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Intolerance of uncertainty, anxiety, and worry in children and young people: Improving assessment of intolerance of uncertainty in preadolescent children

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Declaration of Original Authorship

I confirm this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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Abstract

Anxiety disorders are one of the most common mental health problems among children and adolescents. Studies in adults suggest that intolerance of uncertainty (IU) is closely linked to a range of anxiety disorders; however, there is a relative lack of research focusing on IU in children and young people. Four studies are presented in this thesis that together aim to: 1. review existing evidence for associations between IU, anxiety, and worry in children and adolescents; 2. begin addressing issues around the assessment of IU in preadolescent children.

Study 1, a meta-analysis of the current literature on IU, anxiety, and worry in children and adolescents revealed robust relationships between IU and both anxiety and worry. Following this, study 2 assessed the psychometric properties of the current child IU questionnaire measure in a preadolescent sample. Although the measure showed good psychometric properties, younger children had some difficulty understanding certain items. Studies 3 and 4 adapted behavioural tasks designed to assess IU and evaluated the suitability of these tasks for preadolescent children. Further, these studies examined children's reactions to uncertainty and explored whether these tasks can capture reactions to uncertainty that are related with self-reported IU, anxiety and worry. Both studies concluded that the tasks were suitable for preadolescent children. In addition, general reactions to uncertainty manipulations such as increased worry, more information seeking and longer reaction times were found, although there was some task specificity. There was some evidence that responses on these tasks may be associated with IU, but this was strongest for subjective reports of task-related certainty rather than objective measures of task performance.

Overall, these studies provide a systematic overview of the current IU literature in children and young people, reveal shortcomings of the self-reported IU for younger children and provide new assessments to measure IU in preadolescent children. The work presented in this thesis underlines the importance of taking age and cognitive development into account when designing and selecting IU assessments in children and leads to several suggestions for future research in order to improve understanding of the IU specific mechanisms across development.

Chapter 1 - General Introduction

1.1 Anxiety in young people

Anxiety and fear can be adaptive emotions which facilitate self-protection in the presence of a perceived potential danger by eliciting a fight or flight response (Rosen & Schulkin, 1998). Fear and anxiety have considerable overlap yet there are key elements that differentiate them from one another. Fear triggers a "fight or flight "response to an immediate and certain threat whereas anxiety is a more prolonged state of tension, worry and apprehension in relation to a potential and uncertain threat (Duval, Javanbakht, & Liberzon, 2015; Rosen & Schulkin, 1998). Anxiety exists across a spectrum which at its most extreme is pathological.

Normal feelings of anxiety and fear can be differentiated from pathological anxiety, or anxiety disorders, in a number of ways. In disorders, worry and/or fear are not temporary states, the intensity and length of fear and/or worries is greater. In disorders there is significant impairment with symptoms interfering with daily life and functioning (APA, 2013). Some fears and worries are typical at certain developmental stages (Weems, Silverman, & La Greca, 2000). For example, fear of strangers, being alone, the dark and the supernatural emerge during the preschool years. These fears begin to decrease after age 7 and continue to decrease until adolescence. In contrast, fear of social evaluation and disease related fears and worries increase with age and are more common among adolescents (Gullone, 2000; Laing, Fernyhough, Turner, & Freeston, 2009; Westenberg, Drewes, Goedhart, Siebelink, & Treffers, 2004). Age of onset for anxiety disorders parallels the development of typical fears. Separation anxiety disorder, specific phobia, and social anxiety disorder have an earlier onset (mean onset before the age of 15) and obsessive compulsive disorder, panic disorder, post-traumatic stress disorder, and generalized anxiety disorder have a later onset (between 21.1 and 34.9) (Lijster et al., 2017).

Anxiety disorders are among the most common mental health problems, with lifetime prevalence of around 28.8% (Kessler et al., 2005). Anxiety disorders have an early age of onset and prevalence estimates in children and adolescents range from 2% to 24% (Merikangas, Nakamura, & Kessler, 2009). Although there is a significant variation in prevalence estimates, it is generally accepted that the prevalence of any anxiety disorder in young people is between 2.4% and 6.5% (Costello, Mustillo, Erkanli, Keeler, &

Angold, 2003; Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). Anxiety disorders among children and adolescents are associated with adverse outcomes such as increased risk for other disorders (e.g. another anxiety disorder or a mood disorder), substance dependence, low educational attainment and family quality of life, which place a burden not only on the child and their family but also on society more broadly (Costello et al., 2003; Essau, Conradt, & Petermann, 2000; Essau, Lewinsohn, Lim, Ho, & Rohde, 2018; Kessler et al., 2009; Kim-Cohen et al., 2003). Specific risk factors for developing an anxiety disorder include behavioural inhibition (BI) in childhood, being female, having lower income, stressful life events, family history of mental disorders, certain personality traits, being exposed to particular parenting styles and having elevated cortisol levels (Bienvenu et al., 2004; Costello & Osborne, 2005; Costello, Egger, & Angold, 2005; McLeod, Wood, & Weisz, 2007; Miloyan, Joseph Bienvenu, Brilot, & Eaton, 2018; Svihra & Katzman, 2004; Vreeburg et al., 2010).

Cognitive-behaviour therapy (CBT) is widely accepted form of therapy which can be delivered in various ways (e.g. individual therapy, group therapy, family-based interventions) for the treatment of anxiety disorders. The components commonly include psycho-education, problem-solving, emotion-regulation, and exposure-based techniques. CBT has been found to be an effective form of therapy. James, James, Cowdrey, Soler, and Choke (2015) found that 58.9% of the young people were free from anxiety diagnosis after CBT and Weisz et al. (2017) reported a moderate effect size for post-treatment (0.61) and follow-up (0.55) following CBT for anxiety disorders. Although the last decades have seen tremendous advancements for the treatment of anxiety disorders in young people, these results indicate that a significant proportion of young people remain clinically anxious even after CBT. There is, therefore, room for improvement in the treatment of anxiety disorders.

As described, anxiety exists across a continuum. There is significant overlap between the risk factors and mechanisms that underpin normal variation in anxiety across non-clinical samples and clinical anxiety disorders. Information processing biases are, for example, associated with clinically significant anxiety as well as high levels of non-clinical anxiety. Threat-related attentional biases are observed in high anxious non-clinical individuals and individuals with clinically significant anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). Similarly, negative interpretation bias is

linked to anxiety in children and young people and a recent meta-analysis showed that this association did not differ significantly between studies using clinically anxious participants as compared to those using community samples (Stuijfzand, Creswell, Field, Pearcey, and Dodd, 2017). Furthermore, some of the risk factors for developing an anxiety disorder are also linked to elevated levels of non-clinical anxiety. For example, behavioural inhibition (BI) in early childhood is associated with elevated scores on continuous anxiety questionnaire measures as well as clinical anxiety diagnoses (Hudson and Dodd, 2012). Similarly, maternal overprotection has been linked to subsequent elevated anxiety (Edwards et al., 2010) as well as clinical anxiety diagnoses (Hudson and Rapee, 2001). It is possible to gain a better understanding of mechanisms that underpin and maintain anxiety disorders by studying non-clinical community samples. This work can then be extended to clinical populations if it shows promise. The work contained in this thesis focuses on uncertainty, which appears to play an important role in anxiety and worry. Participants are drawn from community samples with a view to improving understanding of mechanisms related with anxiety. It is hoped that this work will inform future work focused on anxiety disorders as well as potential improvements to treatment. The next section introduces models regarding the relationship between uncertainty and anxiety.

1.2 Models of Uncertainty-Related Anxiety

In general, people have a strong preference for certainty over uncertainty. For example, de Berker et al. (2016) showed that people would prefer to get a definite electric shock now than to get it in an unpredictable time, and greater nervous-system activation occurs in response to an unpredictable shock over a predictable one. Similarly, relative to an aversive stimuli after a certain cue, an aversive stimuli after an uncertain cue leads to increased skin conductance, self-reported negative mood (Grupe & Nitschke, 2011) and elevated diastolic blood pressure (Greco & Roger, 2003). Under uncertain circumstances individuals also interpret information in a negative way, anticipate threat, and have an implicit goal to reduce uncertainty (e.g. Bensi & Giusberti, 2007; Calvo & Castillo, 2001; Dugas et al., 2005; Fergus, Bardeen, & Wu, 2013; Grupe & Nitschke, 2011). Taken together, the results of these studies describe the physical and cognitive manifestations of anxiety and worry, indicating that uncertainty provokes anxiety and worry.

1.2.1 Anxiety as an epistemic emotion

Miceli and Castelfranchi (2005) posit anxiety within an epistemic control perspective. It is proposed that, in general, people have a need to know "how things are and how things will be" with the highest possible degree of certainty. This allows us to perceive that we have control (prediction of occurrence) and can be prepared for what is to come (prediction of consequences). Uncertainty may lead to a lack of perceived epistemic control, whether goals will be achieved and/or what will happen; and this, in turn, may lead to the anticipation of an indefinite threat to an individual's goal. This anticipation of an indefinite threat is viewed by Miceli and Castelfranchi (2005) as a central component of anxiety as an "epistemic emotion". A "what if…" scenario operates by building conflict between hope that a goal will be attained and fear that a goal cannot be attained. Anxiety is the epistemic emotion experienced during this waiting period until the result or feedback becomes available. Anxiety is greatest when the goal is important and uncertainty is high and anxiety is low when the goal is not important and uncertainty is low (Miceli & Castelfranchi, 2005).

Engaging in the 'What if…' processing proposed by this approach requires individuals to have certain cognitive abilities including probabilistic thinking and the ability to consider multiple possible outcomes. To experience uncertainty there must first be awareness that there is an information gap in one's knowledge or that one does not have much control over the outcome of an event or that there is conflicting evidence. Once an individual has an awareness of uncertainty, the cognitive system operates in a way to consider multiple possible outcomes. For each outcome, the probability of the outcome happening and the potential costs and benefits of the outcome are estimated. In addition, perceived control is evaluated. The metacognitive ability to reflect on this complex mental activity triggered by the subjective experience of uncertainty is a vital skill that develops across childhood (e.g. Beran, Decker, Schwartz, & Smith, 2012; Lyons & Ghetti, 2013; Robinson, Martin, Beck, Dan, & Apperly, 2006).

1.2.2 Psychological entropy

Similar to the model discussed above, the framework of uncertainty as psychological entropy also conceptualizes anxiety in terms of uncertainty and goal conflict. Entropy is used to describe the amount

of uncertainty and disorder within a system and psychological entropy refers to an individual as a self-organizing system, which aims to keep internal entropy at a manageable level (Hirsh, Mar, & Peterson, 2012). The authors of this model suggested four principles (Hirsh et al., 2012 p. 1):

1. Uncertainty poses a critical adaptive challenge for any organism, so individuals are motivated to keep it at a manageable level,
2. Uncertainty emerges as a function of the conflict between competing perceptual and behavioural affordances,
3. Adopting clear goals and belief structures helps to constrain the experience of uncertainty by reducing the spread of competing affordances,
4. Uncertainty is experienced subjectively as anxiety and is associated with activity in the anterior cingulate cortex and with heightened noradrenaline release.

The model builds on the evolutionary perspective, which suggests that organisms survive by lowering their internal entropy. Much of human cognition and behaviour reflect efforts to establish a coherent and predictable world model. The mind has to modify multiple possible perceptions and actions to adapt to the environment and act purposefully in it. The psychological entropy model suggests that uncertainty is reflected within an individual, highlighting goal-conflict as activating an anxiety response, which in turn motivates individuals to return to a familiar low-entropy state to regain a sense of control (Hirsh et al., 2012). Therefore, uncertainty is viewed as innately threatening because it indicates that an individual does not understand the current situation sufficiently and survival may therefore be at stake. Performing repetitive and predictable actions helps to minimize conflicting behavioural and perceptual affordances in a competitive environment of the mind and to return familiar low-entropy states. Within the psychological entropy model, anxiety, uncertainty and behavioural conflicts are indistinguishable. Having clear goals provides clarity to an individual regarding how to behave, which minimises uncertainty and anxiety.

1.2.3 Uncertainty and anticipation model of anxiety (UAMA)

The UAMA differs from the above models in that it distinguishes between normal and maladaptive anxiety whereas the above models are about normal anxiety reactions to uncertainty. In the UAMA model it is proposed that in maladaptive anxiety the processing of uncertainty is dysfunctional. Grupe and Nitschke (2013) suggested five processes that are involved in maladaptive responses to uncertainty (p.4):

1. Inflated estimates of threat cost and probability,
2. Increased threat attention and hypervigilance,
3. Deficient safety learning,
4. Behavioural and cognitive avoidance,
5. Heightened reactivity to threat uncertainty.

Inflated estimates of potential threat probability and cost are proposed as a key feature of clinical anxiety in the model. It is hypothesized that these biased calculations result in a feedback loop in which clinically anxious individuals are more attentive toward perceived threat, fail to recognize safety cues in the environment, avoid situations in which negative outcomes are expected and have heightened reactions towards potential threat uncertainty (Grupe & Nitschke, 2013). In contrast, it is hypothesized that adaptive responses to uncertainty require flexible coordination of these processes.

1.2.4 Summary

The models reviewed describe how uncertainty may be associated with anxiety in a general sense. While the first two models explain how anxiety and uncertainty are related in general, only the final model considers the difference between adaptive and maladaptive responses to uncertainty in terms of normal and pathological anxiety.

It is clear that individuals differ in their responses to uncertainty. In the next section, the focus will be on intolerance of uncertainty (IU) which is an individual difference factor regarding responses to uncertainty. The next section discusses the definition of IU, research evidence that links IU with anxiety

and worries, changes in IU in the treatment of anxiety disorders, and IU assessments.

1.3 Intolerance of uncertainty (IU)

IU has been defined in a number of ways. For example, Krohne (1989) defined it as a hypervigilance when faced with uncertainty along with an inability to tolerate this response and later Dugas, Gosselin, and Ladouceur (2001) defined IU as an excessive tendency to consider uncertainty unacceptable and anticipate that a negative event may occur regardless of the small probability. The most recent definition of IU is provided by Carleton (2016b) as "an individual's dispositional incapacity to endure an aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (p. 31).

1.3.1 Theory of IU and Initial Evidence

Initial work on IU focused on the role of IU in worry and GAD. The IU model of GAD conceptualized IU as central to GAD, alongside negative problem orientation and cognitive avoidance. It was proposed that IU leads to the exacerbation and generation of 'what if…?' questions, which lead to worry (Dugas, Freeston, & Ladouceur, 1997; Dugas, Gagnon, Ladouceur, & Freeston, 1998). Beliefs about worry such as the belief that worrying could help the individual to cope with the situation or prevent an event from happening perpetuate the worry.

Initial research evaluating this model showed that IU distinguished people with GAD from people with no anxiety diagnosis (Dugas et al., 1998). Furthermore, individuals with GAD could be differentiated from individuals with other anxiety disorders based on IU (Ladouceur et al., 1999). The causal link between IU and worry is also supported by treatment research showing that CBT with a focus on IU for people with GAD can lead to a decrease in worry and IU as well as high rates of treatment success as most were free from GAD diagnosis (e.g. Dugas et al., 2003; Ladouceur, Dugas, et al., 2000). Treatments that target IU and changes in IU in generic CBT are discussed further in section 1.3.2 below. An experimental study, in which a computerized roulette game was used, has also supported a causal link between IU and worry (Ladouceur, Gosselin, & Dugas, 2000). In this study, tolerance of uncertainty was manipulated across conditions. One group of participants received information that lead them to believe their chance

of winning was low whereas the other group received information that their chance of winning was high, while the odds of winning were the same across groups. The results showed that participants in the latter group demonstrated higher levels of worry than participants in the former group. Whilst this provides some support for an association between uncertainty and worry, as IU is conceptualised as a trait measure, it is not clear that IU is in fact what was being manipulated in this study.

Although early theory and evidence related to IU focused on worry and GAD, more recent work has shown that IU may in fact be a transdiagnostic factor that has relevance across anxiety disorders. For example, individuals with obsessive compulsive disorder (OCD) who have checking compulsions have been found to have higher IU than those without checking compulsions and individuals with no anxiety diagnoses (Tolin, Abramowitz, Brigidi, & Foa, 2003). Further, Holaway, Heimberg, and Coles (2006) also showed that individuals with OCD and GAD do not differ on IU, although both groups report higher IU than controls with no diagnosis. More recently, IU has been found to be significantly associated with social anxiety disorder (Boelen & Reijntjes, 2009; Carleton, Collimore, & Asmundson, 2010), panic disorder (Carleton et al., 2014; Carleton, Fetzner, Hackl, & McEvoy, 2013), post-traumatic stress disorder (Bardeen, Fergus, & Wu, 2013; Fetzner, Horswill, Boelen, & Carleton, 2013; Oglesby, Boffa, Short, Raines, & Schmidt, 2016) and adult separation anxiety (Boelen, Reijntjes, & Carleton, 2014), indicating IU as a transdiagnostic risk factor across anxiety disorders.

A recent review highlighted that there are significant gaps in understanding of IU, especially in relation to its developmental origins, normative responses to uncertainty, and behavioural manifestations (Shihata, McEvoy, Mullan, & Carleton, 2016). The original IU model was developed within the context of GAD and, with the recent research highlighting the transdiagnostic nature of IU across anxiety disorders, there is a need for transdiagnostic models of IU in anxiety disorders along with an in-depth research to clarify the role of IU across anxiety disorders. Einstein (2014)proposed a transdiagnostic model of IU for anxiety disorders which is based on evidence from factor analytic studies of IU questionnaire measures. From the factor analytic studies, two factors suggested to underlie IU were “need for predictability” and “uncertainty arousal/paralysis” and these factors were differentially associated with different forms of anxious psychopathology. The former was more closely associated with apprehensive anxiety problems

such as OCD and GAD whereas the latter was more significantly associated with present-focus anxiety problems such as social anxiety and panic disorder (Carleton, Collimore, et al., 2010; Carleton, Sharpe, & Asmundson, 2007; Hong, 2015). The transdiagnostic model of IU for anxiety disorders suggested by Einstein (2014) hypothesized that multiple previews of the future are generated when faced with uncertainty leading individuals to make a threat estimate that is exaggerated and activates emotional arousal if uncertainty is in areas of personal importance (e.g. negative social evaluation for social anxiety disorder/ physiological symptoms indicating illness for panic disorder). When threat expectancy is present, individuals with high need for predictability will sustain uncertainty arousal for a time and will display safety behaviours, rumination, or reassurance seeking to eliminate threat expectancy whereas uncertainty arousal will be short for individuals with low need for predictability and they will display reorganization of threat expectancy (Einstein, 2014).

