relationship from intolerance of uncertainty to excessive worry in a clinical sample of individuals with GAD.

The IUM is one 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 intolerance of uncertainty 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, intolerance of uncertainty 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, intolerance of uncertainty cannot be activated. Whereas, if the threat appraisal is elevated (i.e., higher probability, cost, coping to negative consequence) two paths emerge depending on the persons intolerance of uncertainty. If the individual possesses high intolerance of uncertainty, the TMIU suggests that the individual will have a negative-outcome-focused state and consequently engage in behaviours that focus on eliminating the threat estimate 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 intolerance of uncertainty, the individuals can reflect on their goals and reorganize them in a way that focuses on their advancement and accomplishment (Einstein, 2014; Klenk et al., 2011).

Within the TMIU, intolerance of uncertainty 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 have 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 RCTs, found that CBT produced significant medium effect (Hedges' g = 0.76) 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 (Hedges' g = 0.35) (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 intolerance of uncertainty (Carleton, 2016; Hebert & Dugas, 2019), that state that uncertainty is, in and of itself, threatening, and as a result intolerance of uncertainty predicts negative biases in processing, particularly in uncertain situations. Most of the research has focused on exploring the latter conceptualisation of intolerance of uncertainty, which aligns with the IUM (Dugas, Gagnon, et al., 1998). However, some research has found that individuals high in intolerance of uncertainty found not only ambiguous, but also negative and positive situations as more concerning (Koerner & Dugas, 2008). If individuals high in intolerance of uncertainty 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 and anxiety-related disorders (i.e., GAD, panic disorder, social anxiety disorder, OCD) 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 intolerance of uncertainty (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 intolerance of uncertainty 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 (2009), 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 intolerance of uncertainty to worry in individuals with high intolerance of uncertainty. The study did not explore whether concern about negative situations also had an indirect effect on the relationship from intolerance of uncertainty to worry in individuals high in intolerance of uncertainty, as after controlling for demographics, GAD symptoms, and mood variables, only the high intolerance of uncertainty group differed in their appraisals of ambiguous situations when compared to the low intolerance of uncertainty group. Therefore, research is yet to explore if threat estimates indirectly effect the relationship between intolerance of uncertainty and worry in adults with GAD. Contrastingly, research is also yet to explore whether intolerance of uncertainty indirectly effects the relationship between threat estimates and worry, as suggested in the TMIU for adult 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

cognitive avoidance and positive beliefs about worry have an indirect effect on the relationship between intolerance of uncertainty and worry, as well as anxiety. The study also aimed to test aspects of the TMIU, with a model created to determine if intolerance of uncertainty 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 intolerance of uncertainty predicts biases in processing, and therefore intolerance of uncertainty may contribute to a threat estimate. Significant positive bivariate correlations were hypothesised to be present between measures of worry, intolerance of uncertainty, positive beliefs about worry, cognitive avoidance, 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, intolerance of uncertainty was modelled as the predictor variable, as it was hypothesised that cognitive avoidance and positive beliefs about worry would demonstrate a significant indirect effect between intolerance of uncertainty and worry (first model) and intolerance of uncertainty and anxiety (second model). It was predicted that intolerance of uncertainty 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 intolerance of uncertainty 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, intolerance of uncertainty predicts biases in processing (rather than threat estimate predicting intolerance of uncertainty). The fourth model was created with intolerance of uncertainty as a predictor variable (rather than 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 intolerance of uncertainty 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; DiNardo 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) was 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 zero to eight, 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). Regarding co-morbidity of the total sample 71.4% of 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%), OCD (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 (κ = 0.84), indicating strong inter-rater reliability.

Intolerance of Uncertainty Scale – 12 (IUS – 12)

Intolerance of uncertainty 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, intolerance of uncertainty 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 fit 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 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 TIUM. The IUS-12 total score demonstrated good construct

validity, good internal consistency, good test-retest 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 stable unidimensional fit, as well as good construct validity and internal reliability in a sample of adults with GAD (Wilson et al., 2025). Internal consistency in this study was good, $\alpha = 0.85$

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

Positive beliefs about worry was 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 comprises 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 MCQ-30-PBW subscale in adults with GAD (White et al., 2024). In the current sample, 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 amongst the clinical sample for this measure was good, α = 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, 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 was 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 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 cutoff criterion, a non-significant chi-squared statistic was suggestive of acceptable fit (Tabachnick & Fidell, 2013; West et al., 2012), with both SRMR and RMSEA values ≤ 0.08 indicative of acceptable fit, with SRMR and RMSEA values < 0.06 suggested to be of good fit (Hu & Bentler, 1999). A non-significant PCLOSE and lower limit of the RMSEA 90% CI close to zero indicative of 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), CFI and TLI cutoff criterion stated values ≥ 0.90 are indicative of good fit, with values ≥ 0.95 to be indicative of excellent model fit (Hu & Bentler, 1999). Standardised path coefficients (i.e., regression weight) were used to assess the strength of pathways, with paths above 0.30 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 intolerance of uncertainty, and the outcome variables were worry, cognitive avoidance and positive beliefs about worry. For the second IUM path analysis model the predictor variable was intolerance of uncertainty, and the outcome variables were anxiety, cognitive avoidance, and positive beliefs about worry. This was constructed based on the configuration by Bottesi et al. (2016, 2018) in undergraduate samples. A measure of negative problem orientation was not administered to participants at the time of data collection and therefore was not able to be included in the analyses. Specifically, the data used in the study is from an archival data set, and at the time of testing the Negative Problem Orientation Questionnaire had not been developed

(Robichaud & Dugas, 2005). 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 intolerance of uncertainty, 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 intolerance of uncertainty and increased concern 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 intolerance of uncertainty and worry as well as anxiety. Thus, intolerance of uncertainty 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 ($p = 0.89$). Descriptive and normality statistics for each of the measures are presented in Table 6. 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 positive beliefs about worry subscale appeared positively skewed, with 15.1% of participants endorsing the minimum possible score. Bivariate relationships between each measure were assessed using the Spearman's rho non-parametric correlations given most scales did not appear to be normally distributed. Correlations are reported in Table 7. The MCQ-30 positive beliefs about worry subscale was not significantly correlated with the following measures: WBSI, PCCQ and DASS-21 Anxiety. All other correlations were significant, with a small to moderate 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 cognitive avoidance and positive beliefs about worry would have an indirect effect on the relationship between intolerance of uncertainty and worry as well as with anxiety.

TABLE 6

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 7

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**

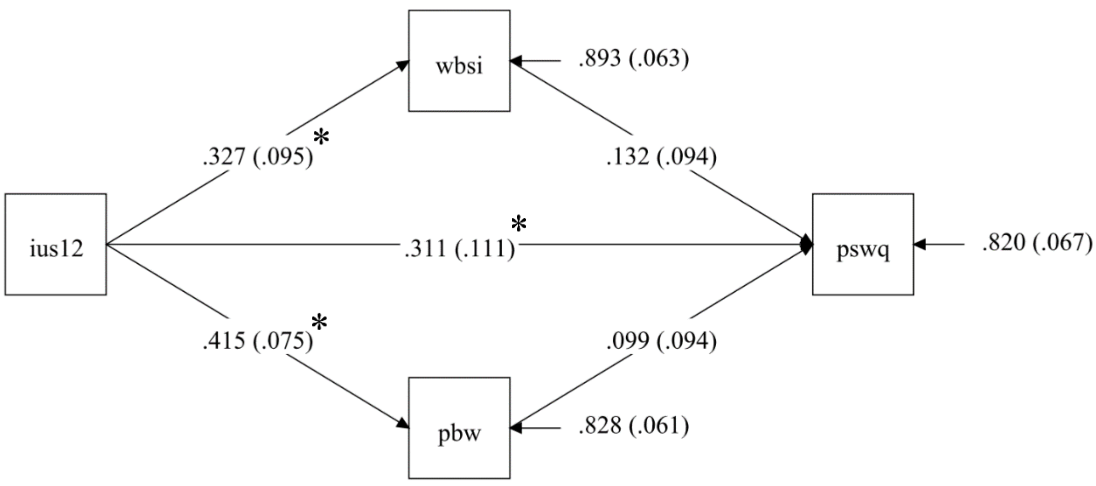
Note. IUS-12 Intolerance of Uncertainty Scale – 12, *PSWQ* Penn State Worry Questionnaire, *MCQ-30 PBW* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *WBSI* White Bear Suppression Inventory, *PCCQ* Probability Cost Coping Questionnaire, *DASS-21 Anxiety* Depression Anxiety Stress Scale-21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

* $p < 0.05$, ** $p < 0.01$.

The first model represented 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 statistical significance: 1) intolerance of uncertainty to worry via cognitive avoidance (β = 0.04, SE = 0.04, p = 0.22), 2) intolerance of uncertainty to worry via positive beliefs about worry (β = 0.04, SE = 0.04, p = 0.28). See Figure 1 for visual representation of model and significance of direct effects

FIGURE 1

Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and worry in adults with GAD.



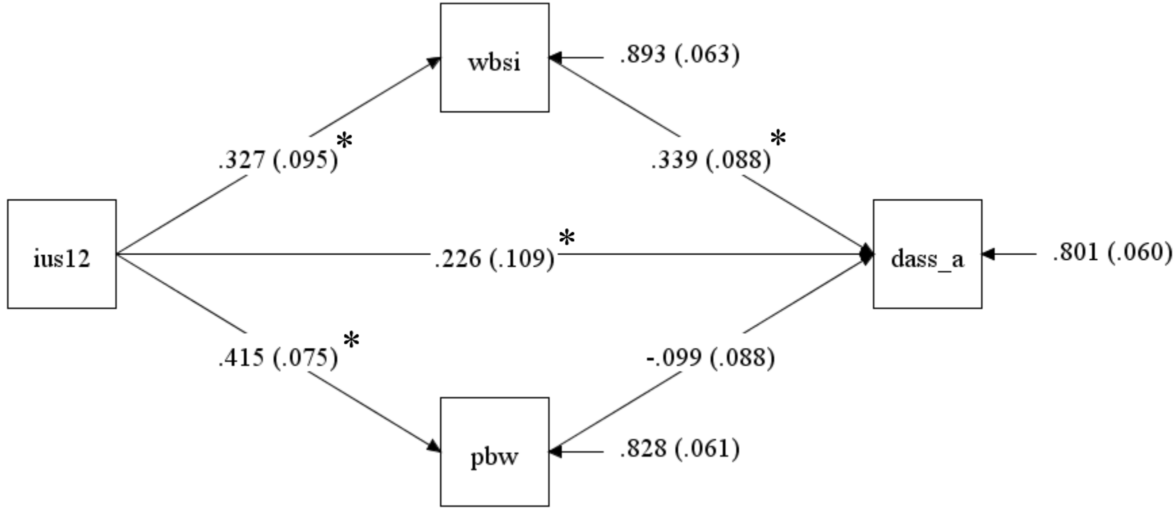
Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White Bear Suppression Inventory, *PSWQ* Penn State Worry Questionnaire.

* $p < 0.05$.

The second model represented 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 = 0.76. Tests of indirect effects indicated that the path from intolerance of uncertainty to anxiety via cognitive avoidance was significant (β = 0.11, SE = 0.04, p = 0.01). The path from intolerance of uncertainty to anxiety via positive beliefs about worry was not significant (β = -0.04, SE = 0.04, p = 0.27). See Figure 2 for visual representation of the second model and significance of direct effects.

FIGURE 2

Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and anxiety in adults with GAD.



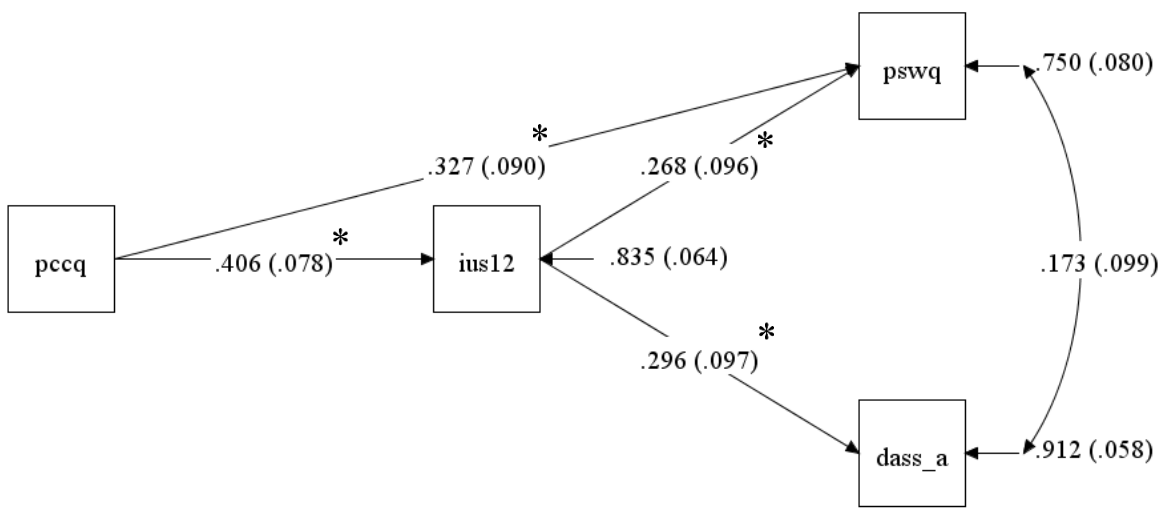
Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White Bear Suppression Inventory, *dass_a* Depression Anxiety Stress Scale-21 Anxiety.

* $p < 0.05$.

A third model was created to explore the hypothesised relationships suggested in the TMIU, with threat estimate as a predictor variable, and intolerance of uncertainty, 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 test, RMSEA, RMSEA 90% CI, PCLOSE) and incremental (i.e., TLI) indices did not meet 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 intolerance of uncertainty (β = 0.11, SE = 0.04, $p < 0.01$), 2) threat estimates to anxiety via intolerance of uncertainty (β = 0.12, SE = 0.05, p = 0.03).

FIGURE 3

Standardised path coefficients and errors between threat appraisal, intolerance of uncertainty, worry, and anxiety in adults with GAD.



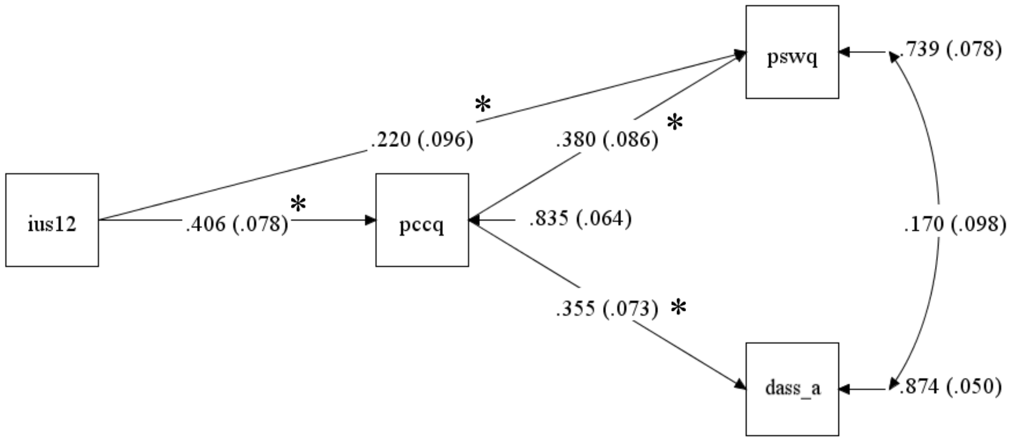
Note. pccq Probability Cost Coping Questionnaire, *ius12* Intolerance of Uncertainty Scale – 12, *pswq* Penn State Worry Questionnaire, *dass_a* DASS-21 Anxiety subscale.

* $p < 0.05$.

A fourth model was created to examine an alternative pathway based on research that identified that intolerance of uncertainty may lead to more concern in negative situations (Anderson et al., 2012). Specifically, the fourth model identified intolerance of uncertainty 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 (90% CI) = 0.15 (<0.01 - 0.34) and PCLOSE = 0.09. Only, TLI and RMSEA did not meet cutoff criteria, suggesting reasonable fit. See Figure 4 for visual representation of model, with standardised estimates, standard errors, and significance of direct effects. Tests of indirect effects were significant for both paths tested: 1) intolerance of uncertainty to worry via threat estimate (β = 0.15, SE = 0.05, p < 0.01), 2) intolerance of uncertainty to anxiety via threat estimate (β = 0.14, SE = 0.05, p < 0.01).

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.

Discussion

Intolerance of uncertainty 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 intolerance of uncertainty 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 intolerance of uncertainty 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 intolerance of uncertainty, worry, and anxiety were all found to be significantly related to each other. Further intolerance of uncertainty, worry and anxiety, were found to have a significant positive small to medium association with each process (i.e., cognitive avoidance, positive beliefs about worry, and threat estimates), except for anxiety and positive beliefs about worry, where there was no significant relationship. These results were largely consistent with extant correlational literature, confirming the relationship between intolerance of uncertainty 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, Gagnon, et al., 1998), with two path analysis models constructed to explore the relationship between intolerance of uncertainty and worry (model 1), and intolerance of uncertainty 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, intolerance of uncertainty demonstrated a significant and direct path

to excessive worry in the first model, and from intolerance of uncertainty to anxiety in the second model. The direct path from intolerance of uncertainty to positive beliefs about worry had the largest standardised coefficient in both models for the IUM. Despite the path from intolerance of uncertainty to positive beliefs about worry showing the strongest predictive power, positive beliefs about worry did not indirectly effect the relationship between intolerance of uncertainty and worry, nor indirectly effect the relationship between intolerance of uncertainty and anxiety. Of note, the direct path from positive beliefs about worry to worry as well as the path from positive beliefs about worry 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 positive beliefs about worry and cognitive avoidance did not have an indirect effect on the relationship between intolerance of uncertainty and worry in a UK undergraduate sample, despite all variables sharing significant zero-order correlations. Contrastingly, in two different Italian undergraduate samples, Bottessi et al. (2016, 2018), found that positive beliefs about worry and negative problem orientation (not cognitive avoidance) had an indirect effect on the relationship between intolerance of uncertainty and worry. Though, there have been inconsistent findings cross-culturally in undergraduate samples regarding the nature of the relationship between intolerance of uncertainty, worry and positive beliefs about worry, the current study utilised a clinical GAD sample, suggesting that positive beliefs about worry does not play a role in the relationship between intolerance of uncertainty and pathological worry. The metacognitive model is an alternative cognitive model of GAD, that argues that people who have positive beliefs about worry will likely have higher levels of worry, however, what sets worriers apart from individuals with GAD, are negative metacognitive beliefs about worry (Wells, 2010). Previous research has found that non-GAD

high worriers and clinical GAD participants report equivalent ratings on positive beliefs about worry, whereas, only negative metacognitive beliefs about worry distinguished participants with clinical GAD from non-GAD high worriers (Ruscio & Borkovec, 2004). In addition, the study aimed to determine whether cognitive avoidance impacted the relationship between intolerance of uncertainty and worry, as well as with anxiety in line with the IUM. Consistent with previous research, the current study found that cognitive avoidance did not have an indirect effect the relationship between intolerance of uncertainty and worry. Whereas, cognitive avoidance was found to indirectly effect the relationship between intolerance of uncertainty and anxiety, mirroring previous research in Italian undergraduate samples (Bottesi et al., 2016, 2018). Overall, these results suggest that that supressing mental imagery as well as positive beliefs about worry are not implicated in pathological worry, whereas engaging in cognitive avoidance is implicated in increasing 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 intolerance of uncertainty had an indirect effect on the relationship between threat estimate (i.e., predictor variable) and worry as well as anxiety as suggested by the TMIU. The third model was found to have poor fit across most fit indices (i.e., chi-squared *p* value, RMSEA, RMSEA 90% CI, PCLOSE) 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 intolerance of uncertainty is a predictor of subsequent psychological processes and symptoms. This model fit the data well across most indices except for RMSEA and TLI, suggesting adequate fit. This data suggests that intolerance of uncertainty 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 intolerance of uncertainty 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 intolerance of uncertainty and worry, as well as to anxiety, with a significant direct effect from intolerance of uncertainty to worry. Thus, these findings suggest that intolerance of uncertainty impacts the extent to which an individual is going to appraise threat 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 intolerance of uncertainty and worry, as well as anxiety. However, it is yet to be explored whether increased negative appraisals in uncertain scenarios also impact the relationship between intolerance of uncertainty and worry in adults with GAD. A study by Anderson et al. (2012) found that intolerance of uncertainty predicted appraisals in both negative and ambiguous situations using a combined clinical anxiety disorder (i.e., GAD, social anxiety disorder, OCD, panic disorder) and non-clinical sample. Beyond the study by Anderson et al. (2012) there is a paucity of evidence in clinical GAD samples, exploring the interplay of intolerance of uncertainty and appraisals in negative and ambiguous situations. Therefore, given intolerance of uncertainty appears to provide a predictive relationship to state-based threat in negative situations, future research is needed to explore whether intolerance of uncertainty is a predictor in ambiguous situations in a clinical GAD sample.

These findings complement the treatment protocol proposed by Hebert and Dugas (2019) that focuses exclusively on behavioural experiments targeting intolerance of uncertainty 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). Behavioural experiments are one way to target both threat estimates (about negative situations) and intolerance of uncertainty, research is yet to explore whether behavioural experiments targeting intolerance of uncertainty, impact appraisals regarding uncertainty or threat (i.e., negative situations).

Dugas et al. (2022) recently performed a large-scale RCT 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 waitlist, however, the behavioural experiment 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 metacognitive therapy, and found that metacognitive therapy yielded a significantly greater reduction in worry and depression at post-treatment when compared to CBT-IU (af Winklerfelt Hammarberg et al., 2023; van der Heiden et al., 2012). van der Heiden et al. (2012) also found that metacognitive therapy demonstrated a significantly greater reduction in intolerance of uncertainty and anxiety. The CBT-IU protocol used in comparison to metacognitive therapy did not include behavioural experiments targeting negative beliefs about uncertainty. Given that threat appraisals, and neither cognitive avoidance and positive beliefs about worry, were found to have an indirect effect on the relationship between intolerance of uncertainty 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 considering 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 negative problem orientation was omitted from the first and second models. This is a major limitation, as previous research found negative problem orientation to be the only significant process to demonstrate a significant indirect effect between intolerance of uncertainty and worry in both UK and Italian undergraduate samples (Bottesi et al., 2016, 2018). It is therefore important that path analysis including negative problem orientation be investigated in future research in a clinical sample of adults with GAD. Another limitation was the cross-sectional design, preventing the ability to infer causality with directional pathways. This is of particular interest in future research as previous research exploring process (i.e., intolerance of uncertainty) and symptom (worry) change over the course of psychological treatment for adults with GAD have had mixed results. One study found that intolerance of uncertainty preceded reductions in worry, and not vice versa, during individual psychological treatment (Bomyea et al., 2015). In contrast, recent research found that change in intolerance of uncertainty 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 directionality of the relationship between intolerance of uncertainty 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 intolerance of uncertainty 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.

The current study 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, intolerance of uncertainty, and worry have focused on the cost component in different negative scenarios (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 are 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 relevance to the relationship between intolerance of uncertainty and worry in GAD.

In conclusion, the present study sought to understand potential mechanisms through which the relationship between intolerance of uncertainty and worry operates in adults with GAD. The study conducted a partial examination of certain processes in the IUM (Dugas, Gagnon, et al., 1998) and TMIU (Einstein, 2014). Regarding the IUM, the study found that positive beliefs about worry and cognitive avoidance did not have an indirect effect on the relationship between intolerance of uncertainty and worry. However, cognitive avoidance was found to indirectly effect the relationship between intolerance of uncertainty and anxiety (but not

anxiety). For the TMIU, the study found that intolerance of uncertainty 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 intolerance of uncertainty, the data suggests that this relationship is better explained when intolerance of uncertainty is modelled as a predictor variable for adults with GAD. Overall, these findings support the use of techniques that target intolerance of uncertainty and threat appraisals, such as behavioural experiments, when working clinically with individuals with GAD.

CHAPTER 4. Systematic Review and Meta-Analysis

Abstract

Research has demonstrated a strong link between intolerance of uncertainty and GAD. The current systematic review and meta-analysis aimed to evaluate how effective evidence-based psychological treatments are at reducing intolerance of uncertainty for adults with GAD. An extensive literature search identified 26 eligible studies, with a total of 1199 participants with GAD. Psychological treatments (k = 32 treatment groups) yielded large significant within-group effect size from pre- to post-treatment and pre-treatment to follow-up for intolerance of uncertainty ($g = 0.88$; $g = 1.05$), as well as related symptoms including worry ($g = 1.32$; $g = 1.45$), anxiety ($g = 0.94$; $g = 1.04$) and depression ($g = 0.96$; $g = 1.00$). Psychological treatment also yielded a large significant between-group effect on intolerance of uncertainty ($g = 1.35$) and worry ($g = 1.71$). Subgroups analysis found that CBT that directly targeted intolerance of uncertainty (CBT-IU) throughout treatment was significantly more effective than general CBT at reducing intolerance of uncertainty ($p < 0.01$) and worry ($p < 0.01$) from pre- to post treatment, however, this result was not maintained at follow-up. Meta-regression analyses supported this finding as increases in the amount of time spent directly targeting intolerance of uncertainty, significantly increased the effect size for both intolerance of uncertainty ($z = 2.01$, $p < 0.01$) and worry ($z = 2.23$, $p < 0.01$). Overall, these findings indicate that psychological treatments are effective at reducing intolerance of uncertainty, worry, anxiety and depression in adults with GAD.

Please see Appendix D for published peer-reviewed journal article.

Introduction

GAD is a mental health condition typified by excessive and difficult to control worry about a range of life events and activities, more days than not (American Psychiatric Association, 2022). For individuals with GAD, excessive worry is also experienced in combination with increased feelings of anxiety as well as physical symptoms (e.g., muscle tension, restlessness, sleep disturbance) leading to significant impairment in functioning and/or distress (American Psychiatric Association, 2022). Recent estimates suggest that approximately 4% of individuals will experience GAD over the life course (Kessler et al., 2012) with up to 10% of all mental health presentations in primary care settings made by individuals with GAD (Ansseau et al., 2005; Maier et al., 2000). Individuals with GAD are more likely than the general population to experience major depressive disorder (Carter et al., 2001), that in turn has been associated with lower physical and psychological quality of life (Zhou et al., 2017). In surveys completed by individuals with GAD, they report levels of moderate to severe psychological distress as well as mild to moderate disability (Pelletier et al., 2017), as well as higher use of medical resources as well as increased use of leave and absenteeism at work (Hoffman et al., 2008). Therefore, effective treatments are necessary to alleviate both individual distress and societal burden.

A range of psychological and pharmacological interventions are considered evidence-based for the treatment GAD (Carl et al., 2020). Psychological treatment utilising principals of CBT are recommended as one of the first line treatments for GAD using a stepped care approach (Kendall et al., 2011). Research utilising meta-analytic methods have consistently found CBT approaches to demonstrate medium to large effect sizes on GAD-related outcome measures, with small to medium effect sizes found for pharmacological interventions (Carl et al., 2020; Cuijpers et al., 2014). Despite these findings, remission rates remain lower than expected, with

approximately 40-60% of individuals continuing to meet the diagnostic threshold for GAD following either treatment (Baldwin et al., 2011; Bolognesi et al., 2014; Reinhold & Rickels, 2015). One avenue to improve psychological treatment is to examine the impact that these interventions have on cognitive processes hypothesised to underlie psychopathology to directly target these processes during treatment. One such cognitive process is intolerance of uncertainty.

Intolerance of uncertainty is conceptualised as a dispositional characteristic that manifests as negative beliefs about uncertainty and its consequences (Dugas & Robichaud, 2007). Over the past two decades, there has been growing interest in the role of intolerance of uncertainty as a cognitive vulnerability factor for a range of emotional disorders (Carleton, 2016). Research has found that a range of anxiety-related disorders report significantly higher levels of intolerance of uncertainty than community samples (Carleton et al., 2012). A recent meta-analysis found a significant association between intolerance of uncertainty and clinical symptoms for people with social anxiety, OCD, depression, panic, eating disorders, and GAD; with the strength of this association significantly higher for individuals with GAD (McEvoy, Hyett, et al., 2019). Extensive research has found a strong relationship between intolerance of uncertainty and excessive worry, leading researchers to suggest intolerance of uncertainty is of particular importance in the maintainence of GAD (Robichaud et al., 2019). In keeping with this hypothesis, experimental studies manipulating levels of tolerance to uncertainty correspond to parallel changes in worry (Ladouceur, Gosselin, et al., 2000; Rosen & Knäuper, 2009) and longitudinal studies have demonstrated that levels of intolerance of uncertainty predict levels of worry throughout adolescence (Dugas et al., 2012). Further, improvements in intolerance of uncertainty during psychological treatment have been shown to predict a reduction in worry for individuals with GAD (Bomyea et al., 2015; Dugas & Ladouceur, 2000).

The IUM of GAD was developed to explain the robust relationship between intolerance of uncertainty and excessive worry (Dugas, Gagnon, et al., 1998). The IUM is a cognitive behavioural conceptualisation that emphasises the role of intolerance of uncertainty as the primary process leading to the development and maintenance of excessive worry, with three secondary variables, namely, positive beliefs about worry, negative problem orientation, and cognitive avoidance (Dugas, Gagnon, et al., 1998; Dugas & Robichaud, 2007). In order to target intolerance of uncertainty and address the three secondary variables, a CBT protocol, CBT-Intolerance of Uncertainty (CBT-IU) was developed (Dugas, Gagnon, et al., 1998). The manual comprises of a number of modules, including psychoeducation and worry awareness training, re-evaluation of the usefulness of worry, problem solving training, imaginal exposure, and relapse prevention, with behavioural experiments to test negative beliefs about uncertainty and target intolerance of uncertainty (Dugas & Robichaud, 2007).

Research has shown that CBT-IU is significantly more effective than waitlist control at reducing intolerance of uncertainty and worry in adults (Dugas et al., 2003; Ladouceur, Dugas, et al., 2000) and older adults with GAD (Hui & Zhihui, 2017). Additionally, a trial comparing CBT-IU to a pharmacological intervention, found CBT-IU to be significantly more effective at reducing intolerance of uncertainty and worry (Zemestani et al., 2021). However, one study comparing CBT and CBT-IU found that metacognitive therapy (i.e., CBT) was significantly more effective at reducing intolerance of uncertainty and excessive worry than CBT-IU (van der Heiden et al., 2012). Therefore, in an attempt to further improve treatment efficacy, two CBT-IU interventions have focused exclusively targeting intolerance of uncertainty using behavioural experiments for individuals with GAD (Dugas et al., 2022; Hebert & Dugas, 2019). Hebert and Dugas (2019) conducted a preliminary evaluation of efficacy with a small sample size (n = 7)

and found a large effect size on measures of intolerance of uncertainty, worry, anxiety, and depression from pre- to post-treatment. Dugas et al. (2022) replicated these findings in a randomised controlled trial (RCT) and found that CBT-IU was significantly more effective at reducing intolerance of uncertainty, worry, anxiety, and depression than the waitlist control condition. Other forms of CBT have also demonstrated a significant reduction in intolerance of uncertainty and worry from pre- to post-treatment (Laposa & Fracalanza, 2019; Talkovsky & Norton, 2016) as well as performing significantly better than waitlist control conditions (Beheshtian et al., 2020). Similarly, acceptance based therapies (ABT) also demonstrate a significant decrease from pre- to post-treatment for both intolerance of uncertainty and worry (Treanor et al., 2011), with no difference found between CBT and ABT at post-treatment (Avdagic et al., 2014; Wilson et al., 2020). Thus, it remains essential to assess the impact that different forms of psychological treatment have on intolerance of uncertainty for individuals with GAD.

Several meta-analyses have explored the relationship between intolerance of uncertainty and symptoms of GAD. Gentes and Ruscio (2011) demonstrated a mean correlation between intolerance of uncertainty and GAD symptoms ($r = 0.57$), which was replicated in a recent meta-analysis by McEvoy, Hyett and colleagues (2019). Meta-analyses exploring the effects of psychological interventions for GAD have demonstrated large average effect sizes for GAD symptoms (Hedges' $g = 0.84$) and a medium effect for depression (Hedges' $g = 0.71$) (Cuijpers et al., 2014). These findings were replicated in a recent meta-analysis with psychological interventions for GAD showing a medium to large effect (Hedges' $g = 0.76$) on GAD symptom measures and medium effects (Hedges' $g = 0.64$) on depression outcomes (Carl et al., 2020). While meta-analyses have assessed the impact of psychological treatments on GAD-related

symptomatology, few studies have assessed the impact of such treatments on key maintaining processes in GAD. To the best of our knowledge, no studies have used systematic review or meta-analytic techniques to explore the effect of psychological interventions for GAD on intolerance of uncertainty.

The current study aimed to determine the effectiveness of evidence-based psychological treatments for GAD in reducing intolerance of uncertainty using systematic review and meta-analytic techniques. The study aimed to provide a systematic review of the various evidence-based psychological interventions for GAD and their impact on intolerance of uncertainty, as well as three related outcome variables namely worry, anxiety, and depression. In alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, the quality of studies will be assessed using a standardised risk of bias tool. In addition, the study aimed to use meta-analytic methods to determine whether psychological treatment significantly reduced intolerance of uncertainty, as well as worry, anxiety and depression for individuals with GAD. Subgroups analyses will also be conducted to determine if treatment/s are *more effective* at reducing intolerance of uncertainty, worry, anxiety and depression. Meta-regression analyses will be performed to explore whether sample and treatment characteristics moderate the within-group effect size for intolerance of uncertainty and worry. Sample and treatment characteristics include age, gender, number of sessions, total treatment time, total time spent targeting intolerance of uncertainty, and treatment format (group vs individual).

Method

Search Strategy

The study protocol was published on PROSPERO, ID: CRD42020205097,

https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020205097. An extensive literature search was conducted using the following databases: PsycINFO, Medline, PubMed, CINAHL, Web of Science, and SCOPUS. These databases were used to identify intervention studies that included a course of evidence-based psychological treatment that measured intolerance of uncertainty at pre-treatment and post-treatment for individuals with a diagnosis of GAD. The key search terms employed included: (*anxi** or *GAD* or *worr**) AND (*intolerance of uncertainty* or *IUS*) AND (*cognitive behavio(u)ral therapy* or *CBT or psychotherapy* or *intervention** or *trial* or *treatment* or *program*). No limits were placed on publication date. Both English and non-English speaking populations were included in the review. Reference lists of relevant articles were also examined to identify any additional studies relevant to the review. The final search was conducted on 16 February 2023.

Selection and Exclusion

Titles, abstracts, and full texts were systematically reviewed to eliminate studies that did not meet inclusion criteria. Studies were considered for further review if 1) individuals had a primary diagnosis of GAD, 2) the study comprised of individuals 18 years or older, 3) a course of evidence-based psychological treatment was administered, and 4) intolerance of uncertainty was measured at pre-treatment and post-treatment. Studies that used case studies or reviews were excluded. Abstracts were screened, and the full text of eligible studies was reviewed independently by two authors (EW & MA). At both stages, any discrepancy was resolved through discussion until 100% agreement was reached. Publication dates ranged from 2000 to 2023. Research articles were reviewed to extract relevant data, including participant demographics, study design, diagnostic status, outcome measures, treatment type and characteristics. Intent-to-treat (ITT) data was extracted if it was available, otherwise completer

data was included in the analysis. ITT data was reported for 15 out of 32 treatment groups. There was no significant difference in the pre- to post effect size for intolerance of uncertainty ($p > 0.20$) and worry ($p > 0.75$) for studies that reported ITT data vs completer data. The corresponding authors were contacted for further information as required. A total of 58% of authors were contacted for clarification of data. Of the authors who were contacted the majority replied (73%), however, two articles could not be included as pre-post intolerance of uncertainty data was unable to be retrieved from the authors. Therefore, of the 1920 articles screened, 26 articles (with 32 treatment groups) were included in the current systematic review and meta-analysis. Please refer to Figure 5 for PRISMA flowchart of the selection process. See Appendix E for a list of the articles and psychological treatment manual citations utilised in the systematic review and meta-analysis.

Data Analysis

Systematic Review

The systematic review aimed to describe as well as evaluate the effectiveness of each psychological intervention. The overall treatment effects for both treatment and waitlist conditions were also reported using Cohen's *d* effect sizes to determine the degree of intolerance of uncertainty, worry, anxiety and depression change over time. Cohen's *d* effect sizes were interpreted as small ($d = 0.20$), medium ($d = 0.50$) and large ($d = 0.80$) (Cohen, 1977). Methodological quality was assessed using the Joanna Briggs Institute Checklist for Quasi-Experimental Studies to determine the extent that each study addressed bias in its design, conduct, and analysis (Tufanaru et al., 2017). This checklist was utilised because it provides a critical appraisal for experimental studies without random allocation. The 26 articles were assessed for methodological quality using 9-criteria with the scoring framework of *Yes*, *Unclear*,

No and *Not Applicable*. Three grades of methodological quality were used for articles: low quality (0–33% of criteria met in the article), medium quality (34–66% of criteria met) and high quality (67% or more of criteria met)(Schultz et al., 2016). Criteria were deemed as met when the article scored a *Yes*. Methodological quality was assessed for all articles by two authors (EW and AN), with the exception of Wilson et al. (2020) that was assessed by AN and an independent assessor to ensure objectivity. There was a 99% agreement between raters for methodological quality. Please see Appendix F for scoring framework and quality ratings.

Meta-analysis

Meta-analytic statistics were calculated using Comprehensive Meta-Analysis (CMA), version 4.0.000. The random-effects model was used for all analyses since the included studies varied in design and protocol (Borenstein et al., 2021; Borenstein & Higgins, 2013). Both within-group and between-group effect sizes were calculated using the Hedges' *g* statistic. The confidence interval was also reported to indicate how precisely the Hedges' *g* statistic had been estimated, as well as *z* values and significance (Borenstein et al., 2021). Between-group pre-post effect sizes were calculated for RCTs that employed a waitlist/delayed treatment as their control condition. Concerning follow-up time points, if studies included two follow-up time-points then the first time-point was utilised. Given that the correlation between pre- to post-treatment and pre-treatment to follow-up was not typically reported for the outcome measures, a conservative estimate of $r = 0.50$ was used for the outcome measures. This estimate was based on an empirical study where out of 811 within-group correlations in health-related interventions, the median correlation was $r = 0.59$ (Balk et al., 2012).

Heterogeneity was investigated to determine the variation in true effect sizes. Cochran's *Q* statistic, degrees of freedom, and *p* value were used as a test to determine whether all studies

in the analysis share a common true effect size. The I^2 statistic reflects the proportion of variance that is attributable to true effects rather than sampling error for the observed effects and has a range of 0 to 100% (Borenstein et al., 2017). A tentative benchmark for I^2 and suggested that values of 25%, 50%, and 75% could be considered to reflect the descriptors of low, moderate, and high, respectively (Higgins, 2003). Tau^2 (T^2) was utilised to indicate the estimated variance of true effect sizes, with Tau (T) utilised as the estimated standard deviation of true effect sizes. The prediction interval (PI) was utilised to determine the distribution of effects, that is, how widely the true effect size varies across studies. The prediction interval is intended to capture the true effect size in 95% of all comparable populations (Borenstein et al., 2021).

Subgroups analyses were conducted to compare the overall treatment group to the waitlist control sample, as well as to compare two treatment groups, CBT vs CBT-IU. A treatment group was coded as CBT-IU if the treatment manual explicitly discussed intolerance of uncertainty as the main cognitive process directly targeted for at least 50% of the treatment. Groups coded as CBT-IU could include psychoeducation regarding the nature of intolerance of uncertainty and worry awareness training, re-evaluation of negative beliefs about uncertainty via behavioural experiments, re-evaluation of usefulness of worry, problem solving training and worry exposure. Treatment groups were coded as CBT if the manual predominantly aimed to directly challenge dysfunctional/maladaptive cognitive processes, other than intolerance of uncertainty (e.g., negative beliefs about worry). Treatment groups were coded as acceptance-based therapy (ABT) if the intervention predominantly aimed to change the relationship with internal experiences through detachment and acceptance strategies rather than efforts to directly challenge cognitive processes. If the number of studies in the subgroup is ≤5, T^2 estimate will likely be imprecise (Borenstein et al., 2021), therefore ABT interventions were not included in the subgroups

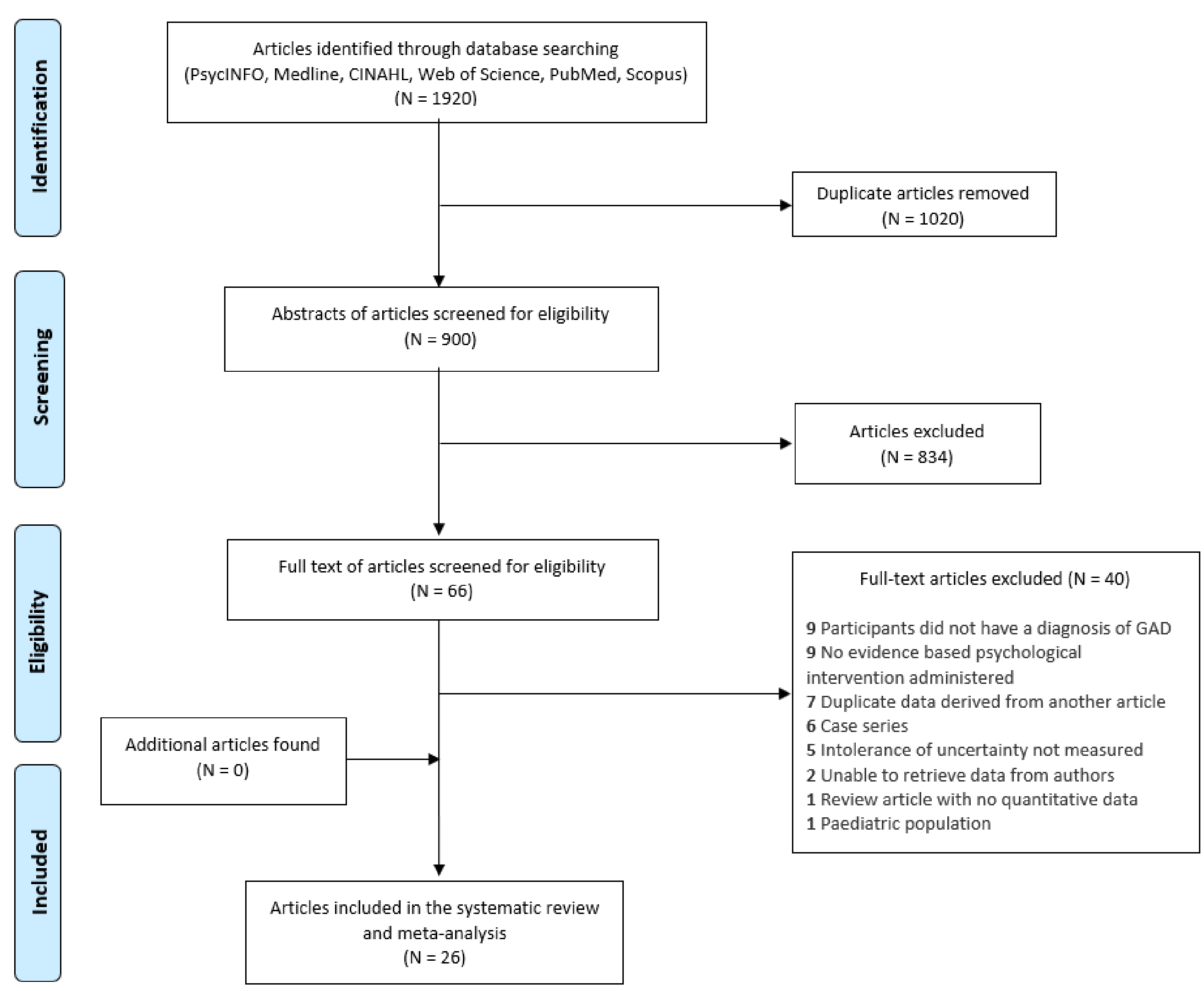
analyses due to the small sample size (k = 3). Given a random-effects model was selected, the pooled mean effect size (Hedges' *g*), a 95% CI, *z* value with corresponding *p* value, as well as the variance (*v*) for each subgroup were provided as we assumed that the between-studies variance was *not* the same for all subgroups (Borenstein et al., 2021; Borenstein & Higgins, 2013). A *Q*-test based on analysis of variance (ANOVA) was utilised to compare the effects and determine whether there is a significant difference between subgroups, utilising *Q* statistic and *p* value, with alpha set at .05.

Meta-regression analyses were also employed to determine which study-level covariates could potentially explain the true effects found in the observed effects from pre- to post-treatment. Meta-regression analyses were performed on the within-group overall treatment sample for intolerance of uncertainty and worry. Moderator variables included: age ('Age'), percentage of female participants ('% Female'), treatment format ('Group vs. individual'), number of overall treatment sessions ('Total sessions'), total treatment hours ('Total Tx hours'), and total number of treatment hours targeting intolerance of uncertainty ('Total IU Tx hours'). A random effects model was employed, and *z*-test were performed to assess the study-level covariates for statistical significance, with the regression co-efficient for latitude (β), *z* value and corresponding *p* value reported. R^2 was also reported to demonstrate the proportion of between-group variance explained by the covariate, with R^2 having a range of 0 to 1.

Risk of publication bias was investigated utilising Duval and Tweedie's Trim and Fill Procedure with the aim being to determine an unbiased estimate of the effect size, via adjusting the pooled effect size (Duval & Tweedie, 2000a, 2000b). The Classic fail-safe N was also calculated to identify the number of missing studies required to increase the *p* value to greater than alpha (set to 0.05).

FIGURE 5

Prisma flow-chart for systematic review



Results

Systematic Review

Please refer to Table 8 for study and treatment characteristics. Please see Appendix G for within-group Cohen's *d* effect sizes for pre- to post-treatment as well as from pre-treatment to follow-up time points for intolerance of uncertainty, excessive worry, anxiety and depression.

Participant Characteristics

A total sample of 1199 participants were included in the review from a total of 26 studies (*K*). From this total group, there were 32 psychological treatment groups (*k*) with 971 participants, with the remaining participants either part of a waitlist condition (*k* = 9; *n* = 187) or active control treatment (*k* = 3; *n* = 41). The total sample sizes ranged from 6 to 148 participants (*Mdn* = 34.5). The *mean* percentage of female participants ranged from of 7% to 100% (*Mdn* = 73%). The *mean* age of GAD participants ranged from 21.53 to 73.15 years (*Mdn* = 34.66).

Study Design Characteristics

A total of 17 studies were designed as an RCT, with the remaining nine studies designed as an uncontrolled trial (UCT). Of the RCTs, the majority compared a psychological treatment/s to a waitlist (*K* = 9), whilst others compared two psychological treatments (*K* = 5). A small number of RCTs compared a psychological treatment to either an active treatment control (*K* = 2), or an active treatment control and waitlist (*K* = 1). Active treatment controls included behavioural activation, a spiritually based intervention (SBI), and a serotonin-reuptake inhibitor. A total of 13 studies included a follow-up time point for intolerance of uncertainty outcome measures, ranging from 1 month to 12 months (*Mdn* = 3 months). A number of these studies (*K* = 4) included two follow-up time points.

TABLE 8

Study Design and Treatment Characteristics for Systematic Review

Study	Total N	% F	Clinical Ax	Design	Tx (n)	Tx Program	Format	Total Hrs/ Total Wks	Total IU Hrs/ Total Hrs	F/up
Avdagic et al. (2014)	38	66%	ADIS-IV	RCT	ABT (19)	Glaser et al. (2009)	G	12/6	0/12	3 m
					CBT (19)	Zinbarg, et al (1993)	G	12/6	0/12	3 m
Beheshtian et al. (2020)	45	100%	Clinical Interview	RCT	CBT (15)	Protocol*	G	12/8	0/12	1 m
					BA (15)!	Protocol*	G	18/6	0/18	1 m
					WL (15)	NA	NA	NA	NA	1 m
Boily & Belleville (2018)	20	85%	ADIS-IV	RCT	CBT IU (10)	Protocol* Dugas et al. (1998)	G	13/12	13/13	3 m & 6 m
					CBT IU+ER (10)	Protocol* Dugas et al. (1998); Mennin et al.(2002)	G	13/12	9/13	3 m & 6 m
Bomyea et al. (2015)	28^	71%	MINI	UCT	CBT	Craske et al. (2009)	I	10/10-12 (r)	0/10	3 m
Boswell et al. (2013)	6	12%	ADIS-IV	Extracted RCT	CBT	Barlow et al. (2011)	I	14.88(a)/ 8-18 (r)	0/14.88	No F/up
Bouchard et al. (2022)	148^	82%	ADIS-IV	RCT	CBT IU F2F (79)	Dugas et al. (2007)	I	15/15	15/15	6 m & 12 m
					CBT IU VC (69)	Dugas et al. (2007)	I	15/15	15/15	6 m & 12 m
Donegan et al. (2022)	65	86.7%	SCID-1	RCT	CBT (33)	Green et al. (2019)	G	12/6	0/12	No F/up
					WL (32)	NA	NA			No F/up
Dugas et al. (2003)	52^	71%	ADIS-IV	RCT	CBT IU (25)	Protocol* Dugas (2002)	G	28/14	28/28	No sep F/up
					WL (27)	NA	NA	NA	NA	
Dugas et al. (2022)	50	85%	ADIS-IV	RCT	CBT IU (23)	Protocol* Dugas et al. (2007)	I	12/12	12/12	No sep F/up
					WL (27)	NA	NA	NA	NA	No sep F/up
Green et al. (2022)	51	100%	MINI	UCT	CBT Postpartum (37)	Protocol* Green et al. (2019)	G	16/8	4/16	3 m
					CBT Pregnant (14)	Protocol* Green et al. (2019)	G	16/8	4/16	3 m
Hall et al. (2020)	11	73%	Clinical Interview	UCT	CBT IU	Dugas et al. (2007)	G	24/12	24/24	No F/up
Hebert & Dugas (2019)	7	71%	ADIS-IV	UCT	CBT IU	Protocol* Dugas et al. (2007)	I	12/12	12/12 100%	3 m & 6 m
Hui & Zhihui (2017)	63	43%	Clinical Interview	RCT	CBT IU (32)	Protocol* Robichaud (2013)	G	24/12	24/24 100%	6 m
					WL (31)	NA	NA	NA	NA	6 m
Khakpoor et al. (2019)	7	71%	ADIS-IV	RCT	CBT (4)	Barlow et al. (2011)	I	20/20	0/20 0%	2 m
					WL (3)	NA	NA	NA	NA	2 m
Koszycki et al. (2010)	22^	55%	SCID-1	RCT	CBT (11)	Zinbarg et al.(2006)	I	10/12	0/10	3 m & 6 m
					SBI (11)!	Walsh (1999)	I	10/12	0/10	3 m & 6 m

Study	Total N	% F	Clinical Ax	Design	Tx (n)	Tx Program	Format	Total Hrs/ Total Wks	Approx Total IU Hrs/ Total Hrs	F/up
Ladouceur et al. (2000)	26^	77%	ADIS-IV	Extracted RCT	CBT IU (26)	Protocol*	G	16/16	16/16	No sep F/up
Laposa & Fracalanza (2019)	26	65%	Clinical Interview	UCT	CBT	Protocol* Torbit and Laposa (2016)	G	24/12	2/24	No F/up
Laposa et al. (2022)	90	66%	SCID-5	UCT	CBT	Protocol*Torbit and Laposa (2016)	G	24/12	2/24	No F/up
McEvoy & Erceg-Hurn (2019)	37	69%	MINI	UCT	CBT	Anderson et al. (2011)	G	14/7	0/14	1 m
Nasiri et al. (2020)	30	7%	ADIS-IV	RCT	CBT (15)	Barlow et al. (2011)	I	12/12	0/12	3 m
					WL (15)	NA	NA	NA	NA	3 m
Talkovsky & Norton (2016)	32	65%	ADIS-IV	UCT	CBT	Norton (2012)	G	24/12	0/24	No F/up
Torbit & Laposa (2016)	81	NR	SCID-1	UCT	CBT	Protocol*	G	24/12	2/24	No F/up
Treanor et al. (2011)	31^	71%	ADIS-IV	RCT	ABT (15)	Roemer et al. (2009)	I	16/16	0/16	No sep F/up
					WL (16)	NA	NA	NA	NA	No sep F/up
Wilson et al. (2020)	82	78%	ADIS-IV	RCT	ABT (30)	Huxter (2006)	G	36/12	0/36	No F/up
					CBT (31)	Abbott & Kemp (2003)	G	36/12	3/36	No F/up
					WL (21)	NA	NA	NA	NA	No F/up
van der Heiden et al. (2012)	121^	73%	SCID-1	RCT	CBT (61)	Protocol* Wells (1997)	I	10.5/14	0/10.5	6 m
					CBT IU (60)	Protocol* Dugas et al (2000)	I	10.5/14	10.5/10.5	6 m
Zemestani et al. (2021)	30^	100%	SCID-5	RCT	CBT IU (15)	Dugas et al. (2007)	I	12/12	12/12	No F/up
					SSRI (15)!	NA	NA	NA	NA	No F/up

Note. Total N Total completer sample size at post-treatment, ^ Total intent to treat sample size at post-treatment, *% F* Percentage female participants, *NR* Not reported*, Clinical Ax* Clinical Assessment, *ADIS-IV* Anxiety disorders interview schedule for DSM-IV, *MINI* Mini-international neuropsychiatric interview, *SCID-1* Structured clinical interview for DSM-IV Axis 1, *SCID-5* Structured clinical interview for DSM-5, *Dx* Diagnosis, *RCT* Randomised controlled trial, *UCT* Uncontrolled trial, *Tx (n)* Treatment and sample size, *ABT* Acceptance Based Therapy, *CBT* Cognitive behavioural therapy, *BA* Behavioural activation, *!* active control treatment, *WL* Waitlist, *CBT IU* CBT – intolerance of uncertainty, *ER* Emotion Regulation, *VC* Video conferencing, *F2F* Face to ace, *SBI* Spiritually Based Intervention*, SSRI* Selective serotonin reuptake inhibitor, *Tx program* Treatment program, *Authors Protocol** Please find outline of the treatment protocol in the research article, *NA* Not applicable, *G* Group, *I* Individual, *Total Hrs/Total Wks* Total number of treatment hours/total number of weeks, *(a)* average treatment time, *(r)* range of weeks treatment delivered over, *Total IU Hrs/Total Hrs* Total hours of intolerance of uncertainty targeted / total hours, *F/up* Follow-up, *m* Month, *w* Week, *No sep F/up* Study did not report data (means/standard deviation) for each group separately at follow-up.

Assessment Measures

Most studies used a semi-structured clinical interview to diagnose GAD. A total of 13 studies used a version of the Anxiety Disorders Interview Schedule-IV (ADIS-IV) (Brown et al., 1994), four studies used a version of the Structured Clinical Interview for the DSM-IV, Axis 1 (SCID-1) (First et al., 1994, 2001), three studies used the Mini-International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998) and two studies used the Structured Clinical Interview for the DSM-5 (SCID-5) (First & Williams, 2016). The remaining four studies used a clinical interview performed by a psychologist or a psychiatrist to discern GAD as the primary diagnosis.

Outcome Measures

The primary outcome measure used to assess intolerance of uncertainty was a version of the Intolerance of Uncertainty Scale (IUS). The IUS-27 (Freeston et al., 1994) total score was used in the majority of studies ($K = 20$), with the IUS-12 (Carleton et al., 2007) total score used less frequently ($K = 6$). Excessive worry was measured using the 16-item Penn State Worry Questionnaire (PSWQ) (Meyer et al., 1990) for the majority of studies ($K = 21$), and the 8-item PSWQ-Abbreviated (PSWQ-A) (Hopko et al., 2003) was only used once ($K = 1$) with three studies not including a measure of excessive worry. Anxiety was measured using the Beck Anxiety Inventory (BAI) (Beck & Steer, 1990), the Depression Anxiety Stress Scale (DASS) anxiety subscale (DASS – A) (Lovibond & Lovibond, 1995), the State–Trait Inventory for Cognitive and Somatic Anxiety – Trait (STICSA-T) (Grös et al., 2007) and the State-Trait Anxiety Inventory – Trait (STAI-T) (Spielberger et al., 1983). The majority used the BAI ($K = 10$), followed by the DASS-A ($K = 3$), STICSA-T ($K = 1$), and STAI-T ($K = 1$). Depression was measured via a version of the Beck Depression Inventory (BDI) (Beck et al., 1979, 1996), the DASS depression subscale (DASS-D) (Lovibond & Lovibond, 1995) and the Edinburgh

Postnatal Depression Scale (EPDS) (Cox et al., 1987). The BDI ($K = 11$) was the most common measure of depression, followed by the DASS-D ($K = 3$), and the EPDS ($K = 2$). A handful of studies did not include a measure of anxiety ($K = 11$) or depression ($K = 10$). Please see Appendix H for questionnaires used for each study.

Treatment Program Characteristics

Treatment was delivered in either a group ($K = 14$) or individual format ($K = 12$). The total number of treatment hours provided across studies ranged from 10 to 36 hours (*Mdn* = 17.37 hrs), over a range of 6 to 20 weeks (*Mdn* = 12 weeks). The total number of sessions ranged from 3 to 16 (*Mdn* = 12). From the total treatment group ($k = 32$) most interventions were a form of CBT ($k = 29$), followed by ABT ($k = 3$). A large proportion of the CBT treatment group employed a version of a CBT-IU protocol ($k = 12$). The remaining CBT treatment groups ($k = 17$) utilised a range of protocols to target worry and anxiety, and in turn indirectly targeting intolerance of uncertainty. These included strategies such as psychoeducation regarding GAD, cognitive re-structuring of worries, examining and challenging negative and positive metacognitions about worry, imaginal worry exposure, behavioural experiments, and breathing/relaxation training. Four CBT treatment groups included 1-2 sessions aimed at directly addressing intolerance of uncertainty (Green et al., 2022; Laposa & Fracalanza, 2019; Torbit & Laposa, 2016; Wilson et al., 2020). Dropout rates were reported by most articles ($K = 25$) with treatment dropout ($k = 24$) ranging from 0% to 32% (*Mdn* = 17%) and waitlist dropout ($k = 7$) ranging from 0% to 25% (*Mdn* = 12%) from pre-to post-treatment.

Overall Treatment Effects for Intolerance of Uncertainty

Within-group effect sizes from pre- to post-treatment for psychological treatment ($k = 32$), ranged from a small positive effect $d = 0.32$ to a large effect $d = 2.78$ (*Mdn* $d = 0.98$). Effect

sizes from pre- to post-treatment for the waitlist group (k = 9) ranged from *d* = -0.15 to 0.19 (*Mdn d* = 0.05). Cohen's *d* effect sizes from pre-treatment to follow-up for psychological treatment (*k* = 19) ranged from a positive small effect *d* = 0.30 to a large effect *d* = 3.49 (*Mdn d* = 1.09), using the first follow-up time point (*Mean* time = 3 months).

Overall Treatment Effects for Excessive Worry

Within-group effect sizes from pre- to post-treatment ranged from a medium positive effect *d* = 0.59 to a large effect *d* = 3.46 (*Mdn d* = 1.36) for psychological treatment. The waitlist group (*k* = 6) effects ranged from no effect *d* = 0.01 to a medium effect 0.63 (*Mdn d* = 0.30). Within-group effect sizes from pre-treatment to follow-up for the psychological treatment group (*k* = 16) ranged from a medium positive effect *d* = 0.67 to a large effect *d* = 3.44 (*Mdn d* = 1.65), using the first follow-up time point (*Mean* time = 3.28 months).

Overall Treatment Effects for Anxiety

From pre- to post-treatment, within-group effect sizes (*k* = 19) ranged from a small effect, *d* = 0.48, to a large effect, *d* = 1.82 (*Mdn d* = 1.16) for psychological intervention. The waitlist group (k = 7) demonstrated no effect (*Mdn d* = 0.08). From pre-treatment to follow-up for the psychological treatment group (*k* = 14) effects were all within the large range (*Mdn d* = 1.35) using the first follow-up time point (*Mean* time = 3.83 months).

Overall Treatment Effects for Depression

Effect sizes from pre- to post-treatment for the psychological treatment group (*K* = 22) ranged from a small effect, *d* = 0.28 to a large effect *d* = 2.25 (*Mdn d* = 1.23). Cohen's *d* effect size from pre- to post-treatment for the for the waitlist group (*k* = 7) demonstrated no effect (*Mdn d* = 0.09). From pre-treatment to follow-up for the psychological treatment group (*k* = 16) ranged

from a medium effect *d* = 0.78 to a large effect, *d* = 2.51 (*Mdn d* = 1.26) using the first follow-up time point (*Mean* time = 3.5 months).

Quality Appraisal and Risk of Bias

Most studies were evaluated as meeting criteria for high (*K* = 12) or medium quality (*K* = 13), with small percentage meeting criteria for low quality (*K* = 1). Regarding each of the nine criteria, studies did well at clearly describing what the ‘cause’ and ‘effect’ was (Q1:100% of studies met criteria), as well as whether participants in comparison groups were similar (Q2: 90%). Studies did *less* well at describing whether participants were receiving another psychological or pharmacological treatment in addition to the treatment being provided (Q3: 63%) and at including a control group (Q4: 62%). Most studies included multiple outcome measures (e.g., intolerance of uncertainty and worry, depression or anxiety) at both pre-treatment and post-treatment (Q5: 96%), however many studies did not account for missing data adequately (Q6: 71%). Most studies accurately described the outcomes measures in the methods that were analysed and reported in the results section (Q7: 96%). Similarly, most studies utilised appropriate statistical analysis (Q9: 90%). Many studies did not assess treatment fidelity effectively (Q8: 33%), and in many cases it was unclear how adherence to the protocol was assessed and the integrity of the treatment. Please see Appendix F for quality ratings using the 9 criteria for each of the 26 articles.

Meta-analysis

Within Group Effects and Between Group Effects

Table 9 reports within-group effects for the treatment group from pre- to post-treatment as well as from pre-treatment to follow-up. Table 9 also reports between-group effects for studies that employed a waitlist RCT design from pre- to post-treatment. See Appendix I for forest plots

for within-group and between-group effects for intolerance of uncertainty, worry, anxiety and depression.

Subgroup Analyses

The subgroups analyses from pre- to post-treatment as well as pre-treatment to follow-up are found in Table 10. The psychological treatment group was significantly more effective than waitlist at reducing intolerance of uncertainty ($p < 0.01$), worry, ($p < 0.01$), anxiety ($p < 0.01$), and depression ($p < 0.01$). Both treatment subgroups (i.e., CBT-IU and CBT) demonstrated a significant reduction in mean scores from pre-treatment to post-treatment, as well as from pre-treatment to follow-up for all outcome measures. CBT-IU was significantly more effective than CBT at reducing intolerance of uncertainty (Q (1) = 6.19, $p < 0.01$), and excessive worry (Q (1) = 7.92, $p < 0.01$) from pre- to post-treatment. There was no difference between CBT-IU and CBT at follow-up for intolerance of uncertainty and worry. CBT was significantly more effective than CBT-IU at reducing depressive symptoms (Q (1) = 6.03, $p < 0.01$).

Meta-Regression

Table 11 provides a summary of meta-regression analyses. For both, intolerance of uncertainty and worry, increasing the total number of sessions spent directly targeting intolerance of uncertainty significantly increased the effect size. For intolerance of uncertainty, analyses found that *increasing* the total treatment hours led to a significant *decrease* in the effect size, however, on inspection it appeared there was an outlier, and with the removal of this study the effect was no longer significant. Moreover, for intolerance of uncertainty, individual therapy (when compared to group therapy) significantly increased the effect size. Total number of sessions, percentage of female participants, and age did not significantly impact the effect size for intolerance of uncertainty. Regarding pre-post effects for worry, total treatment hours,

treatment format (individual vs group), total sessions, and age did not moderate treatment effects, however, increase in the percentage of female participants significantly increased the effect size.

Publication Bias. Duval and Tweedie's Trim and Fill Procedure was utilised to provide an adjusted pooled mean effect size for intolerance of uncertainty and worry, considering any publication bias identified via the funnel plot (Duval & Tweedie, 2000a, 2000b). The within-group intolerance of uncertainty mean effect size was reduced from $g = 0.88$ to $g = 0.74$ as nine studies were trimmed to yield an unbiased pooled effect size on the lower left side of the funnel plot. The within-group mean effect size for excessive worry was reduced from $g = 1.32$ to $g = 1.15$ as seven values were missing from the lower quadrant of the left side. The between-group effect size for intolerance of uncertainty was also reduced from $g = 1.35$ to 1.10 as two studies were trimmed from the lower left quadrant. The between group-effect for worry did not identify missing studies, therefore the effect remained unchanged $g = 1.71$. See Appendix J for funnel plots of within-group and between-group effect sizes.

Publication bias was also assessed using the Classic fail-safe N calculation. The number of missing studies with non-significant treatment effects needed to increase the p value to greater than alpha (<0.05) for the overall within-group effect from pre- to post-treatment was calculated as k = 3968 for intolerance of uncertainty and k = 5665 for excessive worry. The number of missing studies for the between-group effect from pre- to post-treatment was calculated as k = 278 for intolerance of uncertainty and k = 207 for excessive worry. This suggests that publication bias does not affect the significant relationship reported for intolerance of uncertainty and excessive worry for individuals with GAD.

TABLE 9

Within-group and between-group effect sizes as well as heterogeneity for intolerance of uncertainty, worry, depression, and anxiety

Measure	Time point	*k*	*N*	Random-effects model					Heterogeneity						
				Hedges' *g*	95% CI Lower	95% Higher	Z	Z *p*	*Q* (df)	*Q p*	I^2	T^2	T	95% PI Lower	95% PI Higher
Within-group															
Overall Treatment															
IU	Pre – post	32	971	0.88	0.75	1.01	13.50	<0.01	81.18 (31)	<0.01	62%	0.07	0.27	0.32	1.45
	Pre – F/up	19	523	1.05	0.86	1.25	10.63	<0.01	50.41 (18)	<0.01	64%	0.10	0.32	0.35	1.76
Worry	Pre – post	29	923	1.32	1.16	1.48	16.08	<0.01	82.82 (28)	<0.01	66%	0.11	0.33	0.61	2.03
	Pre – F/up	16	476	1.45	1.22	1.68	12.33	<0.01	41.32 (15)	<0.01	64%	0.12	0.35	0.66	2.24
Depression	Pre – post	22	696	0.96	0.80	1.01	12.34	<0.01	53.39 (21)	<0.01	61%	0.07	0.26	0.38	1.53
	Pre – F/up	16	446	1.00	0.87	1.14	14.30	<0.01	19.42 (15)	<0.01	23%	0.02	0.13	0.70	1.32
Anxiety	Pre – post	19	529	0.94	0.78	1.11	11.17	<0.01	42.67 (18)	<0.01	58%	0.07	0.26	0.36	1.53
	Pre – F/up	14	325	1.04	0.82	1.25	9.48	<0.01	28.95 (13)	<0.01	55%	0.08	0.29	0.37	1.70
Between-group															
WL RCTs															
IU	Pre – post	9	380	1.35	0.89	1.81	5.73	<0.01	32.03 (8)	<0.01	75%	0.35	0.59	-0.16	2.86
Worry	Pre – post	6	280	1.71	1.06	2.37	5.12	<0.01	27.93 (5)	<0.01	82%	0.54	0.74	-0.53	3.96
Depression	Pre – post	7	319	1.10	0.73	1.48	5.73	<0.01	14.29 (6)	0.03	58%	0.14	0.38	0.01	2.19
Anxiety	Pre – post	7	319	1.27	0.87	1.68	6.16	<0.01	15.75 (6)	0.02	62%	0.18	0.42	0.07	2.47

Note. *k* Number of treatment groups, *Q (df)* Q statistic (degrees of freedom), I^2 I^2 statistic, T^2 Tau^2, *T* Tau, *PI* Prediction Interval, *IU* Intolerance of uncertainty, *Pre – post* Pre-treatment to post-treatment, *Pre – F/up* Pre-treatment to follow up, *WL RCTs* Waitlist Randomised Controlled Trials.

TABLE 10

Subgroup analyses for intolerance of uncertainty, worry, anxiety and depression at pre-treatment to post-treatment and pre-treatment to follow up

Measure	Timepoint	Subgroup	Random-effects model							Q-test	
			k	Hedges' *g*	*v*	95% CI lower	95% CI higher	*Z*	*Z p*	*Q* (df)	*Q p*
IU	Pre – post	Overall Tx	32	0.88	<0.01	0.75	0.98	14.77	<0.01	**41.48 (1)**	**<0.01**
		WL	9	0.10	0.01	-0.10	0.30	0.96	0.34		
	Pre – post	CBT	17	0.75	0.01	0.59	0.92	8.93	<0.01	**6.19 (1)**	**0.01**
		CBT - IU	12	1.09	0.01	0.88	1.30	10.23	<0.01		
	Pre – F/up	CBT	10	1.02	0.02	0.73	1.31	6.90	<0.01	0.27	0.61
		CBT - IU	8	1.13	0.03	0.83	1.44	7.24	<0.01		
Worry	Pre – post	Overall Tx	29	1.32	<0.01	1.16	1.46	17.08	<0.01	**35.79**	**<0.01**
		WL	6	0.30	0.02	0.01	0.60	2.01	0.04		
	Pre – post	CBT vs	14	1.13	0.01	0.91	1.34	10.08	<0.01	**7.92**	**0.01**
		CBT - IU	12	1.62	0.02	1.35	1.89	11.91	<0.01		
	Pre – F/up	CBT vs	7	1.36	0.04	0.99	1.73	7.16	<0.01	0.54 (1)	0.46
		CBT - IU	8	1.55	0.03	1.21	1.90	8.81	<0.01		
Anxiety	Pre – post	Overall Tx	19	0.94	<0.01	0.78	1.08	12.28	<0.01	**32.83 (1)**	**<0.01**
		WL	7	0.15	0.01	-0.08	0.37	1.27	0.20		
	Pre – post	CBT	9	0.83	0.01	0.61	1.06	7.21	<0.01	2.07 (1)	0.15
		CBT - IU	8	1.09	0.02	0.83	1.35	8.18	<0.01		
	Pre – F/up	CBT	6	1.16	0.03	0.83	1.48	6.95	<0.01	0.93 (1)	0.34
		CBT - IU	6	0.94	0.03	0.63	1.24	5.91	<0.01		
Depression	Pre – post	Overall Tx	22	0.94	<0.01	0.80	1.08	13.21	<0.01	**33.70 (1)**	**<0.01**
		WL	7	0.14	0.01	-0.09	0.38	1.22	0.22		
	Pre – post	CBT	10	0.93	0.02	0.68	1.17	7.45	<0.01	0.42 (1)	0.52
		CBT - IU	10	1.04	0.02	0.80	1.28	8.33	<0.01		
	Pre – F/up	CBT	7	1.19	0.01	0.98	1.41	10.90	<0.01	**6.03 (1)**	**0.01**
		CBT - IU	8	0.88	0.01	0.74	1.01	12.86	<0.01		

Note. IU Intolerance of uncertainty, *k* Number of treatment groups, *CBT* Cognitive Behaviour Therapy *WL* Waitlist.

TABLE 11

Meta-regression analyses for the overall treatment group from pre- to post-treatment.

Measure	Moderator variable	k	*β*	R^2	*Z*	*p*
IU	Total IU Tx hours	32	0.01	0.41	2.01	**0.04**
	Total Tx hours	32	-0.02	0.39	-2.59	**0.01**
	Total Tx hours^	29	0.01	0.33	1.49	0.13
	Group vs Individual	32	0.32	0.49	2.90	**< 0.01**
	Total sessions	32	0.38	0.22	1.87	0.062
	% Female	31	-0.57	0.09	-1.62	0.10
	Age	30	-0.01	0.00	-0.83	0.41
	Completers vs ITT	32	0.16	0.25	1.28	0.20
Worry	Total IU Tx hours	29	0.02	0.26	2.23	**0.03**
	Total Tx hours	29	-0.01	0.00	-0.84	0.40
	Group vs Individual	29	0.21	0.05	1.18	0.24
	Total sessions	29	0.04	0.13	1.29	0.20
	% Female	28	-1.09	0.33	-2.46	**0.01**
	Age	27	0.01	0.16	0.92	0.36
	Completers vs ITT	29	-0.05	0.00	-0.26	0.79

Note. k Number of treatment groups, *β* Regression coefficient, R^2 Proportion of variance, *Z* Z value, *p* Z-test value of significance, *IU* Intolerance of uncertainty, *Total Tx hours* Total number of treatment hours, *Total IU mins* Total number of hours spent directly targeting intolerance of uncertainty during treatment, *Total sessions* Number of sessions, *% Female* Percentage female participants, *ITT* Intention to treat. ^ Outlier (i.e., Wilson et al., 2020) excluded from analysis.

Discussion

The current study examined the effect evidence-based psychological treatments have on intolerance of uncertainty for individuals with GAD using a systematic review and meta-analytic approach. An extensive literature search led to the inclusion of 26 articles and found strong evidence that psychological treatments are effective at reducing intolerance of uncertainty, as well as GAD-related symptoms including worry, anxiety and depression. Significant large within-group pre-post treatment effect sizes (i.e., Hedges' *g*) were observed for the overall treatment group for intolerance of uncertainty as well as worry, anxiety and depression. These results were maintained from post-treatment to follow-up for all outcome measures. Subgroups analyses found that the within-group overall treatment effects were significantly greater than the waitlist/delayed conditions from pre- to post-treatment. This indicated that psychological treatments resulted in a greater reduction in intolerance of uncertainty, worry, anxiety and depression than waitlist/delayed treatment. Further evidence for this conclusion was demonstrated by the between-group analyses that only included RCTs with waitlist/delayed treatment condition. Specifically, significant large between-group effects were observed in favour of the psychological treatment condition from pre- to post-treatment for intolerance of uncertainty, worry, anxiety and depression. Together these results provide corroborating evidence for the efficacy of psychological interventions in the reduction of intolerance of uncertainty and related outcomes for individuals with GAD.

Further analyses sought to explore whether these outcomes differed based on type of psychological treatment. Specifically, subgroups analyses found that both CBT and CBT-IU led to a significant reduction in intolerance of uncertainty and GAD-related symptoms from pre-treatment to post-treatment as well as at follow-up. Of note, CBT-IU was found to be

significantly more effective than CBT at reducing both intolerance of uncertainty and worry from pre- to post-treatment. These findings were further supported by the meta-regression, in that *increasing* the total time spent targeting intolerance of uncertainty significantly *increased* the effect size for both intolerance of uncertainty and excessive worry. Though these results were supported by the meta-regression this result was not maintained at follow-up. Specifically, based on inspection of effect sizes, CBT-IU effects appeared to plateau from post to follow-up, whereas CBT effects continued to improve for individuals throughout this time period. Moreover, CBT outperformed CBT-IU at follow-up in reducing depressive symptoms. This finding may be of relevance when treating individuals with GAD and depressive symptoms, particularly given the high co-morbidity of GAD and depression (Carter et al., 2001; Zhou et al., 2017). Given CBT-IU is a multifaceted treatment protocol, it is unclear whether the combination of treatment components or a specific individual treatment component contributed to distinguishing it from CBT at post-treatment (on intolerance of uncertainty and worry) and follow-up (on depressive symptoms). Future research could dismantling studies of the various treatment components to discern which treatment elements are most effective at process and symptom reduction. Additionally, although studies using an acceptance-based treatment protocol (i.e., ABT) were included in the meta-analysis, there were insufficient studies to include this comparison in the subgroups analysis. Therefore, in the event more studies are published using ABT protocols, future meta-analysis could endeavour to include these in subgroups analyses, as the comparative efficacy of ABT to CBT formats (i.e., CBT and CBT-IU) for intolerance of uncertainty remains unknown.

Meta-regression analyses were also performed to explore the moderating effect of participant and treatment characteristics on intolerance of uncertainty and worry from pre- to

post-treatment. Total time spent targeting intolerance of uncertainty during treatment emerged as a significant moderator for both intolerance of uncertainty and worry, as described in relation to the subgroups analyses. One unexpected finding was that an *increase* in total treatment time led to a significant *decrease* in the overall effect size. This result was hypothesised to be the result of an outlier study (Wilson et al., 2020), as this study had the lowest effect size (i.e., CBT: $d = 0.30$) and the highest overall treatment time, as it was delivered over 36 hours (i.e., 3-hour sessions over 12 weeks). This study also appeared to contribute to the large variation of within-group Cohen's *d* effect sizes for intolerance of uncertainty, anxiety, and depression. Therefore, when this study was removed from the meta-regression the covariate (i.e., total treatment time) no longer significantly impacted the effect size.

Additionally, treatment format was found to significantly moderate intolerance of uncertainty, with individual treatment related to a significant increased effect size. These findings are not surprisingly given that individual therapy is likely to be more tailored to the individual and allow the development of a stronger therapeutic relationship (Bisseling et al., 2019). Regarding worry, the percentage of female participants moderated the effect size such that an *increase* in the percentage of females corresponded to a significant *decrease* in the effect size. This finding mirrors a previous meta-analysis investigating the impact of methodological factors on intolerance of uncertainty in GAD, as the study found that a higher proportion of women was significantly associated with increased worry (McEvoy, Hyett, et al., 2019). Thus, future studies may need to consider accounting for gender differences within their design or statistical modelling when exploring the relationship between GAD symptoms and cognitive processes.

The majority of studies included in the systematic review were rated as either medium or high quality. This indicated that studies were typically of sound methodological quality with low risk of bias. However, treatment fidelity ratings were largely not reported by studies, thus it is recommended that future studies include ratings of adherence to protocol to improve methodological quality. Another aspect of bias related to treatment delivery not assessed by the studies or the review was allegiance effects. This may be a form of bias in treatment studies as researchers that have allegiance to a particular treatment are likely to be involved in research to optimise the therapeutic experience and learn the subtleties and nuances of its delivery (McLeod, 2009). Therefore, future studies could aim to assess this bias.

Furthermore, the meta-analysis demonstrated some indication of publication bias as there were missing studies from the left lower quadrant of the funnel plot for both intolerance of uncertainty and worry. Specifically, this indicated that studies with smaller sample sizes with non-significant findings were not included in the analysis and may not be published. It may also be the case that this finding is attributable to the exclusion criteria used in the current study as case studies were not included. Future studies could therefore expand the inclusion criteria to attempt to address this potential sampling bias. Despite this, the Classic fail-safe N indicated that a substantial number of papers for both within-group (i.e., 3968 and 5665) and between-group effects (i.e., 278 and 207) would be needed to increase the p value to greater than alpha (> 0.05), suggesting this sampling bias does not affect the significant findings. Overall, these findings suggest the results from the systematic review and meta-analysis possess sound methodological quality and minimal publication bias.

Notwithstanding several strengths for the present study, several limitations are of note. A potential limitation was the varied ability to accurately quantify whether psychological

interventions directly or indirectly targeted intolerance of uncertainty, despite efforts made to maximize the accuracy of these calculations (e.g., referring to method sections, treatment manuals, contacting authors for additional information). Indeed, it is possible that some of the CBT protocols included in the analyses directly targeted intolerance of uncertainty for some individuals in some sessions, despite not referring to this directly in the treatment protocol.

In addition, a limitation of the current study is the generalisability of the findings regarding worry, anxiety and depressive symptoms to studies that did *not* include a measure of intolerance of uncertainty. As inclusion of a measure of intolerance of uncertainty was a requirement, not all studies exploring the effects of psychological treatment on GAD-related outcomes could be included. For example, some studies utilising the CBT-IU protocol (Dugas et al., 2010; Ladouceur et al., 2004) or attempting to target intolerance of uncertainty (Popa et al., 2022) did not include a measure intolerance of uncertainty so were not included in the current analyses. Therefore, the differences found in outcomes for CBT-IU compared to CBT warrant replication utilising a broader inclusion criteria.

Another limitation of the current study was the comparison of intent-to-treat (ITT) and completer data. ITT data was collected as the preferable data in comparison to treatment completers, as ITT analysis protects against the inflation of success rates at post-treatment and follow-up. There were no significant differences found between studies that reported ITT vs completer data for the pre-post effect size for intolerance of uncertainty and worry, and the treatment dropout rate of 17% was comparable to previous studies in anxiety disorders (Gersh et al., 2017). Nevertheless, future studies could aim to conduct separate meta-analysis for the different data types in the future.

In addition, the COVID-19 pandemic led to wide-spread changes to health care delivery out of necessity, however, accessible evidence-based psychological treatment options such as teleconferencing remain important for consumers. One study included in the meta-analysis compared teleconferencing to face to face therapy and found no difference between the two delivery methods (Bouchard et al., 2022). This provides preliminary evidence that therapy delivered online is effective, however, given the paucity of studies this could not be included in the subgroups analysis, therefore with the likely rise of teleconferencing, future studies may wish to compare such studies in the future.

In summary, this systematic review and meta-analysis indicated that evidence-based psychological treatment is effective at reducing intolerance of uncertainty and related outcomes for people with GAD. Both CBT and CBT-IU significantly reduced intolerance of uncertainty, worry, anxiety and depression from pre- to post-treatment as well as at follow-up. Future research is warranted to further explore the therapeutic components of these interventions that contribute to the significant reduction of intolerance of uncertainty and related outcomes for individuals with GAD.