There is another transdiagnostic model, which is related with IU. Although this model is not centred on IU, it is closely related to IU and the perspective provided in the model has potential implications for IU and anxiety disorders. Carleton (2016a) recently argued that 'fear of the unknown' may be the fundamental fear underpinning anxiety disorders. He described the concept as "an individual's propensity to experience fear caused by the perceived absence of information at any level of consciousness or point of processing" (p. 5). It is argued that individuals with social anxiety disorder and panic disorder for example, may be anxious about different, specific threats but that across all anxiety disorders there is anticipatory anxiety related to fear of the unknown as timing, duration, and the intensity of threat is unpredictable and uncertain.

1.3.2 IU in the Treatment of Anxiety Disorders

Theory regarding the role of IU in anxiety psychopathology (e.g. Dugas et al., 1998) and robust associations of IU with anxiety and worry motivated the development of treatments, which target IU. Dugas and Ladouceur (2000) developed a cognitive-behavioural intervention which aimed to increase tolerance of uncertainty for adults with a GAD diagnosis. In a pilot study, the treatment was effective, with three out of four participants no longer having a GAD diagnosis at a post-treatment assessment or

at 6-month follow-up. A further investigation using an RCT design with a relatively small sample (N=14 for treatment group and N=12 delayed treatment control group) showed that IU significantly decreased over treatment in the treatment group relative to the waitlist group and that 77% of the participants were free from GAD diagnosis following treatment (Ladouceur, Dugas, et al., 2000).

The efficacy of a CBT treatment targeting IU, beliefs about worry, poor problem orientation, and cognitive avoidance in group-therapy has also been examined using an RCT design with 52 adults diagnosed with GAD (N=25 for treatment group and N=27 for wait-list). The results revealed post-test improvement on worry, anxiety, IU, and depression (Dugas et al., 2003). Comparison of this CBT treatment based on the IU model of GAD versus applied relaxation based on general theories of anxiety and wait-list controls also confirmed the superiority or targeting IU in treatment at post-treatment and follow-ups (Dugas et al., 2010). The potential importance of focusing on IU is demonstrated by Bomyea et al. (2015) who assessed IU and worry bi-weekly during a CBT treatment targeting IU. Their results showed that changes in IU preceded changes in worry but not vice versa, thus indicating a potential causal role of IU in worry.

There is also treatment research which has supported the efficacy of targeting IU in treatment for panic disorder and social anxiety disorder, along with CBT treatments showing reductions in IU and anxiety symptoms (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013; Hewitt, Egan, & Rees, 2009; Mahoney & McEvoy, 2012b; McEvoy & Erceg-Hurn, 2016; Talkovsky & Norton, 2016). This body of research is consistent with the transdiagnostic nature of IU across anxiety disorders and suggests that changes in IU may drive post-treatment improvements in anxiety; however, the mechanisms underlying the change process remains unclear. Further research is needed to evaluate specific therapeutic approaches that contribute to changes in IU. In addition there are models for transdiagnostic IU treatment (Einstein, 2014) and for disorder-specific IU (Thibodeau et al., 2015); however, empirical research is required to explore the efficacy of these approaches.

1.3.3 IU Assessment in Adults

Individual differences in IU have primarily been measured using subjective questionnaire measures

and there are several self-report measures designed to assess IU. The original measure of IU was created by Freeston, Rhéaume, Letarte, Dugas, and Ladouceur (1994). This measure included 27 items and was designed to assess responses to uncertainty on a 5-point Likert-type scale (Intolerance of Uncertainty Scale – IUS). The scale showed excellent internal consistency, test-retest reliability, and construct validity. Initial factor analytic studies revealed inconsistent number of factors across studies along with unstable and redundant items (Buhr & Dugas, 2002; Freeston et al., 1994; Norton, 2005). This led to the development of 12-item short form of the IUS. The short form of the scale demonstrated excellent internal consistency and a stable two-factor structure in clinical and non-clinical samples (Carleton, Norton, & Asmundson, 2007; Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013; McEvoy & Mahoney, 2011). These factors are labelled *prospective IU* and *inhibitory IU*. The first refers to desire for predictability indicating a future-focused perspective and is more strongly associated with GAD and OCD (Hong, 2015; McEvoy & Mahoney, 2011). The latter refers to avoidance and paralysis when faced with uncertainty indicating a present-focused perspective. This inhibitory IU is more strongly associated with social anxiety and panic disorder (Carleton, Collimore, et al., 2010; Carleton, Sharpe, et al., 2007). The subscales of IU are associated with distinct anxiety profiles as prospective IU was linked with anxiety disorders characterized by worry and anticipation while inhibitory IU was linked with anxiety disorders characterized by avoidance and paralysis. This distinction is analogous to the fear-anxiety distinction described earlier in the section 1.2, with anxiety being future-focused and fear present-focused.

Concerns that the IUS items do not satisfactorily correspond to the definition of IU led to the development of another measure of IU, the Intolerance of Uncertainty Inventory (IUI). This is a 45-item measure consisting of two parts designed to distinguish between trait IU on the one hand and associated behavioural and cognitive expressions of IU on the other hand (Gosselin et al., 2008). The instrument has demonstrated good reliability, temporal stability, and convergent validity (Carleton, Gosselin, & Asmundson, 2010; Gosselin et al., 2008).

Later, Mahoney and McEvoy (2012a) developed an IU Scale- Situation Specific (IUS-SS), which is a modified version of IUS-12 in which respondents complete 12 items referring to specific situations. IUS-SS is designed as a measure of IU in relation to diagnostically relevant situations (social evaluative

domain, worry domain, panic domain, and intrusive thoughts/repetitive behaviours). It has demonstrated excellent internal consistency, good convergent and divergent validity, unitary factor structure, and supports the transdiagnostic nature of IU (Mahoney & McEvoy, 2012a).

Most recently Thibodeau et al. (2015) developed a 24 –item Disorder-Specific IU Scale (DSIU) to expand the scope of existing IU measures in order to identify the nature and intensity of the IU. The DSIU consists of 8 subscales in the context of various anxiety disorders (e.g. GAD< OCD, social anxiety, panic disorder, specific phobia, PTSD, major depression, and health anxiety). Although evidence is needed for the stability and the clinical validity of the DSIU as the sample was non-clinical, the scale demonstrates high reliability and convergent validity (Thibodeau et al., 2015).

As summarized above, there are various measures to assess IU in adults, with each measure having different strengths and weaknesses. The IUS-12 and IUI assess general reactions to uncertainty, whereas IUS-SS and DSIU assess IU that is diagnostically relevant. Even within these categories there is inconsistency in the operational definitions of IU across measures. For example, the IUS corresponds to the definition of IU provided by Freeston et al. (1994) whereas the IUI assesses IU as a tendency to find uncertainty acceptable, which corresponds to the definition Dugas et al. (2001) and Gosselin et al. (2008). Although both of these measures significantly correlate, each assess different aspect of IU (Fergus, 2013). Certainly, the development of these IU measures initiated research in this field, which has led to significant advances in our understanding of IU and anxiety. However, there is a level of complexity introduced by the range of measures available. At this time there is no accepted 'best' measure of IU in adults. In contrast, there is currently only one measure of IU designed for children and adolescents.

1.3.4 IU Assessment in Children and Young People

A measure to assess IU in children and young people was also developed in the last decade and is a downward extension of the IUS, the first measure to assess IU in adults. The Intolerance of Uncertainty Scale for Children (IUS-C) is designed to be administered to youth between the ages of 7 and 17 and comes with two parallel forms (parent and child report). The IUS-C shows stronger associations with worry and anxiety in clinical samples than in community samples (Comer et al., 2009) and scores on

the IUS-C scores are particularly associated with GAD and anxiety severity (Read, Comer, & Kendall, 2013). Although both forms shows favourable psychometric properties, the scale has less favourable psychometric properties for children younger than 9 years and there is a poor agreement between child and parent forms (Comer et al., 2009). Poor agreement between child and parents forms is common for self-reports of such nature; however, it also raises questions about which one is more accurate / reliable. Questionnaires of this nature are also a good candidate for test-retest reliability; however, to date no studies have investigated the test-retest reliability of the IUS-C. Furthermore only one study has examined the factor structure, however this did confirm a two factor structure for the 12 items IUS-C which was consistent with what has been found in adult studies (Cornacchio et al., 2017).

Sanchez et al. (2017) recently developed a measure of IU (Responses to Uncertainty and Low Environmental Structure-RULES) which is a 17-item parent-report measure of children's responses to uncertainty. The RULES also demonstrated convergent, divergent, and predictive validity along with strong internal consistency and showed more favourable psychometric properties and relatively stronger predictive validity then the parent-report IUS-C (Sanchez et al., 2017).

To summarize, limited research has focused on measuring IU in young people and more research is needed in this area. For example test-retest reliability, the reason for the poor agreement between child and parent forms, the factor structure of the IUS-C, and the clinical relevance of these factors remains to be explored. It is also important to point out that IU is typically assessed by self-report which is subject to response bias, shared method variance with measures of anxiety and depression, and are limited in that they can only measure what the reporter is consciously aware of and willing to share. It will be important for future work to develop behavioural measures that can capture IU to move the field beyond the reliance on questionnaires.

1.3.5 Developmental Changes

Despite the promise and advancement of IU research in adults, research with children and young people within the context of anxiety is relatively new. Given that there are significant developmental changes in the processing of uncertainty (e.g. Robinson et al., 2006), we must be cautious about

generalising findings from adults to children. This emerging area of research has only recently started to get attention from researchers (Donovan, Holmes, & Farrell, 2016; Donovan, Holmes, Farrell, & Hearn, 2017; Read et al., 2013). The majority of research to date has included community samples of children and adolescents across a wide age range. As such, it is not yet clear how robust associations between IU and anxiety and worry are in children and adolescents and whether there are age-related differences in associations.

Child and adolescent research is often a downward extension of adult research. When this happens, there is an assumption that adult models and constructs are applicable to children. However, in the case of IU, there are good reasons for taking a critical view of this approach, primarily because metacognitive skills around uncertainty undergo significant development during childhood and adolescence (e.g. Roebers & Howie, 2003; Roebers, von der Linden, & Howie, 2007; Weil et al., 2013). For example, children as young as 3 years old show evidence of awareness of their subjective uncertainty as they are able to reflect on their likely accuracy. Importantly however, their ability to discriminate their own accuracy from inaccuracy increases with age (Lyons & Ghetti, 2011) and continues to improve until elementary school years (Roebers & Howie, 2003; Roebers et al., 2007). This indicates that, whilst young children are aware of uncertainty, sophisticated understanding and reasoning about uncertainty continues to develop for a number of years. Further evidence for this comes from research showing that 5-6 years olds overestimate their knowledge and are less likely to engage in information seeking than 7-8 years old (Beck & Robinson, 2001). Children also demonstrate strategic behaviours under subjective uncertainty such as withholding an answer (Lyons & Ghetti, 2013) or asking for help from around the age of 4.5 (Beran et al., 2012). Yet being able to make more than one possible interpretation under uncertain circumstances or making a tentative interpretation in such events develops gradually (Moshman, 2004). As awareness and reflection on uncertainty develops gradually, a direct downward extension of the adult IU assessments and models may not be appropriate for children.

Ultimately, the applicability of the IU model suggested by Dugas et al. (1998) to children and adolescents needs to be tested. If the IU model of GAD is not appropriate for children, this means that there is no theory to underpin and direct research related to IU in children. Fialko, Bolton, and Perrin (2012)

examined this in children and adolescents by collecting self-report data on worry, anxiety, IU, cognitive avoidance, and positive beliefs about worry. The results suggested that IU is a higher order cognitive vulnerability factor for both positive beliefs about worry and cognitive avoidance in adolescents (13-19 years) but only for cognitive avoidance in children (7-12 years). Thus, there is some support that the GAD model of Dugas and colleagues applies to children, although this study was based on a non-clinical sample. In adults, IU is indicated as a transdiagnostic risk factor across anxiety disorders, not specific to GAD and a transdiagnostic model of IU across anxiety disorders has also recently developed by (Einstein, 2014). Considering the developmental differences in the processing uncertainty and possible different pathways from IU to anxiety and worry in children and adolescents, the transdiagnostic nature of IU in young people is yet to be confirmed. In addition, little is currently understood about the development of IU and there is a need for longitudinal research to examine whether IU is a fixed factor over the course of development and whether IU acts as a risk factor for the development of anxiety disorders. However, for this important work to be conducted, theoretically and developmentally sound measures of IU for young people are required.

1.4 General aims of the thesis

There is a lack of developmentally sensitive research within the context of IU and uncertainty-related anxiety in young people. The overall aim of the thesis is to gain a greater understanding of IU within children and adolescents in the context of anxiety. Therefore, the first aim is to review the literature and to examine the existing evidence systematically in order to evaluate the nature and quality of the association between IU and both anxiety and worry in children and young people (see chapter 2). On the basis of the systematic review, recommendations will be made about gaps in the literature and important next steps in IU research. These recommendations will be discussed in chapter 3. The second aim is to begin addressing an important issue for the field: the assessment of IU in preadolescent children. This aim is addressed in chapters 4, 5, and 6.

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Chapter 2 – Study 1: Intolerance of Uncertainty, Anxiety, and Worry in Children and Adolescents: A meta-analysis

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Please note Tables and Figures referred to in the Paper can be found at the end of the manuscript.

Abstract

Background

Intolerance of uncertainty (IU) has been implicated in the development and maintenance of worry and anxiety in adults and there is an increasing interest in the role that IU may play in anxiety and worry in children and adolescents.

Method

We conducted a systematic review and meta-analysis to summarize existing research on IU with regard to anxiety and worry in young people, and to provide a context for considering future directions in this area of research. The systematic review yielded 31 studies that investigated the association of IU with either anxiety or worry in children and adolescents.

Results

The meta-analysis showed that IU accounted for 36% of the variance in anxiety and 39.69% in worry. Due to the low number of studies and methodological factors, examination of potential moderators was limited; and of those we were able to examine, none were significant moderators of either association. Most studies relied on questionnaire measures of IU, anxiety, and worry; all studies except one were cross-sectional and the majority of the studies were with community samples.

Limitations

The inclusion of eligible studies was limited to studies published in English that focus on typically developing children.

Conclusions

There is a strong association between IU and both anxiety and worry in young people therefore IU may be a relevant construct to target in treatment. To extend the existing literature, future research should incorporate longitudinal and experimental designs, and include samples of young people who have a range of anxiety disorders.

2.1 Introduction

Anxiety disorders are among the most common mental health problems; the lifetime prevalence of anxiety disorders is estimated as 28.8% with onset usually in childhood and adolescence (Kessler et al., 2005). Anxiety disorders follow a chronic course (Costello et al., 2003), affect daily life (Jarrett et al., 2015; Paulus et al., 2015), and are associated with significant global burden (Whiteford et al., 2013). Cognitive Behaviour Therapy (CBT) for anxiety disorders in young people is effective, with recent data showing 58.9% of the children and adolescents were free from any anxiety diagnosis following CBT (James et al., 2015). However, this leaves a substantial proportion of young people who continue to have an anxiety diagnosis after completing CBT. As such, there is significant scope to improve treatments. To inform the advancement of treatment, we require a better understanding of the factors that underpin the development and maintenance of anxiety disorders in children and adolescents.

Intolerance of Uncertainty (IU) has been defined in a number of ways. Most recently as "an individual's dispositional incapacity to endure an aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016b). At the core of IU is fear of the unknown (Carleton, 2016a). IU based models of worry hypothesize that individuals with high IU will be more prone to engage in worry as IU sets off a chain of worrying, negative problem orientation and cognitive avoidance as well as directly affecting problem orientation and cognitive avoidance (Dugas and Koerner, 2005). These models have received empirical support and there is evidence that IU has an important role in the maintenance of anxiety disorders in adults.

Although early work on IU focused on the association with generalized anxiety disorder (GAD), there is now evidence that IU might be a transdiagnostic risk factor for the development and maintenance of clinically significant anxiety more broadly as well as for depression (Carleton et al., 2010; Holaway et al., 2006; McEvoy and Mahoney, 2011; Norr et al., 2013; Tolin et al., 2003). Indeed, a meta-analysis of the association between IU and GAD, obsessive-compulsive disorder (OCD), and major depressive disorder (MDD) revealed IU as a shared factor in all three syndromes in adults (Gentes and Ruscio, 2011).

Further, a recent meta-analysis revealed that six cognitive vulnerability factors associated with anxiety and depression (pessimistic inferential style, dysfunctional attitudes, rumination, anxiety sensitivity, IU, and fear of negative evaluation) loaded onto a single factor. Of these, IU had the strongest factor loading, further indicating that IU may be linked to both anxiety and depression (Hong and Cheung, 2015).

Treatment research in adults has highlighted the potential benefit of focusing on IU; treatments that target tolerating uncertainty have been found to reduce symptoms of GAD (Dugas and Ladouceur, 2000; Dugas et al., 2003; van der Heiden et al., 2012), and social phobia (Mahoney and McEvoy, 2012). Furthermore, in transdiagnostic CBT for adults with heterogeneous anxiety and depressive disorders, changes in IU across treatment significantly predicted changes in anxiety and depressive symptoms (Boswell et al., 2013). Examination of the factors underlying IU sets the stage for more specific targeted interventions. For example, prospective IU, which is characterized by the desire for predictability, is associated with worry and anticipatory apprehension, while inhibitory IU, which is a more immediate behaviourally focused facet of IU, is linked with social anxiety and depression (Hong, 2015).