CHAPTER 5. Empirical Study 3

Abstract

Accessing psychological treatment is often met with barriers of time, cost, availability, and convenience. Focused brief interventions delivered via video conference can overcome some of these barriers that clients face when accessing treatment. We sought to evaluate the efficacy and feasibility, as well as processes of exposure-based learning for a brief intervention delivered via videoconference. Participants ($N = 40$) with a primary diagnosis of GAD were assessed via clinical interview and randomized to either the treatment condition ($n = 20$) or waitlist condition ($n = 20$). Treatment consisted of two weekly 1-hour sessions delivered via videoconference where participants learned to use behavioural experiments to test negative beliefs about uncertainty. The waitlist condition consisted of a two-week waiting period and following this time, participants were offered treatment. The primary outcomes were worry, anxiety, physiological tension, safety behaviours avoidance, depression, and intolerance of uncertainty. Linear mixed models indicated that the treatment group was only superior to the waitlist group on change from pre- to post-treatment for worry. The combined group (once waitlisted participants received treatment) evidenced significant reduction across all outcomes from pre- to post-treatment, except for anxiety. Additionally, there was significant reduction in the strength of negative beliefs about uncertainty from pre-experiment to post-experiment suggesting belief change occurred. A significant reduction in distress from pre-experiment to during the experiment, as well as from pre-experiment to post-experiment, suggested habituation occurred. The intervention was also found to be acceptable, appropriate, and feasible by adults with GAD.

Please see Appendix K for UTS HREC Approval Letter for Chapter 5.

Introduction

GAD is typified by excessive worry and anxiety, that is persistent and marked by a range of physiological symptoms including restlessness, irritability, muscle tension, concentration disturbance, and/or sleep difficulties (American Psychiatric Association, 2022). A recent cross-sectional survey across 26 countries found GAD had a lifetime prevalence of 3.7% (Ruscio et al., 2017), which is consistent with surveys reporting a prevalence of 6.1% in the Australian (McEvoy et al., 2011) and 4.3% in the US population (Kessler et al., 2012).

CBT is the gold-standard treatment for GAD (Newman et al., 2022). Despite its established efficacy, a considerable proportion of adults with mental health difficulties do not engage in or complete CBT (Harris et al., 2015). This gap in treatment uptake can be attributed to several factors, including individuals' preference for managing symptoms independently, financial and time constraints, and the additional burden of coping with co-occurring physical and mental health conditions (Coombs et al., 2021). While low-intensity, internet-delivered CBT offers a potential solution to these barriers, recent research investigating obstacles to care for adults with GAD symptoms found the majority of participants preferred real-time contact with an individual therapist, through face-to-face or video-conference (Basile et al., 2024). Currently there is a lack of research regarding the efficacy and acceptability of briefer interventions delivered by a therapist for individuals with GAD that could overcome some of the barriers to treatment.

There are multiple cognitive-behavioural conceptualisations of GAD (Freeston, 2023), and as a result there are numerous CBT-based treatments for the disorder (Newman et al., 2022). The IUM of GAD, is one model and suggests that intolerance of uncertainty is the key maintaining factor of excessive worry, along with three secondary processes: negative problem

orientation, cognitive avoidance, and positive beliefs about worry (Dugas et al., 1998). Intolerance of uncertainty is a set of negative beliefs about uncertainty and its consequences (Robichaud et al., 2019). From the IUM, a treatment targeting each component of the model was developed, CBT-IU. A meta-analysis found that CBT-IU was significantly more effective than general CBT at reducing worry and intolerance of uncertainty at post-treatment (Wilson et al., 2023). These findings suggest that the reduction in worry and intolerance of uncertainty occurs faster in CBT-IU and may be of benefit for briefer interventions. In addition, a recent study found that CBT-IU was comparable in both face-to-face and videoconference settings (Bouchard et al., 2022).

Given the importance of intolerance of uncertainty in GAD, Hebert and Dugas (2019) proposed a model that centres on intolerance of uncertainty as the driving factor leading to worry, anxiety, and safety behaviours. A treatment protocol was developed using one technique from CBT-IU, namely behavioural experiments targeting intolerance of uncertainty (Hebert & Dugas, 2019). The treatment protocol was developed to include 12 weekly 50-minute sessions, with session one and two involving psychoeducation and uncertainty awareness training, sessions three to eleven focusing on behavioural experiments testing beliefs about uncertainty, and session twelve providing relapse prevention. A case series using the protocol found large effect sizes across worry, intolerance of uncertainty, and anxiety for seven participants with GAD (Hebert & Dugas, 2019). A RCT compared the behavioural experiment treatment to a 12-week waitlist condition, finding that adults in the treatment condition had significantly greater reduction from pre-to post-treatment across GAD severity, worry, intolerance of uncertainty, anxiety and depression, compared to waitlist (Dugas et al., 2022). Thus, a brief intervention utilising behavioural experiments targeting beliefs about uncertainty could be an effective option.

Behavioural experiments are a cognitive strategy that require clients to formulate specific expectations about a feared situation and compare these expectations to the actual outcome following exposure (Bennett-Levy et al., 2004). Behavioural experiments have been found to instigate belief change, with research demonstrating that they are effective at reducing the endorsement of specific target beliefs in adults with OCD cognitions (McManus et al., 2012). Behavioural experiments utilise inhibitory-based learning as they are set up to facilitate expectancy violation regarding the feared situation (Craske et al., 2008). Specifically, reflections on the outcome of the behavioural experiment are centred around whether the expected negative outcome occurred or not, as well as exploring how 'bad' and how well they 'coped' if the negative outcome did occur are important in this type of learning (Craske et al., 2014).

Behavioural experiments targeting IU aim to reduce the endorsement of specific idiosyncratic beliefs about uncertainty. Individuals with anxiety disorders demonstrate an interpretation bias towards generating negative interpretations towards ambiguous or uncertain material (Hirsch et al., 2016). Specifically, individuals with anxiety disorders report significantly more concern for negative and ambiguous situations, when compared to control participants (Anderson et al., 2012). As such, behavioural experiments may not only alter specific beliefs but also may facilitate broader cognitive change in the way individuals interpret ambiguous or uncertainty information their environment.

Behavioural experiments that target IU may also assist individuals with habituation. Habituation is the reduction in anxiety in the presence of a feared situation, while minimising the use of safety behaviours (Benito & Walther, 2015; Rankin et al., 2009). Within GAD, research has largely focussed on identifying the cognitive and somatic features, rather than the maladaptive safety and avoidance behaviours (American Psychiatric Association, 2022). This is

likely due to the current nosology within the DSM-5, as it does not include behavioural components for GAD, despite behavioural avoidance being included in all other DSM-5 anxiety disorder classifications. Recent research has found that individuals with GAD use maladaptive behaviours, consisting of safety behaviours (checking, watching, planning, reassurance seeking and attempts to control others) and avoidance (avoidance of decision making, situations, people, and activities) (Mahoney et al., 2016, 2018). Thus, it is hypothesised that behavioural experiments instigate change through expectancy violation as well as habituation.

Considering this research, the current study aimed to assess the efficacy of a brief, video-conference intervention using behavioural experiments targeting intolerance of uncertainty for individuals with GAD. The study consists of a mixed factorial design, with 2 conditions (treatment and waitlist) x 2 time-points (pre-treatment and post-treatment). Forty participants were randomised to receive either 1) the treatment condition, consisting of a two-session behavioural experiment intervention, or alternatively 2) the waitlist condition, involving a two-week waitlist. Participants in the waitlist condition were offered the two-session behavioural experiment intervention following waitlist period.

Hypothesis 1) predicted that the combined treatment group (i.e., once waitlist participants received treatment) would demonstrate a significant within-group reduction from pre- to post-treatment across all GAD-related outcome measures, including worry, safety behaviours, avoidance, depression, anxiety, physiological tension, and intolerance of uncertainty. It was also predicted that there would be a medium within-group effect from pre- to post-treatment across all GAD-related outcomes. Hypothesis 2) anticipated that the combined treatment group would demonstrate a clinically significant and reliable change from pre- to post-treatment in cardinal symptom of GAD: worry. Hypothesis 3) pertained to the treatment and waitlist group and

predicted that participants in the treatment condition would experience a greater reduction in all GAD outcomes, including worry, safety behaviours, avoidance, depression, anxiety, physiological tension, and intolerance of uncertainty at post-treatment, compared to the waitlist group. Hypothesis 4) predicted that participants would find the intervention acceptable, feasible, and appropriate.

The study also aimed to assess the exposure-based processes hypothesised to underlie learning including expectancy violation as well as habituation. Hypothesis 5a) predicted that expectancy violation would occur, that this would be indexed by significant reduction in the strength of the negative belief about uncertainty from pre-experiment to post-experiment. Hypothesis 5b) predicted that concern (i.e., bias) regarding uncertain and negative situations would reduce from pre-treatment to post-treatment, and there would be no impact on concern regarding positive situations. Hypothesis 5c) predicted that habituation would occur and the subjective units of distress (i.e., SUDs) would be significantly higher in anticipation of completing the behavioural experiment, when compared to 1) during the behavioural experiment as well as 2) after completing the behavioural experiment if they were to re-complete the experiment again (i.e., re-complete).

Method

Participants

The University of Technology Sydney (UTS) Human Research Ethics Committee (Project: ETH22-7185) approved all aspects of this research. The trial was registered on the Australian New Zealand Clinical Trials Registry (ANZCTR) under identifier [ACTRN12623000262606].

Participants were 40 individuals who met criteria for DSM-5-TR GAD (American Psychiatric Association, 2022). All participants were administered the Diagnostic Interview for Anxiety, Mood, and OCD Related Neuropsychatric Disorders (DIAMOND) version 1.2 (Tolin et al., 2018) by a registered psychologist in the clinical psychology registrar program or a provisionally registered psychologist in a clinical psychology training program under the supervision of a senior clinical psychologist. Each diagnosis was provided with a clinician severity rating (CSR) based on distress and functional impairment in the past month, rated on a 7-point Likert scale ranging from 1 (Normal) to 7 (Extreme). The mean CSR was 5.25 (*SD* = 0.74).

Participants demonstrated high rates of comorbidity, with 20% of the sample having no additional diagnosis, with the remaining 80% having one to four additional diagnoses. Additional diagnosis included social anxiety disorder (37.5%), major depressive disorder or persistent depressive disorder (20%), adjustment disorder (10%), OCD (10%), panic disorder (7.5%), specific phobia (5%), attention deficit hyperactivity disorder (5%), trichotillomania or excoriation disorder (5%), eating disorders (5%), hoarding disorder (5%), illness anxiety disorder (5%), premenstrual dysphoric disorder (2.5%), post-traumatic stress disorder (2.5%), and autism spectrum disorder (2.5%).

Most participants (62.5%) were not taking medication for their mental health prescribed by a medical professional. For participants that were taking medications, these included SSRIs (15%), serotonin-norepinephrine reuptake inhibitors (7.5%), benzodiazepines (5%), stimulants (5%), tricyclic anti-depressants (2.5%), beta-antagonist (2.5%). In combination with the medications previously detailed participants were also prescribed tetrahydrocannabinol (THC: 5%), and an alpha agonist (2.5%).

Procedure

Inclusion Criteria

Participants met inclusion criteria if they 1) had a principal diagnosis of GAD, 2) were at least 18 years or older, 3) living in Australia, 4) fluent in English, 5) had access to a computer-based device with stable internet connection; 6) no evidence of active suicidal intent (based on clinical judgment), 7) no evidence of active psychotic symptoms (based on DIAMOND self-report screener and clinical judgement), 8) no concurrent engagement in psychological treatment during the trial, and 9) if taking medication for their mental health, able to make a commitment to keep medication dose stable for the duration of the study.

Recruitment

The majority of participants were recruited between October 2023 and July 2024 via online advertisements on the Meta platform, Facebook (70%) with remaining participants recruited through The University of Sydney Psychology Clinic, or through flyers placed around the University of Sydney and UTS campuses. See Figure 6 for flow chart. Of note, there were six participants who were excluded as they had a primary diagnosis other than GAD when screened using the DIAMOND.

Telephone Screening Interview

Participants who signed up for the study were contacted via telephone by a psychologist. The psychologist explained what would be involved in the study, as well as assessing if the participant met inclusion criteria. Participants where the study did not appear suitable were provided with referral options and appropriate follow-up. The telephone interview was approximately 20 minutes.

Pre-Treatment Assessment Session

All sessions were conducted via Zoom. Informed consent was obtained and if a primary diagnosis of GAD was indicated by the diagnostic interview, participants were accepted into the study and completed measures. Participants were told at the end of the assessment session whether they were randomised to treatment or waitlist condition.

Randomisation

Participants were randomised to the condition with a block randomisation method (block size = 2) using a computer-generated randomisation procedure.

Experimental Conditions

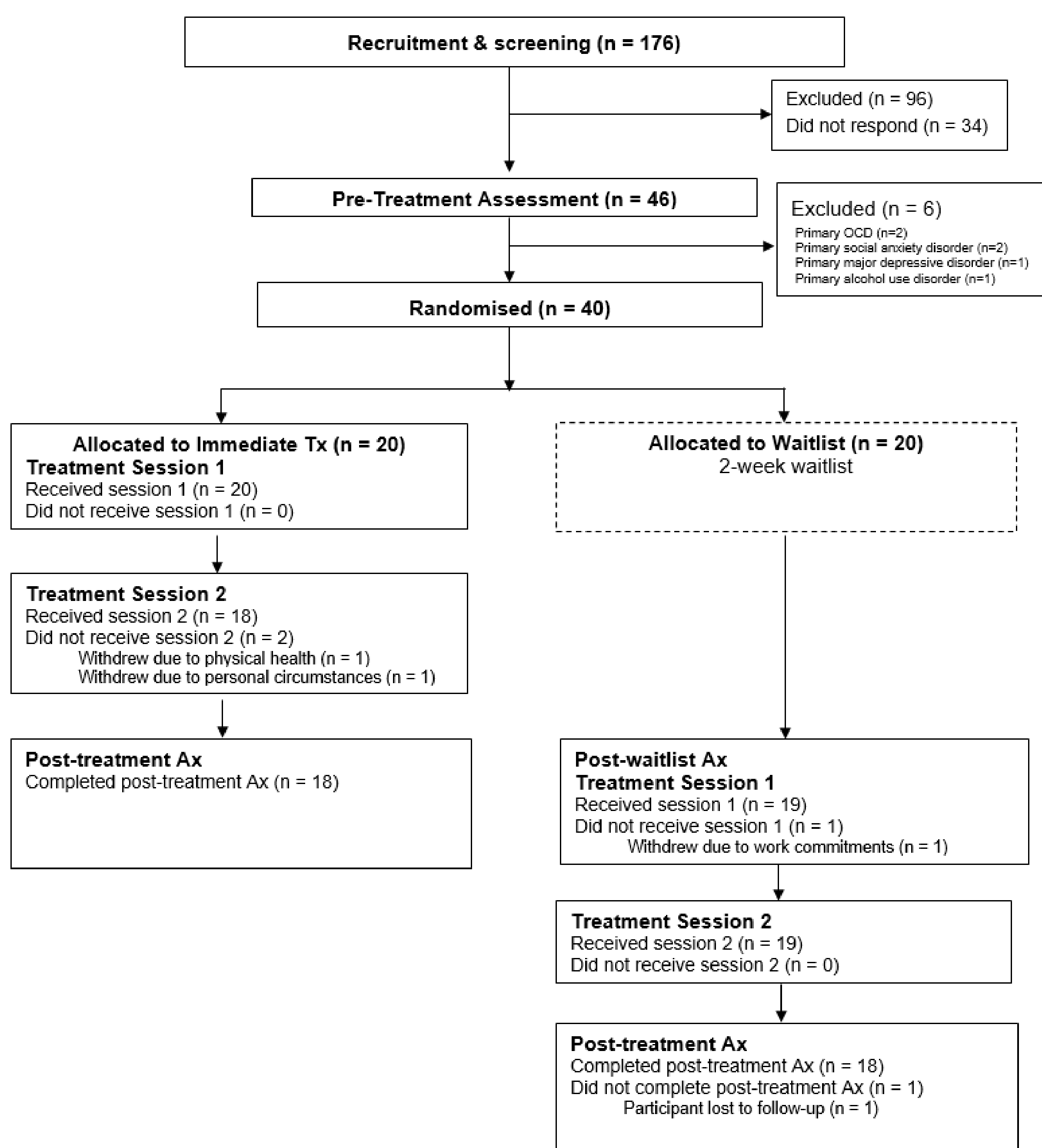
Participants randomized to the treatment condition were offered the treatment immediately, two weekly individual 60-minute sessions, followed by a 30-minute post-treatment assessment one week after completing treatment. Participants randomised to the waitlist condition completed a 2-week waitlist period. After the waitlist period, participants re-completed the questionnaires and were offered the treatment with another post-treatment assessment one week after completing the treatment.

Therapists

Treatment was delivered either by a registered psychologist in a clinical psychology registrar program or a provisionally registered psychologist in a clinical psychology training program under the supervision of a senior clinical psychologist. The same psychologist that conducted the pre-treatment assessment session, would go on to complete all treatment sessions and the post-treatment session with the participant. The therapist was therefore not blind to the treatment condition.

FIGURE 6

Flowchart of recruitment and procedure



Measures

Diagnostic Interview

Diagnostic Interview for Anxiety, Mood, and OCD and Related Neuropsychiatric Disorders (DIAMOND). The DIAMOND is a structured diagnostic interview based on DSM-5 criteria for assessment of a range of mental health disorders including anxiety disorders, mood disorders, OCD, and related neuropsychiatric conditions. Both psychologists that conducted the DIAMOND interviews completed the DIAMOND Training Course and Rater Certification through the Anxiety Disorders Center at The Institute of Living. The psychologists received scores in the training exam that corresponded with a kappa coefficient of 0.84 and 0.76, indicating excellent and very good reliability respectively. All DIAMOND interviews were video-recorded and 15% were randomly selected for coding by a second rater and blind to the diagnostic status of participants and showed 100% agreement $\kappa = 1.0$.

GAD Symptom and Process Outcome Measures

Penn State Worry Questionnaire-Abbreviated (PSWQ-A). The PSWQ-A is an 8-item measure of excessive worry (Hopko et al., 2003). The PSWQ-A has been found to have a stable one-factor structure as well as good construct validity and internal consistency in adults with GAD (Wilson et al., 2025). The Cronbach's α was adequate, $\alpha = 0.77$.

Intolerance of Uncertainty Scale -12 (IUS-12). Intolerance of uncertainty was measured using the IUS-12, a 12-item questionnaire (Carleton et al., 2007; Freeston et al., 1994). The IUS-12 has demonstrated good construct validity, internal consistency, test- retest reliability, and treatment sensitivity in adults with GAD (Wilson et al., 2020). Cronbach's $\alpha = 0.91$ was excellent for the current study.

Depression Anxiety Stress Scales – Short Form (DASS-21). The DASS-21 assess symptoms of depression, anxiety (e.g., autonomic arousal/situational anxiety), and stress (e.g., physiological arousal) (Lovibond & Lovibond, 1995). Psychometric analysis has found the DASS-21 has a stable three-factor structure with adequate construct validity and internal consistency in a variety of clinical samples (Brown et al., 1997; Page et al., 2007). Cronbach's α for depression (α = 0.85), anxiety (α = 0.80) and stress (α = 0.85) were good for the current sample.

Worry Behaviors Inventory (WBI). The WBI is a 10-item measure aimed to evaluate behavioural avoidant behaviours associated with GAD (Mahoney et al., 2016). The WBI has two subscales: safety behaviours (7 items) and avoidance (3 items). The WBI is rated on a 5-point Likert scale (ranging 0-4). Both subscales have good convergent validity as well as treatment sensitivity in adults with anxiety and/or depression (Mahoney et al., 2018). Cronbach's α was good for both subscales: safety behaviours (α = 0.88) and avoidance (α = 0.81).

Implementation Outcome Measures

Acceptability of Intervention Measure (AIM), the Intervention Appropriateness Measure (IAM), and the Feasibility of Intervention Measure (FIM) were used to assess implementation of treatment (Weiner et al., 2017). The AIM, IAM, and FIM each have four items rated on a 5-point scale. Each measure has a stable one-factor structure with adequate test-retest reliability (Weiner et al., 2017). A total score ≥16 on the AIM, IAM, and FIM were used as an indicator for effective implementation. Cronbach's α was good for the AIM (α = 0.88) and excellent for the IAM (α = 0.96) and FIM (α = 0.91).

Treatment Fidelity

All treatment sessions were video recorded to check treatment fidelity. Consistent with established practices in treatment fidelity, whereby 20–25% of sessions are commonly coded to assess adherence (McManus et al., 2012; Schoenwald & Garland, 2013), fidelity ratings were conducted on 30% of participants (N = 12) in the present study. An independent rater (who also completed the DIAMOND ratings) viewed all treatment sessions for 12 participants (30%). The independent rater was a clinical psychologist and used a checklist of 9 items that concerned to key components from both intervention sessions (e.g., introduced intolerance of uncertainty, explored how worry behaviours maintain intolerance of uncertainty, setting up behavioural experiment, debriefing about the outcome). The checklist was dichotomous (Y/N), yielding a total score from 0 to 9.

Behavioural Experiment Variables

Amount completed. The number of behavioural experiments each participant completed was reported. This number could be between 1 and 3 behavioural experiments completed per participant.

Negative belief about uncertainty. Participants were asked to identify a specific negative belief about uncertainty to be tested in each behavioural experiment. Participants were asked to rate how strongly they think this belief is true from 0 (not at all true) to 100 (completely true) before completing the behavioural experiment (i.e., pre-experiment) as well as after completing the behavioural experiment (i.e., post-experiment).

Subjective Units of Distress (SUDs). Participants were asked to rate their level of distress from 0 (not at all distressed) to 100 (extremely distressed) before the experiment (i.e., anticipation), during behavioural experiment, and after the behavioural experiment if they were to re-complete the experiment again (i.e., recomplete).

The Ambiguous/Unambiguous Situations Diary (AUSD). The AUSD measures concern for ambiguous and unambiguous situations (Davey et al., 1992). The AUSD consists of fictitious diary entries for 28 consecutive days. There are 14 ambiguously framed entries and 14 unambiguously framed entries - with seven positively framed and seven negatively. Participants were asked to read each entry and decided whether they would be 'concerned' or 'unconcerned'. Total scores for ambiguous entries ranged from 0 to 14, with positive and negative entries ranging from 0-7, with higher scores indicating greater concern.

Treatment

The protocol was based on the behavioural experiment protocol developed to directly target intolerance of uncertainty, by Robichaud et al. (2019). In the first session, the psychologist oriented the participant to a CBT model of GAD, (adapted from Robichaud et al., 2019, p. 165), and introduced the concept of intolerance of uncertainty. The psychologist used Socratic questioning to explore the function of worry (i.e., mental attempt to reduce uncertainty) with participants, as well as provide psychoeducation that worry, anxiety, and safety behaviours/avoidance are all normal reactions to uncertainty. Participants then identified specific types of safety behaviours (e.g., reassurance seeking, excessive re-checking, excessive information gathering, second guessing decisions) and avoidance (e.g., avoidance of situations and/or feelings, procrastinating) that they engage in. Socratic questioning was used to further understand the function of safety behaviours and avoidance (i.e., physical attempt to reduce uncertainty), as well as their short-term consequences (e.g., temporary anxiety reduction) and long-term consequences (e.g., interferes with new learning -preventing any violation of expectancy - in turn maintaining negative beliefs about uncertainty). Following this, the psychologist and participant collaboratively set-up at least one (with a maximum of three)

behavioural experiment for the participant to attempt over the next week before the second treatment session. For example, participants would first identify a situation that they are engaging in avoidance or using a safety behaviour (i.e*., I can't try a new restaurant, without excessive planning*). Participants were guided to identify a negative belief about uncertainty related to this situation (i.e., *If there's uncertainty, then something will always go wrong*) and then rate how strongly they think this belief is true from 0 to 100, as well as how distressed they felt in anticipation of attempting the behavioural experiment.

In the second session the psychologist would re-orient the participant to the content covered in the first session and de-brief with the participant using Socratic questioning regarding the outcome of the behavioural experiment. Debriefing included 1) whether the actual outcome matched the feared prediction, 2) whether the actual outcome was positive, neutral, or negative, 3) if the outcome was negative, A) was the outcome as negative as they anticipated (i.e., catastrophic) and B) how did they perceive their ability to cope with the negative outcome. Participants were asked to rate how distressed they felt during the experiment, and how distressed they would feel about doing the experiment again. In addition, participants were also asked to rerate how strongly they think the negative belief about uncertainty (i.e., *If there is uncertainty, then something will always go wrong*) is true, and attempt to develop a reappraisal statement (i.e., *I can cope, even when there is uncertainty and things don't go to plan*).

Data Analysis

All statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) software 28.0.0.0. To determine if there were any differences across the groups for demographic variables, an independent samples *t*-test and chi-square tests were conducted. A MANOVA was conducted on pre-treatment measures to ensure no differences across groups.

GAD Symptom and Process Measures

To test hypothesis 1, a linear mixed model (LMM) was estimated for each symptom and process measure using the combined treatment group to examine the effect of time (pre-treatment vs post-treatment). For each analysis, time was entered as a fixed variable. Within-group Cohen's *d* effect sizes were also calculated for all measures, with effect sizes interpreted as small (*d* = 0.20), medium (*d* = 0.50) and large (*d* = 0.80) (Cohen, 1977).

To test hypothesis 2, clinical significance as well as reliable change index (RCI) were calculated for the main symptom measure, PSWQ-A, following guidelines by Jacobson and Truax (1991). To determine whether changes from pre- to post-treatment were clinically significant for the combined treatment group, a cutoff score was calculated for the PSWQ-A. A cutoff score was calculated using mean population data from 78 non-clinical participants (i.e., *M* = 13.97, *SD* = 5.75) from Wilson et al. (2025) in combination with mean clinical data from the combined treatment group from the current study (i.e., *M* = 33.59, *SD* = 3.69). See below for calculation of PSWQ-A cutoff score (Jacobson & Truax, 1991). Thus, in theory anyone who has a post-treatment PSWQ-A score under 27.19 would have found treatment to be effective.

$$\text{c(PSWQA cutoff score)} = \frac{s_0 \mathrm{M}_1 + s_1 \mathrm{M}_0}{s_0 + s_1} = \frac{5.75(33.59) + 3.69(13.97)}{5.75 + 3.69} = \frac{244.69}{9.44} = 27.19$$

Second, RCI was also calculated for each participant for the PSWQ-A. The RCI was calculated using the formula in which the difference from post-treatment to pre-treatment scores is divided by the standard error of the difference (Jacobson & Truax, 1991). Symptom change on the PSWQ-A was determined to be reliable if the RCI was less than 1.96.

$$\text{RCI} = \frac{(\text{PSWQA score Pre} - \text{PSWQA score Post})}{\text{Standard error of difference}}$$

To test hypothesis 3, a LMM was estimated for each symptom and process measure to examine the effects of condition (treatment vs waitlist), time-point (pre-treatment vs post-treatment) and their interaction (condition × assessment time-point). Fixed effects included condition, time, and interaction. Within-group and between-group Cohen's *d* effect sizes were also calculated for all measures. LMMs were selected because they account for nested data structures and accommodate varying numbers of observations across individuals, as well as enabling the estimation of unbiased model parameters when data is 'missing-at-random' (Huta, 2014). For each LMM, a restricted maximum likelihood estimation method was used, with an unstructured covariance structure.

Behavioural Experiment Variables

Negative beliefs about uncertainty. Two separate repeated-measures ANOVAs were conducted to determine if there were any significant differences for the pre-experiment belief ratings (i.e., first, second, and third experiments) and the post-experiment belief ratings (i.e., first, second and third experiments). Providing no differences were found between the pre-experiment ratings or post-experiment ratings, an average belief rating was calculated. Subsequently, a paired samples *t*-test was performed to determine if the mean pre-experiment belief rating was significantly higher than the mean post-experiment belief rating.

SUDs. Three separate repeated-measures ANOVAs were conducted to determine if there were any significant differences in SUDs ratings preceding the three experiments (i.e., SUDs anticipation), during the three experiments (i.e., SUDs during), and after the three experiments if they were to have to re-complete the experiment (i.e., SUDs re-complete). On the provision that

there were no significant differences, an average was calculated for each of the SUDs ratings (i.e., mean SUDs anticipation, mean SUDs during, mean SUDs re-complete). Subsequently, a repeated-measures ANOVA was conducted to determine if there were any differences between mean SUDs ratings.

The Ambiguous/Unambiguous Situations Diary (AUSD). To determine if the intervention shifted appraisals, three paired *t*-tests (i.e., positive, negative and uncertain situations) were conducted for the combined treatment group.

Power Analysis

G*Power version 3.1.9.7 (Faul et al., 2007) was used to conduct an *a priori* power analysis to calculate adequate sample size to test the within-between group interaction effect. Previous research has found a medium effect of IU on a one session IU focused psychoeducation session (Shapiro et al., 2023). The study was powered to detect a medium effect (Cohen's f = .25), using two assessment time-points (i.e., pre-treatment vs post-treatment) and two groups (i.e., immediate treatment vs waitlist), as well as specifying a power of .80 and an alpha .05. Power analysis determined that a sample size of 34 was required to detect a significant within-between groups interaction effect. The total sample size for the study was 40 participants.

Results

Demographic and Preliminary Analysis

Most participants identified as being from Oceania, were married or in a de facto relationship (45%), were in full-time employment (30%) and had completed an undergraduate (32.5%) or postgraduate degree (32.5%). See Table 12 for demographics for the combined sample, as well as separate groups.

There was no significant difference in age between the treatment and waitlist group, *t* (38) = 0.61, *p* = 0.54. Chi-square tests revealed that there were no significant differences across groups for gender, χ^2 (2, N = 40) = 3.94, *p* = 0.14; relationship status, χ^2 (4, N = 40) = 2.28, *p* = 0.81; education, χ^2 (3, N = 40) = 0.65, *p* = 0.88; ethnicity, χ^2 (6, N = 40) = 5.44, *p* = 0.49; employment, χ^2 (6, N = 40) = 4.61, *p* = 0.60; taking of medication for mental health, χ^2 (6, N = 40) = 4.69, *p* = 0.58, or co-morbidity (additional diagnosis), χ^2 (13, N = 40) = 8.84, *p* = 0.64. The between-groups MANOVA had a non-significant effect *F* (1, 39) = 1.55, *p* = 0.19, indicating that there was no difference between the groups at pre-treatment for intolerance of uncertainty, worry, depression, physiological tension, safety behaviours, and avoidance. A *t* test demonstrated no significant difference for the CSR between the immediate (*M* = 5.35, *SD* = 0.59) and waitlist group (*M* = 5.15, *SD* = 0.88) *t* (38) = 0.85, *p* = 0.20 at pre-treatment.

TABLE 12

Demographic characteristics for the immediate treatment (*n* = 20), waitlist (*n* = 20), and combined group (*N* = 40)

Demographics	Immediate Tx Condition	Waitlist Condition	Combined
Age			
Mean age in years (SD)	42.05 (16.36)	45.15 (15.57)	43.60 (15.86)
Age range in years	20 to 71	19 to 78	19 to 78
Gender – Frequency (%)			
Female	75	90	82.5
Male	25	5	15
Non-binary	0	5	2.5
Ethnicity – Frequency (%)			
Oceanian (e.g., Aboriginal, Australian, Maori, New Zealand)	50	50	50
North-East Asian (e.g., Chinese, Japanese, Korean)	25	20	22.5
South-East Asian (e.g., Thai, Vietnamese)	15	5	10
North African and Middle Eastern	5	10	7.5
Southern or Central Asia (e.g., Indian)	0	10	5
Americas (e.g., North, Central, and South American)	0	5	2.5
European (e.g., European, British, Irish)	5	0	2.5
Sub-Saharan African (e.g., Central and West African)	0	0	0
Relationship Status – Frequency (%)			
Married or De Facto	40	50	45
Single	35	35	35
Committed Relationship	15	15	15
Dating	5	0	2.5
Separated/Divorced	5	0	2.5
Employment – Frequency (%)			
Full-Time employment	40	20	30
Part-time employment	15	35	25
Full time student	15	20	17.5
Retired	10	15	12.5
Contractually employed	10	5	7.5
Casually employed	5	5	5
Home duties	5	0	2.5
Education* – Frequency (%)			
Post-Graduate degree	30	35	32.5
Undergraduate degree	30	35	32.5
Certificate/Technical and Further Education (TAFE)	25	15	20
High School	15	15	15

Note. * Highest attainment of education

GAD Outcome Measures – Combined Group

Results revealed that all GAD symptom and process outcome measures significantly decreased over time for the combined treatment group. This included worry ($B = 2.71$, $SE = 0.77$, $p < 0.01$, 95% CI [1.15, 4.27]), intolerance of uncertainty ($B = 3.09$, $SE = 1.12$, $p < 0.01$, 95% CI [0.81, 5.36]), safety behaviours ($B = 1.88$, $SE = 0.72$, $p < 0.01$, 95% CI [0.42, 3.35]), avoidance ($B = 0.90$, $SE = 0.34$, $p < 0.01$, 95% CI [0.21, 1.59]), physiological tension/stress ($B = 1.33$, $SE = 0.58$, $p = 0.03$, 95% CI [0.15, 2.51]), anxiety ($B = 0.77$, $SE = 0.50$, $p = 0.14$, 95% CI [-0.25,1.78]), and depression ($B = 1.26$, $SE = 0.58$, $p = 0.04$, 95% CI [0.09, 2.44]). See Table 13 for means, standard deviation and within-group Cohen's *d* effect sizes for the combined treatment group.

Clinical significance and reliable change index (RCI)

For the combined treatment group, 10 participants (25%) demonstrated clinically significant improvement at post-treatment, with a PSWQ-A score lower than 27.19. Twenty participants (54%) showed reliable improvement in worry symptoms, with a RCI below -1.96.

GAD Outcome Measures – Treatment vs Waitlist Condition

See Table 14 for within-group effect sizes. All main effects for condition and time were non-significant. Results revealed a significant interaction between condition (treatment vs waitlist) x time (pre-treatment vs post-treatment) for worry ($B = 3.09$, $SE = 1.24$, $p = 0.02$, 95% CI [0.57, 5.61]). There was a medium between-group effect ($d = 0.54$) at post-treatment, in favour of the treatment condition. All other GAD-related outcome variables had non-significant interaction effects: intolerance of uncertainty ($B = 3.61$, $SE = 1.87$, $p = 0.06$, 95% CI [-0.22, 7.43]), safety behaviours ($B = 1.74$, $SE = 1.30$, $p = 0.19$, 95% CI [-0.89, 4.37]), avoidance ($B = 1.15$, $SE = 0.66$, $p = 0.09$, 95% CI [-0.19, 2.49]), physiological tension ($B = 0.46$, $SE = 1.10$, $p =$

0.68, 95% CI [-1.77, 2.68]), anxiety (*B* = -0.18, *SE* = 1.05, *p* = 0.86, 95% CI [-2.31,1.95]), and depression (*B* = -0.15, *SE* = 1.17, *p* = 0.90, 95% CI [-2.52, 2.22]). Between-groups effects at post-treatment ranged from no effect for intolerance of uncertainty (*d* = 0.06) and depression (*d* = 0.06), to a small effect for safety behaviours (*d* = 0.34), avoidance (*d* = 0.34), and physiological tension (*d* = 0.24).

Treatment Fidelity

Scores on the behavioural experiment adherence checklist indicated high treatment integrity, with 100% adherence for both psychologists that administered the intervention.

Implementation Outcome Measures

Implementation measures suggested that participants found the intervention acceptable (AIM: *M* = 17.5, *SD* = 1.97), feasible, (FIM: *M* = 17.61, *SD* = 1.97) and appropriate (IAM: *M* = 16.75, *SD* = 1.91).

TABLE 13

Within-Group Effect Sizes for the Combined Treatment Group

Measure	**Pre-Treatment Mean (SD) (N = 39)**	**Post-Treatment Mean (SD) (N = 38)**	**Cohen's *d***
PSWQ-A	33.59 (3.96)	30.56 (5.50)	0.63
IUS-12	38.69 (9.79)	35.55 (8.66)	0.34
WBI safety behaviours	17.87 (6.05)	15.94 (5.86)	0.32
WBI avoidance	7.13 (2.77)	6.11 (2.46)	0.39
DASS-21 depression	5.82 (3.82)	4.55 (4.00)	0.32
DASS-21 anxiety	5.41 (3.37)	4.64 (3.54)	0.22
DASS-21 stress	10.03 (3.92)	8.61 (4.08)	0.35

Note. PSWQ-A Penn State Worry Questionnaire – Abbreviated, *IUS – 12* Intolerance of Uncertainty Scale – 12, *WBI* Worry Behaviours Inventory, *DASS – 21* Depression Anxiety Stress Scales – 21, *CSR* Clinician severity rating.

TABLE 14

Within-Group Effect Sizes for the Immediate Treatment and Waitlist Condition at Pre-Treatment Assessment (i.e., week 1) and post-treatment (i.e., week 3).

Condition	**Measure**	**Pre-Treatment Mean (SD) N = 20**	**Post-Treatment Mean (SD) N = 18**	**Cohen's *d***
Immediate Treatment	PSWQ-A	34.30 (3.25)	30.90 (5.91)	0.71
	IUS-12	40.20 (10.36)	36.61 (9.26)	0.37
	WBI safety behaviours	17.90 (6.29)	15.84 (5.92)	0.34
	WBI avoidance	8.30 (2.70)	6.95 (2.55)	0.51
	DASS-21 depression	6.70 (4.48)	5.18 (4.25)	0.35
	DASS-21 anxiety	5.35 (4.07)	4.46 (3.42)	0.24
	DASS-21 stress	10.25 (3.86)	8.84 (4.00)	0.36

Condition	**Measure**	**Pre-Treatment Mean (SD) *N* = 20**	**Post-Treatment Mean (SD) N = 19**	**Cohen's *d***
Waitlist	PSWQ-A	33.10 (4.82)	32.79 (4.37)	0.07
	IUS-12	37.20 (10.05)	37.22 (9.54)	0.00
	WBI safety behaviours	18.15 (6.09)	17.84 (5.87)	0.05
	WBI avoidance	6.15 (2.53)	6.00 (2.33)	0.06
	DASS-21 depression	6.65 (4.31)	4.98 (2.87)	0.45
	DASS-21 anxiety	6.70 (4.07)	5.63 (3.46)	0.28
	DASS-21 stress	10.85 (4.81)	9.90 (4.94)	0.19

Note. PSWQ-A Penn State Worry Questionnaire – Abbreviated, *IUS – 12* Intolerance of Uncertainty Scale – 12, *WBI* Worry Behaviours Inventory, *DASS – 21* Depression Anxiety Stress Scale – 21.

Behavioural Experiment Variables

Number of Behavioural Experiments Completed

All participants (*N* = 37) who finished treatment completed at least two behavioural experiments (100%). Of these, a large percentage (81%) completed three total behavioural experiments (*N* = 30).

Negative Beliefs about Uncertainty

There were no significant differences between pre-experiment belief ratings for the first (*M* = 77.68, *SD* = 17.18), second (*M* = 73.51, *SD* = 17.98) and third behavioural experiments (*M* = 75.33, *SD* = 16.29), F (2, 58) = 0.49, p = 0.61. Similarly, there were no significant differences between post-experiment belief ratings for the first (*M* = 49.92, *SD* = 24.34), second (*M* = 49.27, *SD* = 26.03) and third experiment (*M* = 52.43, *SD* = 21.73), F (2, 58) = 0.28, p = 0.76. Average pre-experiment belief ratings (*M* = 75.84, *SD* = 11.85) were significantly higher than average post-experiment belief ratings (*M* = 50.53 SD = 16.33), t (36) = 7.50, p <0.01. The mean difference was -25.31 (95% CI [-19.18, -33.07]), with a large within-group effect size (d = 1.77).

SUDs

There were no significant differences between SUDs ratings in anticipation of the first (*M* = 56.87, *SD* = 26.40), second (*M* = 60.77, *SD* = 21.12), and third (*M* = 65.50, *SD* = 23.06) experiment, F (2, 58) = 2.44, p = 0.10. There were no significant differences between SUDs ratings during the first (*M* = 48.63, *SD* = 25.90), second (*M* = 53.67, *SD* = 23.33), and third (*M* = 48.10, *SD* = 28.51) behavioural experiment, F (2, 58) = .61, p = 0.55. No significant differences were found for SUDs ratings after the first (*M* = 34.90, SD = 23.77), second (*M* = 37.52, *SD* = 26.05), and third (*M* = 46.14, *SD* = 24.34) behavioural experiment, F (2, 58) = 2.92, p = 0.06.

Mean SUDs anticipation (60.58, *SD* = 21.13), mean SUDs during (49.36, *SD* = 18.97), and mean SUDs to re-complete (38.47, *SD* = 19.36) were significantly different F (2, 72) = 29.42, $p <$ 0.01. Pairwise comparisons demonstrated a significant reduction in SUDs from anticipation of experiment to during the experiment (mean difference was -11.21, $p < 0.01$. 95% CI [-5.04, -17.38]) as well as from anticipation of experiment to if they were to re-complete the experiment (mean difference was -22.10, $p < 0.01$. 95% CI [-15.31, -28.90]). There was also a significant reduction for SUDs rated during the experiment to if they were to re-complete (mean difference was -10.89, $p < 0.01$. 95% CI [-15.17, -6.62]).

Ambiguous/Unambiguous Situations Diary (AUSD)

Appraisals of concern for ambiguous scenarios demonstrated a significant reduction from pre-treatment (*M* = 8.52, *SD* = 2.13) to post-treatment (*M* = 7.19, *SD* = 2.52), t (35) = 3.65, $p <$ 0.01.There was no significant difference between appraisals of concern for positive scenarios at pre-treatment (*M* = 0.86, *SD* = 1.02) and at post-treatment (*M* = 0.64, *SD* = 0.68), t (35) = 1.28, p = 0.21. Similarly, there were no significant differences between appraisals of concern for negative scenarios at pre-treatment (*M* = 6.03, *SD* = 1.18) and at post-treatment (*M* = 6.03, *SD* = 1.16), t (35) = 0.00, $p = 0.99$.

Discussion

Overall, the current study provides support for the use of behavioural experiments in the treatment of GAD. Specifically, the brief two-session intervention delivered via videoconference was found to significantly reduce most GAD-related symptoms and processes. The study also sought to understand the processes underlying exposure, and found evidence of belief change as

well as habituation. In addition, the treatment was also found to be acceptable, feasible, and appropriate by adults with GAD.

The findings for the combined treatment group revealed a significant decrease from pre- to post-treatment across worry, IU, safety behaviours, avoidance, physiological tension, and depression, in accordance with hypotheses. For the combined treatment group, worry demonstrated a medium within-group effect, with all remaining measures demonstrating a small within-group effect from pre- to post-treatment. Contrary to hypotheses, anxiety did not demonstrate a significant reduction from pre- to post-treatment for the combined treatment group after two-sessions. Previous research has found that 12-sessions utilising behavioural experiments has led to a significant reduction in anxiety (Dugas et al., 2022), suggesting that additional sessions are likely necessary to directly target autonomic bodily sensations for individuals with GAD.

In addition, for the combined treatment group there was a clinically significant improvement as well as reliable change in excessive worry for participants that were delivered the treatment. Specifically, 25% of the participants demonstrated clinically significant improvement in worry symptoms, and 54% demonstrating a reliable improvement in worry symptoms. These findings suggest that, while not all participants experienced clinically significant change, a substantial proportion showed meaningful and reliable reductions in excessive worry following the brief intervention, highlighting its potential utility in targeting the core symptom of GAD.

To evaluate the efficacy of the intervention while controlling potential confounding factors, the third hypothesis tested whether participants in the treatment condition demonstrated greater reductions in outcomes compared to those in the waitlist control condition, using a

randomized controlled design. Worry demonstrated a significantly greater reduction from pre- to post-treatment for the treatment group in comparison to the waitlist group. In terms of within-group effect sizes from pre- to post-treatment, the immediate treatment group evidenced medium effect ($d > 0.50$), whereas the waitlist group had no effect ($d < 0.20$). Furthermore, when comparing the post-treatment scores there was a medium between-group effect in favour of the immediate treatment group. In contrast, there was no significant differences between the treatment and waitlist condition at post-treatment for the remaining measures: IU, safety behaviours, avoidance, physiological tension, anxiety, and depression. Interestingly, avoidance had a medium ($d > 0.50$) within-group effect for the immediate treatment condition, and the waitlist group had no effect ($d < 0.20$), there was still no significant interaction at post-treatment. Though this trend appears to be in favour of the treatment, one explanation for the pertains to the elevated pre-treatment avoidance scores for the immediate treatment group. For the remaining measures, the non-significant interaction may be due to initial assumptions about the effect size, as the study was powered for a medium effect size, however, the true effect size found for most of the immediate treatment measures was small. For example, IU, safety behaviours, and physiological tension had a small within-group effect ($d > 0.20$) from pre- to post-treatment for the immediate treatment condition, and despite the waitlist group having no effect ($d < 0.20$) there was no significant difference at post-treatment between the groups. Thus, given the study was adequately powered for a between-group effect, it may be the very design of the study that meant the effect was not detected. Two potential reasons that an effect was not detected could be in relation to treatment dose (i.e., too few sessions) or omission of follow-up time-point (i.e., not enough time to detect changes). With regard to the latter reason, ultra-brief interventions (e.g., one session) in anxiety and depression have found no difference between treatment and waitlist

at 1-week post-baseline or at 5-weeks post-baseline, but instead find a significant difference at 9-weeks post-baseline (Bisby et al., 2024). Furthermore, Bisby et al. (2024) found no significant difference between the ultra-brief intervention (one week) and standard treatment (eight weeks) at the same 9-weeks post-baseline time point, suggesting that ultra-brief interventions can be as effective as standard treatment. Thus, it would be interesting in future research to see if the brief two-session behavioural experiment intervention presented in the current study would demonstrate a significant interaction (in favour of the treatment) at an extended follow-up time-point (e.g., 12-week post-baseline) when compared to a waitlist. It is also possible that the observed effects diminish over time rather than strengthen. Previous research has demonstrated that a standard 12-week intervention targeting IU in individuals with GAD, which incorporated behavioural experiments, either maintained treatment gains or continued to reduce symptom severity at 6- and 12-month follow-up assessments (Dugas et al., 2022). Accordingly, further research is warranted to elucidate whether the effects of the brief behavioural experiment intervention are sustained, attenuated, or amplified over extended periods.

In order to determine whether the intervention was acceptable, feasible, and appropriate for individuals with GAD, hypothesis four assessed participants' perceptions of the intervention following its delivery. The implementation measures identified that the participants rated the intervention acceptable, feasible, and appropriate. In addition, a systematic review estimated mean dropout rate for CBT for adults with GAD to be 16.99% (Gersh et al., 2017). The current study operationalised drop-out as not completing the post-treatment assessment session, thus the study had a relatively low drop-out rate of 10% (n = 4). Furthermore, 100% of participants completed at least one behavioural experiment as per the protocol. Together these findings suggest that the intervention were well received by adults with GAD. The study also aimed to

better understand the processes of exposure-based learning hypothesised to underlie symptom change in behavioural experiments. The study found in line with hypothesis 5a) belief change occurred as the behavioural experiments on average significantly reduced idiosyncratic negative beliefs about uncertainty, evidenced by large effect size on average pre-experiment belief rating to average post-experiment belief rating. Experiments were designed to maximally violate expectancies regarding the predicted outcome, as each experiment was phrased to increase probability estimation and negative valence (i.e., '*Being uncertain means that I can get no work done*') (Craske et al., 2014). These results suggest that there was a mismatch between expectancy and outcome, suggesting that inhibitory learning occurred. In line with hypothesis 5b) concern regarding uncertain situations significantly reduced at post-treatment, whereas positive situations had no change over treatment. Thus, the behavioural experiment intervention not only demonstrated significant reduction idiosyncratic beliefs about uncertainty but also facilitated a reduction in concern related to uncertainty. This shift is further highlighted by the within-group effect (d = 0.34) for intolerance of uncertainty for the combined group from pre-treatment to post treatment which is relatively substantial for a brief intervention for a process-based measure. Contrary to hypotheses, concern regarding negative situations did not change, suggesting that behavioural experiments designed to target IU do indeed target beliefs about uncertainty, and that IU may in fact be a cognitive bias in its own right (Milne et al., 2019). In addition, habituation also occurred with SUDs ratings significantly higher on average in anticipation of the experiment than 1) during and 2) after the experiment if they were to re-complete the experiment (i.e., SUDs re-complete).

The present study supports the clinical utility of a brief, two-session videoconference intervention utilising behavioural experiments targeting IU. Given the high prevalence and

significant distress associated with GAD, alongside common barriers to accessing traditional CBT—such as time constraints, financial costs, and preferences for therapist contact— this brief, remotely delivered protocol offers a promising, accessible alternative. Clinicians may also consider integrating behavioural experiments targeting IU into existing treatment frameworks to enable cognitive restructuring and reduce core GAD symptoms such as worry and maladaptive safety behaviours. The use of telehealth platforms can enhance treatment reach and flexibility, to address geographical and logistical barriers while maintaining therapeutic efficacy and acceptability. This approach aligns with stepped-care models, providing a low-intensity intervention option that could serve as a first-line or adjunctive treatment for individuals with a GAD diagnosis.

This study has several limitations that should be acknowledged. First, the omission of a follow-up time point limits the ability to assess the durability of treatment effects over time. As noted earlier, it is possible that additional symptom reduction may have occurred in the immediate treatment group beyond the post-treatment assessment; however, it is also possible that gains were not maintained, and this could not be evaluated due to the study design. Future research should include follow-up assessments, even for brief interventions, as symptom improvement has been shown to continue beyond the immediate post-treatment period (Bisby et al., 2024; Shapiro et al., 2023). The study did not include an active control condition that involved psychological intervention, which limits the ability to account for non-specific treatment effects such as those associated with therapeutic alliance or participant expectations (Cuijpers et al., 2019). Thus, including an active control in future trials would allow for a more rigorous test of the intervention's specific efficacy. Furthermore, a diagnostic interview conducted by a psychologist at pre-treatment confirmed primary GAD status for all participants.

However, no follow-up clinical interviews were administered post-treatment or after the waitlist period. This limitation restricts the ability to verify diagnostic status and fully evaluate clinical change over time, as assessments relied solely on self-report measures. Future research should incorporate repeated clinical interviews to strengthen the validity of outcome evaluation.

Together these results demonstrate that a two-session protocol can have a significant impact on GAD symptoms and processes, and that behavioural experiments targeting IU are a likely valuable component in the treatment of GAD. Despite the intervention being brief, it was rated as acceptable, feasible and appropriate by participants. Therefore, the findings support the continued exploration and implementation of brief, telehealth treatments for adults with GAD.

CHAPTER 6. General Discussion

Thesis Aims

GAD is characterised by excessive and difficult to control worry, with accompanying anxiety and heightened physiological tension. CBT is considered a first-line psychological intervention for GAD, with evidence indicating moderate to large effect sizes in reducing anxiety and worry-related symptoms (Carl et al., 2020; Kendall et al., 2011). Nevertheless, treatment response remains suboptimal, as approximately 40–60% of individuals continue to meet diagnostic criteria post-intervention (Bolognesi et al., 2014). To enhance therapeutic outcomes a more precise understanding of the associations between core symptoms, such as pathological worry and the cognitive processes posited to contribute to the development and maintenance of the disorder. Intolerance of uncertainty is one such process that has been consistently associated with excessive worry in GAD for the past three decades.

After conducting a scoping literature review of the measurement, mechanisms and treatment of worry and intolerance of uncertainty in GAD in Chapter 1, the present thesis had four overarching aims. These included: 1) improved measurement of worry in adults with GAD; 2) increased understanding of the psychological mechanisms that underlie the relationship between worry and intolerance of uncertainty in adults with GAD; 3) conduct of a comprehensive systematic review and meta-analysis to examine the impact that psychological treatments have on intolerance of uncertainty and worry in adults with GAD; and 4) to evaluate the effectiveness of a brief psychological treatment developed to directly target intolerance of uncertainty in adults with GAD.

First, the thesis aimed to examine and compare the psychometric properties of three different versions of the most widely used measure of excessive worry, the PSWQ in Chapter 2

(Empirical Study 1). To evaluate and compare psychometric properties, factor structure, construct validity, test-retest reliability, criterion validity, floor and ceiling effects, as well as sensitivity and specificity for screening GAD were assessed for each version of the PSWQ including the PSWQ, PSWQ-A and PSWQ-3. Second, Chapter 3 (Empirical Study 2) aimed to further understand the mechanisms through which the relationship between intolerance of uncertainty and worry may operate. Specifically, Chapter 3 conducted a partial examination of two theoretical models, the IUM and the TMIU, using path analysis in a clinical sample of adults with GAD. This study aimed to explore whether cognitive avoidance and positive beliefs about worry impact the relationship between intolerance of uncertainty and worry as per the IUM. In addition, this empirical study 2 aimed to evaluate whether threat estimates are involved in the relationship between intolerance of uncertainty and worry as per the TMIU. Third, we aimed to systematically review and analyse the impact that evidence-based psychological treatment has on intolerance of uncertainty and excessive worry, within Chapter 4. Specifically, both within-group (i.e., combined treatment sample) as well as between-group (i.e., RCT vs waitlist) analyses were conducted to determine if psychological treatment does reduce intolerance of uncertainty and worry for adults with GAD. In addition, subgroup and meta-regression analyses were employed to further understand potential impacts on the efficacy of treatment for adults with GAD. Fourth, and finally, we aimed to assess a brief two-session intervention delivered via videoconference, designed to directly target intolerance of uncertainty via behavioural experiments for adults with GAD. Specifically, this RCT aimed to determine whether behavioural experiments could lead to a significant reduction in worry, intolerance of uncertainty, worry behaviours (i.e., safety behaviours and avoidance), physiological tension and depression. Thus, this thesis aimed to not

only improve assessment of worry and understanding of the relationship between intolerance of uncertainty and worry but also to improve treatment for adults with GAD.

Summary of Empirical Study 1

The first empirical study aimed to evaluate and compare the psychometric properties of the 16-item PSWQ, 8-item PSWQ-A and 3-item PSWQ-3 in a clinical sample of adults with GAD. This is of relevance, as excessive worry is the cardinal feature of GAD, thus validation and comparison in a clinical sample of adults with GAD is important to ensure validity and reliability.

Confirmatory factor analysis was conducted on each of the three versions of the PSWQ, to determine the best factor structure. For the 16-item PSWQ, four different models were fit to the data, including a unidimensional, bifactor, two factor, and one factor with method effects. Overall, the fit indices suggested that the bifactor model fit the 16-item PSWQ better than the other factor models, though there was still room for improvement in absolute and incremental fit indices. Dear et al. (2011) found comparable results, with a similar type of model (i.e., termed ‘three factor’), with room for improvement in absolute fit indices in a clinical GAD sample. Given, the bifactor model fit the data best, multidimensionality of the PSWQ could be explored using bifactor indices. Bifactor indices suggested that the general factor was well-defined (i.e., H), represented the dominant source of variance (i.e., ω_H), and that the general worry factor was sufficiently unidimensional to be treated as a latent variable (i.e., ECV). Together, these results provided strong support for the general PSWQ factor, and therefore PSWQ can be treated as unidimensional. For the 8-item PSWQ-A a unidimensional model fit the data best across all absolute and incremental indices. This is perhaps unsurprising, as the PSWQ-A was developed to rectify the measurement issues created by negatively worded items, as these were removed in

this abbreviated version. For the PSWQ-3 a unidimensional model was fit, however, comparable analyses could not be conducted on the PSWQ-3 because the model was saturated.

After assessing factor structure of each version, the psychometric properties of 16-item PSWQ, 8-item PSWQ-A, and 3-item PSWQ-3 were compared. All three versions of the PSWQ demonstrated moderate positive correlations with physiological stress, providing support for construct validity, as both worry and physiological tension are part of the diagnostic criteria for GAD (American Psychiatric Association, 2022). Further support regarding construct validity was found through moderate positive associations with two key psychological processes: 1) intolerance of uncertainty and 2) negative metacognitive beliefs, as these are central in two leading theoretical models of GAD (Freeston, 2023). It was also found (in line with hypotheses) that related symptomology such as depression and autonomic anxiety, as well as less central components of the metacognitive model, exhibited small positive associations with worry. All three versions also demonstrated moderate test-retest reliability, excellent criterion validity, as well as revealed statistically significant differences in scores between the clinical GAD group and the non-clinical sample, with adults with GAD having higher scores. In addition, ROC curve analysis found that the area under the curve (AUC) approached 1.0, for all versions supporting high diagnostic accuracy and indicating that the cut-off scores effectively balanced sensitivity and specificity in identifying individuals with GAD.

All three versions showed a large amount of equivalence, as described above, however, there were some areas of divergence regarding floor effects and internal consistency. The PSWQ and PSWQ-A showed no evidence of floor or ceiling effects, however, the PSWQ-3 showed some floor effects, suggesting it may have reduced sensitivity at the lower end of the symptom range. Another area of difference among the three versions was regarding internal consistency.

The PSWQ-3 displayed adequate internal consistency, though it was slightly lower than that of the PSWQ and PSWQ-A. This difference may reflect the significantly reduced number of items in the PSWQ-3. However, its internal consistency remained above the recommended threshold ($r > .70$) in line with established quality benchmarks (Terwee et al., 2007).

Overall, the results indicate that all three versions of the PSWQ display strong psychometric validity across multiple criteria. Notably, the PSWQ-A and largely the PSWQ-3 maintained sound measurement properties despite their reduced length and are therefore suitable for use in both clinical practice and research involving adults with GAD.

Summary of Empirical Study 2

Intolerance of uncertainty has been suggested as an important process that is implicated in excessive and difficult to control worry in GAD. Potential mechanisms through which the relationship between intolerance of uncertainty and worry operate had yet to utilise path analysis in a sample of adults with GAD. Thus, the second study aimed to conduct a preliminary and partial examination of certain processes suggested to impact the pathways from intolerance of uncertainty to worry suggested in theoretical models, the IUM and TMIU.

First, the study conducted a partial examination of the IUM, with two path analysis models constructed to explore the relationship between intolerance of uncertainty and worry (model 1), and intolerance of uncertainty and somatic anxiety (model 2). Both models were found to have good fit across all indices, suggesting that both models fit the data well. Interestingly, positive beliefs about worry did not indirectly effect the relationship between intolerance of uncertainty and worry, nor indirectly effect the relationship between intolerance of uncertainty and anxiety. In addition, this study found that cognitive avoidance did not have an indirect effect on the relationship between intolerance of uncertainty and worry. Overall, these

results suggest that engaging in cognitive avoidance as well as holding positive beliefs about worry are not implicated in pathological worry in adults with GAD. Whereas engaging in cognitive avoidance (but not having positive beliefs about worry) is related to increased somatic anxiety in adults with GAD.

In addition to the IUM, empirical study 2 aimed to also examine the TMIU. The study sought to explore whether intolerance of uncertainty indirectly influenced the relationship between threat estimates (as a predictor) and worry and anxiety, as proposed by the TMIU. However, the third model, which tested this hypothesis, showed poor fit across most fit indices, suggesting that the TMIU's proposed path did not adequately explain the data for adults with GAD. In response, an alternative fourth model was developed, conceptualising intolerance of uncertainty as a predictor of subsequent psychological processes and symptoms. This model showed better fit across most fit indices suggesting that intolerance of uncertainty, when modelled as a predictor variable, better accounts for the relationships between threat estimates, worry and anxiety, in adults with GAD. Within the fourth model, threat estimates were found to indirectly effect the relationship between intolerance of uncertainty and both worry and anxiety, suggesting intolerance of uncertainty influences how individuals appraise threats leading to worry and anxiety for people with GAD.

Summary of the Findings of the Systematic Review and Meta-Analysis

This thesis not only aimed to improve theoretical understanding of the relationship between intolerance of uncertainty and worry, but it also aimed to systematically review and analyse the existing literature on the effectiveness of available evidence-based psychological intervention in reducing intolerance of uncertainty and worry. This was of particular interest, as the initial scoping review in Chapter 1 had identified this as a gap in the current literature, since

to date, no studies had used systematic review or meta-analytic techniques to explore the impact CBT-based psychological treatment had on intolerance of uncertainty as well as symptoms of GAD, including worry, anxiety, and depression.

Overall, findings from the systematic review and meta-analysis can be summarised as follows. Twenty-six articles met inclusion criteria for both systematic review and meta-analysis. Most studies included in the systematic review were rated as either medium or high quality, with minimal publication bias that impacted the overall results as indicated by the results of the classic fail-safe N (i.e., a substantial number of papers would have needed to be missed to increase the p value to greater that the set alpha level of 0.05). Meta-analysis found large significant within-group effects from pre-to post-treatment as well as from pre-to follow-up for intolerance of uncertainty and all GAD-related symptomology, including excessive worry, anxiety, and depression. There was also a large significant between-group effect observed in favour of the psychological treatment (when compared to waitlist/delayed treatment condition in RCTs) from pre- to post-treatment for intolerance of uncertainty, worry, anxiety and depression. Further, subgroups analyses found that the overall treatment effects were significantly greater than the waitlist/delayed conditions from pre- to post-treatment. Together these results provide corroborating evidence for the efficacy of psychological interventions in the reduction of intolerance of uncertainty and related outcomes for individuals with GAD.

The meta-analysis in Chapter 4 also sought to determine if any specific treatment factors impacted efficacy through subgroups analysis and meta-regression. Subgroups analysis found that CBT-IU was significantly more effective than CBT at reducing intolerance of uncertainty and worry, from pre- to post-treatment. This result was further supported by the meta-regression as increasing the total number of sessions spent directly targeting intolerance of uncertainty

significantly increased the effect size for intolerance of uncertainty and worry as post-treatment. Interestingly, this result regarding subgroups analysis was not maintained at follow-up, with no significant difference between the treatment groups. Examination of effect sizes indicated that CBT continued to improve from post-treatment to follow-up, whereas the CBT-IU effect size plateaued.

There was also a significant difference at follow-up in favour of CBT regarding depression in the subgroups analysis. Inspection of effect sizes showed that the CBT groups increased from post-to follow-up, whereas those in the CBT-IU groups decreased from post-to follow-up. Though there was a significant within group reduction overall from pre-treatment to follow-up for CBT-IU, it does highlight that other treatment techniques may be required to ameliorate depressive symptoms included in general CBT formats. This is of particular importance because depression is a common co-occurring condition for adults with GAD (Zhou et al., 2017). A recent meta-analysis exploring co-morbidity between mood and anxiety disorders found that found that those with depressive disorders had 11.7 times elevated risk of GAD over 1 to 12 month prevalence period (Saha et al., 2021). The meta-analysis also found GAD to demonstrate the highest risk for depression, when compared to all other anxiety and related disorders, including social anxiety disorder, specific phobia, OCD, PTSD, panic disorder, and agoraphobia (Saha et al., 2021). Thus, it is important for clinicians to consider whether there is comorbid depression and integrate this into the formulation and treatment plan, as the client may require CBT-based techniques beyond CBT-IU.

In addition, treatment format was found to moderate intolerance of uncertainty, and gender was found to moderate worry from pre-to post-treatment in the meta-regression. Individual treatment related to a significant increase effect size compared to group treatment for

intolerance of uncertainty. These findings are not surprisingly given that individual therapy has been found to the develop stronger therapeutic relationship (Bisseling et al., 2019), and may also mean that specific negative beliefs about uncertainty are able to be addressed with increased precision. There was also an inverse relationship between the percentage of females and effect size for worry, as an increase in percentage of females significantly decreased the effect size. Interestingly, pre-treatment severity in intolerance of uncertainty nor worry did not impact treatment efficacy, suggesting that psychological treatment is equally beneficial for individual with mild through to severe symptoms. Overall, the systematic review and meta-analysis found current evidence-based psychological treatment to be effective at reducing intolerance of uncertainty, worry, anxiety, and depression.

Summary of Empirical Study 3

The final study in the thesis aimed to integrate aspects from the preceding chapters and investigate the efficacy a brief two-session intervention delivered via videoconference aimed at targeting intolerance of uncertainty through behavioural experiments. The study included 40 participants who had a primary diagnosis of GAD (American Psychiatric Association, 2022). Overall participants found the intervention acceptable, feasible, and appropriate, with relatively low dropout rate (i.e., 10%). Regarding treatment efficacy, findings indicated that the brief intervention significantly reduced intolerance of uncertainty, worry, safety behaviours, avoidance and depression for the combined treatment group. In addition, there was a clinically significant improvement in worry symptoms for 25% of the sample, with 54% demonstrating a reliable improvement in worry symptoms. Together these results demonstrate that a two-session protocol can have a significant impact on GAD symptoms and processes. The study also found that compared to waitlist, worry demonstrated a significantly greater reduction from pre- to post-

treatment for the treatment group as per the significant interaction in the LMM. There was a medium within-group effect for the treatment group, with no within-group effect for the waitlist group from pre-to post-treatment. In contrast, there was no significant difference between the treatment and waitlist conditions at post-treatment for the remaining measures: intolerance of uncertainty, safety behaviours, avoidance, physiological tension, and depression.

The study demonstrated that behavioural experiments were effective in significantly reducing individuals' idiosyncratic negative beliefs about uncertainty, as shown by a large effect size between their pre- and post-experiment belief ratings. Further support for this new learning about uncertainty came from the AUSD, where concern about uncertain situations notably decreased after treatment. In contrast, concerns related to both negative (threat) and positive situations did not change over the course of treatment. This suggests that while the behavioural experiments effectively target beliefs about uncertainty, intolerance of uncertainty may represent a cognitive bias distinct from threat appraisals related to negative events. In conclusion, this study demonstrated that a brief two-session intervention can significantly impact symptoms and intolerance of uncertainty for adults with GAD.

Theoretical Implications

The findings of this thesis have several important theoretical implications for understanding the relationship between intolerance of uncertainty and worry in GAD. First, and foremost intolerance of uncertainty was found to be significantly related to excessive worry (study 1 and 2), and intolerance of uncertainty was found to be modifiable over the course of psychological treatment (systematic review and empirical study 3) for adults with GAD. These findings provide further evidence of the substantive relationship between intolerance of uncertainty and worry in adults with GAD.

The thesis aimed to further conceptual understanding of intolerance of uncertainty and worry by partially testing the IUM and TMIU in a clinical sample of adults with GAD. Regarding the IUM, the thesis sought to understand how the hypothesised *secondary* processes impact the relationship between IU and worry for adults with GAD in the IUM. Interestingly, neither positive beliefs about worry nor cognitive avoidance indirectly impacted the relationship between intolerance of uncertainty and worry. These findings suggest that supressing mental imagery, and holding beliefs about the helpfulness of worry, are not implicated in pathological worry within GAD, contrary to the IUM.

Of note, the direct path from positive beliefs about worry to worry, as well as the path from positive beliefs about worry to anxiety, was non-significant and had the least predictive power for each of the preliminary IUM models. Whereas the direct path from intolerance of uncertainty to positive beliefs about worry was significant and had the highest predictive power. It may be that positive beliefs about worry are related to intolerance of uncertainty but that these beliefs are not critical in explaining the maintenance of excessive, difficult to control worry in GAD. Interestingly, in a recent empirical study exploring the metacognitive model using path analysis found that positive beliefs about worry significantly contributed to worry, but only accounted for a small amount of the variance in worry (Nordahl, Vollset, et al., 2023). Though this study was completed in a self-report GAD sample, with individuals scoring higher than 10 on the GAD-7, it does suggest that positive beliefs about worry may not be a fundamental process in the perpetuation of excessive worry. Indeed, recent research exploring the relationship between metacognitive beliefs, repetitive negative thinking, and perfectionism using regression analysis in adults with eating disorders, found positive beliefs about worry were the only significant predictor of personal standards perfectionism (Palmieri et al., 2024). Thus, positive

beliefs about worry may be better placed to explain psychopathology in other mental health disorders and presentations, such as clinical perfectionism, rather than GAD.

Other theoretical implications pertain to the TMIU, as empirical study 2 found that only when intolerance of uncertainty (not threat estimates) were modelled as a predictor, did the model demonstrate good fit. In addition, threat estimates were found to indirectly impact the relationship between intolerance of uncertainty and worry. These findings suggest that intolerance of uncertainty impacts the extent to which an individual appraises threat in state-based negative situations leading to worry and anxiety. Furthermore, empirical study 3 aimed to understand how appraisals regarding negative, positive, and uncertain situations may shift over the course of a brief intervention aimed at targeting negative beliefs about uncertainty. Interestingly, there was no change in concern for negative (i.e., threat) or positive situations, however, there was a reduction in appraisals of concern regarding uncertain situations. This provides preliminary evidence that intolerance of uncertainty may in fact be a cognitive bias, related to, but distinct from negative threat appraisals (Milne et al., 2019).

Clinical Implications

The current thesis has a range of clinical implications regarding the treatment of adults with GAD. First, the findings from the systematic review and meta-analysis highlight that CBT-IU and CBT are both effective in reducing intolerance of uncertainty, worry, anxiety, and depression in GAD at post-treatment and follow-up, and can therefore be confidently used by clinicians to treat GAD. Regarding differences between CBT and CBT-IU, CBT-IU was significantly more effective than standard CBT in reducing intolerance of uncertainty and worry immediately following treatment. Meta-regression analyses further supported this finding, showing that dedicating more time to targeting intolerance of uncertainty increased treatment

effects for both intolerance of uncertainty and worry. However, these benefits were not sustained at follow-up; while CBT-IU gains appeared to plateau, outcomes for CBT continued to improve over time. Additionally, CBT outperformed CBT-IU at follow-up in reducing depressive symptoms. This may be particularly important in clinical decision-making, as depression is commonly comorbid for adults with GAD (Zhou et al., 2017).

In addition, empirical study 3 provided important clinical insights regarding inhibitory learning resulting from behavioural experiments. Specifically, the findings suggested that structuring behavioural experiments to strongly violate participants' expectations about feared outcomes can lead to significant cognitive and affective change. In that, participants showed a marked reduction in belief strength from pre- to post-experiment, indicating a significant expectancy violation. Additionally, decreases in distress (as measured by SUDs ratings) after the experiments suggest meaningful experiential learning. These results, in combination with the reduction in questionnaire-based scores (i.e., intolerance of uncertainty, worry, safety behaviours, avoidance), highlight the therapeutic value of expectancy-violating behavioural experiments in reducing negative beliefs about uncertainty and associated emotional distress, offering a practical, and brief technique for clinicians to utilise with adults with GAD.

Finally, it is noteworthy that the COVID-19 pandemic prompted significant shifts in healthcare delivery, leading to the adoption of accessible, evidence-based psychological treatments through videoconferencing to become an important choice for consumers. Empirical study 3 provided preliminary evidence that therapy delivered online is not only effective, but also acceptable, feasible, and, appropriate for adults with GAD.

Strengths of the Thesis

The primary strengths of this thesis include its conceptual grounding in cognitive behavioural theory, sound methodology, and clinical relevance. The overall aims of this thesis were driven by empirically based hypotheses, with methodological rigorous design, involving a mixed-methods series of studies that each adhered to established guidelines for quality research. Chapter 2 encompassed an investigation of the psychometric properties of three versions of the PSWQ based on the Terwee et al. (2007) evaluation criteria including content validity (i.e., confirmatory factor analysis), construct validity, internal consistency, test-retest reliability, criterion validity, and floor and ceiling effects. Chapter 3 was the first study to evaluate key components of the IUM and TMIU in treatment-seeking samples of adults and children with GAD, thereby extending previous correlational and regression analyses by examining the indirect effects of the included variables on clinical symptoms. Chapter 4 utilised thorough systematic review and meta-analytic techniques that followed PRISMA guidelines for reporting (Page et al., 2021), including pre-registration (PROSPERO ID: CRD42020205097). Chapter 5 implemented a RCT design to determine treatment efficacy of a brief intervention, with LMMs selected for statistical analysis, which account for different numbers of observations across individuals, without needing to delete any cases with missing data. The RCT was also pre-registered with ANZCTR under identifier [ACTRN12623000262606]. In addition, treatment fidelity for the RCT, was assessed by a second rater with 100% adherence to the protocol for both psychologists who delivered treatment. In addition, individuals who participated in the RCT were largely recruited from the general community (i.e., through Meta platform Facebook) who self-identified as treatment-seeking, suggesting that these results are generalisable for adults with GAD in the Australian community.

In addition, each empirical Chapter in this thesis included individuals who met DSM-IV-TR or DSM-5-TR criteria for a principal diagnosis of GAD as assessed via clinical interview (American Psychiatric Association, 2022), ensuring that the conclusions drawn do indeed reflect the characteristics of this clinical population. In addition, a second independent rater was used to determine diagnostic status agreement for a random subsample of participants for each of the three empirical studies. The inclusion of rigorously diagnosed clinical samples in all four Chapters of this thesis is a significant strength, particularly in comparison to much of the existing research in this field, which has relied on community or undergraduate samples.

Limitations of the Thesis

In contrast to the strengths, there were also several limitations for each study of the thesis, which also provide an avenue for future research endeavours. Regarding Chapter 2, the PSWQ-A and PSWQ-3 were not administered as separate questionnaires from the full 16-item PSWQ. While this avoids issues regarding repeated measures effects, it may inflate correlations since items overlap. Further methodological issues for Chapter 2 pertain to the small sub-sample used to calculate test-retest reliability, as a sample of at least 50 is required to meet adequate quality criteria (Terwee et al., 2007), whereas only 22 participants were include in Chapter 2 analysis. Chapter 3 included a cross-sectional design with data only collected at the pre-treatment time-point for the treatment-seeking GAD sample. This precluded the use of structural equation modelling and consequent ability to infer causality with directional pathways, that may have been possible if data had also been collected after participants had received treatment. Another key limitation in Chapter 3 was the partial testing of the IUM, as a measure of negative problem orientation was absent from the first two models. This is significant because past research has identified negative problem orientation as the only process to demonstrate a significant indirect

path between intolerance of uncertainty and worry in both UK and Italian undergraduate samples (Bottesi et al., 2016; 2018). A limitation across empirical studies 1 and 2, as well as systematic review and meta-analysis, was that lack of reporting on ethnicity and race for the clinical GAD samples. Without this information, it is difficult to assess the generalisability of the findings across diverse populations. This lack of demographic transparency can obscure potential cultural or racial influences on the variables studied, thus limit cross-cultural comparisons, and contribute to the ongoing underrepresentation of marginalised groups in psychological research (Lewis et al., 2023). For Chapter 5, one limitation was the exclusion of a follow-up time-point to assess whether further symptom change may have occurred for the immediate treatment group, compared with the waitlist group, as symptom reduction has been found beyond the post-treatment time-point in brief interventions (Bisby et al., 2024)

Directions for Future Research

In addition to addressing limitations within the current thesis, the findings also provide suggestions for future research. Empirical study 3 demonstrated that a brief intervention impacted maladaptive behaviours, reducing both safety behaviours and avoidance, suggesting that these factors are substantively implicated in the maintenance of GAD. Historically, studies investigating GAD have primarily focused on cognitive and somatic symptoms of the disorder, and this is likely due to the omission of maladaptive behaviours is in the DSM-5 diagnostic criteria (American Psychiatric Association, 2022). Future research should endeavour to further assess maladaptive behaviours, as well as explore the impact of psychological treatment on maladaptive behaviours, despite not currently being part of the DSM-5 diagnostic criteria. This is of salience, given the importance of reducing safety behaviours within an inhibitory learning framework (Craske et al., 2014).

Within empirical study 1, negative metacognitive beliefs about worry were found to have a significant moderating relationship with excessive worry, like intolerance of uncertainty and excessive worry. Negative metacognitive beliefs are the cornerstone process within the metacognitive model of GAD (Wells, 2010), an alternative cognitive behavioural conceptualisation of GAD. Similar to the CBT-IU, metacognitive therapy is made up of many components (Wells, 2009). One of these components includes behavioural experiments targeting negative metacognitive beliefs. One potential pathway for future research to explore would be the comparison of behavioural experiments targeting intolerance of uncertainty with behavioural experiments targeting negative metacognitive beliefs.

Additionally, although studies using an acceptance-based treatment protocol (i.e., ABT) were included in the systematic review and meta-analysis, there were insufficient studies to include these ABT studies as a comparison in the subgroups analysis. Thus, the comparative efficacy of ABT to CBT treatment formats (i.e., CBT and CBT-IU) for intolerance of uncertainty and worry remains to be investigated. A keystone of ABT is mindfulness, which involves paying attention to the present moment deliberately and nonjudgmentally, and stands in strong contrast to intolerance of uncertainty, wherein one focuses on the uncertainty of future. A recent meta-analysis found that mindfulness was an adaptive strategy with the largest effect size in reducing intolerance of uncertainty, suggesting that it may buffer intolerance of uncertainty (Sahib et al., 2023). Therefore, ABT protocols, may also be compared to behavioural experiments that target intolerance of uncertainty.

Conclusions

The current thesis aimed to address gaps identified in the empirical literature on the measurement of worry, as well as the relationship between intolerance of uncertainty and worry,

to improve psychological treatment outcomes for adults with GAD. Through a series of four studies, this thesis has highlighted the fundamental role that intolerance of uncertainty plays in the maintenance of excessive worry, as well as the necessity to target this process, including related beliefs about uncertainty, in the treatment of GAD. In achieving these aims, it is hoped that these studies substantially contribute to improving the measurement, understanding, and treatment outcomes of worry and generalised anxiety for adults with GAD.

Appendices

Appendix A: Chapter 2 and 3 Ethics Approval Letter

Dear Applicant

Re: ETH22-7702 - "Measurement and modelling of intolerance of uncertainty in people with generalized anxiety disorder."

You have declared your research as Negligible Risk in accordance with the National Statement on Ethical Conduct in Human Research (Chapter 2.1). This declaration is subject to the following standard conditions:

1. you must notify the UTS Human Research Ethics Committees of any variation to this research that may alter the level or risk associated with it;

2. you must undertake this research in compliance with the National Statement; and

3. you will undertake this research in compliance with the UTS Research Policy or any replacement or amendment thereof.

The UTS HRECs consider the following to be of negligible risk:
(1) use of commercial cell lines and/or supply of blood or blood products from Australian Red Cross Lifeblood;
(2) consensus methods (i.e. Delphi) where expert opinion is being canvassed with full disclosure, consent and identification in public use; and
(3) use of existing collections of data or records that contain only non-identifiable data about human beings (i.e. no codes)

Please keep a copy of your ethics application form and approval letter on file to show you have considered the risks associated with your research. You should consider this your official letter of approval.

To access this application, please click here. A copy of your application form has been attached to this email.

If you have any queries about this approval, please do not hesitate to contact your local research office or Research.Ethics@uts.edu.au.

Kind regards,
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Journal of Psychopathology and Behavioral Assessment (2025) 47:24
https://doi.org/10.1007/s10862-025-10200-4

A Comparison of the Long and Short Forms of the Penn State Worry Questionnaire in Adults with Generalised Anxiety Disorder

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Accepted: 2 February 2025 / Published online: 22 February 2025
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Abstract

The Penn State Worry Questionnaire (PSWQ) is a 16-item self-report measure designed to assess pathological worry. The PSWQ has, however, demonstrated inconsistent factor structure in adults and older adults leading to the development of the 8-item PSWQ-A and the ultra-brief 3-item PSWQ-3. The PSWQ is yet to be compared to the PSWQ-A and PSWQ-3 in adults with generalised anxiety disorder (GAD). Thus, the current study aimed to evaluate the psychometric properties of these three versions. Participants were screened using the Anxiety Disorders Interview Schedule for DSM-IV-TR to ascertain clinical principal diagnosis of GAD (n=140) or non-clinical status (n=76). Four different confirmatory factor models were fit to the 16-item PSWQ, with a unidimensional model fit to the 8-item PSWQ-A and to the PSWQ-3. A bifactor model fitted the data best for the PSWQ, and a unidimensional PSWQ-A model fitted the data best for the GAD sample. Results found that all three versions of the PSWQ demonstrated good construct validity, moderate test-retest reliability, and excellent criterion validity. ROC curve analysis indicated that all three versions demonstrated comparable levels of sensitivity and specificity for screening GAD. Both the PSWQ-A and PSWQ demonstrated no floor or ceiling effects and good internal consistency, whereas the PSWQ-3 demonstrated floor effects with adequate internal consistency. Overall, all three versions of the PSWQ share comparable psychometric properties. As such, the brevity of the PSWQ-A and its comparable performance to the 16-item PSWQ, warrant recommendations for use of this version to researchers and clinicians.

Keywords Generalised Anxiety Disorder · Worry · Confirmatory Factor Analysis · Psychometrics · Self-report

Introduction

Worry is a form of repetitive negative thinking (McEvoy et al., 2019a) that is conceptualised as a mental process involving attempts to plan and prepare a favourable solution in the face of an uncertain and potentially negative outcomes (Borkovec, 1994; Fresco et al., 2002). Though worry is experienced to some extent by everyone, excessive, multifocal, and difficult to control worry is a cardinal feature of generalised anxiety disorder (GAD). In GAD, worry is typified by statements that imply catastrophising or inflexible rule-bound interpretations (Dugas et al., 1998; Molina et al., 1998). Worry content centres around life domains such as family, interpersonal relationships, finances, personal health, health of loved ones, work, education, everyday tasks, the world and society, and is relatively stable over time (Constans et al., 2002). In particular, worry themes tend to be related to areas of high personal value (Boehnke et al., 1998).