Despite the extensive body of research examining IU in adults and the clinical promise of this work, relatively little research has examined the association of IU with anxiety and worry in children and adolescents. The significant association of IU with anxiety and worry found in adults may not translate directly into a similar association for young people because the ability to detect and reason about uncertainty develops across childhood and adolescence. The basic cognitive skills necessary for detecting and responding to uncertainty are present from a very young age (Lyons and Ghetti, 2011, 2013; Roebers et al., 2007). For example infants as young as 20 months old show evidence of introspective awareness which is a necessary skill to detect knowledge gaps and to experience uncertainty (Goupil et al., 2016); children as young as 4 years old implicitly demonstrate that they are able to identify multiple possibilities when uncertainty exists both in their mind and in the physical world (Robinson et al., 2006), and children as young as 4.5 years old are able to monitor their perceived uncertainty and ask for help under uncertain circumstances (Beran et al., 2012).

Although children may be aware of uncertainty and able to respond to uncertainty from a young

age, many cognitive processes related to uncertainty continue to develop through middle childhood and adolescence. For example introspective awareness continues to improve through to the elementary school years (Roebers and Howie, 2003; Roebers et al., 2007). Similarly, meta-cognitive skills such as holding possible predicted outcomes in mind, delaying making an interpretation until further information is received or making a tentative interpretation whilst being open to adjusting this interpretation in light of new information, and asking for help in response to uncertainty develop gradually (Moshman, 2004; Weil et al., 2013). As the cognitive skills necessary for reasoning about uncertainty develop, it seems likely that the nature of IU and the association between IU and anxiety and worry may change. Despite this, to our knowledge there is no data that indicates whether IU develops linearly with age or waxes and wanes throughout development and there has been little consideration of how age might affect the association between IU and anxiety and worry.

An emerging body of research has begun to examine IU in the context of anxiety and worry in young people, with studies including children (e.g. Kertz and Woodruff-Borden, 2013) and adolescents (e.g. Laugesen et al., 2003). Age and gender split vary widely across studies and most of the studies include children and young people from broad age ranges such as age 4–18 years. In general, there appears to be a lack of consideration of the effects of age and gender on the associations between IU and both anxiety and worry. Where they have been examined, results appear to be inconsistent. For example, while the link between IU and worry was not moderated by gender in one study (Boelen et al., 2010); in another study IU was found to be associated with worry in females only (Barahmand, 2008). As such, it is not clear what effect age and gender have on the strength of the association of IU with anxiety and worry in young people.

In making sense of divergent findings, it is important to note that methods vary considerably across studies including the study population (clinical vs community), method of anxiety assessment (questionnaire vs diagnostic interview), the measure used to assess IU, the person who reports on the child's anxiety and IU, and study design (cross-sectional or longitudinal). Variation in each of these factors may also influence the magnitude of the associations between IU and both anxiety and worry.

Considering the promise of IU based psychological therapies with adults, it is timely to examine what we know about IU in young people in the context of anxiety and worry and to consider directions for future work in this field. To date there has been no systematic review of IU in relation to child and adolescent anxiety or worry. The aims of this review are therefore 1) to examine the existing evidence for an association between IU and both anxiety and worry in children and adolescents by conducting a meta-analysis; 2) to provide a summary of the critical gaps in the existing literature and the priorities for future work in this area. More specifically, the meta-analysis has 3 objectives: 1) to estimate the mean association between IU and anxiety in children and adolescents, 2) to estimate the mean association between IU and worry in children and adolescents, 3) to test whether these associations are moderated by age, gender, sample type, study design, method of anxiety assessment, IU questionnaire used, and informant of anxiety, worry, and IU. The focus in this work is on worry and anxiety; to our knowledge only one study examined IU and depression in young people (Boelen et al., 2010); therefore, a meta-analysis of an association of IU and depression in young people would be premature.

2.2 Method

2.2.1 Eligibility criteria

Studies were included in the meta-analysis if they met each of the following eligibility criteria:

1. The study must be based upon empirical research. Only research that offers extractable quantitative data is included. Reviews, presentations, and posters are not included due to the potential for overlap with published data.

2.The sample consists of child and adolescent participants, defined as all participants in the study must be under the age of 21 years with a mean age <18 years.

3. Participants are children and adolescents without a diagnosed developmental disorder.

4. Studies include at least one standardized measure of child/adolescent anxiety (state or trait) or worry, completed by either the child/adolescent or parents. Questionnaires must show internal consistency of at least .7 and evidence of construct validity. If a standardized semi-structured diagnostic

interview is used, there is evidence of inter-rater reliability of at least .7 and evidence construct validity. Interviews can be completed either with child, parent, or both.

5. Studies include at least one measure of IU, completed by either the child or parent. The measure is described in the study as a measure of IU by the authors.

6. The association of IU with anxiety or worry is available (reported or provided by the authors).

7. Studies are written in English. Non-English papers are not included due to lack of resources and facilities for translation.

2.2.2 Preliminary search strategy

The literature search was conducted in May 2017 using Web of Science, PubMed, ScienceDirect, and Psych Info/ PsychArticles to identify studies published between 1990 and May 2017. The search was limited within the years from 1990 to 2017 as the term IU was first coined in 1994 (Freeston et al., 1994). We used 14 anxiety related key terms, anxi*, worry, anxi* disorder, fear, GAD, OCD, SA, obsess*, compul*, panic, generali* anxiety disorder, phobi*, social anxiety, and separation anxiety. These were crossed with key terms to identify intolerance of uncertainty dimensions: "intolerance of uncertainty", "need for certainty", "need for predictability"," intolerance of ambiguity", and "need for cognitive closure". The bibliographic software, EndNote, was utilized to import references from electronic databases. Titles and abstracts were screened based on criteria 1, 2 and 7 to select the studies that were eligible for the full-text assessment. The full text assessment was then conducted to identify eligible studies for the review based on all inclusion criteria listed. Next, the reference lists of the studies meeting all inclusion criteria were hand searched in order to identify further studies of interest. In addition, first and corresponding authors of the eligible studies were contacted to request any unpublished, further published, under review or in-press studies that had not yet been indexed by electronic databases. Response rate from these authors was 75%. Whilst conducting the review we were made aware of four additional unpublished datasets (Dodd and Taylor, 2015; Freeston et al., 2015; Morriss et al., 2014; Osmanagaoglu et al., 2017) that were relevant and these were also included to ensure the review was as complete as possible (see Figure 1, p.61).

2.2.3 Study selection

The screening process for inclusion was conducted by a single first coder (NO) and shared between two second coders (MT & CLP), all three were postgraduate students. Initially assessors independently screened the titles and abstracts of the publications. All studies regarded as eligible by either first or second coder were included for further assessment. Inter-assessor reliability between the first and second coders for whether studies met the eligibility criteria at this stage was high (Kappa = .97). Subsequently, coders independently screened full-text versions of these studies and inter-coder reliability for inclusion/exclusion at this stage was Kappa = .96. Any disagreements at this stage were discussed and resolved by consensus with the second author (CC) after referring to the protocol. Fig. 1 (p. 61) provides a flow chart showing the studies remaining at each stage. Where studies met all criteria to be included, corresponding and first authors were contacted to request missing data. The electronic database search resulted in 23 studies that were eligible for the analysis. Additional data for 8 studies (4 unpublished data and 4 under review) were also available, resulting in 31 eligible studies in total.

2.2.4 Quality assessment

Quality assessment is an integral part of a systematic review and there are several instruments developed to assess the quality of studies included in a systematic review. However there is no agreed gold standard tool for evaluating the quality of studies. In this review, we have used a 13-item checklist adapted from Moncrieff et al. (2001). The 13-items that were applicable for this review were: (1) description of objectives and questions of the study, (2) magnitude of the sample size, (3) evidence of power calculation, (4) source of subjects, (5) description of sample demographics, (6) use of diagnostic criteria, (7) explicit statement of inclusion/exclusion criteria and number of exclusions reported, (8) clear description of outcome measures, (9) inclusion of all subjects in the analysis, (10) description of analytic method, (11) presentation of results, (12) conclusion of the results, (13) and declaration of interest. All 13 items were rated on a scale from 0 to 2 (0 = 'no', 1 = 'partial', and 2 = 'yes'). One item on the checklist was only applicable to some studies (use of diagnostic criteria); therefore, the mean score was calculated for each study (see Table 1, p. 64). Enough information to conduct the full quality assessment was

available for the 23 published studies and two of the additional studies identified through contact with corresponding authors. The quality of eligible studies was evaluated by a single first assessor (NO) and one of two second assessors (MT&CLP), a high reliability was found based on the 25 studies included in the quality assessment. The average measure ICC was .82 with a 95% confidence interval .59–. 92 ($F(24, 24) = 5.59$, $p<.001$).

2.2.5 Data extraction

One reviewer (NO) extracted the data, and two postgraduate students (MT&CLP) checked the data that had been extracted correctly for all items. Study authors were contacted where there was missing data or additional data needed. For each study, the following information was extracted: (a) background and demographic information including study location and design, (b) number of participants, (c) participants' age range and mean age, (d) child/adolescent gender, (e) sample type (clinical/community), (f) for longitudinal studies, assessment time points, (g) how anxiety was measured (questionnaire, interview), (g) anxiety measure used, (h) anxiety informant, (i) how worry is measured, (j) worry measure used, (k) worry informant, (l) how IU was measured, (m) IU measure used, (n) IU informant, (o) findings, (p) effect sizes, (r), any ethical issues or source of bias.

2.2.6 Study sample

Table 1 (p.64) provides the details of the data extracted for each of the 31 eligible studies. Here we provide an overview of these studies. All 31 studies that were eligible for the meta-analysis were conducted within the last decade. Nine studies were conducted in the U.S.A (Comer et al., 2009; Cornacchio et al., under-review; Cowie et al., 2016; Kertz and Woodruff-Borden, 2013; Krain et al., 2008; Krain et al., 2006; Read et al., 2013; Sanchez et al., 2017; Sanchez et al., 2016), eight in the U.K. (Boulter et al., 2014; Dodd and Taylor, 2015; Fialko et al., 2012; Freeston et al., 2015; Morriss et al., 2014; Neil et al., 2016; Osmanagaoglu et al., 2017; Perrin et al., under review), three in Canada (Dugas et al., 2012; Laugesen et al., 2003; Wright et al., 2016), three in Australia (Donovan et al., 2016, 2017; Hearn et al., 2017), two in Sweden (Cervin et al., under review), two in the Netherlands (Boelen et al., 2010; Dekkers, Jansen et al., 2017), one in Iran (Barahmand, 2008), one in Germany (Thielsch et al.,

2015), one in China (Lin et al., 2017), and one in Italy (Aloi and Segura-Garcia, 2016). One study also included data on participants outside the age range of our criteria (Krain et al., 2006) and two included children with a developmental disorder (Boulter et al., 2014; Neil et al., 2016). In these cases effect sizes were extracted for data that only referred to typically developing participants and participants within our specified age range. Of the eligible studies, 29 out of 31 were cross-sectional. The remaining two studies were a randomised control trial of CBT for GAD (Perrin et al., under review) and a longitudinal study with 10 distinct time points (Dugas et al., 2012) respectively. Multiple relevant effect sizes (ES) were available at several but not all time points in the later study; therefore, the ES from the first time point provided was included in the analysis (see Table 1, p.64).

Most of the participants in the eligible studies were recruited through schools and by local advertisement. Ten studies included clinical participants drawn from child study centres/clinics (Cervin et al., under review; Comer et al., 2009; Cornacchio et al., under-review; Cowie et al., 2016; Donovan et al., 2016; Hearn et al., 2017; Krain et al., 2008; Perrin et al., under review; Read et al., 2013; Sanchez et al., 2017). The sample size of individual studies ranged from 12 to 2286 and the overall age range was 3–20 years. Ethnic composition of the samples were available in 15 studies (Comer et al., 2009; Cornacchio et al., under-review; Cowie et al., 2016; Dodd and Taylor, 2015; Donovan et al., 2016; Donovan et al., 2017; Dugas et al., 2012; Fialko et al., 2012; Hearn et al., 2017; Kertz and Woodruff-Borden, 2013; Laugesen et al., 2003; Read et al., 2013; Sanchez et al., 2017; Sanchez et al., 2016; Wright et al., 2016). For most of these studies the majority of participants were Caucasian; two studies had a majority of Hispanic participants (Cornacchio et al., under-review; Sanchez et al., 2017) and in one study half of the sample were African American (Sanchez et al., 2016). Socio-economic level of the participants was available in nine studies; in six of these studies the majority of the participants came from middle and high SES (Comer et al., 2009; Dodd and Taylor, 2015; Donovan et al., 2016; Hearn et al., 2017; Laugesen et al., 2003; Sanchez et al., 2017), and participants were mostly of low SES in three studies (Fialko et al., 2012; Sanchez et al., 2016; Wright et al., 2016). Two studies reported family intactness; with 72.3% (Dugas et al., 2012) of the participants reported to have intact families and 79.82% (Donovan et al., 2017) of the participants living with both parents.

Anxiety was measured in 26 studies; however, the correlation between anxiety and IU was only available in 24. Of these 24 studies, 20 relied on questionnaire measures only for anxiety assessment, two of them only used a diagnostic interview with clinical severity ratings (Donovan et al., 2016; Read et al., 2013), and two used both questionnaires and clinical severity ratings (Cowie et al., 2016; Hearn et al., 2017). In the latter case, the association between IU and the questionnaire measure of anxiety was included in the analysis as it provides a more general measure of anxiety. Worry was measured in 22 studies and all of these reported the correlation between the worry measure and IU. All studies used a child self-report questionnaire measure for worry. IU was measured using questionnaire measures in all 31 studies; seven studies used the Intolerance of Uncertainty Scale for Children (IUS-C) child report (Cowie et al., 2016; Dodd and Taylor, 2015; Donovan et al., 2016, 2017; Kertz and Woodruff-Borden, 2013; Osmanagaoglu et al., 2017; Read et al., 2013), three studies used the IUS-C parent report (Neil et al., 2016; Sanchez et al., 2017, 2016), three studies used both the parent and child report of IUS-C (Boulter et al., 2014; Comer et al., 2009; Cornacchio et al., under-review), eight studies used the Intolerance of Uncertainty Scale (IUS) which is a standardized adult measure to assess IU (Aloi and Segura-Garcia, 2016; Barahmand, 2008; Dugas et al., 2012; Krain et al., 2008, 2006; Laugesen et al., 2003; Morriss et al., 2014; Thielsch et al., 2015), six studies used the IUS-12 which is a shortened version of the IUS (Boelen et al., 2010; Dekkers et al., 2017; Freeston et al., 2015; Hearn et al., 2017; Lin et al., 2017; Wright et al., 2016), and four studies assessed IU by using only 5 items from the IUS (Cervin et al., under review; Fialko et al., 2012; Lunderg et al., under-review). Where both child and parent reported IU was available, the child report was used in the analysis, as there is poor agreement between parent and child report of IU; and it has been suggested that children are better reporters of their own IU (Comer et al., 2009). Where multiple effect sizes for the association between IU and both anxiety and worry were reported for independent subgroups such as male and female (Barahmand, 2008), summary effects were calculated across subgroups in order for each study to contribute one ES to the analysis (Borenstein et al., 2009).

2.2.7 Meta-analytic method

Pearson's product-moment correlation coefficient (r) was chosen as the effect size for this meta-analysis as r is readily interpretable in terms of practical importance and in comparison to other effect sizes (Field, 2001; Rosenthal and DiMatteo, 2001). Meta-analyses were conducted using RStudio (version 3.2.3) and the Metafor package (Viechtbauer, 2010). The Hedges-Olkin approach (Hedges and Olkin, 1985) was applied. A random-effects model was chosen as this approach allows meta-analytic results to be generalized to a more extensive population of studies (Field, 2001). To interpret the effect sizes Cohen (1988) guidelines were used (small effect r =.10, moderate effect r =.30, large effect r =.50).

Two separate meta-analyses were carried out, one for the association between IU and anxiety, and one for the association between IU and worry. To assess heterogeneity Chi^2 test and I2 statistic were used. 95% confidence intervals were calculated for the associations between IU and anxiety and for IU and worry. Fisher's Z was used for the meta-analysis, and the final reported effect size was converted back to Pearson r. Funnel and forest plots were created to provide a visual representation of the data and to facilitate examination of publication bias. Rank correlation (Begg and Mazumdar, 1994) and regression tests (Egger et al., 1997) were then conducted to assess the evidence of publication bias. In addition, Rosenthal's fail-safe N (Rosenthal, 1979) was conducted to assess whether the effects of the analyses were artefacts of publication bias.

The following variables were extracted as potential moderators: mean age, gender (coded as proportion male), study population (coded as the proportion of the sample that were from a clinical population), method of anxiety assessment (questionnaire vs diagnostic interview), measure used to assess IU, and study design (cross-sectional vs longitudinal). Moderator analysis is suitable to conduct when there are at least four studies in each subcategory (Bakermans-Kranenburg, 2003). Due to the limited number of studies and variability/non variability of the measures used in the studies, only age, gender, sample type (proportion of the clinical participants), and IU measure were taken into account as moderator variables. Meta-regression analysis was conducted when the moderator variable was a continuous variable to quantify the relationship between the magnitude of the moderator and the IU-anxiety/IU-worry effects (Borenstein et al., 2009).

2.3 Results

2.3.1 Meta-analysis of IU and anxiety

The meta-analysis examining the association between IU and anxiety (see Fig. 2, p.62) identified a significant mean ES of r = .60 (p < .001, 95%CI .55, .64) which meets the criteria for a large effect and suggests that IU explains 36.00% of the variance in anxiety. Heterogeneity was significant, Q (23) = 121.71, p < .001, I2=84.29%, indicating the presence of moderator variables; however, there was no significant moderator effect of age (QM (1) = .03, p = .86), gender (QM (1) = .81, p = .37), sample type (QM (1) = 1.26, p = .26), or IU measure (QM (4) = 2.94, p = .57) on the association of IU and anxiety.

2.3.2 Meta-analysis of IU and worry

The mean effect size for the association between IU and worry (see Fig. 3, p.63) was r = .63 (p < .001, 95%CI .58, .67) which meets the criteria for a large effect and suggests that IU was associated with approximately 39.69% of the variance in worry. There was significant heterogeneity, Q (21) = 108.28, p < .001, I2 = 84.98% suggesting the presence of moderator variables; however, no significant moderator effects of age (QM (1) = 3.05, p = .08), gender (QM (1) = .50, p = .48) sample type (QM (1) = .56, p = .45), or IU measure (QM (3) = 6.09, p =. 11) on the association between IU and worry were found.

2.3.3 Publication bias

Funnel plots were inspected for all analyses and no evidence for publication bias was found. The results of the rank correlation tests (Begg and Mazumdar, 1994) and regression tests (Egger et al., 1997) were all non-significant (smallest p = .50). For the association between IU and anxiety, the fail-safe N (Rosenthal, 1979) was 17943, suggesting 17943 studies with an effect size of zero would be required to increase the p-value of this analysis to above .05 (Orwin, 1983). For the association between IU and worry, a fail-safe N of 20939 was found.

2.4 Discussion

Consistent with the adult literature, this systematic review and meta-analysis revealed a strong positive correlation between IU and both anxiety and worry in children and adolescents. There was

significant heterogeneity between studies; however, the source of heterogeneity remains unclear. Few potentially moderating variables could be examined and, where they could, no significant moderator effects were found. The review revealed clear methodological limitations with the existing body of work. These limitations and the consequences of them will now be discussed in turn, along with associated recommendations for future research.

First, all but one of the studies eligible for this review was cross-sectional, thus little can be concluded about the direction of the association of IU with anxiety and worry. The only longitudinal study identified indicated that the relationship between IU and both anxiety and worry over time is likely reciprocal (Dugas et al., 2012). Further longitudinal research and experimental work that includes a manipulation of IU or anxiety is required to delineate the exact nature of the association between IU and anxiety, and IU and worry in young people. Given potential implications for intervention, it will be particularly valuable to test whether IU might play a causal role in the development and maintenance of anxiety disorders in young people. This fact has recently been highlighted by Shihata et al. (2016) who specifically called for focused research on IU in children and adolescents with longitudinal designs that are also able to examine the factors that may moderate IU throughout development.

Second, all studies measured IU using a questionnaire. Whilst questionnaires provide an efficient way of collecting data on a large sample, they are relatively limited in what they can tell us about the exact nature of IU and they are subject to limitations such as reporter bias and shared method variance with questionnaire measures of anxiety and worry. Now that a robust association of IU with anxiety and worry has been observed, it is time for the field to move beyond documenting these associations using questionnaires and to begin to consider more objective, behavioural and developmentally appropriate tasks that might provide insight into IU. An example can be seen in the work of Krain and colleagues (Krain et al., 2008, 2006) in which associations between anxiety and IU on the one hand and neural activation in response to certainty and uncertainty on the other hand, were examined. There is significant scope for more behavioural and experimental work of this nature. Behavioural tasks designed to measure reactions to uncertainty have a number of benefits over questionnaire measures. First, behavioural tasks are objective, which minimizes response bias and overcomes issues around shared method variance.

Further by observing reactions to certain vs uncertain situations, behavioural tasks have the potential to provide more nuanced insights into the nature of anxiety-linked IU. For example, through behavioural tasks it may be possible to capture distinct responses to uncertainty such as avoidance or information seeking under uncertain conditions, both of which could result from IU. In addition, it may be possible to gain insight into physiological responses to uncertainty, which individuals may not be consciously aware of and able to report.

A third limitation of the existing work relates to the questionnaire measures used. Less than half of the eligible studies (K=13) used the IUS-C, which was specifically developed for use with children. The remaining studies utilized questionnaire measures of IU which have been developed and validated for use with adults rather than children. No overall moderating effect of IU measure was found indicating that, overall, the association between IU and anxiety as well as worry if robust across IU measures. However, as most of the studies included a wide age range of participants, it remains possible that younger children may have experienced difficulty completing adult versions of the IU measures, which could have been masked at the group level. Given age related differences in the understanding of and response to uncertainty (Beck and Robinson, 2001; Lyons and Ghetti, 2011, 2013; Robinson et al., 2006; Roebers and Howie, 2003; Roebers et al., 2007), wherever possible, the measures used to capture IU should be designed to be appropriate for the developmental level of study participants. In addition, while the IUS-C demonstrates favourable psychometrics (Comer et al., 2009), this measure also has some limitations. In terms of psychometrics, the test-retest reliability of the questionnaire, both the child and parent form, has yet to be examined and the factor structure of the questionnaire needs to be explored. Although there is a support for a two-factor structure of the IUS-C (Cornacchio et al., under-review), consistent with that found for the adult measure (Birrell et al., 2011; Carleton et al., 2010; Sexton and Dugas, 2009), there is some evidence that parents may not be able to reliably report on IUS-C items which indicate future oriented cognition of their children (Cornacchio et al., under-review). Finally, the IUS-C is designed to measure IU in young people aged between 7 and 17 which is a broad age range considering the developmental changes that occur throughout childhood and adolescence. Younger children are more likely to have a difficult time understanding items (Cowie et al., 2016) and potentially

as a result; the scale shows poorer utility to distinguish children with and without anxiety disorders in younger (7–8) than older (9–15) participants (Comer et al., 2009). Taken together, there is clear scope to improve questionnaire measures of IU in young people.

Fourth, more than half the studies (K=22) relied exclusively on community participants and where participants with an anxiety diagnosis were included, most of these participants had a diagnosis of GAD. Note that this was true even of a study that focused on young people with social anxiety disorder, where almost 79% of the sample had comorbid GAD (Hearn et al., 2017). Although the association between IU and anxiety appears to be strong and robust, more work with clinical samples, including children with and without GAD is needed if we are to begin to consider how IU might be incorporated into treatment for child anxiety disorders and to examine questions about whether IU is disorder specific or transdiagnostic factor across anxiety disorders for young people.

Finally, design issues in the existing work limits the conclusions that can be made about moderators. Although there was significant unexplained heterogeneity in both associations of interest, neither age nor gender were significant moderators of either. This should be interpreted with caution given the limitations of existing work. The vast majority of studies included participants with a wide age range but did not consider the moderating effect of age. As such, only mean age could be used in the meta-analysis to capture age differences across studies. Given the large age ranges used, mean age is not a very informative statistic. Similarly, it was unusual for studies to report effects by gender so only the proportion of female participants could be used in the moderator analysis. Overall, there was insufficient evidence to conclude whether age and/or gender moderate either association.

The most comprehensive way of addressing how age affects the association between IU and anxiety/worry would be for studies to include large enough groups of participants within narrow age bands that the association can be estimated and compared for each age group. Alternatively, smaller studies conducted with focused samples of children within narrow age bands would provide an estimate of the associations at each age group and the moderating effect of age could then be examined using meta-analytical techniques across studies. The same is true for the effects of gender; larger studies with adequate numbers of boys and girls would provide the most robust solution.

Other factors that might moderate the association of IU with anxiety and worry include methodological factors such as the assessment method of the variable of interest (questionnaire vs diagnostic interview), the informant (parent vs child), and/or factors associated with cognitive and metacognitive maturation such as negative problem orientation, positive beliefs about worry, and cognitive avoidance (Fialko et al., 2012; Kertz and Woodruff-Borden, 2013). Unfortunately there were not enough studies including these potential moderators for us to examine them in the present meta-analysis.

2.4.1 Strengths and limitations

The review has a number of strengths but also some limitations that should be considered. This study is the first to provide a systematic quantitative investigation of the association between IU and both anxiety and worry in children and adolescents. A strength is that we conducted a quality assessment of all included papers. Overall, the studies were of reasonable quality; however, the quality of the future work could be improved in the following ways: more detailed description of the sample characteristics, more thorough reporting of the number of participants excluded in the analysis and the reasons for exclusion, reporting of power calculations/reasons for the sample size, detailed descriptions of main outcomes, and the use of appropriate outcome measures. For example, only 13 of the reviewed studies provided detailed descriptions of their sample characteristics (SES, ethnicity), only four of the reviewed studies reported the reason and number of participants excluded in the analysis, and none of the studies reported the reason for the sample size with reference to a power calculation. A further issue related to quality is that the studies are mainly correlational but the degree to which potential confounds are investigated is limited. By collecting rich data regarding the sample and potential moderators, as already outlined, future research will also be better placed to consider and control for potential confounds.

A strength of the present research is that we included unpublished, in-press and under-review data which were sourced by contacting corresponding authors of studies identified in our systematic review. The response rate from these authors was good (75%) which helps to address concerns about publication bias (note also that there was no evidence of publication bias from the funnel plot, rank correlation tests and regression tests). It should be considered however that not all of these studies have undergone

the peer-review process. Nevertheless, where possible the methodological quality of these studies was assessed using the same criteria as for the published studies and overall, the quality assessment of these studies showed them to have a reasonable quality, consistent with the published studies included in the review.

Considering limitations, we only included English language papers in this review for practical reasons and the focus was restricted to typically developing children, which excluded, for example the growing body of research examining IU in children with autism (Boulter et al., 2014; Chamberlain et al., 2013; Neil et al., 2016; Wigham et al., 2015). Second, although we coded and examined a range of potential moderators for the relationship between IU and anxiety/worry, our ability to consider moderators in detail was affected by the low number of studies found overall and the relative homogeneity of the methodological factors. High heterogeneity may also arise from characteristics of the participants included in each of the studies that the study level data we extracted is unable to capture. For example, two studies could have the same mean participant age but a very different distribution of participant ages. Without individual data points from each participant within each study we are not able to capture these differences between studies (Schmid et al., 2004).

2.5 Conclusion

Given the promise of IU research in adults and the strong correlations found between IU and both anxiety and worry in this review, we conclude that the role of IU in the development and maintenance of anxiety and worry is worthy of further investigation in children and young people; however, it is premature to draw clinical implications because there is a lack of evidence that IU plays a causal or maintaining role in anxiety disorders for children and young people. Future work should consider developmental factors and incorporate longitudinal and experimental designs as well as focusing on clinical samples beyond GAD.

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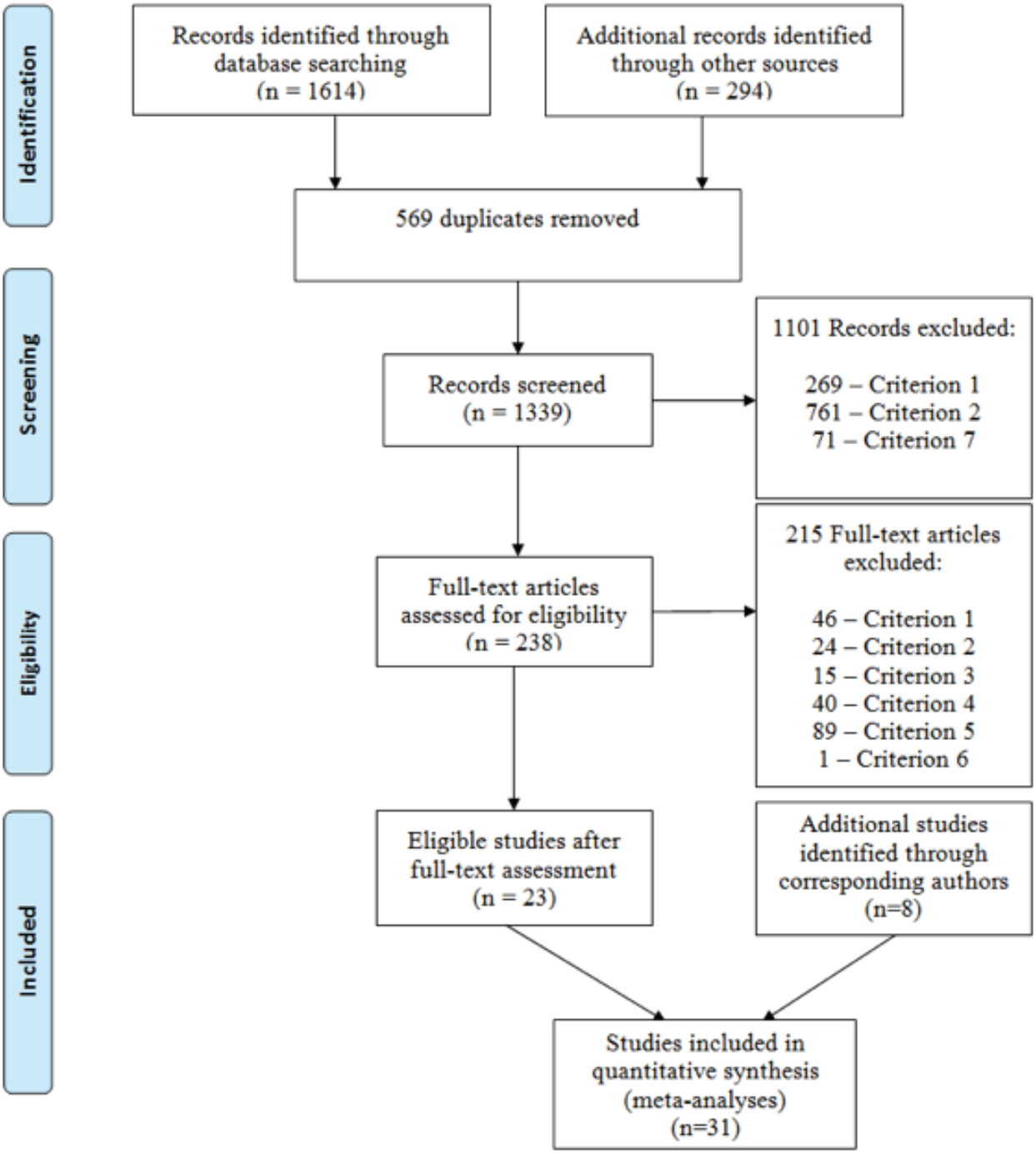

Figure 1. Flow chart of the studies accepted through the eligibility screening process (criterion1: not empirical research, criterion 2: outside of age range, criterion3: atypical development, criterion 4: no anxiety measure, criterion 5: no IU measure, criterion 6: effect size not available, criterion 7: foreign language)

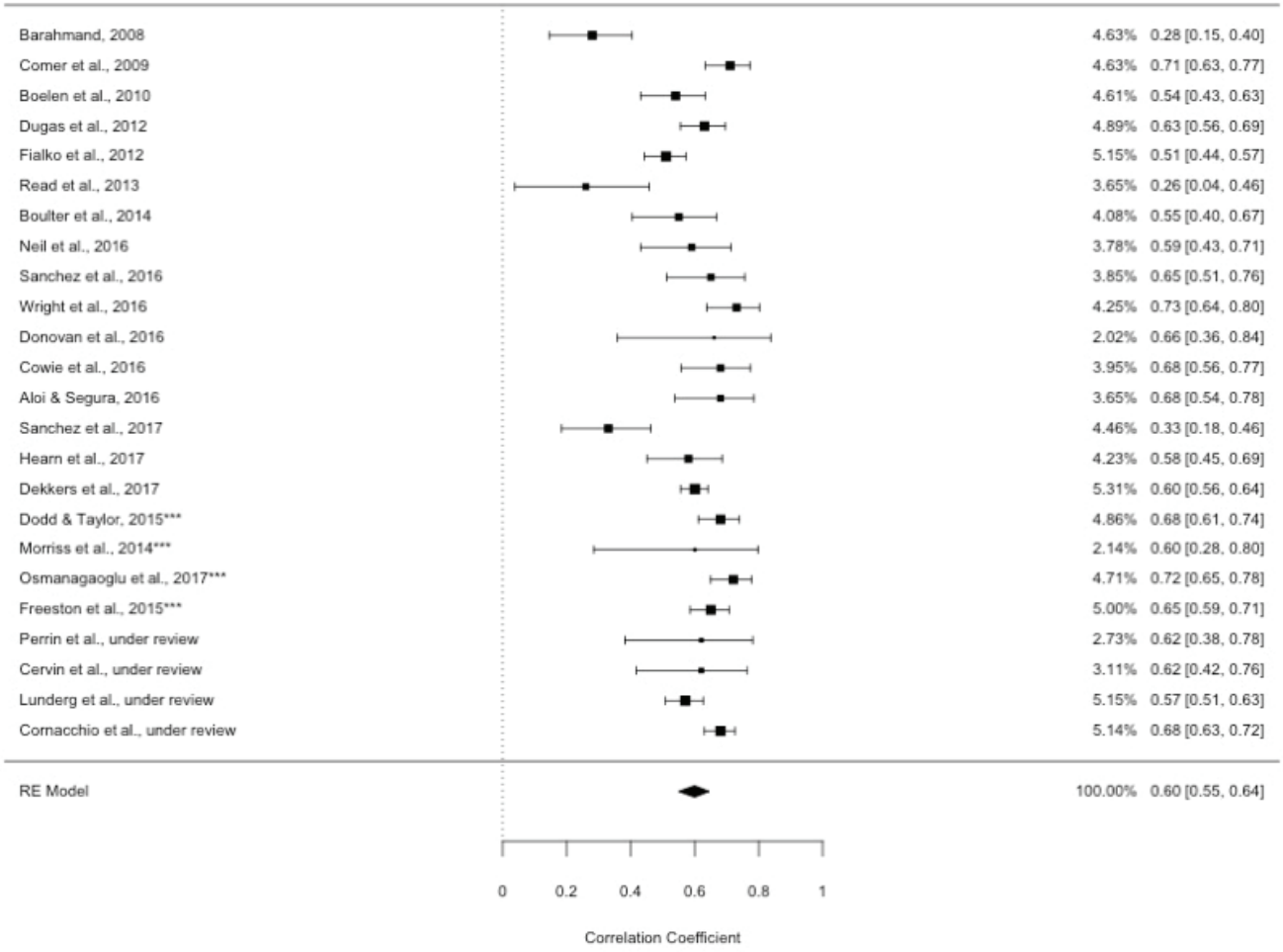

Figure 2. Forest plot showing correlation coefficients (*r*) for the association between IU and anxiety with confidence intervals and study weights for contribution to overall effect size.