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The Penn State Worry Questionnaire is a 16-item self-report questionnaire that is one of the most widely used measures of excessive worry (McEvoy et al., 2019b). The PSWQ has demonstrated good construct validity, internal consistency, and test-retest reliability (Brown et al., 1992; Dear et al., 2011; Hazlett-Stevens et al., 2004; Meyer et al., 1990). Despite these favourable psychometric properties, there has been inconsistent findings in relation to factor structure. The PSWQ was originally found to have a unidimensional factor structure in both undergraduates (Meyer et al., 1990) and in a heterogenous anxiety disorder sample (Brown et al., 1992). In contrast, Fresco et al. (2002) found that a two-factor solution provided superior fit when compared to a unidimensional solution in undergraduate students, with these two factors comprising of (1) worry engagement and (2) absence of worry. This same study found that higher order and lower order factors, general worry and worry engagement respectively, explained the majority of variance in symptom measures (Fresco et al., 2002). Thus, the second factor, absence of worry, appeared to represent methodological variance, as the items loaded onto this factor were negatively worded (i.e., *'I do not tend to worry about things'*) and thus reverse scored, rather than representing a conceptually orthogonal construct. Further investigation in a mixed sample of people with anxiety and mood disorders found that a unidimensional model accounting for method effects (i.e., covariance among errors of reverse-scored items) provided significantly better fit compared to the two-factorsolution (Brown, 2003). Therefore, it appears that the negatively phrased items may have an aberrant function producing an artificial factor, creating a limitation of the 16-item PSWQ. These findings also parallel literature that discourages the intermixing of negatively worded items in scales as they create psychometric artefacts, rather than reducing respondent bias (Chyung et al., 2018; Roszkowski & Soven, 2010), with evidence indicating that reverse-scored items hinder psychometric performance in other anxiety disorder questionnaires (Rodebaugh et al., 2007).

In light of the inconsistent factor structure of the full PSWQ, the 8-item PSWQ-Abbreviated (PSWQ-A) was constructed by Hopko et al. (2003). The PSWQ-A was developed from the full PSWQ items that were only positively worded (i.e., *'I worry all the time'*) to address factorial redundancy as well difficulties that had been previously reported for older adults with answering negatively worded questions due to increased cognitive load. Hopko et al. (2003) demonstrated that the PSWQ-A has strong fit indices, good convergent validity, high internal consistency, and adequate test–retest reliability in a sample of older adults with a principal or co-principal diagnosis of GAD. Wuthrich et al. (2014) went on to reproduce this methodology and compare the PSWQ to the PSWQ-A with a clinical sample of older adults with depression and an anxiety disorder. Wuthrich et al. (2014) again found poor fit across absolute and incremental fit indices for both the one-factor and two-factor models for the 16-item PSWQ, whereas the unidimensional PSWQ-A was found to have good fit across all indices. Further, the PSWQ-A was found to have good construct validity and internal consistency, with adequate test-retest reliability. In addition to the PSWQ-A, another 3-item version of the PSWQ has also been developed by Berle and colleagues (2011). The PSWQ-3 was created to incorporate the essential features of pathological worry (i.e., high frequency, high uncontrollability, multiple worry domains) as well as to exclude any reverse-scored items (Berle et al., 2011). Psychometric properties of the PSWQ-3 were explored with a mixed sample of adults with a principal anxiety or related disorder, and the results indicated similar psychometric properties for the 16-item PSWQ and PSWQ-3. Berle et al. (2011) found comparable construct validity, as well as sensitivity to treatment for individuals with GAD with equivalent large effect sizes following individual cognitive-behaviour therapy (CBT). Participants with GAD also scored higher than participants with another principal anxiety disorder on both the PSWQ and PSWQ-3.

Kertz et al. (2014) aimed to compare all three versions of the PSWQ in a heterogeneous clinical sample (i.e., mood, anxiety, trauma-related, and psychotic disorders) of adults presenting for treatment in a partial hospital setting. The underlying factor structure of the 16-item PSWQ was represented by a two-factor model, although, when compared to the PSWQ-A, the PSWQ-A exhibited the best fit across all indices (i.e., SB χ^2, RMSEA, CFI, GFI and SRMR). In addition, all three versions demonstrated similar psychometric properties, with good construct validity for the briefer versions and excellent internal consistency for the full PSWQ. All three versions showed comparable sensitivity to treatment, demonstrating medium effects following an assorted program of group and individual therapy informed by cognitive behaviour therapy. In adults with GAD, only Dear et al. (2011) has compared four model iterations of the 16-item PSWQ (i.e., unidimensional, two-factor, one-factor with method effects, and a three-factor model) and investigated the psychometric properties in adults with GAD. Interestingly, Dear et al. (2011) found a three-factor solution, with all items loading onto one general factor as well as two separate method factors (i.e., absence of worry and worry engagement), provided the best fit to the data. The path diagram of the three-factor model from Dear et al. (2011, p.20), demonstrated a similar structure to a bifactor model. Bifactor modelling has an advantage (over the three-factor solution) as bifactor indices can determine the extent to which a unidimensional (or multidimensional)

interpretation is supported by the data. In addition, research has yet to compare the 16-item PSWQ to the two shortened versions, PSWQ-A and PSWQ-3, in a clinical sample of *adults* with a *principal diagnosis of GAD*.

The current study aimed to extend previous research by comparing the psychometric properties of the 16-item PSWQ, 8-item PSWQ-A, and 3-item PSWQ-3 in a sample of adults with a principal diagnosis of GAD. It was hypothesised that the shorter PSWQ-A unidimensional model would provide the best fit for the data, when compared to the 16-item PSWQ and 3-item PSWQ-3 (Kertz et al., 2014). In addition, we hypothesised that both PSWQ-A and PSWQ-3 would demonstrate comparable psychometric properties to the longer PSWQ-16. Specifically, we predicted that all three versions would demonstrate no floor or ceiling effects. All three versions were predicted to demonstrate good construct validity though significant positive moderate correlations with a GAD symptom measures (i.e., physiological tension) and processes hypothesised to maintain pathological worry in cognitive-behavioural models of GAD (i.e., intolerance of uncertainty and negative metacognitive beliefs about worry). Significant moderate positive correlations were predicted for these aforementioned variables in line with previous research in mixed clinical and undergraduate samples (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004). We also predicted significant low correlations with distinct, yet overlapping psychopathology constructs, including depression and autonomic anxiety, as well as a range of metacognitive beliefs (i.e., positive beliefs about worry, lack of cognitive confidence, cognitive self-consciousness, and need for control of thoughts) in line with previous research (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004). Further, all three versions were predicted to demonstrate good internal consistency as well as reproducibility through adequate test-retest reliability over a 12-week period. Finally, we also predicted that the measure would significantly discriminate participants with GAD from non-clinical participants, with high sensitivity and specificity.

Method

Participants

A total of 216 participants were included in the study, with the combined group being predominantly female (73.6%), with an age range from 18 to 70 years (M=36.58 years, SD=13.07). All participants were assessed using the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Brown et al., 1994). Participants needed to be at least 18 years old, living in Australia and fluent in English to participate. Individuals who were experiencing active psychosis or active suicidal ideation were excluded from the study and referred to appropriate mental health services.

Non-clinical participants (N=76) were predominantly female (65.8%) and aged between 18 and 70 years (M=35.55; SD=14.08). Non-clinical participants were screened using the using the ADIS-IV and did not meet diagnostic criteria for any mental health disorder. Non-clinical participants were recruited via community notices in local newspapers.

The clinical sample was recruited from a specialist university-based clinical research unit for the assessment and treatment of anxiety disorders. All clinical participants met criteria for a principal diagnosis of GAD (N=140) and were aged between 18 and 70 years old (M=37.14; SD=12.50), with the majority identifying as female (77.9%). The clinician severity rating (CSR) was assigned by the clinician who administered the ADIS-IV and reflects the severity of symptoms and related interference or distress. The CSR ranges from zero to eight, a CSR of four or higher suggests a clinical level of severity. The average CSR for the principal diagnosis of GAD in this study was 6.15 (SD=0.93). Regarding co-morbidity within the clinical sample, 73.6% of participants satisfied criteria for at least one additional diagnosis (i.e., secondary diagnosis), including social anxiety disorder (41.4%), major depressive disorder (12.9%), dysthymia (5.0%), panic disorder with agoraphobia (5%), panic disorder without agoraphobia (1.4%), obsessive-compulsive disorder (1.4%), specific phobia (2.9%), and other (3.6%). At the time of assessment, 41.4% reported that they were taking some form of psychotropic medication.

There were no significant differences between the two groups on age, t (214)=0.82, p=.41, gender χ^2 (1)=3.69, p=.06, employment status, χ^2 (7)=4.76, p=.68 and education, χ^2 (2)=57, p=.06. There was a significant difference between groups in terms of marital status, χ^2 (4)=24.56, p<.001. A greater proportion of the non-clinical group were single (52.6%) or had been divorced (18.4%), compared to the clinical group who were single (38.7%) or divorced (6.4%). Whereas in the clinical group the majority were married/de facto (54.9%) compared to the non-clinical group (27.6%). With only a small percentage of people widowed in the non-clinical sample (1.4%).

Procedure

The original research study 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). All participants (N=140) completed the measures as part of a

clinical trial at the initial assessment session (Abbott, 2007). At the initial assessment session, all participants signed the consent form and were administered the ADIS-IV by a clinical psychologist or doctoral-level graduate student, supervised by senior clinical psychologists. A subsample (N=22) of the participants were in a waitlist condition for the clinical trial. These participants re-completed the PSWQ after a 12-week waitlist period (with no treatment). Participants in the waitlist condition were offered either group cognitive behaviour therapy or group mindfulness-based therapy after the 12-week waitlist, with results from the treatment not reported in the current study.

Measures

Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV)

The ADIS-IV is a semi-structured interview designed to evaluate anxiety and mood disorders in accordance with DSM-IV diagnostic criteria (Brown et al., 1994). Extensive research has demonstrated good to excellent inter-rater reliability for this interview (Brown et al., 1994). In the current study, blind raters exhibited high agreement (κ=0.84), underscoring strong inter-rater reliability in assessing diagnostic consistency.

Penn State Worry Questionnaire (PSWQ)

The PSWQ is a measure of excessive worry (Meyer et al., 1990). The PSWQ is a 16-item inventory created to capture the excessive and uncontrollable nature of pathological worry. The PSWQ is rated on a 5-point Likert scale, with scores ranging from 16 to 80. There are 12 items that are positively worded (i.e., '*I worry all the* time') and the remaining five items are negatively worded (i.e., '*I never worry about* anything') and need to be reverse scored. The PSWQ has been found to have good construct and internal reliability in a sample of participants with GAD (Brown et al., 1992; Dear et al., 2011). Internal consistency for the combined sample was α=0.97.

Penn State Worry Questionnaire- Abbreviated (PSWQ-A)

The PSWQ-A is an abridged version of the PSWQ, incorporating only eight positively worded items from the original PSWQ (Hopko et al., 2003). The PSWQ-A has been found to have a stable one-factor structure in older adult samples with mixed anxiety as well as undergraduate samples (Crittendon & Hopko, 2006; Wuthrich et al., 2014). The PSWQ-A was derived from the PSWQ and was not provided as a separate measure to participants. Cronbach's α for the combined sample was 0.95.

Penn State Worry Questionnaire – 3 (PSWQ-3)

The PSWQ-3 is an ultra-brief version on the PSWQ, with three items selected from the original PSWQ (Berle et al., 2011). The three items reflect the cardinal features of pathological worry (i.e., high frequency, perceived uncontrollability and multiple domains of worry). The PSWQ-3 has been found have good psychometric properties in both adults with GAD, as well as heterogenous mental health samples (Berle et al., 2011; Kertz et al., 2014). Like the PSWQ-A, the PSWQ-3 was extracted from the PSWQ and was not provided as a separate measure to participants. Cronbach's α for the combined sample was 0.93.

Intolerance of Uncertainty Scale – 12 (IUS – 12)

The IUS-12 was used as a measure of intolerance of uncertainty (Carleton et al., 2007; Freeston et al., 1994). There are 12 items that assess specific negative beliefs about uncertainty that someone may hold, such as '*When it is time to act*, *uncertainty paralyses me*' or '*I always want to know what the future has in store for me'*. The IUS-12 has a bifactor structure, with the total score to be utilised in the clinical sample of individuals with GAD (Wilson et al., 2020). It has also demonstrated good construct validity, treatment sensitivity, test-retest reliability as well as good internal consistency in a sample of individuals with GAD (Wilson et al., 2020). Internal consistency for the combined sample was excellent (α=0.93).

Metacognitions Questionnaire-30 (MCQ-30)

The MCQ-30 is 30-item inventory, developed to assess metacognitive beliefs and cognitive monitoring tendencies (Wells & Cartwright-Hatton, 2004). There are five subscales in the MCQ-30: (1) cognitive self-consciousness; (2) beliefs about the need to control thoughts; (3) positive beliefs about worry; (4) cognitive confidence; and (5) negative beliefs about the uncontrollability and danger of worry. The MCQ-30 has demonstrated acceptable fit within a five-factor model, as well as good construct validity and internal consistency for each subscale (Huntley et al., 2020; Nordahl et al., 2023). In the current sample, internal consistency ranged from adequate to excellent in the combined sample: cognitive confidence, α=0.90; positive beliefs about worry, α=0.90; cognitive self-consciousness, α=0.85; uncontrollability of thoughts and danger, α=0.91; and beliefs about need to control thoughts, α=0.77.

Depression Anxiety Stress Scales – Short Form (DASS-21)

The DASS-21 (Lovibond & Lovibond, 1995) includes 21-items aimed at assessing current symptoms of depression, anxiety (e.g., autonomic arousal and situational anxiety), and stress (e.g., agitation, impatience and nervous tension). Factor analysis has consistently demonstrated a three-factor solution, as well as adequate construct validity, internal consistency, and test-retest reliability in a variety of clinical samples (Brown et al., 1997; Lovibond & Lovibond, 1995; Page et al., 2007). Cronbach's α for each of the subscales was good to excellent for the combined sample: depression α = 0.91; anxiety α = 0.82; and stress α = 0.92.

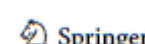
Data Analysis

Confirmatory factor analysis (CFA) was performed to ascertain the best model that fit the data for the 16-item PSWQ, and 8-item PSWQ-A. CFA was selected (over EFA) as there were strong a priori hypotheses regarding the different factor structures from previous research (Flora & Flake, 2017). Models tested for the 16-item PSWQ were informed by previous research (Brown et al., 1997; Dear et al., 2011) and included: (1) a one-factor model with all items loaded onto one general worry factor; (2) a one-factor model accounting for method effects, with all items loaded onto one general worry factor, with an additional method factor to account for the residual covariations among responses to five negatively worded items (i.e., reverse-scored items were permitted to covary with one another, items 1, 3, 8, 10 and 11); (3) a two-factor model with the positively-worded items loaded onto one factor, and the five negatively worded items loaded onto a second factor; (4) bifactor model (i.e., similar to the three factor model tested by Dear et al., 2011) with one general factor (shared variance between items) and two group factors, positive-scored factor and negatively scored (indicative of the covariance not explained by the general factor). The correlations between the general worry factor and the two factors (i.e., positively scored and reverse-scored factors) were constrained to zero. A unidimensional model was fit to the 8-item PSWQ-A and to the 3-item PSWQ-3.

Each confirmatory factor model was created using polychoric correlation coefficients in Mplus, version 6.1 (Muthen & Muthen, 1998–2022). For each CFA model absolute and incremental goodness-of-fit indices were used to evaluate fit (Hu & Bentler, 1999). Missing data was managed using the full information maximum likelihood method (FIML) with a bootstrap resample of 1000 (Hayes, 2009). Absolute goodness-of-fit was evaluated using the chi-squared statistic, where a non-significant value indicates acceptable fit (Tabachnick & Fidell, 2013). Further absolute goodness-of-fit was indicated with the standardised root mean square residual (SRMR), 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 both, SRMR and RMSEA values ≤ 0.08 are indicative of acceptable fit, and values < 0.06 have been suggested as indicative of good fit (Hu & Bentler, 1999). A non-significant PCLOSE and lower limit of the RMSEA 90% CI close to zero indicate good model fit (Kenny et al., 2014). Incremental fit was evaluated with the Tucker-Lewis index (TLI; Tucker & Lewis, 1973), and comparative fit index (CFI; Bentler, 1990). Values ≥ 0.90 for the TLI and CFI are suggestive of good fit, with values for the TLI and CFI ≥ 0.95 suggestive of excellent model fit (Hu & Bentler, 1999). Standardised factor loadings were also reported.

The bifactor indices were computed using the Bifactor Indices Calculator (Dueber, 2017) to determine the extent to which a unidimensional interpretation of PSWQ is supported by the data. Coefficient omega (ω) and omega subscale (ω_S) is a model-based estimate of internal reliability that can be applied to the general factor and group factors, and represents the proportion of variance in raw scores for the total score (ω) and each subscale (ω_S) that is explained by all sources of common variance i.e., both general and each subscale factor (Rodriguez et al., 2016). OmegaH (ω_H) represents the proportion of variance in the total score explained by the general factor. When OmegaH ≥ 0.80 the total score reflects a single construct sufficiently well (Rodriguez et al., 2016). OmegaHS (ω_{HS}), is an index reflecting the reliability of a subscale score (or the unique variance of each group factor) after controlling for the variance accounted for by the general factor (Reise et al., 2013). H is a measure of construct replicability conceptualized by and represents the correlation between a factor and an optimally-weighted item composite (Hancock & Mueller, 2001), thus high H values (> 0.80) suggest a well-defined latent variable. Specifically, explained common variance (ECV) reflects the proportion of all common variance explained by the general factor relative to the group factors. ECV > 0.70 indicates that a measure is sufficiently unidimensional to be treated as such in a latent variable modeling framework (Rodriguez et al., 2016). The Percent of Uncontaminated Correlations (PUC) represents the percentage of covariance terms which only reflect variance from the general dimension, thus the higher the PUC, the more the correlation matrix reflects the general factor (Rodriguez et al., 2016).

Subsequent psychometric analyses were conducted in SPSS 28.0.0 across all three measures. Data was screened for missing values Little's Missing Completely at Random Test and indicated that the data was missing completely at random, $\chi^2(45) = 46.03$, $p = .43$. Missing data was handled using a multiple imputation method. The Shapiro-Wilk statistic was non-significant ($p > .05$) for the 16-item PSWQ,



the 8-item PSWQ-A and PSWQ-3, indicating normality of data. Inspection of data and histograms indicated acceptable levels of skewness (i.e., < 2) and kurtosis (i.e., < 7). Group mean differences were calculated between the GAD and non-clinical samples using a one-way ANOVA. Floor and ceiling effects were considered to be present if 15% or more of participants scored the lowest or highest score, respectively (Terwee et al., 2007). Construct validity was assessed for the clinical sample using Pearson's r correlations, with descriptors used as per the following ranges: low = 0.10 − 0.39; moderate = 0.40-0.69; strong = 0.70 − 0.90. (Akoglu, 2018). Internal consistency was examined using Cronbach's alpha, with a score between 0.70 and 0.95, deemed as adequate for quality criteria (Mokkink et al., 2010). Test-retest reliability was assessed using a subsample of the participants with GAD (N = 22) who were in a waitlist condition for the clinical trial. Specifically, scores taken at the initial assessment were compared to scores taken at the end of the waitlist period (i.e., 12-weeks after the initial assessment). Test-retest reliability was assessed using the intraclass correlation coefficient (ICC). For the ICC (calculated for absolute agreement using the two-way random effects model) a value lower than 0.5 indicates poor reliability, a value between 0.5 and 0.75 suggests moderate reliability, a value between 0.75 and 0.90 indicates good reliability, with values greater than 0.9 suggesting excellent reliability (Koo & Li, 2016; McGraw & Wong, 1996). To assess criterion validity, the 16-item PSWQ will be correlated with the two briefer versions, PSWQ-A and PSWQ-3, using a split-half sample of participant with GAD. A Pearson's r correlation > 0.70 with the gold-standard measure (i.e., 16-item PSWQ) is suggested to meet quality criteria for criterion validity (Terwee et al., 2007). In addition, ROC curve analyses were conducted to determine if the measure could distinguish individuals with GAD from non-clinical participants. Specifically, for these analyses we reported the Youden-Index for the Area Under the Curve (AUC) which provides a cut-off score that maximises both sensitivity (proportion of true positive) and specificity (proportion of false negatives) (Fluss et al., 2005; Youngstrom, 2014). An accurate cut-off score should have an AUC close to 1.0, with scores above 0.85 classified as convincing evidence, scores between 0.75 and 0.85 classified as partially convincing, and AUC < 0.75 as unconvincing evidence for the accuracy of the cut-off score (Bowers & Zhou, 2019).

Results

Confirmatory Factor Analysis

Fit Indices

The results of the testing goodness of fit for the separate CFA models can be found in Table 1. See Table 2 for standardised factor loadings for the version of the PSWQ and PSWQ-A. The absolute and incremental fit indices were inconsistent for all four separate CFA models for the 16-item PSWQ. The bifactor model, though exhibited the most reliable fit for the 16-item PSWQ, however, there was room for improvement as the TLI < 0.90 and $\chi^2 p$ value was < 0.05. The PSWQ-A fit the data well across all absolute and incremental fit indices. A unidimensional model was also estimated for the 3-item PSWQ-3, however, the model was fully saturated, which was similar to (Kertz et al., 2014). As a result, goodness of fit indices could not be interpreted for the PSWQ-3.

Bifactor Indices

The omega coefficients for the general worry factor, and the positive worded factor were high. OmegaH for the general factor (ω_H) suggested that 80% of the variance in PSWQ scores can be explained by individual differences on the general factor. Whereas the omegaHS for the group factors (ω_{HS}) suggested only 13% and 29% of the variance in PSWQ scores can be attributed to the positively worded and negatively worded factors, respectively. Regarding the H construct, general factor had a high value (0.92), suggesting

Table 1 Fit indices for the PSWQ and PSWQ-A for adults with GAD

Fit Indices	PSWQ One Factor	PSWQ One Factor with method effects†	PSWQ Bifactor	PSWQ Two Factor	PSWQ-A One Factor
χ^2 / (df)	187.34 / 104	166.73 / 94	138.24 / 88	176.92 / 103	27.40 / 20
$\chi^2 p$ value	< 0.01	< 0.01	< 0.01	< 0.01	0.12
RMSEA [90% CI]	0.08 [0.06- 0.09]	0.07 [0.06- 0.09]	0.06 [0.04- 0.08]	0.07 [05- 0.09]	0.05 [< 0.01 − 0.01]
PCLOSE	0.01	0.02	0.13	0.03	0.44
SRMR	0.07	0.06	0.05	0.06	0.05
CFI	0.86	0.88	0.92	0.88	0.97
TLI	0.84	0.84	0.88	0.86	0.95

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *RMSEA* root mean square error of approximation, *PCLOSE* significance of the RMSEA close fit, *SRMR* standardised root mean square residual, *CFI* comparative fit index, *TLI* Tucker-Lewis index

† Method effects indicate that the reverse-scored items were permitted to covary with one another (items 1, 3, 8, 10 and 11)

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Table 2 Standardised factor loadings for PSWQ, PSWQ-A, and PSWQ-3 as well as bifactor indices for the PSWQ for adults with GAD

Items	PSWQ One Factor	PSWQ One Factor with method effects†	PSWQ Two Factor		PSWQ Bifactor			PSWQ-A	PSWQ-3
			Positive	Negative	General	Positive	Negative		
1. If I do not have enough time to do everything, I do not worry about it.	0.40	0.39	-	0.47	0.38	-	0.22	-	-
2. My worries overwhelm me.	0.58	0.58	0.58	-	0.58	0.01	-	0.55	-
3. I do not tend to worry about things.	0.23	0.20	-	0.41	0.17	0.28	0.60	-	-
4. Many situations make me worry.	0.70	0.70	0.70	-	0.67	0.28	-	0.75	0.64
5. I know I should not worry about things; but I just cannot help it.	0.55	0.55	0.55	-	0.54	0.12	-	0.61	-
6. When I am under pressure I worry a lot.	0.55	0.55	0.55	-	0.53	0.21	-	0.60	-
7. I am always worrying about something.	0.81	0.81	0.81	-	0.76	0.30	-	0.79	-
8. I find it easy to dismiss worrisome thoughts.	0.30	0.29	-	0.32	0.32	-	0.10	-	-
9. As soon as I finish one task, I start to worry about everything else I have to do.	0.61	0.61	0.61	-	0.59	0.19	-	0.59	-
10. I never worry about anything.	0.50	0.47	-	0.66	0.45	-	0.50	-	-
11. When there is nothing more I can do about a concern, I do not worry about it anymore.	0.36	0.34	-	0.43	0.35	-	0.21	-	-
12. I have been a worrier all my life.	0.38	0.38	0.38	-	0.37	0.06	-	0.32	-
13. I notice that I have been worrying about things.	0.48	0.48	0.48	-	0.48	0.02	-	0.44	-
14. Once I start worrying; I cannot stop.	0.63	0.63	0.62	-	0.91	0.85	-	-	0.62
15. I worry all the time.	0.82	0.83	0.83	-	0.80	0.20	-	-	0.98
16. I worry about projects until they are all done.	0.61	0.62	0.62	-	0.58	0.25	-	-	-
Bifactor Indices									
Omega					$\omega = 0.90$	$\omega_S = 0.91$	$\omega_S = 0.60$		
OmegaH					$\omega_H = 0.80$	$\omega_{HS} = 0.13$	$\omega_{HS} = 0.29$		
H					0.92	0.79	0.50		
ECV					0.72				
PUC					0.37				

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *ECV* Explained Common Variance, *PUC* Percent of Uncontaminated Correlations

† Method effects indicate that the reverse-scored items were permitted to covary with one another (items 1, 3, 8, 10 and 11)

a well-defined latent construct. Whereas, both positively worded and negatively worded factors were <0.80, suggesting that they are poorly defined latent constructs. The ECV indicates that the general factor explained 72% of the common variance, whereas only 27% was shared among the positively worded and negatively worded factors. The PUC indicated that 37% of the correlation matrix reflected the general factor.

Group Differences

Three separate independent samples *t*-test were performed on all three versions of the PSWQ, with each on finding that the clinical GAD group scored significantly higher those in the non-clinical group: PSWQ, t (214) = 26.76, p<.001; PSWQ-A, t (214) = 24.51, p<.001. PSWQ-3, t (214) = 23.98, p<.001. See Table 3 for descriptives.

Table 3 Group differences between non-clinical participants and adults with GAD for the three versions of the PSWQ

	PSWQ		PSWQ-A		PSWQ-3	
	Non-clinical (N=78)	GAD (N=140)	Non-clinical (N=78)	GAD (N=140)	Non-clinical (N=78)	GAD (N=140)
Mean (SD)	32.46 (9.70)	66.98 (8.68)	13.97 (5.75)	32.84 (5.20)	4.24 (1.62)	11.57 (2.38)

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated

Table 4 Construct validity indicated by Pearsons' r correlations between the three versions of the PSWQ and associated GAD symptoms and processes in adults with GAD (N=140)

Questionnaires	PSWQ	PSWQ-A	PSWQ-3
IUS – 12	0.43**	0.43**	0.40**
DASS – 21: Stress	0.57**	0.53**	0.55**
DASS – 21: Depression	0.26**	0.24**	0.28**
DASS – 21: Anxiety	0.32**	0.32**	0.34**
MCQ – 30: Negative beliefs about worry	0.55**	0.50**	0.59**
MCQ – 30: Positive beliefs about worry	0.29**	0.26**	0.18*
MCQ – 30: (Lack of) cognitive confidence	0.23**	0.21*	0.24**
MCQ – 30: Need for control of thoughts	0.32**	0.27**	0.31**
MCQ – 30: Cognitive self-consciousness	0.34**	0.28**	0.31**

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *IUS-12* Intolerance of Uncertainty Scale − 12, *DASS-21* Depression Anxiety Stress Scales-21, *MCQ-30* Metacognitive Beliefs Questionnaire-30

* p<.05. ** p<.001

Floor and Ceiling Effects

Across all 216 participants, scores on the 16-item PSWQ ranged from 16 to 80, with 0.5% achieving the lowest score of 16, and 1.4% achieved the highest possible score of 80. Across the combined sample, the 8-item PSWQ-A scores ranged from 8 to 40, with 3.2% achieving the lowest score of 8, and 2.8% achieved the highest possible score of 40. Together these results indicate no floor or ceiling effects for the 16-item PSWQ and for the 8-item PSWQ-A. For the PSWQ-3, scores ranged from 3 to 15 in the combined sample, with 16.7% achieving the lowest score of 3, and 6% achieved the highest possible score of 15. These results indicate a presence of floor effects, but not ceiling effects for the PSWQ-3.

Construct Validity

For adults with a diagnosis of GAD, all three versions of the PSWQ (PSWQ, PSWQ-A, and PSWQ-3) were found to moderate correlations with DASS-stress, IUS-12 and MCQ-30 negative metacognitive beliefs subscale, in line with hypotheses. The remaining questionnaires demonstrated a significant but low correlation with all three versions of the PSWQ, again in line with hypotheses. See Table 4 for correlations.

Internal Consistency

For adults with a diagnosis of GAD, the Cronbach's alpha for the 16-item PSWQ (α = 0.86) and the 8-item PSWQ-A (α = 0.80) was good. The Cronbach's alpha for the PSWQ-3 (α = 0.74) was adequate.

Test-retest Reliability

The ICC for all three versions indicated moderate reliability over a 12-week period: PSWQ (ICC r (19) = 0.66, p<.01), PSWQ-A [ICC (19) = 0.66, p<.01] and PSWQ-3 [ICC (19) = 0.56, p=.04].

Criterion Validity

The 16-item PSWQ was correlated using a spilt-half sample, and the strength was excellent for the PSWQ-A (r (140) = 0.95, p<.001) and good for the PSWQ-3 (r (140) = 0.89 p<.001). Criterion validity was also assessed using ROC curve analysis. Table 5 summarises the cut-off criteria and associated test performance indicators for the comparison of participants with GAD versus those without a mental health condition (i.e., non-clinical participants) for all three versions of the PSWQ. Of note, the AUC for the 16-item PSWQ, the PSWQ-A, and PSWQ-3 were all close to 1.0 (i.e., 0.99 − 0.98), indicating high accuracy for each of the respective cut-off scores.

Discussion

The current study compared the psychometric properties of the 16-item PSWQ, 8-item PSWQ-A and 3-item PSWQ-3 in a clinical sample of adults with GAD. Findings

Table 5 Receiver operating characteristic (ROC) curve analysis comparing adults with GAD (n = 140) to non-clinical participants (n = 78)

	PSWQ	PSWQ-A	PSWQ-3
Cut-Off Score	> 50	> 22	> 7
Area Under the Curve (AUC) (95% CI)	0.99 ** (0.97–0.99)	0.98** (0.95 −0.99)	0.99 ** (0.96 −0.99)
Sensitivity (95% CI)	97.14 (92.8–99.2)	96.43 (91.9–98.8)	94.29 (89.1–97.5)
Specificity (95% CI)	94.74 (87.1–98.5)	90.79 (81.9–96.2)	93.42 (85.3–97.8)
Positive Predictive Value (95% CI)	97.12 (92.9–98.9)	95.16 (90.5–97.5)	96.48 (91.9–98.4)
Negative Predictive Value (95% CI)	94.75 (87.2–97.9)	93.23 (85.3–97.0)	89.95 (81.9–94.6)

Note. *PSWQ* Penn State Worry Questionnaire, *PSWQ-A* PSWQ-Abbreviated, *95% CI* 95% Confidence Interval

** $p < .001$

demonstrated that all three versions of the PSWQ possess good psychometric properties across a range of indicators. Despite their brevity, the 8-item PSWQ-A and PSWQ-3 uphold their psychometric properties in comparison to the longer form and can be endorsed for use in both clinical and research settings for adults with GAD.

Initially six different confirmatory factor models were fit to the data, with four models incorporating 16-items from the PSWQ (i.e., unidimensional, bifactor, two factor, one factor with method effects), a unidimensional model for the 8-item PSWQ-A, and a unidimensional model for the PSWQ-3. The bifactor model appeared to fit the 16-item PSWQ better than the other PSWQ model iterations, though there was some room for improvement in absolute (i.e., χ^2 test) and incremental (TLI) fit indices. This finding endorses previous research that compared different versions of the 16-item PSWQ showing that the three-factor solution (i.e., one general factor and two method factors) provided the best fit to the data, mirroring current findings indicating that the longer form can be further improved, in a clinical GAD sample (Dear et al., 2011). Regarding bifactor indices from the current study, the general PSWQ factor represented the dominant source of variance (ω_H) in the total PSWQ score, with the *H* value indicating that the general factor was a well-defined latent variable (H). In addition, the ECV was greater than 0.70, suggesting that the general worry factor is sufficiently unidimensional to be treatment as a latent variable, thus using a total score for the PSWQ is recommended. Together, these results provide support for a strong general PSWQ factor, and unidimensionality (over multidimensionality) for the PSWQ. The unidimensional model also demonstrated the best fit the 8-item PSWQ-A across all absolute and incremental indices. This is perhaps unsurprising, as the PSWQ-A was developed by removing the negatively worded items. Regarding the PSWQ-3, comparable analyses could not be conducted on the PSWQ-3 because the model was saturated.

The psychometric properties of the 16-item PSWQ, 8-item PSWQ-A, and 3-item PSWQ-3 were largely comparable in their results and supported most hypotheses. Of note, all three versions showed moderate positive correlations with physiological stress/tension. This demonstrated construct validity as physiological tension and vigilance symptoms are part of the diagnostic criteria for GAD. All three measures also demonstrated moderate positive relationship with (1) negative metacognitive beliefs and (2) intolerance of uncertainty. These processes of are particular importance as they relate to two dominant models of GAD (Freeston, 2023). The metacognitive model proposes that excessive, pathological worry is primarily the result of negative metacognitive beliefs about worrying (i.e., that worry is uncontrollable and dangerous), in combination with positive beliefs about worry and subsequent ineffective mental control strategies (Wells, 2010). Whereas the intolerance of uncertainty model of GAD suggests that uncertainty is a natural trigger for worry, and therefore individuals who hold negative beliefs about uncertainty (i.e., intolerance of uncertainty) are more likely to experience excessive and difficult to control worry (Dugas et al., 1998; Hebert & Dugas, 2019). The hypotheses also predicted, in keeping with previous research (Kertz et al., 2014; Wells & Cartwright-Hatton, 2004), that less salient components of the metacognitive model, as well as distinct yet overlapping psychopathology constructs (i.e., depression and autonomic anxiety), would show positive relationships with the excessive worry. Together these findings are supported by the broader literature (Freeston, 2023), and highlight the importance for clinicians to target negative metacognitive beliefs about worry, as well as intolerance of uncertainty in psychological treatment, given that these processes were most strongly related to worry in the present study.

In terms of equivalence, all three versions demonstrated moderate test-retest reliability, excellent criterion validity, as well as the ability to distinguish adults with GAD from those with no mental health conditions in the non-clinical group. Criterion validity was assessed using a split-half sample analysis and demonstrated a strong correlation between the PSWQ and each of the two briefer versions (PSWQ-A and PSWQ-3). Though this result is not surprising, it strongly indicates that all three versions are measuring the same construct of excessive worry. One discrepancy between the three versions related to internal consistency, with the PSWQ-3 demonstrating adequate internal consistency, which was slightly lower than that for the PSWQ-A

and PSWQ. This may be partly accounted for by the PSWQ-3's substantial reduction in items, while still falling within an acceptable range (i.e., $r > 0.70$) to meet quality criteria for measurement properties set out by Terwee et al. (2007). All three versions showed a statistically significant difference between the clinical GAD group and the non-clinical group. The PSWQ and PSWQ-A demonstrated no floor or ceiling effects, however, the PSWQ-3 demonstrated a propensity for floor effects suggesting a lack of specificity. Though floor effects were found for the PSWQ-3, ROC curve analysis demonstrated that all three versions showed an AUC close to 1.0, indicating high accuracy for each of the respective cut-off scores that maximises both sensitivity and specificity to distinguish adults with GAD from non-clinical adults. It is noteworthy that despite the substantial reduction in items, the psychometric properties of the briefer versions are largely equivalent to the 16-item PSWQ.

The two briefer versions (i.e., PSWQ-A and PSWQ-3) appear to have relatively comparable psychometric properties to the original 16-item PSWQ in a GAD sample. Researchers and clinicians who need to measure pathological worry while accounting for time constraints may consider the two shorter versions of the PSWQ: the PSWQ-A and PSWQ-3. These briefer forms are particularly beneficial in clinical assessments where a broad range of symptoms are being evaluated, as they help mitigate client questionnaire fatigue. Both the PSWQ-A and PSWQ-3 demonstrate psychometric properties comparable to the full PSWQ, making them effective and efficient options for inclusion in assessment batteries. Another instance where time constraints may favour the use of a briefer version is in tracking weekly treatment progress for adults with GAD. The ultra-brief PSWQ-3 is particularly advantageous in this context due to its quick administration time and its resistance to floor effects within a GAD sample. Another consideration for researchers and clinicians to consider when using the 16-item PSWQ is that not only do the negatively worded items appear to increase the cognitive load when completing the 16-item PSWQ, they can make real-time scoring on pen and paper forms difficult for clinicians. As without a reverse-score template, clinicians are not able to quickly inspect whether the general pattern of worry is decreasing (or increasing) over the course of treatment. One way to overcome this difficulty for clinicians, would be to automate scoring for the 16-item PSWQ through a secure survey platform (i.e., REDCap). However, for clinicians who prefer to stick to pen and paper forms, the briefer versions of the PSWQ provide a readily available solution, that is psychometrically comparable. Thus, not only do the briefer versions avoid the methodological problems related to the reverse scored items on the 16-item PSWQ, but they also increase the speed of completion for participants or consumers in clinical practice.

It is important to highlight potential limitations of the study. First, the PSWQ-A and PSWQ-3 were not administered separately from the 16-item PSWQ, similarly to the methodology used in Wuthrich et al. (2014). Though this avoids potential problems with repeated measure effects, it prevents direct comparison of the measure's performance outside of the context of the full version. This limitation may also mean that there is an overestimation of the correlation between the versions, as the items on the 8-item and 3-item form are counted in both sides of the correlation (Smith et al., 2000). Item position has also been shown to impact questionnaire results (Podsakoff et al., 2012), which may have influenced the current findings. In addition, treatment sensitivity was not examined in the current study, previous research has found that the PSWQ (Dear et al., 2011) and the PSWQ-3 (Berle et al., 2011) were sensitive to evidence-based treatment with significant reductions following CBT, however, the PSWQ-A is yet to be assessed in adults with GAD. Another limitation of the current study was the inability to report on ethnicity and race for both clinical and non-clinical groups. The current sample had a large proportion of missing data for ethnicity in the GAD sample, with only 18.6% of the clinical group reporting their ethnicity. Future research should endeavour to capture ethnicity and race in samples, so that cultural differences can be explored and understood in the reporting of the short and longer forms of the PSWQ. In addition, a relatively small sub-sample of participants with GAD to assess test-retest reliability. This is a methodological limitation as quality criteria set out by Terwee et al. (2007) suggests that a sample size of at least 50 participants is required to meet adequate quality criteria for assessing psychometric properties of a questionnaire. Thus, the current study provides preliminary evidence that all three versions of the PSWQ demonstrate adequate test-retest reliability in adults with GAD, and future research should attempt to replicate this in a larger sample.

Overall, the shorter versions (PSWQ-A and PSWQ-3) performed with psychometric equivalence to the full 16-item PSWQ in a sample of individuals with GAD. Therefore, clinicians and researchers may prefer to utilise these self-report instruments, since they are both quicker to complete and score, and avoid scoring and psychometric issues caused by reverse-scored items, thereby potentially easing questionnaire burnout in the research space as well as facilitating real-time discussions in clinical practice.

Funding Open Access funding enabled and organized by CAUL and its Member Institutions

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COGNITIVE BEHAVIOUR THERAPY
https://doi.org/10.1080/16506073.2025.2478246

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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.