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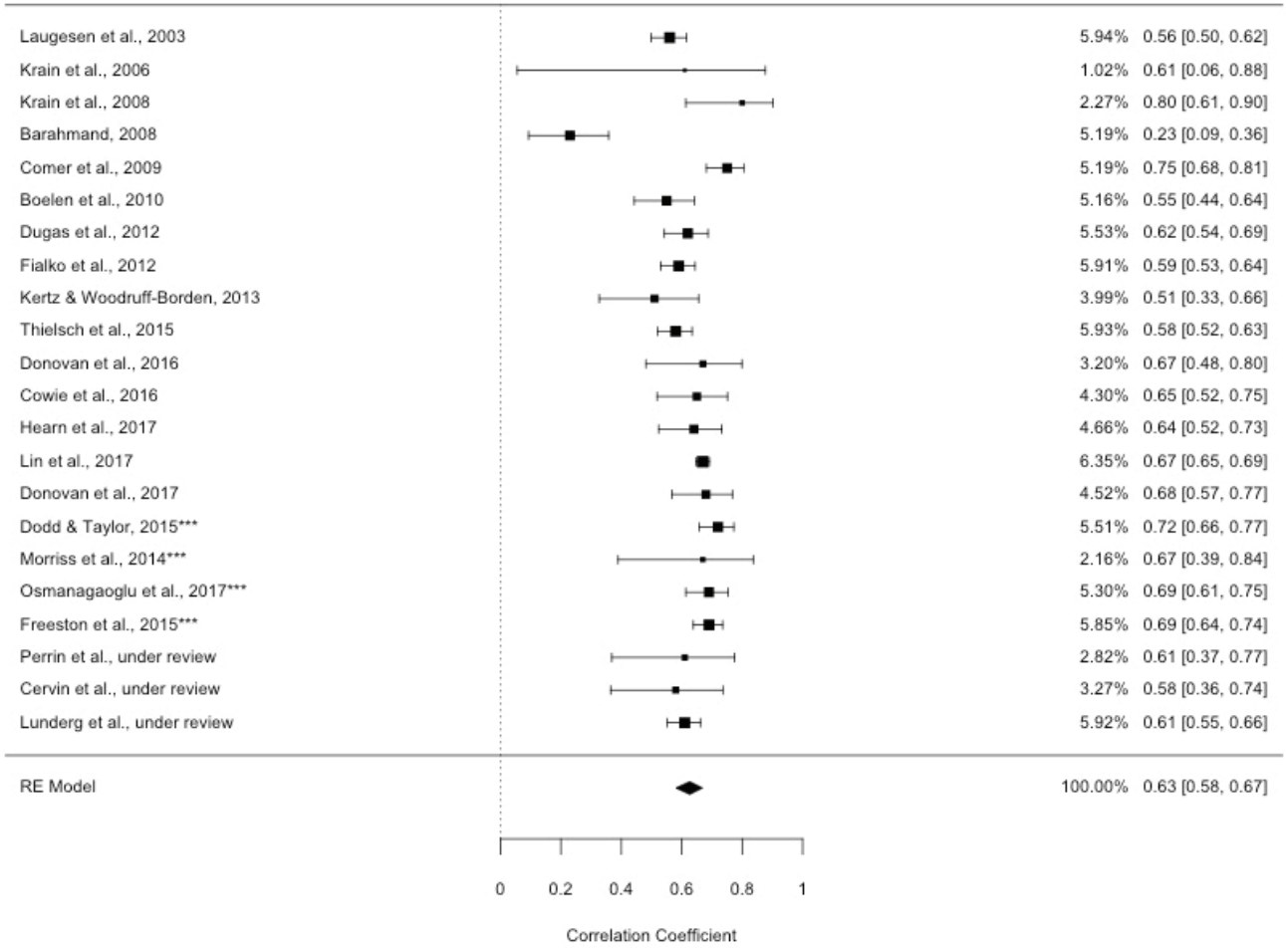

Figure 3. Forest plot showing correlation coefficients (*r*) for the association between IU and worry with confidence intervals and study weights for contribution to overall effect size.

***unpublished data

TABLE 1. ***Reviewed Studies, Sample Characteristics, Anxiety/Worry/IU Measures, Effect Sizes, and Quality Ratings***

Study	Sample Type	Sample Size	Age Range	Mean Age	Anxiety Measure	Worry Measure	IU Measure	Effect size	Average quality across assessors
Laugesen et al. (2003)	Community	528	14-18	15.5		PSWQ	IUS	**IU and worry** (r = .56)	1.51
Krain et al. (2006)	Community	12	13-17	16.4		PSWQ	IUS	**IU and worry** (r = .61)	1.16
Krain et al. (2008)	Community & Clinical (55.17%)	29	13-17	15.29	MASC	PSWQ	IUS	**IU and anxiety** (not available) **IU and worry (**r = .80)	1.46
Barahmand (2008)	Community	197	16-19	17.49	GHQ-anxiety subscale	WAQ	IUS	**IU and anxiety** (r = .52 (girls), r = -.04 (boys)) **IU and worry** (r = .48 (girls), r = -.03 (boys))	1.25
Comer at el. (2009)	Community & Clinical (37.1%)	197	7-17	11.47	MASC	PSWQ	IUS-C (C& P)	**IU and anxiety** (r = .71) **IU and worry** (r =. 75)	1.58
Boelen et al. (2010)	Community	191	14-18	16.09	SAS-A	PSWQ	IUS-12	**IU and anxiety (**r = .54) **IU and worry** (r = .55)	1.50
Dugas et al. (2012)	Community	282-**T1** 290-**T2**		12.5-**T1** 13-**T2**	ACS– Anxiety Subscale	PSWQ	IUS	**IU and anxiety** (r = .63) – reported at **T2** **IU and worry** (r =. 62) – reported at **T1**	1.54
Fialko et al. (2012)	Community	506	7-19	13.66	MASC	PSWQ	IUS -5 items	**IU and anxiety** (r = .51) **IU and worry** (r = .59)	1.58
Kertz & Woodruff-Borden (2013)	Community	80	8-12	9.6	RCMAS	PSWQ	IUS-C	**IU and anxiety** (not available) **IU and worry** (r =. 51)	1.08
Read et al. (2013)	Clinical	77	7-17	11.57	ADIS - CSR		IUS-C	**IU and anxiet**y (r= .26)	1.34
Boulter et al. (2014)	Community	110	8-18	13	SCAS		IUS-C (C&P)	**IU and anxiet**y (r= .55)	1.56
Thielsch et al. (2015)	Community	521	15-20	17.24		PSWQ	IUS	**IU and worry** (r= .58)	1.50
Neil et al. (2016)	Community	85	6-14	9.15	SCAS		IUS-C(Parent)	**IU and anxiety** (r= .59)	1.50
Sanchez et al. (2016)	Community	90	7-13	10.8	MASC		IUS-C(parent)	**IU and anxiety** (r=.65)	1.34
Wright at el. (2016)	Community	128	11-17	12.72	SCAS		IUS-12	**IU and anxiety** (r= .73)	1.34
Donovan et al. (2016)	Community & Clinical (50%)	50	7-12	9.92	ADIS-CSR	PSWQ	IUS-C	**IU and anxiety** (r = .66) for clinical sample **IU and worry** (r = .67) for overall sample	1.39
Cowie et al. (2016)	Community & Clinical (63.27%)	98	6-12	9.08	ADIS-CSR & SCARED	PSWQ	IUS-C	**IU and anxiety (**r = .68) SCARED **IU and worry** (r = .65)	1.70

Study	Sample Type	Sample Size	Age Range	Mean Age	Anxiety Measure	Worry Measure	IU Measure	Effect size	Average quality across assessors
Aloi & Segura (2016)	Community	77		17.56	STAI-Tr		IUS	**IU and anxiety** (r=.68)	1.34
Dekkers et al (2017)	Community	870	13-17	15.3	STAI-C		IUS-12	**IU and anxiety** (r=.60)	1.46
Donovan et al. (2017)	Community	114	8-12	9.87		PSWQ	IUS-C	**IU and worry** (r=.68)	1.63
Sanchez et al. (2017)	Clinical	160	3-10	6.46	CBCL - anxiety problems subscale		IUS-C (Parent)	**IU and anxiety** (r = .33)	1.58
Hearn et al. (2017)	Clinical	126	8-17	11.29	ADIS-CSR & SPAI-C	PSWQ	IUS-12	**IU and anxiety** (r = .58) SPAI-C **IU and worry** (r = .64)	1.62
Lin et al. (2017)	Community	2286	11-18	15		WTQ	IUS-12	**IU and worry** (r=.67)	1.54
Dodd & Taylor (2015)***	Community	276	13-19	16.04	SPIN	PSWQ	IUS-C	**IU and anxiety** (r = .68)**IU and worry** (r = .72)	1.38
Morriss et al. (2014)***	Community	27	13-18	15.65	STAI	PSWQ	IUS	**IU and anxiety** (r = .60)**IU and worry** (r = .67)	
Osmanagaoglu et al. (2017)***	Community	219	7.58-11.81	9.97	SCAS	PSWQ	IUS-C	**IU and anxiety** (r = .72)**IU and worry** (r = .69)	
Freeston et al. (2015)***	Community	452	11.4-14.8	12.9		PSWQ	IUS-12	**IU and worry** (r = .69)	
	Community	451	11.6-14.4	12.7	SCAS		IUS-12	**IU and anxiety** (r = .65)	
Cornacchio et al. (under review)	Community & Clinical (59.3%)	489	4-18	11.41	MASC		IUS-C(Child &Parent)	**IU and anxiety** (r = .68)	1.62
Perrin et al. (under review)	Clinical	40	10-18	13.38	SCARED	PSWQ	IUS -5 items	**IU and anxiety** (r = .62)**IU and worry** (r = .61)	
Cervin et al. (under review)	Clinical	52	8-18	13.78	SCARED	PSWQ	IUS -5 items	**IU and anxiety** (r = .62)**IU and worry** (r = .58)	
Lunderg et al. (under review)	Community	509	9-16	11.61	Beck Youth Inventory -Anxiety	PSWQ	IUS -5 items	**IU and anxiety** (r = .57) **IU and worry** (r = .61)	

Chapter 3 - What Uncertainties Remain?

3.1 IU in Children and Young People

The meta-analysis presented in chapter 2 revealed strong associations between IU and anxiety and worry among children and young people. The review also highlighted some methodological shortcomings common to the majority of existing research, such as heavy reliance on questionnaires to assess IU, limited research with clinical samples, and inclusion of children and adolescents with broad age ranges without careful consideration of the effects of age and development. On the basis of the review, the following recommendations for further research are made:

1. to conduct research with participants within and across narrower age bands to provide insight into potential developmental differences in IU and in associations between IU and anxiety and worry. Childhood and adolescence are full of rapid cognitive changes. Therefore, focusing on narrow age bands will provide insight into the nature of IU and how it manifests within specific developmental periods.
2. to further examine the psychometric properties of self-report measures of IU in children.
3. to develop behavioural measures for the assessment of IU in order to overcome the limitations of self-report and to provide better insight into the nature of IU and the contexts within which uncertainty is linked to anxiety and worry.
4. to utilise experimental designs to examine causal relations between IU and anxiety and worry.
5. to conduct longitudinal research to investigate changes in IU over time as well as the role of IU in pathways to anxiety and worry throughout development.
6. to conduct research with young people with a range of anxiety disorders to confirm IU as a transdiagnostic risk factor across anxiety disorders in children and young people.

The remaining chapters of this thesis will focus on recommendations 1, 2, and 3. Each will now be discussed briefly followed by an outline of the thesis aims and description of each chapter.

3.1.1 Recommendation 1: Focusing on Narrow Age Bands

Understanding of uncertainty and responses to uncertainty change across development.

Metacognition encompasses the process of monitoring one's own cognitive capacities such as whether one is aware of what they know or remember or engaging in various strategies to fill information gaps in one's knowledge (Flavell, Green, & Flavell, 2000; Kathrin & Wolfgang, 2002). Research shows that children as young as 3 years old show evidence of introspective awareness (e.g. ability to observe one's own mental state and knowledge) in the face of uncertainty; they may withdraw from providing an answer when they feel uncertain, which indicates awareness of a gap in their knowledge (Lyons & Ghetti, 2013). However, they tend to overestimate their knowledge more than older children do (Lyons & Ghetti, 2011), and young children (5-6 years) are more likely to come up with one single interpretation and less likely to search for more information in the face of uncertainty compared to 7-8 years old children (Beck & Robinson, 2001; Robinson, Martin, Beck, Dan, & Apperly, 2006). This literature on uncertainty monitoring highlights that even young children are aware of uncertainty but that the skills which they can reason about and respond to uncertainty develops with age. Subtle differences exist even in children who are relatively close in age. As such, focusing on narrow age bands allows for the examination of potential nuanced differences in IU across development.

Most of the research examining IU in children and adolescents involves samples consisting of broad age ranges with little focus on specific developmental periods. For example Wright, Lebell, and Carleton (2016) used a sample consisting of 11 to 17 years old without considering developmental changes. Importantly, when research has focused on subgroups of participants with narrower age bands, different patterns between age groups have been found. For example, Fialko, Bolton, and Perrin (2012) used a sample of 7 to 19 year olds and revealed that pathways from IU to anxiety and worry for children (7 to 12 years) differed from those found for adolescents (13 to 19 years). Although age did not moderate the association between IU and either anxiety or worry in the meta-analysis (see Chapter 2), it is possible that the broad age ranges included in most studies may be masking potential age effects; the meta-analysis used mean age of participants in a study as the moderator but if all studies include a broad age range, this mean age is not informative. It is therefore not clear how well findings can be generalized to specific age groups, especially preadolescent children who are often not included at all or only in small numbers (e.g. Barahmand, 2008; Boelen, Vrinssen, & van Tulder, 2010; Laugesen, Dugas, & Bukowski, 2003).

Given the developmental changes that occur in meta-cognitive understanding of uncertainty across childhood, there is a need for research that focuses on narrow age bands to assess IU and its relationship with anxiety and worry in children. Research focused on using developmentally appropriate tasks within narrower age bands would provide a thorough assessment of IU at that age. Then, by comparing results across studies focused on different age bands, we would have a much better understanding of IU across development than we have currently.

3.1.2 Recommendation 2: The Psychometric Properties of the IUS-C

The most widely used self-report and parent-report measure of IU for young people (IUS-C) is recommended for young people aged between 7 and 17 years (Comer et al., 2009). Both child and parent forms of the Intolerance of Uncertainty Scale for Children (IUS-C) are a downward extension of the adult measure of IUS. Most of the items included in the IUS were translated into the IUS-C with small changes such as from "uncertainty stops me from having strong opinions" to "doubts stop me from having strong opinions". Given that the items are based on the adult measure, younger children may experience difficulty responding to some items (e.g. Cowie, Clementi, & Alfano, 2016). An investigation of the IUS-C is therefore needed with younger samples to ensure that the items are suitable for preadolescent children.

Furthermore, the reason for poor agreement between child and parent forms remains to be explored. Although poor agreement is not uncommon in questionnaires of such nature, it raises a question about which form is more valid/ accurate. One reason for the poor agreement may originate from the items, many of which represent internal experience that may reside outside of parents' awareness. Another reason might be children's limited ability to understand and verbally report on their own experiences.

The factor structure of IU has been thoroughly examined within adult samples and a two-factor model of IU has been most consistently supported incorporating prospective IU and inhibitory IU (Birrell, Meares, Wilkinson, & Freeston, 2011; Hong, 2015; Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013; Sexton & Dugas, 2009). Although one factor analytic study has also been conducted for the IUS-C with younger people, the hypothesis was drawn from adult factor analytic studies and the sample consisted of a broad age range (9-18 years) (Cornacchio et al., 2017). Adult findings may not necessarily

hold true for children and adolescents because of the previously cited cognitive changes across childhood (e.g.Robinson et al., 2006). It is therefore entirely feasible that a different factor structure may be revealed for different age groups and distinct developmental periods. In addition, although IU is defined as a dispositional characteristic, test-retest reliability of the questionnaire has not yet been examined.

3.1.3 Recommendation 3: Behavioural Measures to Assess IU in Children

While IU measurement with self-report needs further examination, it is also timely to think about assessing individual differences in reactions to uncertainty more objectively using behavioural tasks. Developmental research highlights that although some abilities related to reflecting and reasoning about one's own cognitive states emerge early in childhood these skills continue to develop through to at least middle childhood (Beran, Decker, Schwartz, & Smith, 2012; Roebers & Howie, 2003; Roebers, von der Linden, & Howie, 2007). Younger children may struggle to demonstrate metacognitive ability via explicit or verbal reports. As such, self-report measures are problematic for younger children and behavioural methods that allow participants to provide non-verbal responses are required to help us to better understand IU in children.

Behavioural tasks overcome the limitations of self-report, including shared method variance and potential problems with understanding items for younger children. Such measures would also pave the way for IU measurement for children younger than 7 years old. Furthermore, carefully designed behavioural tasks may be able to provide new insights into the nature of IU and the contexts within which uncertainty is particularly problematic for individuals high in IU. The theoretical definition of IU suggests that people who have elevated IU level would respond to uncertainty negatively even when there is no potential for a threatening or negative outcome. It is unclear however whether reactions to uncertainty differ across low and high threat contexts. A recent review highlighted various ways that IU may manifest with most of the behaviours reflected in two main categories; over engagement such as excessive seeking for certainty and under engagement such as avoidance and making snap decisions to end the uncertainty (Sankar, Robinson, Honey, & Freeston, 2017). Different manifestations of IU may be an indication of different anxiety issues or individuals may switch between these reactions depending on the task context.

Some of the earliest ideas for potential tasks that can assess reactions to uncertainty were described by Freeston, Rhéaume, Letarte, Dugas, and Ladouceur (1994) and those who score high and low end of the self-report IU were hypothesized to react differently to uncertainty. Other tasks have been developed more recently. For example, A task used by Jacoby, Abramowitz, Buck, and Fabricant (2014) and by Bensi and Giusberti (2007) has allowed the measurement of information gathering behaviour and decision making time under conditions of uncertainty. The beads task used in these studies consists of jars filled with different ratios of coloured beads. For example, in a low uncertainty condition there might be two jars with a ratio of 85 to 15 f red to black beads. Participants are presented with one bead at a time and asked to make a decision about which jar the beads are being taken from. Participants can request more information (beads) before making a decision which jar. On the other hand a task used by Grupe and Nitschke (2011) developed an uncertainty-based task that could measure biased expectancies and physiological reactions via skin conductance. This task consisted of three cues preceded by either a neutral or aversive picture; one cue always preceded an aversive picture, one always preceded a neutral picture, both of these cues were therefore certain. The third cue preceded either a neutral or aversive picture at 50/50 ratio and therefore signalled uncertainty.

There are, therefore, different paradigms that can capture different types of uncertainty, levels of uncertainty and reaction to uncertainty. For example, one task may allow information seeking behaviour to be captured but the same task may not be able to assess avoidance under uncertainty or threat expectancy. It is likely, therefore, that one behavioural task may not be able to capture all possible different reactions to uncertainty and ultimately a battery of tasks with different paradigms may be required to provide a broad, thorough understanding of reactions to uncertainty and individual differences in those reactions (IU).

When considering tasks that can be used with children, it is also vital to keep in mind the children's cognitive ability such as their ability to understand proportions which may be cognitively demanding for younger children (Bryant & Nunes, 2012) as well as the length of time they can reliably attend to a task and how to make tasks engaging. In addition, it would be important to consider child-friendly stimuli in a task for children to ensure that stimuli are age-appropriate and engaging for them.

3.2 Aims of the thesis

The aim for the remainder of this thesis is to provide an insight and ideas for IU assessment in preadolescent children. Therefore the focus is,

1. To conduct a detailed psychometric examination of the IUS-C child-report and parent-report scale with a view to clarifying whether the scale is a robust measure of IU in preadolescent children.
2. To design behavioural assessments which are suitable for preadolescent children, to measure reactions to uncertainty that may be related to IU, anxiety, and worry.

3.3 Outline of the studies

The three studies included in the next chapters in this thesis investigate the assessment of IU in preadolescent children with the aim of addressing gaps in the existing literature. The following section provides an overview of the research questions addressed by each study.

3.3.1 Study 2: Evaluating the Psychometric Properties of the Intolerance of Uncertainty Scale for Children in a Preadolescent Sample

As outlined above, the IUS-C is a downward extension of an adult measure of IU and can be administered to children and adolescents aged between 7 to 17 years. This is a broad age range during which there is rapid cognitive and emotional development (e.g. Beck & Robinson, 2001; Lyons & Ghetti, 2013). The study examines the child and parent-report versions of the IUS-C, with a particular focus on how well respondents feel able to answer the questions and the psychometric properties of the scales. In chapter 4, the focus is specifically on preadolescent children for several reasons. First, of the broad target age range for the measure, younger children before the age of 12 are the most likely to have difficulty understanding items. Second, children of this age are less adult-like in their meta-cognitive understanding of uncertainty compared to adolescents (Weil et al., 2013). Finally, there has been no examination of the IUS-C specifically in pre-adolescent children. This study uses questionnaire data from 227 typically developing preadolescent children in the community to examine the psychometric properties of the IUS-C in children.

The study investigates (i) what items, if any, were difficult to understand for preadolescent children and parents, (ii) the factor structure of the child and parent IUS-C measures, (iii) test-retest reliability of the child and parent IUS-C measure, and (iv) agreement between child and parent forms of the IUS-C. The study resulted in a revised version of the IUS-C and the analyses for studies 3 and 4 were conducted based on both the original scale and the revised version of the scale.

3.3.2 Study 3: Development of a Behavioural Measure of Intolerance of Uncertainty in Preadolescent Children: Adaptation of the Beads Task

This study reports on the development of a behavioural task for use with typically developing preadolescent children (aged 7-11 years) in the community. The beads task was used by Jacoby et al. (2014) to assess reactions to uncertainty and its relationship with the self-reported IU. The task used in this study is an adaption of this behavioural task that has been used with adults previously to measure reactions to three levels of uncertainty (Jacoby et al., 2014).

Given there is no existing behavioural measure to assess reactions to uncertainty in preadolescent children, the first aim was to design an age-appropriate version of the beads task to assess reactions to uncertainty in this age group. The study examines (i) the suitability of the revised beads task for preadolescent children. Assuming that the beads task is suitable for preadolescents and considering the lack of evidence regarding how children react to uncertainty, the study also explores (ii) how preadolescents respond to uncertainty and (iii) whether the beads task can capture responses to uncertainty that are related to self-reported IU, anxiety, and worry.

3.3.3 Study 4: Reactions to uncertainty with and without potential threat: developing a behavioural measure of intolerance of uncertainty for preadolescent children

Similar to the study described above, this study also addresses the need for behavioural tasks to measure reactions to uncertainty in preadolescent children. While the adapted beads task used in Study 3 allowed reactions to three different levels of uncertainty to be examined, the task had no certain condition. Therefore, in this study, an adapted version of the Hi-Lo task (Krain et al., 2008; Krain et al., 2006) was used, which contains a certain condition as well as varying levels of uncertainty. This allows

reactions to uncertainty to be distinguished from reactions where there is no objective uncertainty. In addition, in this study two parallel tasks were designed to measure reactions to uncertainty in low and heightened threat contexts. This allows the effects of uncertainty within different threat contexts to be examined. Participants completed these tasks along with the questionnaire measures of IU, anxiety, and worry.

The study examines (i) the suitability of the tasks for preadolescent children, (ii) how preadolescent children respond to uncertainty within low and high threat contexts, and (iii) whether the tasks capture reactions to uncertainty that are related with IU, anxiety, and worry.

3.4 Summary

Despite the extensive IU research in adults, there is a paucity of research on IU and anxiety in younger people, especially in children. Considering this area of research is now receiving increasing attention from researchers, it is timely to begin to address the gaps in the literature that require priority. Throughout the papers in the remainder of the thesis, the focus is primarily on measurement of IU. This has been prioritised because reliable and objective ways to assess IU in children are crucial if the field is to move forward. With strong methods, future research will provide new insights into the nature of individual differences in IU and the role that IU plays in the development and maintenance of anxiety disorders. This should, in turn, provide guidance for the development and the improvement of anxiety treatments. In Chapter 7, an overview of the findings of the thesis as a whole as well as the implications for future research and theory will be discussed.

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Chapter 4 – Study 2: Evaluating the Psychometric Properties of the Intolerance of Uncertainty Scale for Children in a Preadolescent Sample

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Please note Tables and Figures, and Appendices referred to in the Paper can be found at the end of the manuscript.

Abstract

Intolerance of Uncertainty (IU) is a dispositional tendency to react negatively to uncertainty. The Intolerance of Uncertainty Scale for Children (IUS-C) is designed to measure IU in children but there has been limited investigation into the psychometric properties of this scale. Using data from 227 preadolescent children and 204 parents, we examined (a) if any items were difficult to understand for children and parents, (b) the factor structure, (c) test-retest reliability, and (d) the agreement between child and parent forms of the IUS-C. Results revealed common items that were difficult to understand for both children and parents. Our data suggested a one-factor structure for both child and parent report versions. Test-retest reliability of the IUS-C was high over a 2-week period but agreement between the child and parent forms was poor. Overall, the results suggest that the full-version of the IUS-C (both child and parent reports) may not be ideal for preadolescent children and their parents. Preliminary recommendations are made regarding which IUS-C items to retain in order to capture IU among this age group based on child or parent report.

4.1 Introduction

Intolerance of Uncertainty (IU) is "a dispositional characteristic that results from an individual's inability to tolerate the aversive response triggered by the perceived absence of information and the associated uncertainty" (Carleton, 2016 p. 31). Over the last two decades extensive research has focused on the role that IU may play in anxiety disorders, delineating the construct as a transdiagnostic risk factor underlying a broad range of anxiety and mood problems in adults (Carleton, Collimore, & Asmundson, 2010; Counsell et al., 2017; Mathes et al., 2017; Oglesby & Schmidt, 2017; Tolin, Abramowitz, Brigidi, & Foa, 2003). Given that anxiety disorders often begin during childhood (Kessler et al., 2005), there has been a growing interest in IU in young people. It is therefore crucial that IU can be reliably assessed in young people. A recent systematic review and meta-analysis revealed a strong positive correlation between IU and both anxiety and worry in children and adolescents (Osmanağaoğlu, Creswell, & Dodd, 2018). However, this review highlighted the heavy dependence on questionnaire measures, which have limited psychometric evaluation, especially in younger children (Comer et al., 2009; Cornacchio et al., 2017). The present research therefore aims to examine the psychometric properties of the Intolerance of Uncertainty Scale for Children (IUS-C) in preadolescent children.

The Intolerance of Uncertainty Scale (IUS) was the first questionnaire developed to assess IU. It was developed for adults and consists of 27 items on a 5-point Likert-type scale (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994). The psychometric properties of the scale have been extensively examined. The IUS shows evidence of convergent and divergent validity, high internal consistency, and good test-retest reliability over a 5-week period (Buhr & Dugas, 2002; Freeston et al., 1994). However, initial exploratory factor analytic (EFA) studies of the IUS indicated inconsistent factors across studies, high inter-item correlations, and poor factor loadings (Berenbaum, Bredemeier, & Thompson, 2008; Buhr & Dugas, 2002; Freeston et al., 1994; Norton, 2005). Overall, these studies indicated that the IUS should have fewer items and subsequent work tested the stability of a two-factor model using 12 of the original items. The resulting IUS-12 correlated with the original IUS, had high internal consistency and a stable two-factor structure (Carleton, Norton, & Asmundson, 2007). These two factors have been labelled as Prospective IU, which refers to desire for predictability, and Inhibitory IU, which refers to behavioural

inhibition in the presence of uncertainty. Later studies demonstrated the clinical relevance of these two factors; prospective IU was found to be associated with worry and obsessive-compulsive symptoms, and inhibitory IU was found to be associated with social anxiety, panic disorder, and depression (Carleton et al., 2010; Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2011).

On the other hand, most recent studies examining the factor structure of the IUS have indicated that a bifactor model would be more suitable to explain the factor structure of the IUS. Bifactor models allow there to be a general factor defined by all items with subdivisions of the scale defined by subsections of the items (Reise, Moore & Haviland, 2010). A general factor underlying all items and two factors consistent with prospective and inhibitory IU as found in earlier studies was supported in these studies (Hale et al., 2015; Lauriola, Mosca & Carleton, 2016; Shihata, McEvoy & Mullan, 2018).

The IUS-C was developed to measure IU in children and is simply a downward extension of the original IUS with 27 items. It has child and parent report versions (Comer et al., 2009). The IUS-C has been shown to have high internal consistency (α=. 92 for the child report & α=. 96 for the parent report). Convergent and discriminant validity have been demonstrated for the child report form, and to a lesser extent for the parent report form (Comer et al., 2009). The only study to have examined the factor structure of the IUS-C in children and adolescents used confirmatory factor analysis (CFA) to compare a one and two factor structure using the full set of items on the IUS-C as well as the 12 items parallel to those in the IUS-12. There was a support for multiple acceptable factor structure; a two factor structure aligning with what has been found in adults and a bi-factor structure suggesting a general factor underlying all items for the IUS-C with 12 items (Cornacchio et al., 2017). The inhibitory IU dimension was associated with social anxiety, separation anxiety, and physical symptoms of anxiety for both child and parent report, consistent with the adult literature. However, the prospective IU dimension was only associated with worry when the measures were completed by the child, not when completed by the parent. This may indicate that children are better reporters of their prospective IU than their parents. Prospective IU is more internalised and cognitive in nature than inhibitory IU; therefore, it may be harder for parents to observe and report reliably.

Further investigation of the psychometric properties of the IUS-C is warranted for a number of reasons. First, there has been no examination of test-retest reliability of the IUS-C. This is important because IU is conceptualized as a dispositional characteristic and therefore measures of IU should show stability over time. Second, very little is known about the factor structure of IU in preadolescent children. Cornacchio et al. (2017) included participants across a wide age range (4 – 18 years), with a mean age of 12.5 years. Their results are very consistent with those of Boelen, Vrinssen, and van Tulder (2010) who used the adult IUS-12 with 14 to 18 year olds and demonstrated the same two-factor structures. It is therefore possible that the older participants in Cornacchio and colleagues' sample drive the results and it remains to be seen whether this factor structure holds for preadolescent children.

Best practice when examining the factor structure of a new scale is to develop hypotheses about underlying factors using exploratory factor analysis (EFA) first, and then test them out using confirmatory factor analysis (CFA). The first method is useful to inform the second and to prevent the premature exclusion of items (Birrell, Meares, Wilkinson, & Freeston, 2011). The only study to have examined the factor structure of the IUS-C (Cornacchio et al., 2017) used CFA to test whether the factor structure found in adults fits the data for children and adolescents. This relies on the assumption that IU is likely to have the same factor structure in children and adolescents as it does in adults; however it is possible that the factor structure may differ through development given that the cognitive and metacognitive skills necessary to detect knowledge gaps and reason about uncertainty develop with age (Beck & Robinson, 2001; Robinson, Martin, Beck, Dan, & Apperly, 2006).

A further issue is that the IUS-C is a downward extension of an adult measure and younger children may have difficulty understanding some of the IUS-C items (Cowie, Clementi, & Alfano, 2016). Similarly, parents may have difficulty responding to some of the prospective items that ask about internal states and cognitions. This may explain in part why the IUS-C showed poorer utility to distinguish between children with and without anxiety disorders aged 7-8 years relative to children aged 9-15 years (Comer et al., 2009). To our knowledge, no research has asked children or parents whether they have difficulty understanding and responding to the items included in the IUS-C or examined the reading ease of the items.

To expand our understanding of IU throughout development, research is needed that focuses on the structure and measurement of IU within narrow age-bands across childhood. In this article we conduct a thorough psychometric evaluation of the IUS-C focusing on children aged 7 to 12 years. We begin by investigating whether there are items that are challenging for children and parents to understand and complete by asking them and by relying on Flesh-Kincaid Readability Test. Next, we conduct EFA to examine the factor structure of both the child and parent forms. As relatively little is known about the nature and measurement of IU in preadolescent children, we decided to use EFA to ensure that differences that may appear in the structure of IU across development aren't missed. Third, we examine the test-retest reliability of both forms of the measure. Finally, we examine the agreement between the child and parent-report forms.

4.2 Method

4.2.1 Participants

A total of 227 children (115 male) aged between 7.58 and 11.81 (M=9.97, SD=1.03) were recruited for time 1. Of those, 173 children were recruited from two primary schools in the UK and 54 were recruited via public advertising for a larger study examining IU in children. Children from the primary schools also took part at a second time-point (n = 144), two-weeks after time 1 (74 male, M=10.15, SD=0.97).

A total of 204 parents (187 mothers and 17 fathers) of children (102 male) aged between 6.56 and 12.46 (M=9.6, SD=1.17) were recruited for time 1. Of those, 143 parents were recruited through online advertising, 7 were recruited through the schools mentioned above, and 54 were recruited by local advertising from the Berkshire area in the UK to take part in a larger study on IU in children (see Table 1 for more detailed demographic information, p. 107). All parents were invited to take a part in the study again at time 2 and were sent a link to complete an online questionnaire, 72 completed it (their children were 38 male, M=9.44, SD=1.1).

Within the child and parent samples, there were 61 child and parent dyads whose data could be used to examine the agreement between child and parent forms of the IUS-C. For this subsample, children

were aged between 7.83 and 12.46 years (M=9.52, SD=1.12, 33 female), and 58 parents were mothers. These participants were the 54 recruited through local advertising for a larger study on IU and the seven parents who took part after their child had completed measures during school time.

4.2.2 Measures

Intolerance of Uncertainty for Children (IUS-C)-Child & Parent Report (Comer et al., 2009). IU was measured by the IUS-C child and parent-report forms which are each 27 item measures on a 5-point Likert scale (1 = Not at all characteristic of me/my child, 3 = Somewhat characteristic of me/my child, 5 = Entirely characteristic of me/my child) resulting in a total score ranging from 27 to 135, higher scores reflecting higher intolerance of uncertainty. The IUS-C was adapted from the adult IU measure (Freeston et al., 1994), and was validated for use with children aged 7 to 17 years. Both the child and parent form demonstrate some convergent validity and internal consistency (Comer et al., 2009). For the purpose of this study, a column was added for children and parents to report whether they found each item difficult to judge. They were asked to provide an answer for each item regardless of the difficulty. The internal consistencies of the IUS-C in the present sample were also excellent for child (α=0.92) and parent report (α=0.97).

Spence Child Anxiety Scale (SCAS) – Child & Parent Report (Spence, 1998). Anxiety symptoms were measured using the child report and parent-report versions of the SCAS. Both measures use a 4-point Likert scale (0 = never, 1 = sometimes, 2 = often, 3 = always). The child report consists of 44 items (38 items related to anxiety symptoms and 6 filler items) and parent report consists of 38 items; higher scores indicate higher anxiety. The SCAS measures have good psychometric properties, including excellent internal consistency (α=0.89 for parent report, α=0.92 for child report), convergent and divergent validity (Nauta et al., 2004; Spence, 1998). The internal consistencies in the present sample were also excellent (α=0.92 for both child and parent report).

Penn State Worry Questionnaire for Children (PSWQ-C) (Chorpita, Tracey, Brown, Collica, & Barlow, 1997). Worry was measured using the PSWQ-C, which is a 14 item self-report measure on a 4-point Likert Scale (0 = not at all true, 1 = sometime true, 2 = often true, 3 = always true) resulting in a total score

ranging from 0-42, with higher scores indicating higher worry. The measure was adapted from the adult Penn-State Worry Questionnaire (Meyer, Miller, Metzger, & Borkovec, 1990), and has demonstrated solid psychometric properties including convergent and discriminative validity, and high internal consistency in clinical and community samples (Chorpita et al., 1997; Pestle, Chorpita, & Schiffman, 2008). The internal consistency of the PSWQ in the present sample was excellent (α=0.89).