ARTICLE HISTORY
Received 22 November 2023
Accepted 3 March 2025

KEYWORDS
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 α = 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, α = 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, α = 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, α = 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 $\leq$ .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 (β = 0.11, SE = 0.04, p = 0.01). The path from IU to anxiety via PBW was not significant (β = −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

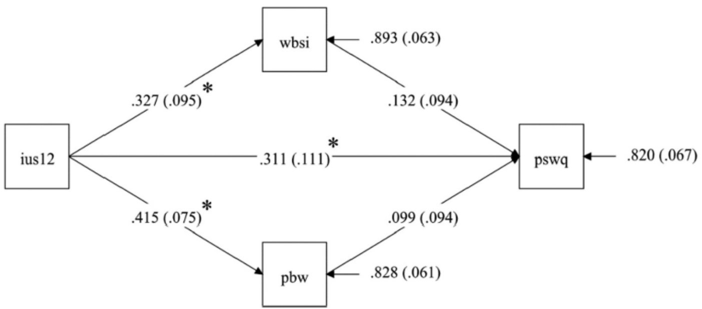

Figure 1. Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and worry in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White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

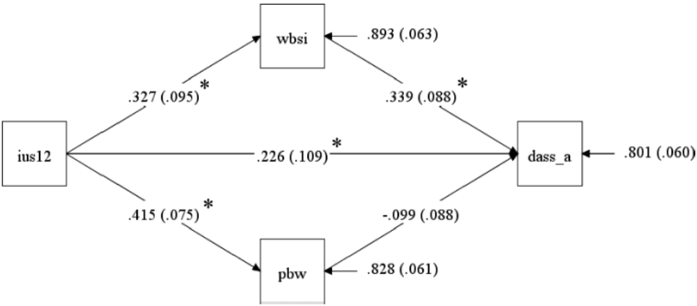

Figure 2. Standardised path coefficients and errors between intolerance of uncertainty, cognitive avoidance, positive beliefs about worry, and anxiety in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pbw* Metacognitions Questionnaire-30 Positive Beliefs about Worry, *wbsi* White 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

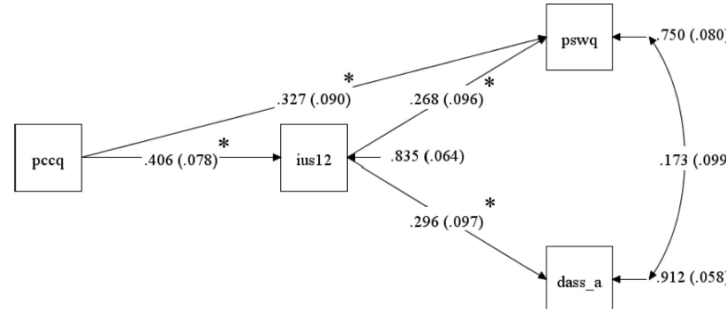

Figure 3. Standardised path coefficients and errors between threat appraisal, intolerance of uncertainty, worry, and anxiety in adults with GAD. Note. *pccq* Probability Cost Coping Questionnaire, *ius12* Intolerance of Uncertainty Scale – 12, *pswq* Penn State Worry Questionnaire, *dass_a* DASS-21 Anxiety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

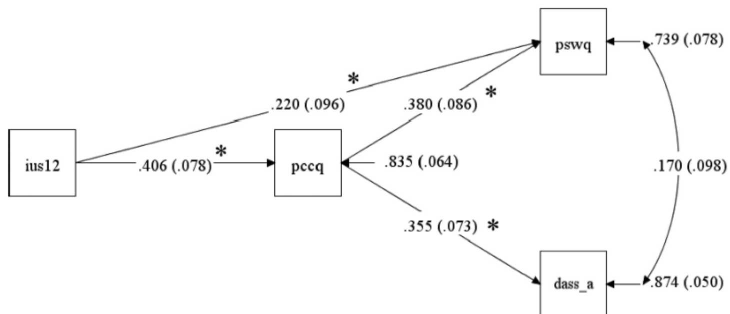

Figure 4. Standardised path coefficients and errors between intolerance of uncertainty, threat appraisals, worry and anxiety in adults with GAD. Note. *ius12* Intolerance of Uncertainty Scale – 12, *pccq* Probability Cost Coping Questionnaire, *pswq* Penn State Worry Questionnaire, *dass_a* DASS-21 Anxiety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

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the Australian Rotary Health Department of Education and Training.

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Appendix D: Chapter 4 Peer-Reviewed Article

Journal of Anxiety Disorders 97 (2023) 102729

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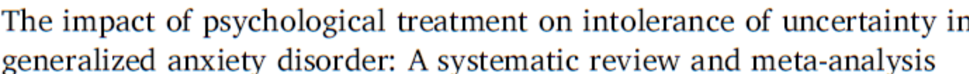

The impact of psychological treatment on intolerance of uncertainty in generalized anxiety disorder: A systematic review and meta-analysis

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ARTICLE INFO

Keywords:
Intolerance of uncertainty
Anxiety
Worry
GAD
Treatment

ABSTRACT

Research has demonstrated a strong link between intolerance of uncertainty and generalized anxiety disorder (GAD). The current systematic review and meta-analysis aimed to evaluate how effective evidence-based psychological treatments are at reducing intolerance of uncertainty for adults with GAD. An extensive literature search identified 26 eligible studies, with a total of 1199 participants with GAD. Psychological treatments ($k = 32$ treatment groups) yielded large significant within-group effect size from pre- to post-treatment and pre-treatment to follow-up for intolerance of uncertainty ($g = 0.88$; $g = 1.05$), as well as related symptoms including worry ($g = 1.32$; $g = 1.45$), anxiety ($g = 0.94$; $g = 1.04$) and depression ($g = 0.96$; $g = 1.00$). Psychological treatment also yielded a large significant between-group effect on intolerance of uncertainty ($g = 1.35$). Subgroups analysis found that CBT that directly targeted intolerance of uncertainty (CBT-IU) throughout treatment was significantly more effective than general CBT at reducing intolerance of uncertainty ($p < 0.01$) and worry ($p < 0.01$) from pre- to post treatment, however, this result was not maintained at follow-up. Meta-regression analyses supported this finding as increases in the amount of time spent directly targeting intolerance of uncertainty, significantly increased the effect size for both intolerance of uncertainty ($z = 2.01$, $p < 0.01$) and worry ($z = 2.23$, $p < 0.01$). Overall, these findings indicate that psychological treatments are effective at reducing IU, and related symptom measures of GAD.

1. Introduction

Generalized anxiety disorder (GAD) is a mental health condition typified by excessive and difficult to control worry about a range of life events and activities, more days than not (American Psychiatric Association, 2013). For individuals with GAD, excessive worry is also experienced in combination with increased feelings of anxiety as well as physical symptoms (e.g., muscle tension, restlessness, sleep disturbance) leading to significant impairment in functioning and/or distress (APA, 2013). Recent estimates suggest that approximately 4% of individuals will experience GAD over the life course (Grant et al., 2005; Kessler et al., 2012) with up to 10% of all mental health presentations in primary care settings made by individuals with GAD (Ansseau et al., 2005; Maier et al., 2000). Individuals with GAD are more likely than the general population to experience major depressive disorder (Carter et al., 2001), that in turn has been associated with lower physical and psychological quality of life (Zhou et al., 2017). In surveys completed by individuals with GAD, they report levels of moderate to severe psychological distress as well as mild to moderate disability (Pelletier et al., 2017), as well as higher use of medical resources as well as increased use of leave and absenteeism at work (Hoffman et al., 2008). Therefore, effective treatments are necessary to alleviate both individual distress and societal burden.

A range of psychological and pharmacological interventions are considered evidence-based for the treatment GAD (Carl et al., 2020). Psychological treatment utilising principals of cognitive behavioural therapy (CBT) are recommended as the first line of treatment for GAD using a stepped care approach (National Institute for Health and Care Excellence (NICE, 2011). Research utilising meta-analytic methods have consistently found CBT approaches to demonstrate medium to large effect sizes on GAD-related outcome measures, with small to large effect sizes found for pharmacological interventions (Bandelow et al., 2015; Carl et al., 2020; Cuijpers et al., 2014). Despite these findings, remission rates remain lower than expected, with approximately 40–60% of individuals continuing to meet the diagnostic threshold for GAD following either treatment (Baldwin et al., 2011; Bolognesi et al., 2014; Reinhold

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https://doi.org/10.1016/j.janxdis.2023.102729
Received 18 August 2022; Received in revised form 3 April 2023; Accepted 18 May 2023
Available online 20 May 2023
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& Rickels, 2015). One avenue to improve psychological treatment is to examine the impact that these interventions have on cognitive processes hypothesised to underlie psychopathology in order to directly target these vulnerabilities during treatment. One such cognitive vulnerability is intolerance of uncertainty.

Intolerance of uncertainty is conceptualised as a dispositional characteristic that manifests as negative beliefs about uncertainty and its consequences (Dugas & Robichaud, 2007). Over the past two decades, there has been growing interest in the role of intolerance of uncertainty as a cognitive vulnerability factor for a range of emotional disorders. Research has found that a range of anxiety-related disorders report significantly higher levels of intolerance of uncertainty than community samples (Carlton et al., 2012). A recent meta-analysis found a significant association between intolerance of uncertainty and clinical symptoms of social anxiety, obsessive-compulsive disorder, depression, panic, eating disorders, and GAD; with the strength of this association significantly higher for GAD symptoms (McEvoy et al., 2019). Extensive research has found a strong relationship between intolerance of uncertainty and excessive worry, leading researchers to suggest intolerance of uncertainty is of particular importance in the maintence of GAD (Robichaud et al., 2019). In keeping with this hypothesis, experimental studies manipulating levels of tolerance to uncertainty correspond to parrallel changes in worry (Rosen & Knäuper, 2009; Ladouceur et al., 2000a) and longitudinal studies have demonstrated that levels of intolerance of uncertainty predict levels of worry throughout adolescence (Dugas et al., 2012). Further, improvements in intolerance of uncertainty during psychological treatment have been shown to predict a reduction in worry for individuals with GAD (Bomyea et al., 2015; Dugas & Ladouceur, 2000).

The Intolerance of Uncertainty Model (IUM) of GAD was developed to explain the robust relationship between intolerance of uncertainty and excessive worry (Dugas, Gagnon, Ladouceur, & Freeston, 1998). The IUM is a cognitive behavioural conceptualisation that emphasises the role of intolerance of uncertainty as the primary process leading to the development and maintenance of excessive worry, with three secondary variables, namely, positive beliefs about worry, negative problem orientation, and cognitive avoidance (Dugas et al., 1998; Dugas & Robichaud, 2007). In order to target intolerance of uncertainty and address the three secondary variables, a CBT protocol, CBT-Intolerance of Uncertainty (CBT-IU) was developed (Dugas et al., 1998). Earlier forms of the manual comprise of a number of modules, including psychoeducation and worry awareness training, re-evaluation of the usefulness of worry, problem solving training, imaginal exposure, and relapse prevention, with later iterations including behavioural experiments to test catastrophic beliefs about uncertainty (Dugas & Robichaud, 2007; Robichaud et al., 2019).

Research has shown that CBT-IU is significantly more effective than waitlist control at reducing intolerance of uncertainty and worry in adults (Dugas et al., 2003; Ladouceur et al., 2000b) and older adults with GAD (Hui & Zhihui, 2017). Additionally, a trial comparing CBT-IU to a pharmacological intervention, found CBT-IU to be significantly more effective at reducing intolerance of uncertainty and worry (Zemestani et al., 2021). However, one study comparing CBT and CBT-IU found that metacognitive therapy (i.e., CBT) was significantly more effective at reducing intolerance of uncertainty and excessive worry than CBT-IU (van der Heiden et al., 2012). Therefore, in an attempt to further improve treatment efficacy, two CBT-IU interventions have focused exclusively targeting intolerance of uncertainty using behavioural experiments for individuals with GAD. Hebert and Dugas (2019) conducted a preliminary evaluation of efficacy with a small sample size ($n = 7$) and found a large effect size on measures of intolerance of uncertainty, worry, anxiety, and depression from pre- to post-treatment. Dugas et al. (2022) replicated these findings in a randomised controlled trial (RCT) and found that CBT-IU was significantly more effective at reducing intolerance of uncertainty, worry, anxiety, and depression than the waitlist control condition. Other forms of CBT have also demonstrated a significant reduction in intolerance of uncertainty and worry from pre- to post-treatment (Talkovsky & Norton, 2016; Laposa & Fracalanza, 2019) as well as performing significantly better than waitlist control conditions (Beheshtian et al., 2020). Similarly, acceptance based therapies (ABT) also demonstrate a significant decrease from pre- to post-treatment for both intolerance of uncertainty and worry (Treanor et al., 2011), with no difference found between CBT and ABT at post-treatment (Avdagic et al., 2014; Wilson et al., 2020). Thus, it remains essential to assess the impact that different forms of psychological treatment have on intolerance of uncertainty for individuals with GAD.

Several meta-analyses have explored the relationship between intolerance of uncertainty and symptoms of GAD. Gentes and Ruscio (2011) demonstrated a mean correlation between intolerance of uncertainty and GAD symptoms ($r = 0.57$), which was replicated in a recent meta-analysis (McEvoy et al., 2019). Meta-analyses exploring the effects of psychological interventions for GAD have demonstrated large average effect sizes for GAD symptoms (Hedges $g = 0.84$) and a medium effect for depression (Hedges $g = 0.71$) (Cuijpers et al., 2020). These findings were replicated in a recent meta-analysis with psychological interventions for GAD showing a medium to large effect (Hedges $g = 0.76$) on GAD symptom measures and medium effects (Hedges $g = 0.64$) on depression outcomes (Carl et al., 2020). While meta-analyses have assessed the impact of psychological treatments on GAD-related symptomatology, few studies have assessed the impact of such treatments on key maintaining processes in GAD. To the best of our knowledge, no studies have used systematic review or meta-analytic techniques to explore the effect of psychological interventions for GAD on intolerance of uncertainty.

The current study aimed to determine the effectiveness of evidence-based psychological treatments for GAD in reducing intolerance of uncertainty using systematic review and meta-analytic techniques. The study aimed to provide a systematic review of the various evidence-based psychological interventions for GAD and their impact on intolerance of uncertainty, as well as three related outcome variables namely worry, anxiety, and depression. In alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, the quality of studies will be assessed using a standardised risk of bias tool. In addition, the study aimed to use meta-analytic methods to determine whether psychological treatment significantly reduced intolerance of uncertainty, as well as worry, anxiety and depression for individuals with GAD. Subgroups analyses will also be conducted to determine if treatment/s are *more effective* at reducing intolerance of uncertainty, worry, anxiety and depression. Meta-regression analyses will be performed to explore whether sample and treatment characteristics moderate the within-group effect size for intolerance of uncertainty and worry. Sample and treatment characteristics include age, gender, number of sessions, total treatment time, total time spent targeting intolerance of uncertainty, and treatment format (group vs individual).

2. Method

2.1. Search strategy

The study protocol was published on PROSPERO, ID: CRD420 20205097, https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020205097.

An extensive literature search was conducted using the following databases: PsycINFO, Medline, PubMed, CINAHL, Web of Science, and SCOPUS. These databases were used to identify intervention studies that included a course of evidence-based psychological treatment that measured intolerance of uncertainty at pre-treatment and post-treatment for individuals with a diagnosis of GAD. The key search terms employed included: (*anxi** or *GAD* or *worr**) AND (*intolerance of uncertainty* or *IUS*) AND (*cognitive behavio(u)ral therapy* or *CBT or*

psychotherapy or *intervention** or *trial* or *treatment* or *program*). No limits were placed on publication date. Both English and non-English speaking populations were included in the review. Reference lists of relevant articles were also examined to identify any additional studies relevant to the review. The final search was conducted on 16 February 2023.

2.2. Selection and exclusion

Titles, abstracts, and full texts were systematically reviewed to eliminate studies that did not meet inclusion criteria. Studies were considered for further review if 1) individuals had a primary diagnosis of GAD, 2) the study comprised of individuals 18 years or older, 3) a course of evidence-based psychological treatment was administered, and 4) intolerance of uncertainty was measured at pre-treatment and post-treatment. Studies that used case studies or reviews were excluded. Abstracts were screened, and the full text of eligible studies was reviewed independently by two authors (EW & MA). At both stages, any discrepancy was resolved through discussion until 100% agreement was reached. Publication dates ranged from 2000 to 2023. Research articles were reviewed to extract relevant data, including participant demographics, study design, diagnostic status, outcome measures, treatment type and characteristics. Intent-to-treat (ITT) data was extracted if it was available, otherwise completer data was included in the analysis. ITT data was reported for 15 out of 32 treatment groups. There was no significant difference in the pre- to post effect size for intolerance of uncertainty ($p = .20$) and worry ($p = .75$) for studies that reported ITT data vs completer data. The corresponding authors were contacted for further information as required. A total of 58% of authors were contacted for clarification of data. Of the authors who were contacted the majority replied (73%), however, two articles could not be included as pre-post intolerance of uncertainty data was unable to be retrieved from the authors. Therefore, of the 1920 articles screened, 26 articles (with 32 treatment groups) were included in the current systematic review and meta-analysis. Please refer to Fig. 1 for PRISMA flowchart of the selection process. Please see Supplemental File 1 for a list of the articles and treatment manual citations utilised in the systematic review and meta-analysis.

Figure 1.
PRIMSA Flow Chart

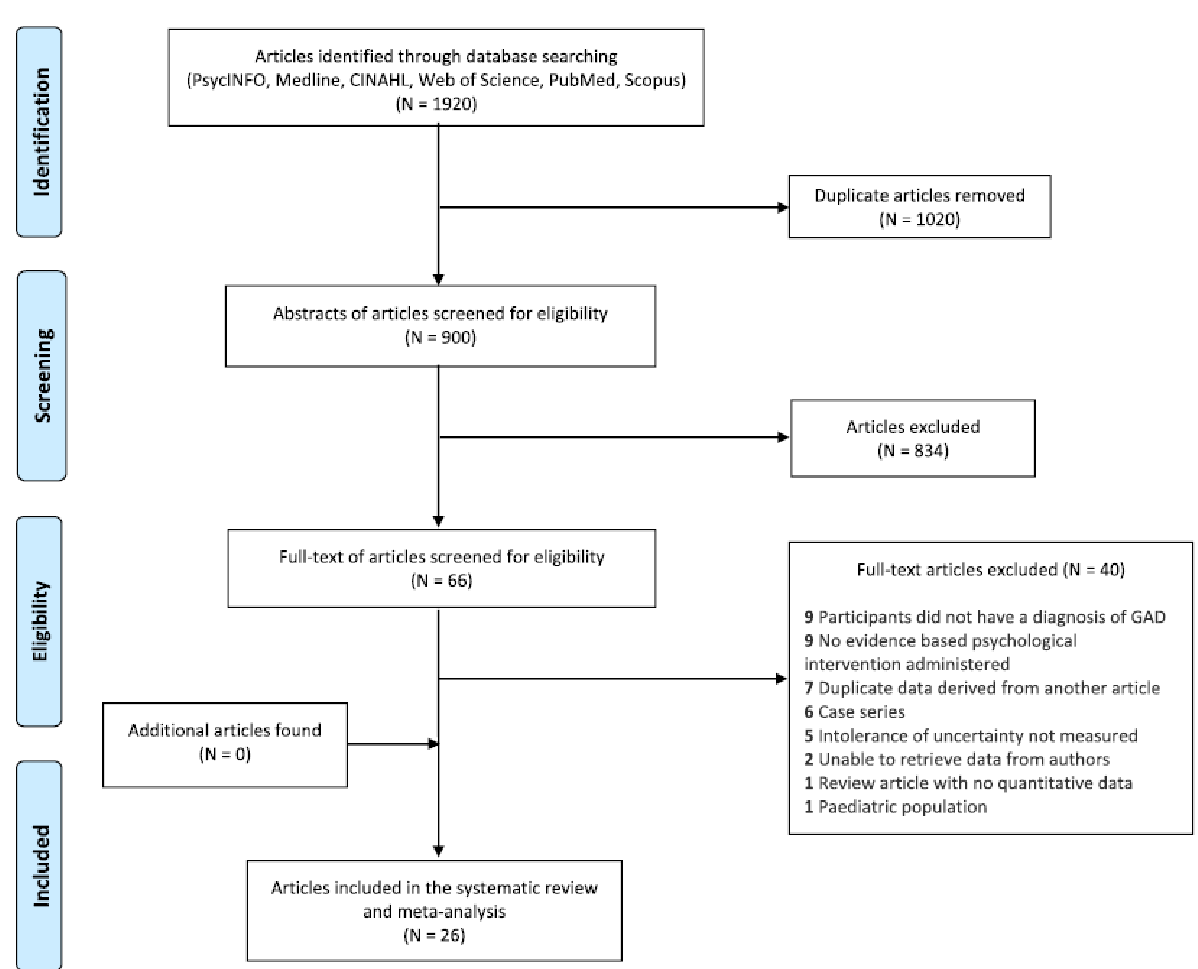

Fig. 1. PRIMSA Flow Chart.

2.3. Data analysis

2.3.1. Systematic review

The systematic review aimed to describe as well as evaluate the effectiveness of each psychological intervention. The overall treatment effects for both treatment and waitlist conditions were also reported using Cohen's *d* effect sizes to determine the degree of intolerance of uncertainty, worry, anxiety and depression change over time. Cohen's *d* effect sizes were interpreted as small ($d = 0.20$), medium ($d = 0.50$) and large ($d = 0.80$) using the benchmarks suggested by Cohen (1977). Methodological quality was assessed using the Joanna Briggs Institute Checklist for Quasi-Experimental Studies to determine the extent that each study addressed bias in its design, conduct, and analysis (Tufanaru et al., 2017). This checklist was utilised because it provides a critical appraisal for experimental studies without random allocation. The 26 articles were assessed for methodological quality using 9-criteria with the scoring framework of *Yes*, *Unclear*, *No* and *Not Applicable*. Three grades of methodological quality were used for articles: low quality (0–33% of criteria met in the article), medium quality (34–66% of criteria met) and high quality (67% or more of criteria met) (Schultz et al., 2016). Criteria were deemed as met when the article scored a *Yes*. Methodological quality was assessed for all articles by two authors (EW and AN), with the exception of Wilson et al. (2020) that was assessed by AN and an independent assessor to ensure objectivity. There was a 99% agreement between raters for methodological quality. Please see Supplemental File 2 for quality ratings and scoring framework.

2.3.2. Meta-analysis

Meta-analytic statistics were calculated using Comprehensive Meta-Analysis, version 4.0.000 (CMA: Borenstein, Hedges, Higgins, & Rothstein, 2014). The random-effects model was used for all analyses since the included studies varied in design and protocol (Borenstein et al., 2009; Borenstein & Higgins, 2013). Both within-group and between-group effect sizes were calculated using the Hedge's *g* statistic. The confidence interval was also reported to indicate how precisely the Hedge's *g* statistic had been estimated, as well as *z* values and significance (Borenstein et al., 2009). Between-group pre-post effect sizes were calculated for RCTs that employed a waitlist/delayed treatment as their control condition. Concerning follow-up time points, if studies included two time points then the first time point was utilised. Given that the correlation between pre- to post-treatment and pre-treatment to follow-up was not typically reported for the outcome measures, a conservative estimate of $r = 0.5$ was used for the outcome measures. This estimate was based on an empirical study where out of 811 within-group correlations in health-related interventions, the median correlation was $r = 0.59$ (Balk et al., 2012).

Heterogeneity was investigated to determine the variation in true effect sizes. Cochran's *Q* statistic, degrees of freedom, and *p* value were used as a test to determine whether all studies in the analysis share a common true effect size. The I^2 statistic reflects the proportion of variance that is attributable to true effects rather than sampling error for the observed effects and has a range of 0–100% (Borenstein et al., 2015). Higgins et al. (2003) provided a tentative benchmark for I^2 and suggested that values of 25%, 50%, and 75% could be considered to reflect the descriptors of low, moderate, and high, respectively. Tau^2 (T^2) was utilised to indicate the estimated variance of true effect sizes, with Tau (T) utilised as the estimated standard deviation of true effect sizes. The prediction interval (PI) was utilised to determine the distribution of effects, that is, how widely the true effect size varies across studies. The prediction interval is intended to capture the true effect size in 95% of all comparable populations (Borenstein et al., 2009).

Subgroups analyses were conducted to compare the overall treatment group to the waitlist control sample, as well as to compare two treatment groups, CBT vs CBT-IU. A treatment group was coded as CBT-IU if the treatment manual explicitly discussed intolerance of uncertainty as the main cognitive process directly targeted for at least 50% of the treatment. Groups coded as CBT-IU could include psychoeducation regarding the nature of intolerance of uncertainty and worry awareness training, re-evaluation of negative beliefs about uncertainty via behavioural experiments, re-evaluation of usefulness of worry, problem solving training and worry exposure (i.e., Dugas & Robichaud, 2007; Hebert & Dugas, 2019). Treatment groups were coded as CBT if the manual predominantly aimed to directly challenge dysfunctional/maladaptive cognitive processes, other than intolerance of uncertainty (e.g., negative beliefs about worry). Treatment groups were coded as acceptance-based therapy (ABT) if the intervention predominantly aimed to change the relationship with internal experiences through detachment and acceptance strategies rather than efforts to directly challenge cognitive processes. If the number of studies in the subgroup is ≤ 5, T^2 estimate will likely be imprecise (Borenstein et al., 2011), therefore ABT interventions were not included in the subgroups analyses due to the small sample size ($k = 3$). Given a random-effects model was selected, the pooled mean effect size (Hedge's *g*), a 95% CI, *z* value with corresponding *p* value, as well as the variance (*v*) for each subgroup were provided as we assumed that the between-studies variance was *not* the same for all subgroups (Borenstein & Higgins, 2013; Borenstein et al., 2009). A *Q*-test based on analysis of variance (ANOVA) was utilised to compare the effects and determine whether there is a significant difference between subgroups, utilising *Q* statistic and *p* value, with alpha set at.05.

Meta-regression analyses were also employed to determine which study-level covariates could potentially explain the true effects found in the observed effects from pre- to post-treatment. Meta-regression analyses were performed on the within-group overall treatment sample for intolerance of uncertainty and worry. Moderator variables included: age ('Age'), percentage of female participants ('% Female'), treatment format ('Group vs. individual'), number of overall treatment sessions ('Total sessions'), total treatment hours ('Total Tx hours'), and total number of treatment hours targeting intolerance of uncertainty ('Total IU Tx hours'). A random effects model was employed, and *z*-test were performed to assess the study-level covariates for statistical significance, with the regression co-efficient for latitude (β), *z* value and corresponding *p* value reported. R^2 was also reported to demonstrate the proportion of between-group variance explained by the covariate, with R^2 having a range of 0–1.

Risk of publication bias was investigated utilising Duval and Tweedie's Trim and Fill Procedure (Duval and Tweedie, 2000a, 2000b), with the aim being to determine an unbiased estimate of the effect size, via adjusting the pooled effect size. The Classic fail-safe N was also calculated to identify the number of missing studies required to increase the *p* value to greater than alpha (set to 0.05).

3. Results

3.1. Systematic review

Please refer to Table 1 for study and treatment characteristics. Please see Supplemental File 3 for within-group Cohen's *d* effect sizes for pre- to post-treatment as well as from pre-treatment to follow-up time points for intolerance of uncertainty, excessive worry, anxiety and depression.

3.1.1. Participant characteristics

A total sample of 1199 participants were included in the review from a total of 26 studies (K). From this total group, there were 32 psychological treatment groups (k) with 971 participants, with the remaining participants either part of a waitlist condition ($k = 9$; $n = 187$) or active control treatment ($k = 3$; $n = 41$). The total sample sizes ranged from 6 to 148 participants ($Mdn = 34.5$). The *mean* percentage of female participants ranged from of 7–100% ($Mdn = 73\%$). The *mean* age of GAD participants ranged from 21.53 to 73.15 years ($Mdn = 34.66$).

3.1.2. Study design characteristics

A total of 17 studies were designed as an RCT, with the remaining

Table 1
Study design and treatment characteristics for systematic review.

Study	Total N	% F	Clinical Ax	Design	Tx (n)	Tx Program	Format	Total Hrs/ Total Wks	Approx Total IU Hrs/ Total Hrs	F/up
Avdagic et al. (2014)	38	66%	ADIS-IV	RCT	ABT (19)	Glaser et al. (2009)	G	12/6	0/12 0%	3 m
					CBT (19)	Zinbarg, Craske, Barlow, and O'Leary (1993)	G	12/6	0/12 0%	3 m
Beheshtian et al. (2020)	45	100%	Clinical Interview	RCT	CBT (15)	Authors protocol*	G	12/8	0/12 0%	1 m
					BA (15)!	Authors protocol*	G	18/6	0/18 0%	1 m
					WL (15)	NA	NA	NA	NA	1 m
Boily & Belleville (2018)	20	85%	ADIS-IV	RCT	CBT IU (10)	Authors protocol* from Dugas et al. (1998)	G	13/12	13/13 100%	3 m 6 m
					CBT IU+ER (10)	Authors protocol* from Dugas et al. (1998) and Mennin et al. (2002)	G	13/12	9/13 69%	3 m 6 m
Bomyea et al. (2015)	28^	71%	MINI	UCT	CBT	Craske et al. (2009)	I	10/10–12 (r)	0/10 0%	3 m
Boswell et al. (2013)	6	12%	ADIS-IV	Extracted from RCT	CBT	Barlow et al. (2011)	I	14.88 (a)/ 8–18 (r)	0/14.88 0%	No F/up
Bouchard et al. (2022)	148^	82%	ADIS-IV	RCT	CBT IU F2F (79)	Dugas et al. (2007)	I	15/15	15/15 100%	6 m 12 m
					CBT IU VC (69)	Dugas et al. (2007)	I	15/15	15/15 100%	6 m 12 m
Donegan et al. (2022)	65	86.7%	SCID-1	RCT	CBT (33)	Green et al. (2019)	G	12/6	0/12 0%	No F/up
					WL (32)	NA	NA			No F/up
Dugas et al. (2003)	52^	71%	ADIS-IV	RCT	CBT IU (25)	Authors protocol* from Dugas (2002)	G	28/14	28/28 100%	No separate F/up in RCT
					WL (27)	NA	NA	NA	NA	
Dugas et al. (2022)	50	85%	ADIS-IV	RCT	CBT IU (23)	Authors protocol* from Hebert & Dugas (2019)	I	12/12	12/12	No separate F/up in RCT
					WL (27)	NA	NA	NA	NA	No separate F/up in RCT
Green et al. (2022)	51	100%	MINI	UCT	CBT Postpartum (37)	Authors protocol* from Green et al. (2019) manual	G	16/8	4/16	3 m
					CBT Pregnant (14)	Authors protocol* from Green et al. (2019) manual	G	16/8	4/16	3 m
Hall et al. (2020)	11	73%	Clinical Interview	UCT	CBT IU	Dugas & Robichaud (2007)	G	24/12	24/24 100%	No F/up
Hebert & Dugas (2019)	7	71%	ADIS-IV	UCT	CBT IU	Authors protocol* from Hebert & Dugas (2019)	I	12/12	12/12 100%	3 m 6 m
Study	Total N	% F	Clinical Ax	Design	Tx (n)	Tx Program	Format	Total Hrs/ Total Wks	Approx Total IU Hrs/ Total Hrs	F/up
Hui & Zhihui (2017)	63	43%	Clinical Interview	RCT	CBT IU (32)	Authors protocol* from Robichaud (2013)	G	24/12	24/24 100%	6 m
					WL (31)	NA	NA	NA	NA	6 m
Khakpoor et al. (2019)	7	71%	ADIS-IV	RCT	CBT (4)	Barlow et al. (2011)	I	20/20	0/20	2 m
					WL (3)	NA	NA	NA	NA	2 m
Koszycki et al. (2010)	22^	55%	SCID-1	RCT	CBT (11)	Zinbarg, Craske, & Barlow (2006)	I	10/12	0/10	3 m 6 m
					SBI (11)!	Walsh (1999)	I	10/12	0/10	3 m 6 m
Ladouceur et al. (2000)	26^	77%	ADIS-IV	Extracted from RCT	CBT IU (26)	Authors protocol*	G	16/16	16/16 100%	No separate F/up in RCT
Laposa & Fracalanza (2019)	26	65%	Clinical Interview	UCT	CBT	Authors protocol* from Torbit and Laposa (2016)	G	24/12	2/24 8.33%	No F/up
Laposa et al. (2022)	90	66%	SCID-5	UCT	CBT	Authors protocol* from Torbit and Laposa (2016)	G	24/12	2/24 8.33%	No F/up
McEvoy & Erceg-Hurn (2019)	37	69%	MINI	UCT	CBT	Anderson and Campbell (2011)	G	14/7	0/14 0%	1 m
Nasiri et al. (2020)	30	7%	ADIS-IV	RCT	CBT (15)	Barlow et al. (2011)	I	12/12	0/12 0%	3 m
					WL (15)	NA	NA	NA	NA	3 m
Talkovsky & Norton (2016)	32	65%	ADIS-IV	UCT	CBT	Norton (2012)	G	24/12	0/24 0%	No F/up
Torbit & Laposa (2016)	81	NR	SCID-1	UCT	CBT	Authors protocol*	G	24/12	2/24 8.33%	No F/up

(continued on next page)

Table 1 (*continued*)

Study	Total N	% F	Clinical Ax	Design	Tx (n)	Tx Program	Format	Total Hrs/ Total Wks	Approx Total IU Hrs/ Total Hrs	F/up
Treanor et al. (2011)	31^	71%	ADIS-IV	RCT	ABT (15)	Roemer & Orsillo (2009)	I	16/16	0/16	No separate F/up in RCT
					WL (16)	NA	NA	NA	NA	No separate F/up in RCT
Wilson et al. (2020)	82	78%	ADIS-IV	RCT	ABT (30)	Huxter (2006)	G	36/12	0/36 0%	No F/up
					CBT (31)	Abbott & Kemp (2003)	G	36/12	3/36 8.33%	No F/up
					WL (21)	NA	NA	NA	NA	No F/up
van der Heiden et al. (2012)	121^	73%	SCID-1	RCT	CBT (61)	Authors protocol* from Wells (1997)	I	10.5/14	0/10.5 0%	6 m
					CBT IU (60)	Authors protocol* from Dugas & Ladouceur (2000)	I	10.5/14	10.5/10.5 100%	6 m
Zemestani et al. (2021)	30^	100%	SCID-5	RCT	CBT IU (15)	Dugas and Robichaud (2007)	I	12/12	12/12 100%	No F/up
					SSRI (15)!	NA	NA	NA	NA	No F/up

Note. *Total N* Total completer sample size at post-treatment, ^Total intent to treat sample size at post-treatment, *% F* Percentage female participants, *NR* Not reported, *Clinical Ax* Clinical Assessment, *ADIS-IV* Anxiety disorders interview schedule for DSM-IV, *MINI* Mini-international neuropsychiatric interview, *SCID-1* Structured clinical interview for DSM-IV Axis 1, *SCID-5* Structured clinical interview for DSM-5, *Dx* Diagnosis, *RCT* Randomised controlled trial, *UCT* Uncontrolled trial, *Tx (n)* Treatment and sample size, *ABT* Acceptance Based Therapy, *CBT* Cognitive behavioural therapy, *BA* Behavioural activation, *!* active control treatment, *WL* Waitlist, *CBT IU* CBT – intolerance of uncertainty, *ER* Emotion Regulation, *VC* Video Conferencing, *F2F* Face to Face, *SBI* Spiritually Based Intervention, *SSRI* Selective serotonin reuptake inhibitor, *Tx program* Treatment program, *Authors Protocol** Please find outline of the treatment protocol in the research article, *NA* Not applicable, *G* Group, *I* Individual, *Total Hrs/Total Wks* Total number of treatment hours/total number of weeks, *(a)* average treatment time, *(r)* range of weeks treatment delivered over, *Total IU Hrs/Total Hrs* Total hours of intolerance of uncertainty targeted / total hours, *F/up* Follow-up, *m* Month, *w* Week, *No separate F/up in RCT* Study did not report data (means/standard deviation) for each group separately at follow-up.

nine studies designed as an uncontrolled trial (UCT). Of the RCTs, the majority compared a psychological treatment/s to a waitlist (K = 9), whilst others compared two psychological treatments (K = 5). A small number of RCTs compared a psychological treatment to either an active treatment control (K = 2), or an active treatment control and waitlist (K = 1). Active treatment controls included behavioural activation, a spiritually based intervention (SBI), and a serotonin-reuptake inhibitor. A total of 13 studies included a follow-up time point for intolerance of uncertainty outcome measures, ranging from 1 month to 12 months (*Mdn* = 3 months). A number of these studies (K = 4) included two follow-up time points.

3.1.3. Assessment measures

Most studies used a semi-structured clinical interview to diagnose GAD. A total of 13 studies used a version of the Anxiety Disorders Interview Schedule-IV (ADIS-IV; Brown, Barlow, Di Nardo, 1994), four studies used a version of the Structured Clinical Interview for the DSM-IV, Axis 1 (SCID-1; First et al., 1994, 2001), three studies used the Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998), and two studies used the Structured Clinical Interview for the DSM-5 (SCID-5; First & Williams, 2016). The remaining four studies used a clinical interview performed by a psychologist or a psychiatrist to discern GAD as the primary diagnosis.

3.1.4. Outcome measures

The primary outcome measure used to assess intolerance of uncertainty was a version of the Intolerance of Uncertainty Scale (IUS). The IUS-27 (Freeston et al., 1994) total score was used in the majority of studies (K = 20), with the IUS-12 (Carleton et al., 2007) total score used less frequently (K = 6). Excessive worry was measured using the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990) (K = 21) or the PSWQ-Abbreviated (PSWQ-A: Hopko et al., 2003) (K = 1), with three studies not including a measure of excessive worry. Anxiety was measured using the Beck Anxiety Inventory (BAI: Beck & Steer, 1990), the Depression Anxiety Stress Scale (DASS) anxiety subscale (DASS – A; Lovibond & Lovibond, 1995), the State–Trait Inventory for Cognitive and Somatic Anxiety – Trait (STICSA-T: Ree et al., 2000; Grös et al., 2007) and the State-Trait Anxiety Inventory – Trait (STAI-T: Spielberger et al., 1983). The majority used the BAI (K = 10), followed by the DASS-A (K = 3), STICSA-T (K = 1), and STAI-T (K = 1). Depression was measured via a version of the Beck Depression Inventory (BDI: Beck et al., 1979; Beck et al., 1996), the DASS depression subscale (DASS-D; Lovibond & Lovibond, 1995), and the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987). The BDI (K = 11) was the most common measure of depression, followed by the DASS-D (K = 3), and the EPDS (K = 2). A handful of studies did not include a measure of anxiety (K = 11) or depression (K = 10). Please see Supplemental File 1 for questionnaires used for each study.

3.1.5. Treatment program characteristics

Treatment was delivered in either a group (K = 14) or individual format (K = 12). The total number of treatment hours provided across studies ranged from 10 to 36 h (*Mdn* = 17.37 hrs), over a range of 6–20 weeks (*Mdn* = 12 weeks). The total number of sessions ranged from 3 to 16 (*Mdn* = 12). From the total treatment group (k = 32) most interventions were a form of CBT (k = 29), followed by ABT (k = 3). A large proportion of the CBT treatment group employed a version of a CBT-IU protocol (k = 12). The remaining CBT treatment groups (k = 17) utilised a range of protocols to target worry and anxiety, and in turn indirectly targeting intolerance of uncertainty. These included strategies such as psychoeducation regarding generalized anxiety disorder, cognitive re-structuring of worries, examining and challenging negative and positive metacognitions about worry, imaginal worry exposure, behavioural experiments, and breathing/relaxation training. Five CBT treatment groups included 1–2 sessions aimed at directly addressing intolerance of uncertainty (Green et al., 2022; Laposa & Fracalanza, 2019; Laposa et al., 2022; Torbit & Laposa, 2016; Wilson et al., 2020). Dropout rates were reported by most articles (K = 25) with treatment dropout (k = 24) ranging from 0% to 32% (*Mdn* = 17%) and waitlist dropout (k = 7) ranging from 0% to 25% (*Mdn* = 12%) from pre-to post-treatment.

3.1.6. Overall treatment effects for intolerance of uncertainty

Within-group effect sizes from pre- to post-treatment for

psychological treatment (k = 32), ranged from a small positive effect $d = 0.32$ to a large effect $d = 2.78$ (*Mdn* $d = 0.98$). Effect sizes from pre- to post-treatment for the waitlist group (k = 9) ranged from $d = -0.15$ to 0.19 (*Mdn* $d = 0.05$). Cohen's d effect sizes from pre-treatment to follow-up for psychological treatment (k = 19) ranged from a positive small effect $d = 0.30$ to a large effect $d = 3.49$ (*Mdn* $d = 1.09$), using the first follow-up time point (*Mean* time = 3 months).