4.2.3 Procedure

All study procedures were conducted with the approval of the University of Reading research ethics committee. Child participants were recruited through schools (N= 173) and as a part of a larger project (N= 54). The latter sample also took part in the studies described in chapters 5 and 6. For children who completed questionnaires during school time, informed consent was sought from parents prior to the school visit using a passive consent procedure. During the school visit, children were informed about the study and their assent was sought. Children were free to withdraw if they wished to. Questionnaires (IUS-C, SCAS, and PSWQ) were completed in their classroom during school time. Letters were sent home to parents explaining that their child had taken part that day and inviting parents to take part themselves. Parents who were recruited in this way (n = 7) and through online advertising (n = 143) completed questionnaires (IUS-C, SCAS, and demographics) online. Families who were recruited via local advertisement as a part of a larger study (n = 54) completed the questionnaires whilst attending a lab visit at the University of Reading. Parental consent and child assent was obtained at the time of their visit.

The schools were visited again after two-weeks and the children were asked to complete the IUS-C again (time 2). Similarly, all parents were invited via email to complete the IUS-C again after two-weeks.

4.2.4 Missing/Invalid Data

All 227 children and 204 parents in the original sample at Time 1 attempted to complete the questionnaires; however, responses were deemed valid only if 80% of the items were complete for each questionnaire. For the child sample, six IUS-C forms were deemed invalid while all SCAS and PSWQ measures were valid; therefore, 6 participants were excluded from the analysis. For the parent sample, all IUS-C forms were valid and therefore all participants were included in the analysis. Note however that

two parent participants were missing SCAS scores and these cases are removed from analyses involving SCAS scores. All child and parent data was valid at Time 2.

We checked all variables for univariate outliers. The data points ± 3.29 SD from the mean accepted as outliers. One univariate outlier on the IUS-C in child data found and excluded from the analysis. The final sample (children) consisted of 220 participants (111 male) aged between 7.58 and 11.81 (M=9.97, SD=1.04). There were no cases of univariate outliers in the parent data. Taking the data from this final sample, we explored the data further for exploratory factor analysis (EFA). There was unanswered items on the child-report of the IUS-C; 3 cases on item 2 and 14; and 1 case on item 3, 4, 5, 11, 12, 16, 21, 23, and 24 and unanswered items on the parent report of the IUS-C; one case on items 1, 4, 16, and 22; and two cases on item 13 Little's MCAR test suggested that this data can be accepted as missing completely at random for the child (χ 2(177, N=220) = 173.12, p=. 57) and parent (χ 2(76, N=204) = 91.63, p=. 12) data. As such, listwise exclusion of cases for missing values was appropriate for the EFA. Therefore, the EFA analyses were conducted with 210 child participants and 200 parent participants.

4.3 Results

4.3.1 Preliminary Analyses

Means and standard deviations for each questionnaire are presented in Table 2 (p.108). Child data indicated that the IUS-C scores were not significantly different for males and females; t (218) = 1.94, p=. 054 d = 0.26. However, females scored higher on the SCAS (t (218) =4.86, p < .001, d=0.656) and PSWQ (t (218) =3.31, p < .001, d=0.45). There were no significant correlations between age and any of the self-reported variables. There was a significant positive correlation between SCAS and PSWQ scores (r= 0.71, p< .001), between SCAS and IU scores (r=0.75, p< .001), and between PSWQ and IU scores (r=0.70, p< .001).

There were no significant differences between male and female children on the parent reported IUS-C (t (202) = 0.37, p=. 71, d=0.051) and SCAS scores (t (200) = 1.62, p=. 12, d=0.228). There were no significant correlations between child's age and parent-reported SCAS and IUS-C. There was a positive correlation between parent-reported SCAS and IU scores (r=0.73, p< .001).

4.3.2 Item Difficulty Ratings

Flesh-Kincaid readability test is designed to indicate reading ease and grade level of a passage/ sentence written in English. The reading ease generates a score between 1 and 100 and higher reading ease score indicates easier readability and higher Flesh-Kincaid Grade Level indicates that the passage/ sentence requires higher-grade level. For example, the reading ease score between 90 and 100 indicates 5^{th} grade level, the scores between 80 and 90 indicates 6^{th} grade level, the scores between 70 and 80 indicates grade level of 7^{th}, and so on. Considering the age of participants in this sample, at least 5^{th} grade level and the reading ease scores of between 90 and 100 is needed.

The reading ease score for the IUS (adult IU measure) is 66.4 and grade level is indicated as 6.1. For the IUS-12 (short version of the IUS), reading ease score is 68.1 and the grade level is 5.9. The results for the child measure of IU (IUS-C) indicated that this scale has higher reading ease score (84.6) and lower grade level (3.9). On the other hand reading ease for the parent form is 74.0 and the grade level is 5.6. As parallel to the items in the shorter version of the IUS, the reading ease was also calculated for the IUS-C with 12 items. The reading ease score is 84.8 and the grade level is 4.0. For the parent form, the reading ease score is 73.3 and the grade level is 5.9.

The item difficulty rating was conducted using Time 1 data. Table 3 (p.109) shows all items on the IUS-C (both child and parent report) and the proportion of participants who rated the item as difficult to judge. There was a significant correlation between child age and the number of items that were difficult to judge as reported by children; r_s= -0.27, N=220, p< .001 and as reported by parents; r_s= -0.17, N=204, p=0.017. Overall, the items that were seen as most difficult to understand by children were, in order of difficulty; item 2, 16, 1, and 10 respectively. Similarly, the items that were seen as most difficult to understand by parents were item 2, 1 and 13, and 10 respectively. Any items that were rated as difficult to judge by 15% or more of participants were removed during the second EFA (see below). The 15% criterion was chosen based on a balance between rejecting too many items unnecessarily, which may occur with a lower criterion, and leaving in items that were difficult for a significant number, which may occur with a high criterion.

During the data collection process, there was also anecdotal evidence that children also asked for clarification for some items that were not necessarily scored as difficult to understand. Specifically, some children asked what exactly the word "surprise" meant in relation to items 7, 10, and 19 indicating that surprises can be both good and bad. These questions were not removed, as they weren't objectively rated as difficult to judge.

The reading ease and the grade level for the items rated as difficult to judge by parents and children were also calculated with Flesh. The reading ease score for the items 1, 2, 10, and 16 are 66.7, 66.7, 61.2, and 100 respectively (child form) and the reading ease for the items 1, 2, 10, and 13 are 40, 87.9, 71.7, and 89.8 respectively (parent form). However, there were items that had lower reading ease score (e.g. item 7 had a score of 49.4) and similar reading ease score (e.g item 21 had a score of 61.3) that were not rated as difficult to judge by children. Therefore, the issues with the IUS-C items may not be just about the reading ease but about what the item is asking and whether or not children can reflect on.

4.3.3 Factor Analysis

EFA was conducted using Time 1 data collected from children and parents. For factor analysis, guidelines typically recommend that adequate sample size (N) should be decided based on the ratio of N to number of variables being analysed (p); however, recommendations about this ratio vary from 3 to 10 (MacCallum, Wideman, Zhang, & Hong, 1999); we opted to follow the recommendations of (Cattell, 1987) who suggests a range of 3 and 6, and (Gorsuch, 1983) who suggests a minimum ratio of 5. EFA was run with 210 child participants and 200 parent participants. N: p ratios were 7.78 for the child sample and 7.41 for the parent sample.

For both child and parent report, EFA was carried out using principal axis factoring (PAF) using SPSS 22 with all 27 items. In order to determine the number of factors to retain, there are a number of ways to make a decision. Kaiser criterion of retaining all the factors with eigen values greater than 1.0 is one option, the scree plot although it is compromised by subjective judgement is another option. A further option is to use Parallel Analysis, as suggested by Horn (1965), which is based on a comparison of eigen values in the actual data to the eigen values in simulative data. When determining the number of factors

to retain, all three methods were used to inform the decision.

Costello and Osborne (2005) suggest running multiple factor analyses for the range of possible loadings and then selecting the best fit for the data as determined by the pattern matrix with the cleanest factor structure, which is defined as item loadings above 0.30, no or few cross loadings, and no factors with fewer than three items. First, we followed Costello and Osborne (2005) and ran the EFA without removing any items from the IUS-C. By doing the EFA with all 27 items first, we could ensure that items were not excluded prematurely and examine whether a coherent factor structure could be identified using all items. In addition, and for comparison we set criteria for items to meet to be included in the EFA and ran the EFA using only those remaining items that remained after the criteria checks. First, items were excluded if >90% of participants gave the same response. Second, as some correlation between items is expected in order to identify a clear factor structure (Field, 2009 p.648), we only included items that had a correlation with at least four other items within the range r = 0.3 – 0.8. Third, as previously described, we excluded items that were rated as difficult to judge by more than 15% of the sample.

Factor Analysis of the IUS-C Child Report

First, EFA was run with all 27 items of the IUS-C. Kaiser-Meyer Olkin Measure of Sampling Adequacy (KMO) was .90 which is above the recommended value of .6 (MacCallum et al., 1999) and Bartlett's Test of Sphericity was significant ($\chi 2$ (351) = 2144.29, $p < .001$). In this initial analysis, the first ten eigen values were 9.08, 1.65, 1.38, 1.18, 1.06, 1.01, 0.98, 0.87, 0.86, and 0.80; accounting for 56.87% of the variance and suggesting six-factor solution; however, examination of the scree plot suggested a more appropriate solution would be less than six-factor. Parallel analysis also suggested that the 2-factor solution would be appropriate, corresponding to the scree plot.

Several principal factor analysis (PAF) were then performed by employing promax (oblique) rotation as it is reasonable to assume that the factors would correlate with each other and item loadings for a five-factor, four-factor, three-factor, two-factor, and one-factor solution were examined. Overall, the interpretability of the all models was poor due to items presenting problems such as not loading onto any factor above 0.30 and too many cross loadings between 0.30 and 0.40.

We then checked each item against the inclusion criteria stated previously. Response variability for each item was acceptable; however, three items correlated with 3 or fewer other items at r >.3 (10, 19, and 7; Table 4, p.110) so were excluded (all). In addition, items 1, 2 and 16 were rated as difficult to judge by more than 15% of the children in our sample (see Table 3, p. 109) and were therefore excluded. With the remaining 21 items of the IUS-C, KMO was .91 and Bartlett's Test of Sphericity was significant ($\chi 2$ (210) = 1758.10, $p < .001$). This analysis suggested 4 factors above the eigen value 1; however, examination of the scree plot suggested that a more acceptable solution would be less than 4 factors. Several PAF were conducted to examine three, two, and one factor solutions by employing promax rotation. The one factor model explained 37.89% of the variance (α=0.91) and factor loading for all items were sufficient ranging from 0.43 to 0.75. In the two-factor solution, the first factor explained 37.89% of the variance (α=0.90), the second factor explained 6.88% of the variance (α=0.75) and the two factors correlated .59 with each other, as it was assumed in promax rotation. In the three-factor solution, the first factor explained 37.89% of the variance, the second factor explained 6.88% of the variance, the third factor explained 5.43% of the variance and the correlations between factors ranged from 0.44 to 0.62. The three factors given by the three-factor solution did not appear to be conceptually distinct. While the conceptual difference between factors in the two-factor model was more distinct, it was still relatively weak. In addition, adding a second and third factor did not explain substantial additional variance over the one factor solution. Therefore, the results suggest that a one-factor solution offers the best fit for this data conceptually and statistically (see Table 5 for item loadings, p. 111).

Factor Analysis of the IUS-C Parent Report

Using all 27 items on the IUS-C parent form, Kaiser-Meyer Olkin Measure of Sampling Adequacy (KMO) was .96 which is above the recommended value of .6 (MacCallum et al., 1999) and Bartlett's Test of Sphericity was significant ($\chi 2$ (351) = 4320.67, $p < .001$). In this initial analysis, the first ten eigen values were 14.7, 1.49, 1.3, 0.99, 0.84, 0.74, 0.65, 0.58, 0.54, and 0.53; suggesting a three-factor solution and accounting for 64.78% of the variance. The examination of the scree plot suggested a more appropriate solution may be less than three factors. Parallel analysis also suggested that the 2-factor solution would be appropriate, corresponding to the scree plot. Two-factor and one-factor solutions

were then examined by employing promax (oblique) rotation; and the items loadings were examined for coherence. Statistically and conceptually both two-factor and one-factor models were appropriate.

We then checked each item against the inclusion criteria stated previously. Response variability for each item was acceptable and the correlations between items were all between 0.3 and 0.8 in the correlation matrix (Table 6, p. 112) indicating no items that might present any issues in this data. After, removing the items reported as difficult to judge by more than 15% of the parents, KMO was .96 and Bartlett's Test of Sphericity was significant ($\chi 2$ (253) = 3815.28, $p < .001$) for the parent reported IUS-C with 23 items. One factor model explained 58.51% of the variance (α=0.97) and factor loading for all items were sufficient ranging from 0.507 to 0.847. In the two-factor solution, the first factor explained 58.51% of the variance (α=0.95), the second factor explained 5.0% of the variance (α=0.94) and the two factors correlated .80 with each other, as it was assumed in promax rotation. While the two-factor models seem to be statistically and conceptually distinct, the variance explained by the second factor is low; therefore, in the interest of parsimony we suggest that a one-factor solution is most appropriate for this data (see Table 7 for item loadings, p. 113).

4.3.4 Test-Retest Reliability

To assess test-retest reliability, IUS-C scores from *Time 1* and *Time 2* were examined with Pearson correlation coefficient and intra-class correlation coefficient. A paired t-test was also used to examine difference between scores from *Time 1* to *Time 2*. We examined the test-retest reliability of the IUS-C (i) with original 27 items on both forms (child and parent), (ii) with the items suggested by our EFA analysis on both forms, and (iii) with 12 items that parallel to those in IUSC-12 and examined by Cornacchio et al. (2017). Note that the some items removed from the EFA analysis included items that were hard to understand and these items were included in the IUSC-12.

Test-retest reliability of the IUS-C Child Report

A high degree of test-retest reliability was found for the IUS-C (27 items) over the two-week period. The single measure ICC was 0.82 (95% CI 0.75-0.86) indicating high test-retest reliability between two-weeks. A paired samples t-test revealed that scores on the IUS-C at Time 1 (M=59.72, SD=20.16) were

significantly higher than the scores on the IUS-C at Time 2 (M=53.66, SD= 19.18); t (143) = 6.08, p < .001, d=0.51

With the understandable items-suggested by the EFA analysis in this paper, the single measure ICC was 0.80 with (95% CI 0.73-0.85). Paired samples t-test showed that the scores on Time 2 (M=42.88, SD=16.13) were significantly lower than the scores on Time 1(M=47.56, SD=17.27); t (143) =5.30, p<. 001, d= 0.28.

With 12 items of the IUS-C as suggested by Cornacchio et al. (2017), the single measure ICC was 0.73 (95% CI 0.66-0.80). Paired sample t-test revealed that the scores at Time 1 (M=26.85, SD=8.83) were significantly higher than the scores on Time 2 (M=23.94, SD=8.53); t (143) = 5.47, p<. 001, d=0.34.

Test-retest reliability of the IUS-C Parent Report

A high degree of reliability was found for the IUS-C parent-report (27 items) between two-weeks. The single measure ICC was 0.87 (95% CI 0.80-0.92) indicating a good test-retest reliability. Paired samples t-test revealed that scores on the IUS-C at Time 1 (M=56.22, SD=23.59) was significantly lower than the scores on the IUS-C at Time 2 (M=60.44, SD= 25.86); t (71) = 2.87, p =.005, d= 0.34.

With the understandable items suggested by the EFA for the IUS-C parent report in this paper, the single measure ICC was 0.88 (95% CI 0.80-0.92). A paired samples t-test revealed that scores on the IUS-C (23 items) at Time 1 (M= 48.26, SD=21.16) were significantly lower than the scores on the IUS-C (23 items) at Time 2 (M=51.86, SD=23.08); t (71) = 2.67, p=.009, d=0.16.

With 12 items suggested by Cornacchio et al. (2017), the single measure ICC was 0.86 (95% CI 0.79-0.91). A paired sample t-test showed that there was no significant difference between Time 1 total score (M=25.51, SD=11.33) and Time 2 (M=26.88, SD=11.97); t (71) =1.87, p=0.066, d= 0.12.

4.3.5 Agreement between child and parent reports of the IUS-C

The agreement between the child and parent report is examined with three different statistics; Pearson product-moment correlation coefficient, intraclass correlation (ICC), and comparison of group means. All 27 items are included to calculate the total score of the IUS-C for child and parent report and

the data was analysed based on the 61 matched sets. Pearson correlation coefficient for parent-child was not significant for the total scale (r=0.24, p=0.066). The level of agreement between child and parent self-report of the IUS-C was also analysed using two-way random model (absolute agreement, single measure) intraclass correlation coefficient (ICC2,1). An ICC of 0.40 and below indicates poor to fair; between 0.41 and 0.60 indicated moderate agreements; between 0.61 to 0.80 indicates good agreement; and between 0.81 to 1.00 indicates excellent agreement (Sankar, Robinson, Honey, & Freeston, 2017).

For the original IUS-C with 27 items, the single measure of ICC was .28, p=0.032 with a 90% confidence interval 0.03 to 0.43. The paired sample t-test revealed that there is no significant difference between the child (M=58.26, SD=24.61) and parent (M=55.03, SD=23.38) reported IUS-C scores; t (60) =0.85, p=0.399.

For the IUS-C suggested by the EFA analysis, the single measure of ICC was .20, p=.06 with a 90% confidence interval -.052 to 0.429. Paired sample t-tests revealed that, there is no significant differences between the child (M=46.06, SD=19.85) and parent (M=47.51, SD=21.33) reported IUS-C scores, t (60) = .433, p=.667.

We have also examined the child-parent agreement by taking into account the shortened version of the IUS-C (12 items) as suggested by Cornacchio et al. (2017). The single measure of ICC was 0.29 (90% CI 0.086 -0.473), p=0.011. Paired samples t-test also showed that there is no significant difference between the child (M=26.20, SD=11.31) and parent (M=24.70, SD=11.72) reported IUS-C (12 items). Even though the agreement between forms appears to be significant for all versions, they all were relatively poor.