3.1.7. Overall treatment effects for excessive worry

Within-group effect sizes from pre- to post-treatment ranged from a medium positive effect $d = 0.59$ to a large effect $d = 3.46$ (*Mdn* $d = 1.36$) for psychological treatment. The waitlist group (k = 6) effects ranged from no effect $d = 0.01$ to a medium effect 0.63 (*Mdn* $d = 0.30$). Within-group effect sizes from pre-treatment to follow-up for the psychological treatment group (k = 16) ranged from a medium positive effect $d = 0.67$ to a large effect $d = 3.44$ (*Mdn* $d = 1.65$), using the first follow-up time point (*Mean* time = 3.28 months).

3.1.8. Overall treatment effects for anxiety

From pre- to post-treatment, within-group effect sizes (k = 19) ranged from a small effect, $d = 0.48$, to a large effect, $d = 1.82$ (*Mdn* $d =$ 1.16) for psychological intervention. The waitlist group (k = 7) demonstrated no effect (*Mdn* $d = 0.08$). From pre-treatment to follow-up for the psychological treatment group (k = 14) effects were all within the large range (*Mdn* $d = 1.35$) using the first follow-up time point (*Mean* time = 3.83 months).

3.1.9. Overall treatment effects for depression

Effect sizes from pre- to post-treatment for the psychological treatment group (K = 22) ranged from a small effect, $d = 0.28$ to a large effect $d = 2.25$ (*Mdn* $d = 1.23$). Cohen's d effect size from pre- to post-treatment for the for the waitlist group (k = 7) demonstrated no effect (*Mdn* $d = 0.09$). From pre-treatment to follow-up for the psychological treatment group (k = 16) ranged from a medium effect $d = 0.78$ to a large effect, $d = 2.51$ (*Mdn* $d = 1.26$) using the first follow-up time point (*Mean* time = 3.5 months).

3.1.10. Quality appraisal and risk of bias

Most studies were evaluated as meeting criteria for high (K = 12) or medium quality (K = 13), with small percentage meeting criteria for low quality (K = 1). Regarding each of the nine criteria, studies did well at clearly describing what the 'cause' and 'effect' was (Q1:100% of studies met criteria), as well as whether participants in comparison groups were similar (Q2: 90%). Studies did *less* well at describing whether participants were receiving another psychological or pharmacological treatment in addition to the treatment being provided (Q3: 63%) and at including a control group (Q4: 62%). Most studies included multiple outcome measures (e.g., intolerance of uncertainty and worry, depression or anxiety) at both pre-treatment and post-treatment (Q5: 96%), however many studies did not account for missing data adequately (Q6: 71%). Most studies accurately described the outcomes measures in the methods that were analysed and reported in the results section (Q7: 96%). Similarly, most studies utilised appropriate statistical analysis (Q9: 90%). Many studies did not assess treatment fidelity effectively (Q8: 33%), and in many cases it was unclear how adherence to the protocol was assessed and the integrity of the treatment. Please see Supplemental File 2 for quality ratings using the 9 criteria for each of the 26 articles.

3.2. Meta-analysis

3.2.1. Within group effects and between group effects

Table 2 reports within-group effects for the treatment group from pre- to post-treatment as well as from pre-treatment to follow-up. Table 2 also reports between-group effects for studies that employed a waitlist RCT design from pre- to post-treatment. See Supplemental File 4 for forest plots for within-group and between-group effects.

3.2.2. Subgroup analyses

The within-group effects for the subgroups analyses from pre- to post-treatment as well as pre-treatment to follow-up are found in Table 3. The psychological treatment group was significantly more effective than waitlist at reducing intolerance of uncertainty ($p < 0.01$), worry, ($p < 0.01$), anxiety ($p < 0.01$), and depression ($p < 0.01$).

Both treatment subgroups (i.e., CBT-IU and CBT) demonstrated a significant reduction in mean scores from pre-treatment to post-treatment, as well as from pre-treatment to follow-up for all outcome measures. CBT-IU was significantly more effective than CBT at reducing intolerance of uncertainty ($Q\ (1) = 6.19, p < 0.01$), and excessive worry ($Q\ (1) = 7.92$, $p < 0.01$) from pre- to post-treatment. There was no difference between CBT-IU and CBT at follow-up for intolerance of uncertainty and worry. CBT was significantly more effective than CBT-IU at reducing depressive symptoms at follow-up ($Q\ (1) = 6.03$, $p < 0.01$).

Table 2
Within-group and between-group effect sizes as well as heterogeneity for intolerance of uncertainty, worry, depression, and anxiety.

Outcome measure	Time point	*k*	*N*	Random-effects model					Heterogeneity						
				Hedge's *g*	95% CI Lower	95% Higher	Z	Z *p*	Q (df)	Q *p*	I^2	T^2	T	95% PI Lower	95% PI Higher
Within-group															
Overall Treatment															
IU	Pre – post	32	971	0.88	0.75	1.01	13.50	0.001	81.18 (31)	0.001	62%	0.07	0.27	0.32	1.45
	Pre – F/up	19	523	1.05	0.86	1.25	10.63	0.001	50.41 (18)	0.001	64%	0.101	0.32	0.35	1.76
Worry	Pre – post	29	923	1.32	1.16	1.48	16.08	0.001	82.82 (28)	0.001	66%	0.11	0.33	0.61	2.03
	Pre – F/up	16	476	1.45	1.22	1.68	12.33	0.001	41.32 (15)	0.001	64%	0.12	0.35	0.66	2.24
Depression	Pre – post	22	696	0.96	0.80	1.01	12.34	0.001	53.39 (21)	0.001	61%	0.07	0.26	0.38	1.53
	Pre – F/up	16	446	1.00	0.87	1.14	14.30	0.001	19.42 (15)	0.001	23%	0.02	0.13	0.70	1.32
Anxiety	Pre – post	19	529	0.94	0.78	1.11	11.17	0.001	42.67 (18)	0.001	58%	0.07	0.26	0.36	1.53
	Pre – F/up	14	325	1.04	0.82	1.25	9.48	0.001	28.95 (13)	0.01	55%	0.08	0.29	0.37	1.70
Between-group															
WL RCTs															
IU	Pre – post	9	380	1.35	0.89	1.81	5.73	0.001	32.03 (8)	0.001	75%	0.35	0.59	-0.16	2.86
Worry	Pre – post	6	280	1.71	1.06	2.37	5.12	0.001	27.93 (5)	0.001	82%	0.54	0.74	-0.53	3.96
Depression	Pre – post	7	319	1.10	0.73	1.48	5.73	0.001	14.29 (6)	0.027	58%	0.14	0.38	0.01	2.19
Anxiety	Pre – post	7	319	1.27	0.87	1.68	6.16	0.001	15.75 (6)	0.015	62%	0.18	0.42	0.07	2.47

Note. *k* Number of treatment groups, *N* Number of participants, *CI* Confidence Interval, *Z* Z value, *p* Z-test value of significance, *Q (df)* Q statistic (degrees of freedom), *Q p* Q-test value of significance, I^2 I^2 statistic, T^2 Tau^2, *T* Tau, *PI* Prediction Interval, *IU* Intolerance of uncertainty, *Pre – post* Pre- to post-treatment, *Pre – F/up* Pre-treatment to follow up, *WL RCTs* Waitlist Randomised Controlled Trials.

Table 3
Within-group subgroup analyses for intolerance of uncertainty, worry, anxiety and depression at pre- to post-treatment and pre-treatment to follow up.

Subgroup	Time point	*k*	Random-effects model						Q-test	
			Hedge's *g*	*v*	95% CI lower	95% CI higher	*Z*	*Z p*	*Q* (df)	*Q p*
Intolerance of Uncertainty										
Overall Tx	Pre – post	32	0.88	0.01	0.75	0.98	14.77	0.01	**41.48 (1)**	**0.01**
vs WL		9	0.10	0.01	-0.10	0.30	0.96	0.34		
CBT vs	Pre – post	17	0.75	0.01	0.59	0.92	8.93	0.01	**6.19 (1)**	**0.01**
CBT - IU		12	1.09	0.01	0.88	1.30	10.23	0.01		
CBT vs	Pre – F/up	10	1.02	0.02	0.73	1.31	6.90	0.01	0.27 (1)	0.61
CBT - IU		8	1.13	0.03	0.83	1.44	7.24	0.01		
Worry										
Overall Tx	Pre – post	29	1.32	0.01	1.16	1.46	17.08	0.01	**35.79 (1)**	**0.01**
WL		6	0.30	0.02	0.01	0.60	2.01	0.04		
CBT vs	Pre – post	14	1.13	0.01	0.91	1.34	10.08	0.01	**7.92 (1)**	**0.01**
CBT - IU		12	1.62	0.02	1.35	1.89	11.91	0.01		
CBT vs	Pre – F/up	7	1.36	0.04	0.99	1.73	7.16	0.01	0.54 (1)	0.46
CBT - IU		8	1.55	0.03	1.21	1.90	8.81	0.01		
Anxiety										
Overall Tx	Pre – post	19	0.94	0.01	0.78	1.08	12.28	0.01	**32.83 (1)**	**0.01**
WL		7	0.15	0.01	-0.08	0.37	1.27	0.20		
CBT	Pre – post	9	0.83	0.01	0.61	1.06	7.21	0.01	2.07 (1)	0.15
CBT - IU		8	1.09	0.02	0.83	1.35	8.18	0.01		
CBT	Pre – F/up	6	1.16	0.03	0.83	1.48	6.95	0.01	0.93 (1)	0.34
CBT - IU		6	0.94	0.03	0.63	1.24	5.91	0.01		
Depression										
Overall Tx	Pre – post	22	0.94	0.01	0.80	1.08	13.21	0.01	**33.70 (1)**	**0.01**
WL		7	0.14	0.01	-0.09	0.38	1.22	0.22		
CBT	Pre – post	10	0.93	0.02	0.68	1.17	7.45	0.01	0.42 (1)	0.52
CBT - IU		10	1.04	0.02	0.80	1.28	8.33	0.01		
CBT	Pre – F/up	7	1.19	0.01	0.98	1.41	10.90	0.01	**6.03 (1)**	**0.01**
CBT - IU		8	0.88	0.01	0.74	1.01	12.86	0.01		

Note. *k* Treatment groups, *v* variance, *CI* Confidence Interval, *Z* Z value, *p* Z-test value of significance, *Q (df)* Q statistic (degrees of freedom), *Q p* Q-test value of significance, *Tx* Treatment, *WL* Waitlist, *Pre – post* Pre- to post-treatment, *Pre – F/up* Pre-treatment to follow up, *CBT* Cognitive Behavioural Therapy, *CBT-IU* Cognitive Behavioural Therapy – Intolerance of Uncertainty,

3.2.3. *Meta-regression*

Table 4 provides a summary of meta-regression analyses. For both, intolerance of uncertainty and worry, increasing the total number of sessions spent directly targeting intolerance of uncertainty significantly increased the effect size. For intolerance of uncertainty, analyses found that *increasing* the total treatment hours led to a significant *decrease* in the effect size, however, on inspection it appeared there was an outlier (Wilson et al., 2020), and with the removal of this study the effect was no longer significant. Moreover, for intolerance of uncertainty, individual therapy (when compared to group therapy) significantly increased the effect size. Total number of sessions, percentage of female participants, and age did not significantly impact the effect size for intolerance of uncertainty. Regarding pre-post effects for worry, total treatment hours, treatment format (individual vs group), total sessions, and age did not moderate treatment effects, however, increase in the percentage of female participants significantly increased the effect size.

Table 4
Meta-regression analyses for the overall treatment group for intolerance of uncertainty and worry from pre- to post-treatment.

Outcome Measure	Moderator variable	k	*β*	R^2	*Z*	*p*
Intolerance of Uncertainty	Total IU Tx hours	32	0.01	0.41	2.01	**0.04**
	Total Tx hours	32	-0.02	0.39	-2.59	**0.01**
	Total Tx hours^	29	0.01	0.33	1.49	0.13
	Group vs Individual	32	0.32	0.49	2.90	**0.01**
	Total sessions	32	0.38	0.22	1.87	0.06
	% Female	31	-0.57	0.09	-1.62	0.10
	Age	30	-0.01	0.00	-0.83	0.41
	Completers vs ITT	32	0.16	0.25	1.28	0.20
Worry	Total IU Tx hours	29	0.02	0.26	2.23	**0.03**
	Total Tx hours	29	-0.01	0.00	-0.84	0.40
	Group vs Individual	29	0.21	0.05	1.18	0.24
	Total sessions	29	0.04	0.13	1.29	0.20
	% Female	28	-1.09	0.33	-2.46	**0.01**
	Age	27	0.01	0.16	0.92	0.36
	Completers vs ITT	29	-0.05	0.00	-0.26	0.79

Note. *k* Number of treatment groups, *β* Regression coefficient, R^2 Proportion of variance, *Z* Z value, *p* Z-test value of significance, *IU* Intolerance of uncertainty, *Total Tx hours* Total number of treatment hours, *Total IU mins* Total number of hours spent directly targeting intolerance of uncertainty during treatment, *Total sessions* Number of sessions, *% Female* Percentage female participants, *ITT* Intention to treat. ^ Outlier (i.e., Wilson et al., 2020) excluded from analysis.

3.2.4. *Publication bias*

Duval and Tweedie's Trim and Fill Procedure (Duval and Tweedie, 2000a, 2000b) was utilised to provide an adjusted pooled mean effect size for intolerance of uncertainty and worry, considering any publication bias identified via the funnel plot. The within-group intolerance of uncertainty mean effect size was reduced from $g = 0.88$ to $g = 0.74$ as nine studies were trimmed to yield an unbiased pooled effect size on the lower left side of the funnel plot. The within-group mean effect size for excessive worry was reduced from $g = 1.32$ to $g = 1.15$ as seven values were missing from the lower quadrant of the left side. The between-group effect size for intolerance of uncertainty was also reduced from $g = 1.35$–1.10 as two studies were trimmed from the lower left quadrant. The between group-effect for worry did not identify missing studies, therefore the effect remained unchanged $g = 1.71$. See Supplemental File 5 for funnel plots.

Publication bias was also assessed using the Classic fail-safe N calculation. The number of missing studies with non-significant treatment effects needed to increase the *p* value to greater than alpha (<0.05) for the overall within-group effect from pre- to post-treatment was calculated as k = 3968 for intolerance of uncertainty and k = 5665 for excessive worry. The number of missing studies for the between-group

effect from pre- to post-treatment was calculated as k = 278 for intolerance of uncertainty and k = 207 for excessive worry. This suggests that publication bias does not affect the significant relationship reported for intolerance of uncertainty and excessive worry for individuals with GAD.

4. Discussion

The current study examined the effect evidence-based psychological treatments have on intolerance of uncertainty for individuals with GAD using a systematic review and meta-analytic approach. An extensive literature search led to the inclusion of 26 articles and found strong evidence that psychological treatments are effective at reducing intolerance of uncertainty, as well as GAD-related symptoms including worry, anxiety and depression. Significant large within-group pre-post treatment effect sizes (i.e., Hedge's *g*) were observed for the overall treatment group for intolerance of uncertainty as well as worry, anxiety and depression. These results were maintained from post-treatment to follow-up for all outcome measures. Subgroups analyses found that the within-group overall treatment effects were significantly greater than the waitlist/delayed conditions from pre- to post-treatment. This indicated that psychological treatments resulted in a greater reduction in intolerance of uncertainty, worry, anxiety and depression than waitlist/delayed treatment. Further evidence for this conclusion was demonstrated by the between-group analyses that only included RCTs with waitlist/delayed treatment condition. Specifically, significant large between-group effects were observed in favour of the psychological treatment condition from pre- to post-treatment for intolerance of uncertainty, worry, anxiety and depression. Together these results provide corroborating evidence for the efficacy of psychological interventions in the reduction of intolerance of uncertainty and related outcomes for individuals with GAD.

Further analyses sought to explore whether these outcomes differed based on type of psychological treatment. Specifically, subgroups analyses found that both CBT and CBT-IU led to a significant reduction in intolerance of uncertainty and GAD-related symptoms from pre-treatment to post-treatment as well as at follow-up. Of note, CBT-IU was found to be significantly more effective than CBT at reducing both intolerance of uncertainty and worry from pre- to post-treatment. These findings were further supported by the meta-regression, in that *increasing* the total time spent targeting intolerance of uncertainty significantly *increased* the effect size for both intolerance of uncertainty and excessive worry. Though these results were supported by the meta-regression this result was not maintained at follow-up. Specifically, based on inspection of effect sizes, CBT-IU effects appeared to plateau from post to follow-up, whereas CBT effects continued to improve for individuals throughout this time period. Moreover, CBT outperformed CBT-IU at follow-up in reducing depressive symptoms. This finding may be of relevance when treating individuals with GAD and depressive symptoms, particularly given the high co-morbidity of GAD and depression (Carter et al., 2001; Zhou et al., 2017). Given CBT-IU is a multifaceted treatment protocol, it is unclear whether the combination of treatment components or a specific individual treatment component contributed to distinguishing it from CBT at post-treatment (on intolerance of uncertainty and worry) and follow-up (on depressive symptoms). Future research could investigate these differences through dismantling studies of the various treatment components to discern which treatment elements are most effective at process and symptom reduction. Additionally, although studies using an acceptance-based treatment protocol (i.e., ABT) were included in the meta-analysis, there were insufficient studies to include this comparison in the subgroups analysis. Therefore, in the event more studies are published using ABT protocols, future meta-analysis could endeavour to include these in subgroups analyses, as the comparative efficacy of ABT to CBT formats (i.e., CBT and CBT-IU) for intolerance of uncertainty remains unknown.

Meta-regression analyses were also performed to explore the moderating effect of participant and treatment characteristics on intolerance of uncertainty and worry from pre- to post-treatment. Total time spent targeting intolerance of uncertainty during treatment emerged as a significant moderator for both intolerance of uncertainty and worry, as described in relation to the subgroups analyses. One unexpected finding was that an *increase* in total treatment time led to a significant *decrease* in the overall effect size. This result was hypothesised to be the result of an outlier study (Wilson et al., 2020), as this study had the lowest effect size (i.e., CBT: $d = 0.30$) and the highest overall treatment time, as it was delivered over 36 h (i.e., 3-hour sessions over 12 weeks). This study also appeared to contribute to the large variation of within-group Cohen's *d* effect sizes for intolerance of uncertainty, anxiety, and depression. Therefore, when this study was removed from the meta-regression the covariate (i.e., total treatment time) no longer significantly impacted the effect size.

Additionally, treatment format was found to significantly moderate intolerance of uncertainty, with individual treatment related to a significant increased effect size. These findings are not surprisingly given that individual therapy is likely to be more tailored to the individual and allow the development of a stronger therapeutic relationship (Bisseling et al., 2019). Regarding worry, the percentage of female participants moderated the effect size such that an *increase* in the percentage of females corresponded to a significant *decrease* in the effect size. This finding mirrors a previous meta-analysis investigating the impact of methodological factors on intolerance of uncertainty in GAD, as the study found that a higher proportion of women was significantly associated with increased worry (McEvoy et al., 2019). Thus, future studies may need to consider accounting for gender differences within their design or statistical modelling when exploring the relationship between GAD symptoms and cognitive processes.

The majority of studies included in the systematic review were rated as either medium or high quality. This indicated that studies were typically of sound methodological quality with low risk of bias. However, treatment fidelity ratings were largely not reported by studies, thus it is recommended that future studies include ratings of adherence to protocol to improve methodological quality. Another aspect of bias related to treatment delivery not assessed by the studies or the review was allegiance effects. This may be a form of bias in treatment studies as researchers that have allegiance to a particular treatment are likely to be involved in research to optimise the therapeutic experience and learn the subtleties and nuances of its delivery (McLeod, 2009). Therefore, future studies could aim to assess this bias.

Furthermore, the meta-analysis demonstrated some indication of publication bias as there were missing studies from the left lower quadrant of the funnel plot for both intolerance of uncertainty and worry. Specifically, this indicated that studies with smaller sample sizes with non-significant findings were not included in the analysis and may not be published. It may also be the case that this finding is attributable to the exclusion criteria used in the current study as case studies were not included. Future studies could therefore expand the inclusion criteria to attempt to address this potential sampling bias. Despite this, the Classic fail-safe N indicated that a substantial number of papers for both within-group (i.e., 3968 and 5665) and between-group effects (i.e., 278 and 207) would be needed to increase the *p* value to greater than alpha (>.05), suggesting this sampling bias does not affect the significant findings. Overall, these findings suggest the results from the systematic review and meta-analysis possess sound methodological quality and minimal publication bias.

Notwithstanding several strengths for the present study, several limitations are of note. A potential limitation was the varied ability to accurately quantify whether psychological interventions directly or indirectly targeted intolerance of uncertainty, despite efforts made to maximize the accuracy of these calculations (e.g., referring to method sections, treatment manuals, contacting authors for additional information). Indeed, it is possible that some of the CBT protocols included in the analyses directly targeted intolerance of uncertainty for some

individuals in some sessions, despite not referring to this directly in the treatment protocol.

In addition, a limitation of the current study is the generalisability of the findings regarding worry, anxiety and depressive symptoms to studies that did *not* include a measure of intolerance of uncertainty. As inclusion of a measure of intolerance of uncertainty was a requirement, not all studies exploring the effects of psychological treatment on GAD-related outcomes could be included. For example, some studies utilising the CBT-IU protocol (e.g., Dugas et al., 2010; Ladouceur et al., 2004) or attempting to target intolerance of uncertainty (e.g., Popa et al., 2022) did not include a measure intolerance of uncertainty so were not included in the current analyses. Therefore, the differences found in outcomes for CBT-IU compared to CBT warrant replication utilising a broader inclusion criteria.

Another limitation of the current study was the comparison of intent-to-treat (ITT) and completer data. ITT data was collected as the preferable data in comparison to treatment completers, as ITT analysis protects against the inflation of success rates at post-treatment and follow-up. There were no significant differences found between studies that reported ITT vs completer data for the pre-post effect size for intolerance of uncertainty and worry, and the treatment dropout rate of 17% was comparable to previous studies in anxiety disorders (Gersch et al., 2017). Nevertheless, future studies could aim to conduct separate meta-analysis for the different data types in the future.

In addition, the COVID-19 pandemic led to wide-spread changes to health care delivery out of necessity, however, accessible evidence-based psychological treatment options such as teleconferencing remain important for consumers. One study included in the meta-analysis compared teleconferencing to face to face therapy and found no difference between the two delivery methods (Bouchard et al., 2022). This provides preliminary evidence that therapy delivered online is effective, however, given the paucity of studies this could not be included in the subgroups analysis, therefore with the likely rise of teleconferencing, future studies may wish to compare such studies in the future.

In summary, this systematic review and meta-analysis indicated that evidence-based psychological treatment is effective at reducing intolerance of uncertainty and related outcomes for people with GAD. Both CBT and CBT-IU significantly reduced intolerance of uncertainty, worry, anxiety and depression from pre- to post-treatment as well as at follow-up. Future research is warranted to further explore the therapeutic components of these interventions that contribute to the significant reduction of intolerance of uncertainty and related outcomes for individuals with GAD.

Role of funding sources

Emily Wilson is a recipient of a UTS Research Excellence Scholarship which is funded by the Commonwealth Government Department of Education and Training.

CRediT authorship contribution statement

Emily Wilson contributed to development of the research questions, design, method, data extraction, analysis, and manuscript writing. Maree Abbott contributed to development of the research questions, design, method, data extraction, and manuscript writing. Alice Norton contributed to the data extraction and manuscript writing. All authors reviewed and approved the final manuscript.

Declaration of Competing Interest

All authors declare they have no conflicts of interest.

Acknowledgements

We would like to thank Dr Jemma Todd for her assistance with statistical analysis with this research.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.janxdis.2023.102729.

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Appendix E Articles included in meta-analysis and psychological treatment programs

Article	Treatment	Treatment Manual/Article Citation
Avdagic et al. (2014)	CBT	Zinbarg, R.E., Craske, M.G., Barlow, D.H., & O'Leary, T. (1993). Mastery of your anxiety and worry, therapist guide. San Antonio, TX: Psychological Corporation.
	Acceptance Based Therapy (ABT)	Glaser, N.M., Blackledge, J.T., Shepherd, L.M., & Deane, F.P. (2009). Brief group ACT for anxiety. In J.T. Blackledge, J. Ciarrochi, & F.P. Deane (Eds.), *Acceptance and commitment therapy: Contemporary theory research and practice* (pp. 175–200). Brisbane, Australia: Australian Academic Press. ACT group was founded on the work of: Forsyth, J.P., & Eifert, G.H. (2007). The mindfulness and acceptance workbook for anxiety: A guide to breaking free from anxiety, phobias and worry using acceptance and commitment therapy. Oakland, CA: New Harbinger Publications. Eifert, G.H., & Forsyth, J.P. (2005). *Acceptance and commitment therapy for anxiety disorders: A practitioner's treatment guide to using mindfulness, acceptance, and values-based behavior change strategies*. Oakland, CA: New Harbinger Publications.
Beheshtian et al. (2020)	CBT	Authors protocol* see Beheshtian et al. (2020). Beheshtian, E., Toozandehjani, H., & Tousi, M., R., S. (2020). Comparison of modular cognitive-behavioral therapy and behavioural activation on the intolerance of uncertainty in students with generalized anxiety disorder. Journal of Nursing and Midwifery Sciences, 7, 30-35.
	Behavioural Activation	Authors protocol* see Beheshtian et al. (2020). Beheshtian, E., Toozandehjani, H., & Tousi, M., R., S. (2020). Comparison of modular cognitive-behavioral therapy and behavioural activation on the intolerance of uncertainty in students with generalized anxiety disorder. Journal of Nursing and Midwifery Sciences, 7, 30-35.
Boily & Belleville (2018)	CBT-Intolerance of Uncertainty (CBT-IUS) + Emotion Dysregulation	Authors protocol* Dugas, M., Gagnon, F., Ladouceur, R., & Freeston, M. H. (1998). Generalized anxiety disorder: A preliminary test of a conceptual model. Behaviour Research and Therapy, 36(2), 215–226. doi:10.1016/S0005-7967(97)00070-3 Mennin, D. S., Heimberg, R. G., Turk, C. L., & Fresco, D. M. (2002). Applying an emotion regulation framework to integrative approaches to generalized anxiety disorder. *Clinical Psychology: Science and Practice, 9*(1), 85–90. https://doi.org/10.1093/clipsy.9.1.85
	CBT-IU	Authors protocol* Dugas, M., Gagnon, F., Ladouceur, R., & Freeston, M. H. (1998). Generalized anxiety disorder: A preliminary test of a conceptual model. *Behaviour Research and Therapy, 36*(2), 215–226.
Bomyea et al. (2015)	CBT	Craske, M. G., Roy-Byrne, P., Stein, M. B., Sullivan, G., Sherbourne, C., & Bystritsky, A. (2009). Treatment for anxiety disorders: Efficacy to effectiveness to implementation. *Behaviour Research and Therapy, 47*, 931–937. http://dx.doi.org/10.1016/j.brat.2009.07.012 Craske, M. G., Rose, R. D., Lang, A., Welch, S. S., Campbell-Sills, L., Sullivan, G., Sherbourne, C., Bystritsky, A., Stein, M. B., & Roy-Byrne, P. P. (2009). Computer-assisted delivery of cognitive behavioral therapy for anxiety disorders in primary-care settings. *Depression and Anxiety, 26*(3), 235–242. https://doi.org/10.1002/da.20542

Boswell et al. (2013)	CBT	Barlow, D. H., Farchione, T. J., Fairholme, C. P., Ellard, K. K., Boisseau, C. L., Allen, L. B., & Ehrenreich-May, J. (2011). Unified protocol for transdiagnostic treatment of emotional disorders: Therapist guide. Oxford University Press.
Bouchard	CBT IU	Dugas, M. J., & Robichaud, M. (2007). Cognitive-behavioral treatment for generalized anxiety disorder: From science to practice. London, UK: Routledge.
Donegan	CBT	Green, S. M., Frey, B. N., Donegan, E., & McCabe, R. E. (2019). Cognitive behavioral therapy for anxiety and depression during pregnancy and beyond: How to manage symptoms and maximize well-being. Routledge
Dugas et al. (2003)	CBT IU	Authors protocol* outlined in Dugas (2002) Dugas, M. J. (2002). Generalized anxiety disorder. In M. Hersen (Ed.), Clinical behavior therapy: Adults and children (pp. 125–143). New York: Wiley.
Dugas et al. (2022)	CBT IU	Authors protocol* Dugas, M. J., & Robichaud, M. (2007). Cognitive-behavioral treatment for generalized anxiety disorder: From science to practice. London, UK: Routledge.
Green et al. (2022a) Green et al. (2022b)	CBT	Authors protocol* adapted from Green et al. (2019)Green, S. M., Frey, B. N., Donegan, E., and McCabe, R. (2019). *Cognitive Behavioral Therapy for Anxiety and Depression during Pregnancy and Beyond: How to Manage Symptoms and Maximise Well-being,* 1st edition; New York: Routledge. Green, S. M., Innessm B., Furtado, M., McCabe, R. E., & Frey, B., N. (2021) further outlines two additional sessions targeting intolerance of uncertainty.
Hall et al. (2020)	CBT IU	Dugas, M. J., & Robichaud, M. (2007). Cognitive-behavioral treatment for generalized anxiety disorder: From science to practice. London, UK: Routledge.
Hebert & Dugas (2019)	CBT IU	Authors protocol* adapted from Dugas & Robichaud (2007) Hebert, E. A., & Dugas, M. J. (2019). Behavioral experiments for intolerance of uncertainty: Challenging the unknown in the treatment of generalized anxiety disorder. *Cognitive and Behavioral Practice, 26,* 421-436.
Hui & Zhihui (2017)	CBT IU	Robichaud, M. (2013). Cognitive behavior therapy targeting intolerance of uncertainty: Application to a clinical case of generalized anxiety disorder. Cognitive and Behavioral Practice, 20, 251–263. doi:10.1016/j.cbpra.2012.09.001
Khakpoor et al. (2019)	CBT	Barlow, D. H., Farchione, T. J., Fairholme, C. P., Ellard, K. K., Boisseau, C. L., Allen, L. B., & Ehrenreich-May, J. (2011). Unified protocol for transdiagnostic treatment of emotional disorders: Therapist guide. Oxford University Press
Koszycki et al. (2010)	CBT Spiritually Based	Zinbarg, R.E., Craske, M.G., & Barlow, D.H. (2006). Mastery of your anxiety and worry (2nd ed.). New York Walsh, R. (1999). Essential spirituality: The 7 central practices to awaken heart and mind. New York: John Wiley & Sons, Inc
Ladouceur et al. (2000)	CBT IU	Authors protocol see Ladouceur et al. (2000). Ladouceur, R., Dugas, M. J., Freeston, M. H., & Leger, E. (2000). Efficacy of a cognitive-behavioral treatment for generalized anxiety disorder: evaluation in a controlled clinical trial. *Journal of Consulting and Clinical Psychology, 68,* 957-964.
Laposa & Fracalanza (2019)	CBT	Authors protocol see Torbit & Laposa (2016).Torbit, L., & Laposa, J. M. (2016). Group CBT for GAD: The role of change in intolerance of uncertainty in treatment outcomes. *International Journal of Cognitive Therapy, 9,* 356-368.

Laposa et al. (2022)	CBT	Authors protocol see Torbit & Laposa (2016) Torbit, L., & Laposa, J. M. (2016). Group CBT for GAD: The role of change in intolerance of uncertainty in treatment outcomes. *International Journal of Cognitive Therapy, 9,* 356-368.
McEvoy & Erceg-Hurn (2019)	CBT	Anderson, R. A., & Campbell, B.N.C. (2011). Working with Worry and Rumination: A Cognitive Behavioural Group Treatment Programme for Repetitive Negative Thinking. Centre for Clinical Interventions, Perth (ISBN: 0975799584).
Nasiri et al. (2020)	CBT	Barlow, D. H., Farchione, T. J., Fairholme, C. P., Ellard, K. K., Boisseau, C. L., Allen, L. B., & Ehrenreich-May, J. (2011). Unified protocol for transdiagnostic treatment of emotional disorders: Therapist guide. Oxford University Press. Unified protocol was also founded on the work of: Barlow, D.H., Farchione, T.J., Sauer-Zavala, S., Latin, H.M., Ellard, K.K., Bullis, J.R., Bentley, K.H., Boettcher, H.T., & Cassiello-Robbins, C. (2017) Unified Protocol for Transdiagnostic Treatment of Emotional Disorders: Therapist Guide. Oxford University Press.
Talkovsky & Norton (2016)	CBT	Norton, P. J. (2012). Group cognitive-behavioral therapy of anxiety: A transdiagnostic treatment manual. New York: Guilford Press.
Torbit & Laposa (2016)	CBT	Authors protocol see Torbit et al. (2016) Torbit, L., & Laposa, J. M. (2016). Group CBT for GAD: The role of change in intolerance of uncertainty in treatment outcomes. *International Journal of Cognitive Therapy, 9,* 356-368.
Treanor et al. (2011)	ABT	Roemer, L., Orsillo, S.M. (2009) Mindfulness and Acceptance-Based Behavioral Therapies in Practice. New York: The Guilford Press.
Wilson et al. (2020)	CBT	Abbott, M.J., & Kemp, N. (2003). Cognitive–Behavioural Group Treatment for Excessive Worry: A Twelve-Session Program — Therapist Manual and Client Workbook. Macquarie University, Sydney: Macquarie University Anxiety Research Unit.
	ABT	Huxter, M. (2006). Mindfulness and a path of understanding. A workbook for the release from stress, anxiety and depression.
van der Heiden et al. (2012)	CBT IU	Authors protocol adapted from Dugas & Ladouceur (2000) Dugas, M. J., & Ladouceur, R. (2000). Treatment of generalised anxiety disorder: targeting intolerance of uncertainty in two types of worry. *Behavior Modification, 24,* 635-658.
	CBT	Authors protocol adapted from Wells (1997) Wells, A. (1997). Cognitive therapy of anxiety disorders: A practice manual and conceptual guide. Chichester, UK: John Wiley & Sons.
Zemestani et al. (2021)	CBT IU	Dugas, M. J., & Robichaud, M. (2007). Cognitive-behavioral treatment for generalized anxiety disorder: From science to practice. London, UK: Routledge.

Appendix F Quality Appraisal and Risk of Bias

Quality appraisal criteria used in the JBI Checklist for Quasi-Experimental Studies

Question	Criteria
Q1	Is it clear in the study what is the 'cause' and what is the 'effect'?
Q2	Were the participants included in any comparisons similar?
Q3	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
Q4	Was there a control group?
Q5	Were there multiple measurements of the outcome both pre and post the intervention/exposure?
Q6	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
Q7	Were the outcomes of participants included in any comparisons measured in the same way?
Q8	Were outcomes measured in a reliable way?
Q9	Was appropriate statistical analysis used?

Quality appraisal conducted using the Joanna Briggs Institute (JBI) Checklist for Quasi-Experimental Studies

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total Criteria Met	Descriptor
Avdagic et al. (2014)	Y	Y	U	U	Y	Y	Y	Y	Y	7	High
Beheshtian et al. (2020)	Y	Y	N	Y	N	N	N	N	Y	4	Medium
Boily & Belleville (2018)	Y	Y	Y	U	Y	Y	Y	Y	Y	8	High
Bomyea et al. (2015)	Y	Y	U	N	Y	N	Y	Y	Y	6	Medium
Boswell et al. (2013)	Y	Y	Y	Y	Y	U	Y	N	N	6	Medium
Bouchard et al. (2022)	Y	Y	Y	U	Y	Y	Y	Y	Y	8	High
Donegan et al. (2022)	Y	Y	Y	Y	Y	N	Y	N	Y	8	High
Dugas et al. (2003)	Y	Y	U	Y	Y	Y	Y	Y	Y	8	High
Dugas et al. (2022)	Y	Y	Y	Y	Y	Y	Y	Y	Y	9	High
Green et al. (2022)	Y	Y	U	U	Y	Y	Y	N	Y	6	Medium
Hall et al. (2020)	Y	U	N	N	Y	U	Y	U	U	3	Low
Hebert & Dugas (2019)	Y	Y	U	N	Y	U	Y	Y	U	5	Medium
Hui & Zhihui (2017)	Y	U	Y	Y	Y	U	Y	N	Y	6	Medium
Khakpoor et al. (2019)	Y	Y	Y	Y	Y	Y	Y	N	U	7	High
Koszycki et al. (2010)	Y	Y	U	U	Y	Y	Y	N	Y	6	Medium
Ladouceur et al. (2000)	Y	Y	Y	Y	Y	Y	Y	Y	Y	9	High
Laposa & Fracalanza (2019)	Y	U	N	N	Y	U	Y	N	Y	4	Medium
Laposa et al. (2022)	Y	Y	U	N	Y	N	Y	N	Y	5	Medium
McEvoy & Erceg-Hurn (2016)	Y	U	U	U	Y	Y	Y	N	Y	5	Medium
Nasiri et al. (2020)	Y	Y	Y	Y	Y	Y	Y	N	Y	8	High
Talkovsky & Norton (2016)	Y	U	N	N	Y	U	Y	N	Y	4	Medium
Torbit & Laposa (2016)	Y	Y	U	N	Y	U	Y	N	Y	5	Medium
Treanor et al. (2011)	Y	Y	Y	Y	Y	Y	Y	N	Y	8	High
van der Heiden et al. (2012)	Y	Y	U	Y	Y	Y	Y	N	Y	7	High
Wilson et al. (2020)	Y	Y	Y	Y	Y	Y	Y	Y	Y	9	High
Zemestani et al. (2021)	Y	Y	U	U	Y	Y	Y	U	Y	6	Medium

Note. *Y* Yes, *U* Unclear, *N* No

Appendix G: Cohen's *d* effect sizes for systematic review

Cohen's d within group effect sizes for intolerance of uncertainty, excessive worry, anxiety and depression.

Study	Tx	IU *d* pre-post	IU *d* pre-F/up	Worry *d* pre-post	Worry *d* pre-F/up	Anx *d* pre-post	Anx *d* pre-F/up	Dep *d* pre-post	Dep *d* pre-F/up
Avdagic et al. (2014)	ABT	0.92	3m 1.07	1.75	3m 1.56	1.36	2.03	0.93	3m 1.38
	CBT	0.61	3m 0.78	0.98	3m 1.00	0.92	1.65	0.92	3m 1.61
Beheshtian et al. (2020)	CBT	2.41	1m 2.82						
	BA	1.46	1m 1.68						
	WL	0.01	1m 0.09						
Boily & Belleville (2018)	CBT IU	1.58	3m 1.55	2.61	3m 2.22				
			6m 1.09		6m 1.92	1.30	1.44	1.25	3m 1.42
	CBT IU+ER	1.86	3m 2.12	2.07	3m 2.47				
			6m 1.46		6m 2.64	1.54	1.64	1.81	3m 1.71
Bomyea et al. (2015)	CBT	0.62	6m 0.87	0.59				0.77	
Boswell et al. (2013)	CBT	1.37		1.53				0.81	
Bouchard et al. (2022)	CBT IU F2F	1.04	6m 1.09	1.52	6m 1.69			1.20	6m 0.88
	CBT IU VC	1.04	6m 1.18	1.31	6m 1.39			1.27	6m 0.84
Donegan et al. (2022)	CBT	0.89				0.94		1.59	
	WL	0.16				0.11		0.11	
Dugas et al. (2003)	CBT IU	0.99		1.23		1.19		1.27	
	WL	0.18		0.28		0.08		0.04	
Dugas et al. (2022)	CBT IU	1.95		2.84		1.82		1.59	
	WL	0.02		0.52		0.54		0.59	
Green et al. (2022)	CBT postpartum	0.65	3m 0.30	0.76	3m 0.67			1.09	3m 0.83
	CBT pregnant	0.50	3m 0.60	0.77	3m 1.17			1.05	3m 1.59
Hall et al. (2020)	CBT IU	0.88		1.79					
Hebert & Dugas (2019)	CBT IU	1.72	3m 1.14	1.13	3m 0.89	1.64	3m 1.25	2.08	3m 0.53
			6m 1.66		6m 1.06		6m 1.47		6m 2.15
Hui & Zhihui (2017)	CBT IU	1.02	6m 1.01	2.41	6m 2.33	1.12	6m 1.05	0.99	6m 1.19
	WL	0.09	6m 0.01	0.18	6m 0.11	0.06	6m 0.04	0.09	6m 0.12
Khakpoor et al. (2019)	CBT	1.63	2m 1.69			1.35	2m 1.56	1.03	2m 1.34
	WL	0.00	2m 0.17			0.27	2m 0.18	0.23	2m 0.15
Koszycki et al. (2010)	CBT	1.16	3m 1.17	1.32	3m 1.29	0.73	3m 0.97	1.26	3m 1.26
			6m 1.22		6m 1.19		6m 0.92		6m 1.18
	SBI	0.44	3m 0.64	0.82	3m 1.08	1.24	3m 1.22	1.10	3m 1.22
			6m 0.57		6m 0.82		6m 1.00		6m 0.95
Ladouceur et al. (2000)	CBT IU	1.83	6m 1.41	2.21	6m 1.76	1.02	6m 0.62	1.36	6m 0.96
			12m 1.56		12m 1.76		12m 0.70		12m 1.02

Study	Tx	IU *d* pre-post	IU *d* pre-F/up	Worry *d* pre-post	Worry *d* pre-F/up	Anx *d* pre-post	Anx *d* pre-F/up	Dep *d* pre-post	Dep *d* pre-F/up
Laposa et al. (2022)	CBT	0.63		1.36					
Laposa & Fracalanza (2019)	CBT	0.75		1.10					
McEvoy & Erceg-Hurn (2016)	CBT	0.73	1 m 1.07	1.57	1m 2.03				
Nasiri et al. (2020)	CBT	2.78	3m 3.49	3.46	3m 3.44	1.76	3m 2.19	2.25	3m 2.51
	WL	-0.15	3m -0.35	0.01	3m -0.43	-0.06	3m -0.46	0.05	3m -0.04
Talkovsky & Norton (2016)	CBT	0.46		1.06					
Torbit & Laposa (2016)	CBT	0.63		1.15		0.48		0.51	
Treanor et al. (2011)	ABT	0.97		1.33					
	WL	0.05		0.63					
Wilson et al. (2020)	ABT	0.64		1.10		0.73	0.65	0.83	
	CBT	0.32		1.24		0.45	0.63	0.28	
	WL	0.19		0.31		0.05		0.04	
van der Heiden et al.	CBT	1.02	6m 1.03	1.67	6m 1.66				6m 1.25
(2012)						1.51	1.53	1.28	
	CBT IU	0.58	6m 0.68	1.46	6m 1.63	0.94	1.04	0.73	6m 0.78
Zemestani et al. (2021)	CBT IU	1.30		2.64					
	SSRI	0.50		0.76					

Note. *Tx* Treatment, *IU* Intolerance of uncertainty, *Pre – post* Pre- to post-treatment, *Pre – FU* Pre-treatment to follow up, *Anx* Anxiety, *Dep* Depression, *ABT* Acceptance based therapy, *CBT* Cognitive behavioural therapy, *BA* Behavioural Activation, *WL* Waitlist, *CBT IU* CBT – intolerance of uncertainty, *ER* Emotion Regulation, *F2F* Face to Face, *VC* Video Conferencing, *SBI* Spiritually Based Intervention, *SSRI* Selective serotonin reuptake inhibitor, *d* Cohen's d, *m* Month, *w* Week,

Appendix H: Questionnaires in meta-analysis

Study	IU	Worry	Anxiety	Depression
Avdagic et al. (2014)	IUS-27	PSWQ	DASS A	DASS D
Avdagic et al. (2014)	IUS-27	PSWQ	DASS A	DASS D
Beheshtian et al. (2020)	IUS-27	No measure	No measure	No measure
Boily & Belleville (2018)	IUS-27	PSWQ	BAI	BDI
Boily & Belleville (2018)	IUS-27	PSWQ	BAI	BDI
Bomyea et al. (2015)	IUS-27	PSWQ-A	No measure	No measure
Boswell et al. (2013)	IUS-27	PSWQ	No measure	No measure
Bouchard et al. (2022)	IUS-27	PSWQ	No measure	BDI-II
Bouchard et al. (2022)	IUS-27	PSWQ	No measure	BDI-II
Donegan et al. (2022)	IUS-12	No measure	STICSA-T	EPDS
Dugas et al. (2003)	IUS-27	PSWQ	BAI	BDI-II
Dugas et al. (2022)	IUS-27	PSWQ	BAI	BDI-II
Green et al. (2022)	IUS-27	PSWQ	No measure	EPDS
Green et al. (2022)	IUS-27	PSWQ	No measure	EPDS
Hall et al. (2020)	IUS-27	PSWQ	No measure	No measure
Hebert & Dugas (2019)	IUS-27	PSWQ	BAI	BDI-II
Hui & Zhihui (2017)	IUS-27	PSWQ	BAI	BDI-II
Khakpoor et al. (2019)	IUS-12	No measure	BAI	BDI-II
Koszycki et al. (2010)	IUS-27	PSWQ	BAI	BDI-II
Ladouceur et al. (2000)	IUS-27	PSWQ	BAI	BDI-II
Laposa & Fracalanza (2019)	IUS-12	PSWQ	No measure	No Dep
Laposa et al. (2022)	IUS-12	PSWQ	No measure	No Dep
McEvoy & Erceg-Hurn (2016)	IUS-12	PSWQ	No measure	No measure
Nasiri et al. (2020)	IUS-27	PSWQ	BAI	BDI-II
Talkovsky & Norton (2016)	IUS-27	PSWQ	BAI	No measure
Torbit & Laposa (2016)	IUS-27	PSWQ	DASS A	DASS D
Treanor et al. (2011)	IUS-27	PSWQ	No measure	No Dep
Wilson et al. (2020)	IUS-12	PSWQ	DASS A	DASS D
Wilson et al. (2020)	IUS-12	PSWQ	DASS A	DASS D
van der Heiden et al. (2012)	IUS-27	PSWQ	STAI-T	BDI-II
van der Heiden et al. (2012)	IUS-27	PSWQ	STAI-T	BDI-II
Zemestani et al. (2021)	IUS-27	PSWQ	No measure	No measure

Note: *IUS* Intolerance of Uncertainty Scale, *PSWQ* Penn State Worry Questionnaire, *DASS A* Depression Anxiety Stress Scale – Anxiety, *BAI* Beck Anxiety Inventory, *STICSA-T* State–Trait Inventory for Cognitive and Somatic Anxiety – Trait, *STAI-T* State-Trait Anxiety Inventory – Trait, *DASS D* Depression Anxiety Stress Scale – Depression, *BDI* Beck Depression Inventory, *EPDS Edinburgh Postnatal Depression Inventory*

Appendix I: Forest plots for within-group and between-group effects

Appendix I - Intolerance of Uncertainty

Within Group Pre-Post Tx Effect on Intolerance of Uncertainty

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Avdagic et al. (2014)	ABT	0.914	0.265	0.070	0.394	1.433	3.448	0.001
Avdagic et al. (2014)	CBT	0.588	0.240	0.057	0.118	1.057	2.453	0.014
Beheshtian et al. (2020)	CBT	2.253	0.478	0.229	1.316	3.191	4.710	0.000
Boily & Belleville (2018)	CBT IU	1.453	0.435	0.189	0.600	2.305	3.340	0.001
Boily & Belleville (2018)	CBT IU+ER	1.600	0.460	0.212	0.698	2.501	3.478	0.001
Bomyea et al. (2015)	CBT	0.602	0.201	0.040	0.209	0.995	3.003	0.003
Boswell et al. (2013)	CBT	1.088	0.466	0.217	0.176	2.001	2.337	0.019
Bouchard et al. (2022)	CBT IU F2F	1.030	0.138	0.019	0.759	1.301	7.446	0.000
Bouchard et al. (2022)	CBT IU VC	1.028	0.148	0.022	0.738	1.317	6.956	0.000
Donegan et al. (2022)	CBT	0.870	0.201	0.040	0.476	1.264	4.331	0.000
Dugas et al. (2003)	CBT IU	0.956	0.236	0.056	0.493	1.419	4.048	0.000
Dugas et al. (2022)	CBT IU	1.866	0.341	0.116	1.197	2.534	5.473	0.000
Green et al. (2022)	CBT Postpartum	0.631	0.177	0.031	0.284	0.977	3.566	0.000
Green et al. (2022)	CBT Pregnant	0.471	0.267	0.071	-0.052	0.994	1.764	0.078
Hall et al. (2020)	CBT IU	0.738	0.320	0.102	0.112	1.365	2.309	0.021
Hebert & Dugas (2019)	CBT IU	1.763	0.574	0.330	0.637	2.889	3.069	0.002
Hui & Zhihui (2017)	CBT IU	0.929	0.208	0.043	0.521	1.336	4.467	0.000
Khakpoor et al. (2019)	CBT	1.068	0.524	0.275	0.040	2.095	2.037	0.042
Koszycki et al. (2010)	CBT	1.067	0.360	0.129	0.363	1.772	2.969	0.003
Ladouceur et al. (2000)	CBT IU	1.745	0.308	0.095	1.141	2.348	5.669	0.000
Laposa & Fracalanza (2019)	CBT	0.728	0.215	0.046	0.306	1.150	3.380	0.001
Laposa et al. (2022)	CBT	0.629	0.115	0.013	0.404	0.853	5.489	0.000
McEvoy & Erceg-Hurn (2016)	CBT	0.709	0.181	0.033	0.354	1.063	3.920	0.000
Nasiri et al. (2020)	CBT	2.579	0.530	0.281	1.539	3.618	4.862	0.000
Talkovsky & Norton (2016)	CBT	0.447	0.181	0.033	0.092	0.803	2.468	0.014
Torbit & Laposa (2016)	CBT	0.619	0.120	0.014	0.383	0.855	5.143	0.000
Treanor et al. (2011)	ABT	0.910	0.295	0.087	0.332	1.489	3.082	0.002
Wilson et al. (2020)	ABT	0.619	0.195	0.038	0.236	1.001	3.173	0.002
Wilson et al. (2020)	CBT	0.311	0.179	0.032	-0.041	0.663	1.733	0.083
van der Heiden et al. (2012)	CBT	1.002	0.156	0.024	0.697	1.307	6.437	0.000
van der Heiden et al. (2012)	CBT IU	0.576	0.138	0.019	0.305	0.846	4.176	0.000
Zemestani et al. (2021)	CBT IU	0.970	0.302	0.091	0.379	1.562	3.217	0.001
Pooled		0.881	0.065	0.004	0.753	1.009	13.503	0.000
Prediction Interval		0.881			0.317	1.446		

Hedges's g and 95% CI

-2.50 -1.25 0.00 1.25 2.50

Increase in IU Decrease in IU

Within Group Pre-Fup Tx Effects on Intolerance of Uncertainty

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	0.867	0.291	0.085	0.297	1.437	2.980	0.003	15
Avdagic et al. (2014)	CBT	0.838	0.288	0.083	0.273	1.403	2.909	0.004	15
Beheshtian et al. (2020)	CBT	2.670	0.545	0.297	1.601	3.738	4.897	0.000	15
Boily & Belleville (2018)	CBT IU	1.399	0.426	0.181	0.564	2.234	3.284	0.001	10
Boily & Belleville (2018)	CBT IU+ER	1.730	0.535	0.286	0.682	2.778	3.236	0.001	8
Bomyea et al. (2015)	CBT	0.834	0.215	0.046	0.413	1.255	3.882	0.000	28
Bouchard et al. (2022)	CBT IU F2F	1.071	0.140	0.020	0.796	1.346	7.635	0.000	79
Bouchard et al. (2022)	CBT IU VC	1.162	0.155	0.024	0.859	1.466	7.508	0.000	69
Green et al. (2022)	CBT Postpartum	0.287	0.202	0.041	-0.108	0.683	1.425	0.154	24
Green et al. (2022)	CBT Pregnant	0.557	0.303	0.092	-0.036	1.150	1.841	0.066	11
Hebert & Dugas (2019)	CBT IU	1.669	0.554	0.307	0.583	2.755	3.012	0.003	7
Hui & Zhihui (2017)	CBT IU	0.930	0.208	0.043	0.522	1.338	4.471	0.000	32
Khakpoor et al. (2019)	CBT	1.210	0.562	0.315	0.110	2.311	2.155	0.031	4
Koszycki et al. (2010)	CBT	1.084	0.362	0.131	0.375	1.793	2.996	0.003	11
Ladouceur et al. (2000)	CBT IU	1.370	0.269	0.072	0.843	1.897	5.097	0.000	26
McEvoy & Erceg-Hurn (2016)	CBT	1.037	0.213	0.045	0.620	1.454	4.878	0.000	33
Nasiri et al. (2020)	CBT	3.282	0.647	0.419	2.014	4.551	5.073	0.000	15
van der Heiden et al. (2012)	CBT	1.013	0.156	0.024	0.707	1.319	6.485	0.000	61
van der Heiden et al. (2012)	CBT IU	0.671	0.141	0.020	0.394	0.948	4.745	0.000	60
Pooled		1.054	0.099	0.010	0.860	1.249	10.625	0.000	
Prediction Interval		1.054			0.351	1.757			

Hedges's g and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Increase in IU Decrease in IU

Between Group Pre-Post Tx Effects on Intolerance of Uncertainty

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Sample size: Treatment	Sample size: Waitlist
Beheshtian et al. (2020)	CBT	2.258	0.460	0.211	1.357	3.159	4.914	0.000	15	15
Donegan et al. (2022)	CBT	1.074	0.263	0.069	0.560	1.589	4.091	0.000	33	32
Dugas et al. (2003)	CBT IU	0.590	0.279	0.078	0.042	1.137	2.111	0.035	25	27
Dugas et al. (2022)	CBT IU	1.835	0.334	0.112	1.180	2.490	5.491	0.000	23	27
Hui & Zhihui (2017)	CBT IU	1.245	0.272	0.074	0.711	1.779	4.568	0.000	32	31
Khakpoor et al. (2019)	CBT	2.157	0.864	0.746	0.464	3.849	2.497	0.013	4	3
Nasiri et al. (2020)	CBT	2.766	0.504	0.254	1.779	3.754	5.492	0.000	15	15
Treanor et al. (2011)	ABT	0.834	0.366	0.134	0.117	1.551	2.280	0.023	15	16
Wilson et al. (2020)	CBT	0.492	0.283	0.080	-0.061	1.046	1.743	0.081	31	21
Pooled		1.350	0.236	0.056	0.888	1.813	5.726	0.000		
Prediction Interval		1.350			-0.156	2.857				

Hedges's g and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Increase in IU Decrease in IU

Appendix I - Worry

Within Group Pre-Post Tx Effects on Worry

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	1.659	0.347	0.121	0.978	2.340	4.775	0.000	19
Avdagic et al. (2014)	CBT	0.938	0.267	0.071	0.414	1.461	3.508	0.000	19
Boily & Belleville (2018)	CBT IU	2.168	0.564	0.319	1.062	3.274	3.841	0.000	10
Boily & Belleville (2018)	CBT IU+ER	1.742	0.485	0.235	0.791	2.693	3.591	0.000	10
Bomyea et al. (2015)	CBT	0.569	0.199	0.040	0.179	0.958	2.861	0.004	28
Boswell et al. (2013)	CBT	1.147	0.477	0.228	0.211	2.082	2.403	0.016	6
Bouchard et al. (2022)	CBT IU F2F	1.236	0.149	0.022	0.944	1.527	8.316	0.000	79
Bouchard et al. (2022)	CBT IU VC	1.426	0.170	0.029	1.092	1.759	8.385	0.000	69
Dugas et al. (2003)	CBT IU	1.131	0.251	0.063	0.639	1.623	4.502	0.000	25
Dugas et al. (2022)	CBT IU	2.727	0.450	0.202	1.846	3.608	6.065	0.000	23
Green et al. (2022)	CBT Postpartum	0.744	0.178	0.032	0.395	1.093	4.175	0.000	39
Green et al. (2022)	CBT Pregnant	0.719	0.277	0.077	0.175	1.262	2.593	0.010	15
Hall et al. (2020)	CBT IU	1.539	0.430	0.185	0.695	2.382	3.576	0.000	11
Hebert & Dugas (2019)	CBT IU	1.362	0.490	0.241	0.401	2.323	2.777	0.005	7
Hui & Zhihui (2017)	CBT IU	2.346	0.340	0.116	1.679	3.012	6.895	0.000	32
Koszycki et al. (2010)	CBT	1.219	0.381	0.145	0.473	1.965	3.201	0.001	11
Ladouceur et al. (2000)	CBT IU	2.135	0.352	0.124	1.445	2.824	6.067	0.000	26
Laposa & Fracalanza (2019)	CBT	1.035	0.238	0.057	0.568	1.501	4.343	0.000	26
Laposa et al. (2022)	CBT	1.301	0.143	0.020	1.022	1.581	9.127	0.000	90
McEvoy & Erceg-Hurn (2016)	CBT	1.517	0.239	0.057	1.049	1.985	6.354	0.000	37
Nasiri et al. (2020)	CBT	3.141	0.623	0.388	1.919	4.362	5.040	0.000	15
Talkovsky & Norton (2016)	CBT	0.981	0.212	0.045	0.566	1.396	4.636	0.000	32
Torbit & Laposa (2016)	CBT	1.129	0.141	0.020	0.852	1.406	7.987	0.000	81
Treanor et al. (2011)	ABT	1.263	0.326	0.106	0.624	1.902	3.876	0.000	16
Wilson et al. (2020)	ABT	1.046	0.223	0.050	0.608	1.483	4.684	0.000	30
Wilson et al. (2020)	CBT	1.204	0.232	0.054	0.748	1.660	5.180	0.000	31
van der Heiden et al. (2012)	CBT	1.464	0.183	0.034	1.105	1.823	7.993	0.000	61
van der Heiden et al. (2012)	CBT IU	0.993	0.156	0.024	0.687	1.300	6.351	0.000	60
Zemestani et al. (2021)	CBT IU	2.410	0.503	0.253	1.424	3.397	4.790	0.000	15
Pooled		1.321	0.082	0.007	1.160	1.482	16.076	0.000	
Prediction Interval		1.321			0.614	2.027			

Hedges's g and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Increase in Worry Decrease in Worry

Within Group Pre-Follow up Tx Effects on Worry

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	1.342	0.346	0.120	0.664	2.020	3.880	0.000	15
Avdagic et al. (2014)	CBT	1.062	0.312	0.097	0.451	1.674	3.407	0.001	15
Boily & Belleville (2018)	CBT IU	1.774	0.491	0.241	0.812	2.736	3.614	0.000	10
Boily & Belleville (2018)	CBT IU+ER	2.165	0.626	0.392	0.938	3.391	3.459	0.001	8
Bouchard et al. (2022)	CBT IU F2F	1.290	0.151	0.023	0.993	1.587	8.515	0.000	79
Bouchard et al. (2022)	CBT IU VC	1.575	0.179	0.032	1.224	1.927	8.785	0.000	69
Green et al. (2022)	CBT Postpartum	0.644	0.218	0.048	0.216	1.071	2.951	0.003	24
Green et al. (2022)	CBT Pregnant	1.074	0.360	0.130	0.368	1.781	2.980	0.003	11
Hebert & Dugas (2019)	CBT IU	1.300	0.478	0.229	0.363	2.238	2.718	0.007	7
Hui & Zhihui (2017)	CBT IU	2.268	0.332	0.110	1.618	2.919	6.835	0.000	32
Koszycki et al. (2010)	CBT	1.192	0.377	0.142	0.453	1.931	3.163	0.002	11
Ladouceur et al. (2000)	CBT IU	1.644	0.297	0.088	1.062	2.226	5.538	0.000	26
McEvoy & Erceg-Hurn (2016)	CBT	1.961	0.295	0.087	1.382	2.539	6.642	0.000	33
Nasiri et al. (2020)	CBT	3.217	0.636	0.404	1.970	4.463	5.058	0.000	15
van der Heiden et al. (2012)	CBT	1.468	0.183	0.034	1.108	1.827	8.003	0.000	61
van der Heiden et al. (2012)	CBT IU	1.066	0.160	0.026	0.752	1.381	6.650	0.000	60
Pooled		1.448	0.117	0.014	1.218	1.678	12.330	0.000	
Prediction Interval		1.448			0.660	2.237			

Hedges's g and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Increase in Worry Decrease in Worry

Between Group Pre-Post Tx Effects on Worry

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Treatment	Waitlist
Dugas et al. (2003)	CBT IU	1.047	0.287	0.082	0.486	1.609	3.655	0.000	27	27
Dugas et al. (2022)	CBT IU	2.219	0.357	0.127	1.519	2.918	6.220	0.000	23	27
Hui & Zhihui (2017)	CBT IU	2.210	0.317	0.101	1.588	2.831	6.963	0.000	32	31
Nasiri et al. (2020)	CBT	3.275	0.552	0.305	2.193	4.358	5.930	0.000	15	15
Treanor et al. (2011)	ABT	1.081	0.376	0.141	0.344	1.817	2.874	0.004	15	16
Wilson et al. (2020)	CBT	0.856	0.291	0.085	0.286	1.425	2.943	0.003	31	21
Pooled		1.714	0.335	0.112	1.057	2.371	5.116	0.000		
Prediction Interval		1.714			-0.530	3.958				

Hedges's g and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Increase in Worry Reduction in Worry

Appendix I - Anxiety

Within Group Pre-Post Tx Effects on Anxiety

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	1.304	0.305	0.093	0.706	1.902	4.275	0.000	19
Avdagic et al. (2014)	CBT	0.860	0.260	0.068	0.350	1.370	3.305	0.001	19
Boily & Belleville (2018)	CBT IU	1.152	0.387	0.150	0.393	1.911	2.975	0.003	10
Boily & Belleville (2018)	CBT IU+ER	1.135	0.385	0.148	0.381	1.889	2.950	0.003	10
Donegan et al. (2022)	CBT	0.919	0.204	0.042	0.518	1.319	4.500	0.000	33
Dugas et al. (2003)	CBT IU	1.085	0.247	0.061	0.601	1.569	4.391	0.000	25
Dugas et al. (2022)	CBT IU	1.605	0.311	0.097	0.996	2.214	5.166	0.000	23
Hebert & Dugas (2019)	CBT IU	1.145	0.449	0.202	0.265	2.026	2.550	0.011	7
Hui & Zhihui (2017)	CBT IU	0.979	0.212	0.045	0.565	1.394	4.631	0.000	32
Khakpoor et al. (2019)	CBT	0.884	0.479	0.230	-0.056	1.824	1.843	0.065	4
Koszycki et al. (2010)	CBT	0.671	0.313	0.098	0.058	1.284	2.144	0.032	11
Ladouceur et al. (2000)	CBT IU	0.953	0.232	0.054	0.499	1.407	4.115	0.000	26
Nasiri et al. (2020)	CBT	1.655	0.388	0.151	0.894	2.417	4.261	0.000	15
Talkovsky & Norton (2016)	CBT	0.685	0.193	0.037	0.308	1.063	3.559	0.000	32
Torbit & Laposa (2016)	CBT	0.477	0.116	0.014	0.249	0.705	4.102	0.000	81
Wilson et al. (2020)	ABT	0.704	0.200	0.040	0.313	1.095	3.525	0.000	30
Wilson et al. (2020)	CBT	0.434	0.184	0.034	0.075	0.794	2.367	0.018	31
van der Heiden et al. (2012)	CBT	1.417	0.180	0.032	1.064	1.770	7.866	0.000	61
van der Heiden et al. (2012)	CBT IU	0.919	0.153	0.023	0.620	1.218	6.023	0.000	60
Pooled		0.944	0.084	0.007	0.778	1.110	11.171	0.000	
Prediction Interval		0.944			0.358	1.530			

Hedges's g and 95% CI

-3.50 -1.75 0.00 1.75 3.50

Increase in Anxiety Decrease in Anxiety

Within Group Pre-Follow up Tx Effects on Anxiety

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	1.765	0.404	0.163	0.973	2.557	4.366	0.000	15
Avdagic et al. (2014)	CBT	1.425	0.357	0.127	0.726	2.124	3.994	0.000	15
Boily & Belleville (2018)	CBT IU	1.299	0.410	0.168	0.495	2.102	3.169	0.002	10
Boily & Belleville (2018)	CBT IU+ER	1.230	0.440	0.193	0.368	2.092	2.797	0.005	8
Hebert & Dugas (2019)	CBT IU	0.802	0.392	0.154	0.033	1.571	2.043	0.041	7
Hui & Zhihui (2017)	CBT IU	0.957	0.210	0.044	0.546	1.368	4.559	0.000	32
Khakpoor et al. (2019)	CBT	0.878	0.478	0.229	-0.059	1.815	1.836	0.066	4
Koszycki et al. (2010)	CBT	0.899	0.338	0.114	0.236	1.561	2.660	0.008	11
Ladouceur et al. (2000)	CBT IU	0.593	0.207	0.043	0.187	0.999	2.862	0.004	26
Nasiri et al. (2020)	CBT	2.047	0.446	0.199	1.172	2.922	4.586	0.000	15
Wilson et al. (2020)	ABT	0.630	0.196	0.038	0.246	1.013	3.221	0.001	30
Wilson et al. (2020)	CBT	0.613	0.192	0.037	0.238	0.989	3.201	0.001	31
van der Heiden et al. (2012)	CBT	1.434	0.181	0.033	1.079	1.789	7.913	0.000	61
van der Heiden et al. (2012)	CBT IU	1.006	0.157	0.025	0.699	1.314	6.406	0.000	60
Pooled		1.036	0.109	0.012	0.822	1.251	9.478	0.000	
Prediction Interval		1.036			0.370	1.703			

Hedges's g and 95% CI

-3.50 -1.75 0.00 1.75 3.50

Increase in Anxiety Decrease in Anxiety

Between Group Pre-Post Tx Effects on Anxiety

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Sample size: Treatment	Sample size: Waitlist
Donegan et al. (2022)	CBT	1.006	0.261	0.068	0.495	1.516	3.860	0.000	33	32
Dugas et al. (2003)	CBT IU	1.322	0.303	0.092	0.729	1.915	4.371	0.000	25	27
Dugas et al. (2022)	CBT IU	1.869	0.336	0.113	1.210	2.528	5.561	0.000	23	27
Hui & Zhihui (2017)	CBT IU	1.224	0.272	0.074	0.691	1.756	4.504	0.000	32	31
Khakpoor et al. (2019)	CBT	1.237	0.723	0.523	-0.181	2.654	1.710	0.087	4	3
Nasiri et al. (2020)	CBT	2.127	0.449	0.202	1.247	3.007	4.736	0.000	15	15
Wilson et al. (2020)	CBT	0.464	0.282	0.080	-0.088	1.017	1.646	0.100	31	21
Pooled		1.273	0.207	0.043	0.868	1.678	6.158	0.000		
Prediction Interval		1.273			0.074	2.471				

Hedges's g and 95% CI

-3.50 -1.75 0.00 1.75 3.50

Increase in Anxiety Decrease in Anxiety

Appendix I - Depression

Within Group Pre-Post Tx Effects on Depression

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	0.841	0.259	0.067	0.334	1.348	3.252	0.001	19
Avdagic et al. (2014)	CBT	0.841	0.259	0.067	0.334	1.348	3.253	0.001	19
Boily & Belleville (2018)	CBT IU	1.113	0.382	0.146	0.365	1.861	2.918	0.004	10
Boily & Belleville (2018)	CBT IU+ER	1.565	0.454	0.206	0.675	2.455	3.448	0.001	10
Bouchard et al. (2022)	CBT IU F2F	0.752	0.126	0.016	0.504	1.000	5.945	0.000	79
Bouchard et al. (2022)	CBT IU VC	0.802	0.137	0.019	0.533	1.071	5.846	0.000	69
Donegan et al. (2022)	CBT	1.165	0.222	0.049	0.729	1.601	5.239	0.000	33
Dugas et al. (2003)	CBT IU	1.206	0.258	0.067	0.700	1.712	4.673	0.000	25
Dugas et al. (2022)	CBT IU	1.509	0.300	0.090	0.921	2.098	5.030	0.000	23
Green et al. (2022)	CBT Postpartum	1.070	0.203	0.041	0.672	1.469	5.262	0.000	37
Green et al. (2022)	CBT Pregnant	0.989	0.313	0.098	0.375	1.603	3.156	0.002	14
Hebert & Dugas (2019)	CBT IU	1.803	0.583	0.340	0.660	2.947	3.091	0.002	7
Hui & Zhihui (2017)	CBT IU	0.911	0.207	0.043	0.506	1.316	4.406	0.000	32
Khakpoor et al. (2019)	CBT	0.699	0.440	0.193	-0.163	1.560	1.589	0.112	4
Koszycki et al. (2010)	CBT	1.125	0.367	0.135	0.405	1.846	3.063	0.002	11
Ladouceur et al. (2000)	CBT IU	1.241	0.256	0.066	0.738	1.743	4.838	0.000	26
Nasiri et al. (2020)	CBT	2.103	0.455	0.207	1.212	2.995	4.622	0.000	15
Torbit & Laposa (2016)	CBT	0.501	0.117	0.014	0.272	0.730	4.288	0.000	81
Wilson et al. (2020)	ABT	0.798	0.205	0.042	0.395	1.200	3.882	0.000	30
Wilson et al. (2020)	CBT	0.271	0.178	0.032	-0.078	0.621	1.520	0.128	31
van der Heiden et al. (2012)	CBT	1.265	0.171	0.029	0.931	1.599	7.415	0.000	61
van der Heiden et al. (2012)	CBT IU	0.717	0.143	0.021	0.436	0.998	5.004	0.000	60
Pooled		0.956	0.077	0.006	0.804	1.108	12.342	0.000	
Prediction Interval		0.956			0.384	1.527			

Hedges's g and 95% CI

-3.50 -1.75 0.00 1.75 3.50

Increase in Depression Decrease in Depression

Within Group Pre-Follow up Tx Effects on Depression

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Total
Avdagic et al. (2014)	ABT	1.255	0.335	0.112	0.599	1.912	3.749	0.000	15
Avdagic et al. (2014)	CBT	1.385	0.351	0.123	0.696	2.073	3.940	0.000	15
Boily & Belleville (2018)	CBT IU	1.190	0.393	0.154	0.420	1.960	3.029	0.002	10
Boily & Belleville (2018)	CBT IU+ER	1.366	0.464	0.215	0.456	2.276	2.943	0.003	8
Bouchard et al. (2022)	CBT IU F2F	0.856	0.131	0.017	0.600	1.112	6.555	0.000	79
Bouchard et al. (2022)	CBT IU VC	0.825	0.138	0.019	0.554	1.096	5.970	0.000	69
Green et al. (2022)	CBT Postpartum	0.794	0.233	0.054	0.337	1.250	3.409	0.001	23
Green et al. (2022)	CBT Pregnant	1.459	0.417	0.174	0.641	2.277	3.495	0.000	11
Hebert & Dugas (2019)	CBT IU	0.709	0.379	0.144	-0.035	1.453	1.869	0.062	7
Hui & Zhihui (2017)	CBT IU	1.111	0.221	0.049	0.677	1.544	5.016	0.000	32
Khakpoor et al. (2019)	CBT	0.908	0.485	0.235	-0.043	1.858	1.871	0.061	4
Koszycki et al. (2010)	CBT	1.109	0.365	0.133	0.393	1.825	3.037	0.002	11
Ladouceur et al. (2000)	CBT IU	0.917	0.229	0.052	0.469	1.365	4.009	0.000	26
Nasiri et al. (2020)	CBT	2.229	0.475	0.225	1.299	3.160	4.697	0.000	15
van der Heiden et al. (2012)	CBT	1.233	0.169	0.028	0.902	1.563	7.310	0.000	61
van der Heiden et al. (2012)	CBT IU	0.769	0.146	0.021	0.484	1.055	5.287	0.000	60
Pooled		1.004	0.070	0.005	0.866	1.142	14.303	0.000	
Prediction Interval		1.004			0.692	1.316			

Hedges's g and 95% CI

-3.50 -1.75 0.00 1.75 3.50

Increase in Depression Decrease in Depression

Between Group Pre-Post Tx Effects on Depression

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Treatment	Waitlist
Donegan et al. (2022)	CBT	1.287	0.270	0.073	0.758	1.816	4.768	0.000	33	32
Dugas et al. (2003)	CBT IU	1.348	0.304	0.092	0.753	1.943	4.439	0.000	25	27
Dugas et al. (2022)	CBT IU	1.075	0.299	0.090	0.488	1.661	3.591	0.000	23	27
Hui & Zhihui (2017)	CBT IU	0.849	0.260	0.068	0.339	1.359	3.264	0.001	32	31
Khakpoor et al. (2019)	CBT	1.201	0.719	0.517	-0.208	2.610	1.671	0.095	4	3
Nasiri et al. (2020)	CBT	2.053	0.443	0.196	1.184	2.921	4.631	0.000	15	15
Wilson et al. (2020)	CBT	0.320	0.280	0.078	-0.229	0.869	1.142	0.254	31	21
Pooled		1.102	0.192	0.037	0.725	1.479	5.726	0.000		
Prediction Interval		1.102			0.014	2.190				

Statistics for each study; Sample size

Hedges's g and 95% CI

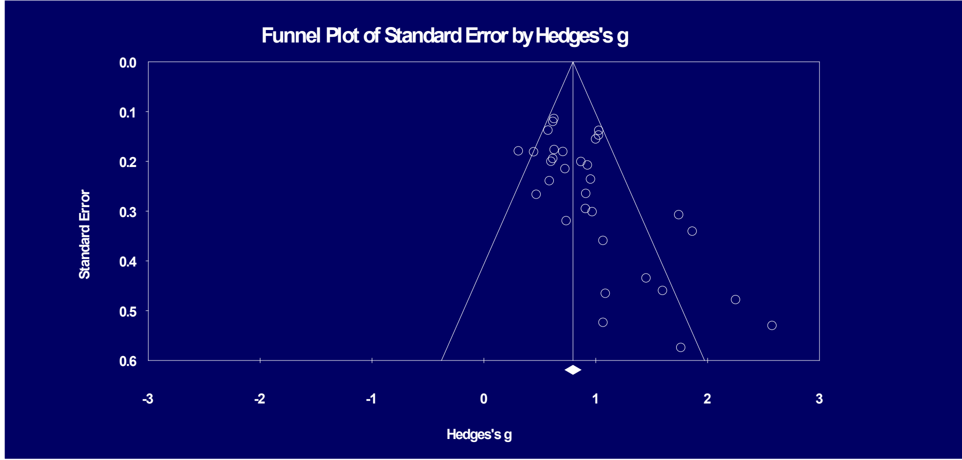
-3.50 -1.75 0.00 1.75 3.50

Increase in Depression Decrease in Depression

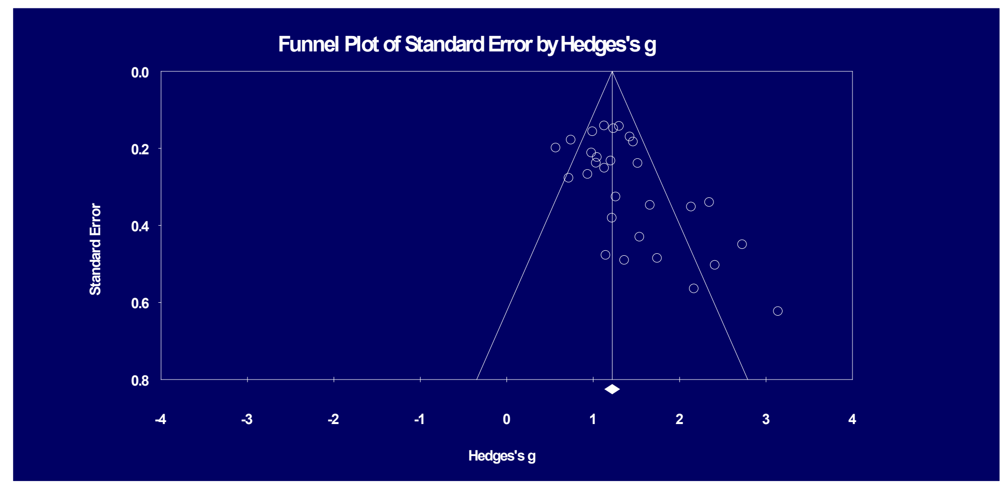
Appendix J: Funnel plots

Funnel plots for within-group effects for intolerance of uncertainty and worry from pre- to post-treatment.

Appendix J Figure 1. Funnel plot of standard error for within-group Hedges' *g* indices from pre- to post-treatment for intolerance of uncertainty for all treatment groups (k = 32)

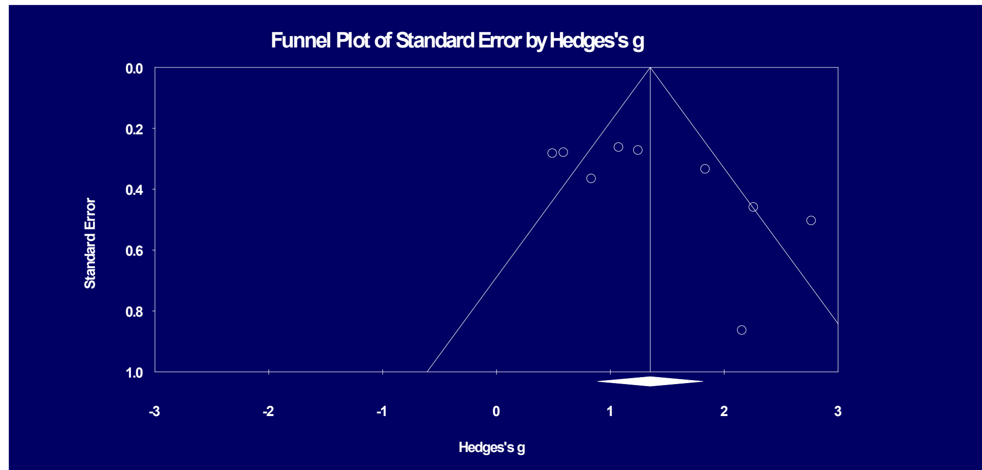


Appendix J Figure 2. Funnel plot of standard error by within-group Hedges' *g* indices from pre- to post-treatment for excessive worry for all treatment groups (k = 29)

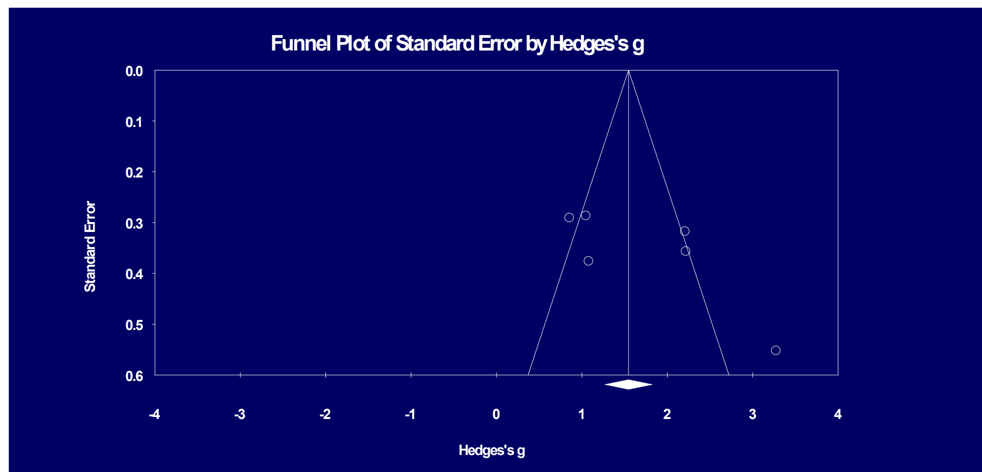


Funnel plots for between-group effects for intolerance of uncertainty and worry from pre-to post-treatment.

Appendix J Figure 3. Funnel plot of standard error for between-group Hedges' *g* indices from pre-to post-treatment for intolerance of uncertainty for all treatment groups (k = 9)



Appendix J Figure 4. Funnel plot of standard error for between-group Hedges' *g* indices from pre-to post-treatment for worry for all treatment groups (k = 6)



Appendix K: Chapter 5 Ethics Approval Letter

Dear Applicant

Re: ETH22-7185 - "Coping with Uncertainty"

Thank you for your response to the Committee's comments for your project. The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis.

You are therefore authorised to commence activities as outlined in your application. You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

Your approval number is UTS HREC REF NO. ETH22-7185.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:

- Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.
- The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat.
- The Principal Investigator will notify the Committee of any event that requires a modification to the protocol or other project documents and submit any required amendments prior to implementation. Instructions on how to submit an amendment application can be found here.
- The Principal Investigator will promptly report adverse events to the Ethics Secretariat. An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property.
- The Principal Investigator will report to the UTS HREC or UTS MREC annually and notify the Committee when the project is completed at all sites. The Principal Investigator will notify the Committee of any plan to extend the duration of the project past the approval period listed above.
- The Principal Investigator will obtain any additional approvals or authorisations as required (e.g. from other ethics committees, collaborating institutions, supporting organisations).
- The Principal Investigator will notify the Committee of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

This research must be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research.

You should consider this your official letter of approval. If you require a hardcopy please contact the Ethics Secretariat.If you have any queries about your ethics approval or require any amendments to your research in the future, please don't hesitate to contact the Ethics Secretariat and quote the ethics application number (e.g. ETH20-xxxx) in all correspondence.

Yours sincerely,
The Research Ethics Secretariat
On behalf of the UTS Human Research Ethics Committees
C/- Research Office
University of Technology Sydney
E: Research.Ethics@uts.edu.au

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