4.3.6 Internal consistency and convergent validity across versions

Table 8 (p. 114) shows the internal consistencies and correlations with anxiety and worry scales for the original IUS-C (27 items), the IUS-C-12 (Cornacchio et al., 2017) and the version of the IUS-C with understandable items suggested by the EFA above. All versions of the IUS-C child report correlated significantly with both anxiety and worry, and showed good internal consistencies. All versions of the IUS-C parent report also showed good internal consistencies, and all of them showed significant

associations with parent reported anxiety; however, the poor agreement between child and parent report remained as an issue across all versions.

4.4 Discussion

We examined the psychometric properties of the IUS-C in preadolescent children with the aim of advancing understanding of the structure and measurement of IU in children. The sample chosen for this study consisted of a narrow age band of preadolescent children in order to investigate the suitability of the IUS-C items for this period of development. Factor structure of the IUS-C was also examined using EFA for the first time to draw possible hypotheses about the structure of IU for preadolescent children. The present study is also the first to examine the test-retest reliability of the IUS-C in any age group. The agreement between child and parent report was also studied. The results and limitations of the study will now be discussed along with suggestions for future research in this area.

The IUS-C is designed to measure IU in children and adolescents (7 to 17 years) and is a downward extension of the adult measure of IU (Comer et al., 2009). However, between age 7 and adulthood there is rapid cognitive and metacognitive development that may affect children's processing and responses to uncertainty. Therefore here we focused on a narrow age band (7-12 years) to clarify the suitability of the child and parent versions of the IUS-C for preadolescent children. Our results showed that three items on the child-report and four on the parent-report forms were identified as difficult to judge by more than 15% of children and parents. Flesh-Kincaid scores also indicated that the items that are rated as difficult to judge by more than 15% of the participants required a grade level of 8^{th} or 9^{th}, which is above the reading level of participants in this sample. Careful scrutiny of these items suggested that other items in the measures captured similar constructs and they could therefore be removed without significantly affecting the construct being measured. Three more items on the child report were removed on the basis of showing no correlations with the other IUS-C items. Interestingly, these items (item 7, 10, and 19) included the word "surprise". This aligns with the fact that participants regularly asked questions about these items during data collection. It seems likely that for young children surprise is almost always positive and they may therefore feel differently about it to other types of uncertainty. It is also important to note

that themes picked up by the removed items can be covered by the remaining items such as “one should always think ahead to avoid surprises” which is one of the removed items from the IUS-C can be covered by the item “ it is not fair that other kids are more sure of things”. On the other hand, a greater number of items were reported as challenging by younger children and parents of younger children in our sample. This may suggest that it may be particularly important to adapt the measure for younger children.

Unlike previous studies, we found that a one-factor structure provided the best fit in the factor analysis yet given the relatively small sample size, results should be interpreted with caution. Although this is not consistent with the results of previous factor analysis studies with younger samples (Boelen et al., 2010; Cornacchio et al., 2017), it may reflect the possibility that distinct prospective and inhibitory components of IU emerge as children develop and transition into adolescence and adulthood. Considering the most recent studies examining providing evidence for the bifactor structure of the IUS in adult samples (e.g Hale et al., 2015) and the conceptual difference between factors in the two-factor model was distinct -although relatively weak compared to the one-factor structure- in our data, a bifactor model for the IUS-C should also be examined. Further studies, which can evaluate how factor structure changes with age, are also warranted. Ideally, to examine the factor structure of the IUS-C across development, a large enough sample consisting of different narrow age bands would be recruited so that this can be examined within a single study.

We examined the test-retest reliability of the IUS-C across all versions and all versions showed high test-retest reliability over two-weeks. This supports the idea that IU is a trait that is relatively stable over time and suggests that all versions of the measure are equally reliable with regard to test-rest reliability. However, longitudinal research that tracks changes in IU over a long time period can also contribute to knowledge with regards whether IU is a stable construct over a long time period or waxes and wanes throughout development.

In contrast, but consistent with the previous research conducted by Comer et al. (2009), we found poor agreement between child and parent forms across all versions of the IUS-C. One reason for low agreement between child and parents forms may be that some features of IU are unobservable to the parents, meaning that children may be better placed to report on their IU (Comer et al., 2009). However,

it is also important to acknowledge that discrepancies in parent-child report are a common issue for self-report measures of this nature and that young children may have limited ability to reliably self-report (e.g. Cosi, Canals, Hernández-Martinez, & Vigil-Colet, 2010; March, Parker, Sullivan, Stallings, & Conners, 1997; Miller, Martinez, Shumka, & Baker, 2014). Further research is needed to better understand the cause of discrepancies between parent and child forms and to make recommendations about who is best placed to report on child IU or how reports from parents and children might be combined.

4.4.1 Strengths and limitations

This study is the first to provide a thorough psychometric examination of the IUS-C in terms of test-retest reliability and exploratory factor analysis along with respondents' perception of the IUS-C items. The sampling and data collection for children and parents were done separately to control the effect of parental influence on children's responses. We focused on a narrow age band to provide specific insights into the measurement and structure of IU in preadolescent children. Furthermore, this is also the first study to ask children and parents about their understanding of the items providing a systematic examination of the items from respondents' perspective. Another strength that the study has is the use of EFA which helps to draw hypothesis regarding the factor structure of the IUS-C. Following the item difficulty rating and the EFA, we have also analysed and compared versions of the IUS-C suggested in the literature and by our analysis.

The study has several limitations. Due to the issues around participant recruitment, we only had 61 parent-child dyads in our sample to examine child-parent agreement; therefore, our sample for this analysis was slightly underpowered. Additionally, despite the high N;p ratio for factor analysis, the sample size was relatively small for a factor analysis. Most the children completed the questionnaires in classrooms during the school time. Students were asked to complete the measures under test conditions but as they were sitting relatively close to one another, it is possible that they could have glanced at one another's responses and that the social context might have affected their responses.

The demographic information collected from the children was also limited to age and gender. These children did not complete a demographics survey as it did not feel appropriate given their age. As such,

the sample is representative of the school population, which is strength, but we were not able to identify and exclude children with learning difficulties or mental health problems, which is a potential limitation. The schools were also located in a middle class area; therefore, the children may not be representative of the wider population. The demographic information provided by parents also suggests a lack of diversity in the sample; therefore, the generalizability of the results may be limited.

4.5 Conclusion and Future Directions

Despite the limitations, our data support the use of the IUS-C with 21 items for the child and 23 items for the parent forms of the IUS-C for preadolescent children. There are several reasons for this. First the internal consistency, correlations with anxiety and worry, and the test-retest reliability are consistent with the original IUS-C. Second, items that participants had difficulty answering have been removed, the content is therefore easier to comprehend and the responses can be accepted as more reliable. Third, the remaining items capture the content of the items that have been removed so no content is lost (for example, item 23. 'It's not fair that other kids are more sure of things' remains in and covers item 16.'Other kids have less doubt than I do', which is removed). Fourth, this measure has fewer items and is therefore less time consuming. Although similar results were also found for the IUS-C with 12 items, we highlight that some items that are rated as difficult to judge are included in this version. The poor agreement between child and parents forms was consistent across all versions and still remains a challenge.

Our intention was to draw hypotheses about the factor structure of IUS-C in preadolescent children using EFA. Now, confirmatory factor analysis is needed to build upon these results. Additionally, further examination of the IUS-C with different samples (i.e. adolescents) consisting of narrow age band would provide insight into how the structure of IU changes with age or remains the same across development. Longitudinal designs to track changes in IU throughout development are also warranted as such work would improve our understanding of whether IU is a fixed trait, as theorised, or whether it waxes and wanes across critical developmental periods (e.g. starting school). One example of such research was conducted by Dugas, Laugesen, and Bukowski (2012) where IU was measured ten times over a 5 year period in a community sample of adolescents and it was observed as descending linearly over time.

Based on the item difficulty ratings, we only removed items identified by more than 15% of participants as difficult to judge but many more items were identified as difficult to judge by a smaller proportion of participants. It may therefore be timely to consider developing a questionnaires measure of IU specifically for children. This could be developed using a bottom-up approach rather than starting with an adult measure. Furthermore, while improving questionnaire measure of IU in young people is crucial, there is also a need for research that examines IU using behavioural measures and experimental designs. These methods may overcome the issues of self-report. Although self-reports are widely used in psychological research, they are subject to issues such as socially desirable responding and are dependent upon cognitive abilities such as reading level, meta-cognition and understanding as well as insight into emotion. This is particularly an issue for extending IU research to younger children who cannot yet provide reliable self-report. Thus, future work should also consider developing behavioural measures that are appropriate for use across a broad age range to examine IU.

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TABLE 1: Demographic Information for the Sample (Parent)

	Total Sample (N=201)
Marital Status (%)	
Married	80.9
Separated	3.4
Divorced	2.9
Widowed	0.5
Never Married	12.3
Living Arrangements (%)	
Two Parent	82.8
Single Parent	7.8
Step or Blended Family	7.4
Other	1.5
Employment Status (%)	
Full-time Employed	31.4
Part-time Employed	46.1
Full or Part-time Student	2
Combined Employment & Study	2.5
At home by choice	9.3
Illness/Disability	2
Unemployed	1
Other	5.9
Education Level (%)	
Year 10 or equivalent	3.9
Year 12 or equivalent	7.4
Tafe/Apprenticeship	1
Certificate/Diploma	20.1
Undergraduate	23.5
Postgraduate	41.7
Other	2.5
Origin (%)	
White-British	83.8
White-Irish	1
African	0.5
Indian	2
Pakistani	0.5
Bangladeshi	0.5
Chinese	0.5
White & Black Caribbean	0.5
White & Asian	2
Other	8.8

TABLE 2: Means & Standard Deviations

		N	Mean (SD)
Child Report – Total Sample	SCAS	220	29.65 (16.32)
	PSWQ	220	15.78 (8.34)
	IUS-C	220	57.74 (20.02)
Child Report –Males	SCAS	111	24.60 (15.24)
	PSWQ	111	13.98 (8.22)
	IUS-C	111	55.16 (19.33)
Child-Report-Females	SCAS	109	34.79 (15.84)
	PSWQ	109	17.62 (8.08)
	IUSC	109	60.37 (20.45)
Parent Report-Total Sample	SCAS	202	23.64 (14.78)
	IUS-C	204	54.54 (23.97)
Parent Report-Males	SCAS	101	21.97 (14.99)
	IUS-C	102	53.92 (25.75)
Parent Report-Females	SCAS	101	25.32 (14.45)
	IUS-C	102	55.16 (22.14)

SCAS: Spence Child Anxiety Scale, IUS-C: Intolerance of Uncertainty Scale for Children, PSWQ: Penn-State Worry Questionnaire

TABLE 3: Proportion of children and parents rating the items as difficult to judge

Item	% of Children	% of Parents
1. Doubts stop me from having strong opinions. Uncertainty stops my child from having strong opinions.	18.2	17.2
2. Being unsure means that person is mixed-up. My child believes that being uncertain means one is mixed up.	25.0	29.9
3. Not knowing what will happen in the future makes life hard. Uncertainty makes my child's life intolerable.	10.5	5.9
4. It's not fair we can't predict future. My child thinks it's unfair that we can't predict future.	6.4	9.3
5. I can't relax if I don't know what will happen tomorrow. My child's mind can't be relaxed if he/she doesn't know what will happen tomorrow.	5.5	2.5
6. Not knowing what will happen in the future makes me uneasy, anxious, or stressed. Uncertainty makes my child uneasy, anxious, or stressed.	5.9	1.0
7. Surprise events upset me greatly. Unforeseen events upset my child greatly.	5.5	0.5
8. It frustrates me to not have all of the information I need. It frustrates my child to not to have all the information he/she needs in a situation.	6.4	3.9
9. Not knowing what could happen keeps me from enjoying life. Uncertainty keeps my child from living a full life.	5.5	5.4
10. One should always think ahead to avoid surprises. My child believes that one should always look ahead so as to avoid surprises.	14.1	15.2
11. Plans can be ruined by things you didn't think would happen. My child believes that a small-unforeseen event can spoil everything, even with the best planning.	7.3	6.4
12. When it is time to do things, not knowing what could happen keeps me from acting. When it is time to act, uncertainty paralyzes my child.	7.3	6.9
13. Being unsure of things means that I am not great. My child believes that being uncertain means that he/she is not first rate.	6.4	16.7
14. When I am not sure something I can't go forward. When my child is uncertain he/she can't go forward.	10.5	5.9
15. When I am not sure of something, I can't work very well. When my child is uncertain, he/she can't function very well.	5.0	3.9
16. Other kids have less doubt than I do. Other children seem to be more certain than my child.	19.1	8.8
17. Not knowing what will happen makes me unhappy or sad. Uncertainty makes my child unhappy or sad.	2.7	2.5
18. I always want to know what will happen to me in the future. My child always wants to know what the future has in store or him/her.	4.1	4.4
19. I don't like being taken by surprise. My child can't stand being taken by surprise.	4.5	1.5
20. The smallest doubt can stop me from doing things. The smallest doubt can stop my child from acting.	5.5	2.5
21. I should be able to prepare for everything in advance. My child feels as though he/she should be able to organize everything in advance.	8.6	4.4
22. Being unclear about things means that I am not confident. My child feels as though being uncertain means that he/she lacks confidence.	6.4	12.3
23. It's not fair that other kids are more sure of things. My child feels as though it's unfair that other people seem to be sure about their future.	6.8	11.3
24. Not knowing what can happen keeps me from sleeping well. Uncertainty keeps my child from sleeping soundly.	5.0	2.0
25. I must get away from all situations where I don't know what will happen. My child tries to get away from all uncertain situations.	8.2	4.4
26. Things that are unclear stress me. The ambiguities of life stress my child.	4.5	3.4
27. I don't like being undecided about the future. My child can't stand being undecided about the future.	10.5	2.9

TABLE 4: Correlation Matrix (IUS-C Child Report)

Child-Report	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1		.275	.267	.168	.388	.308	.220	.277	.281	.038	.387	.356	.375	.289	.321	.355	.344	.248	.245	.396	.082	.332	.336	.372	.375	.393	.318
2	.275		.340	.028	.289	.266	.154	.203	.228	.063	.346	.287	.266	.198	.343	.177	.306	.198	.290	.258	.112	.361	.347	.343	.228	.191	.216
3	.267	.340		.345	.322	.524	.173	.262	.297	.000	.366	.412	.347	.235	.357	.295	.423	.520	.131	.410	.212	.307	.377	.386	.310	.297	.352
4	.168	.028	.345		.238	.300	.146	.233	.165	.124	.137	.292	.150	.137	.182	.239	.234	.501	.120	.205	.297	.121	.262	.117	.251	.258	.316
5	.388	.289	.322	.238		.535	.310	.416	.433	.184	.324	.435	.359	.335	.416	.331	.349	.345	.119	.349	.294	.370	.445	.467	.407	.328	.329
6	.308	.266	.524	.300	.535		.269	.389	.338	.120	.405	.448	.291	.370	.508	.318	.505	.420	.208	.481	.299	.362	.413	.515	.406	.445	.460
7	.220	.154	.173	.146	.310	.269		.261	.256	.191	.263	.249	.241	.242	.282	.209	.244	.212	.272	.311	.077	.228	.345	.246	.279	.274	.137
8	.277	.203	.262	.233	.416	.389	.261		.217	.281	.390	.367	.228	.220	.348	.241	.190	.411	.184	.252	.179	.261	.351	.276	.282	.327	.242
9	.281	.228	.297	.165	.433	.338	.256	.217		.139	.125	.405	.324	.242	.301	.204	.447	.301	.231	.320	.156	.373	.337	.351	.313	.339	.281
10	.038	.063	.000	.124	.184	.120	.191	.281	.139		.173	.123	.076	.101	.141	.196	.039	.165	.280	-014	.298	.003	.128	.038	.240	.088	.126
11	.387	.346	.366	.137	.324	.405	.263	.390	.125	.173		.381	.230	.299	.342	.317	.337	.372	.276	.341	.117	.176	.266	.439	.330	.267	.298
12	.356	.287	.412	.292	.435	.448	.249	.367	.405	.123	.381		.344	.402	.456	.318	.484	.366	.180	.410	.216	.432	.484	.440	.439	.378	.320
13	.375	.266	.347	.150	.359	.291	.241	.228	.324	.076	.230	.344		.465	.352	.360	.439	.238	.274	.326	.256	.335	.391	.252	.371	.330	.334
14	.289	.198	.235	.137	.335	.370	.242	.220	.242	.101	.299	.402	.465		.505	.222	.317	.204	.213	.329	.321	.291	.302	.341	.330	.317	.229
15	.321	.343	.357	.182	.416	.508	.282	.348	.301	.141	.342	.456	.352	.505		.279	.368	.363	.280	.466	.309	.430	.427	.439	.428	.426	.352
16	.355	.177	.295	.239	.331	.318	.209	.241	.204	.196	.317	.318	.360	.222	.279		.393	.347	.172	.325	.262	.248	.410	.301	.314	.324	.408
17	.344	.306	.423	.234	.349	.505	.244	.190	.447	.039	.337	.484	.439	.317	.368	.393		.361	.296	.426	.243	.432	.472	.461	.402	.451	.449
18	.248	.198	.520	.501	.345	.420	.212	.411	.301	.165	.372	.366	.238	.204	.363	.347	.361		.175	.226	.420	.168	.352	.312	.346	.351	.439
19	.245	.290	.131	.120	.119	.208	.272	.184	.231	.280	.276	.180	.274	.213	.280	.172	.296	.175		.213	.113	.253	.353	.250	.264	.243	.251
20	.396	.258	.410	.205	.349	.481	.311	.252	.320	-014	.341	.410	.326	.329	.466	.325	.426	.226	.213		.163	.314	.463	.448	.389	.321	.354
21	.082	.112	.212	.297	.294	.299	.077	.179	.156	.298	.117	.216	.256	.321	.309	.262	.243	.420	.113	.163		.139	.251	.119	.258	.270	.316
22	.332	.361	.307	.121	.370	.362	.228	.261	.373	.003	.176	.432	.335	.291	.430	.248	.432	.168	.253	.314	.139		.403	.366	.328	.367	.283
23	.336	.347	.377	.262	.445	.413	.345	.351	.337	.128	.266	.484	.391	.302	.427	.410	.472	.352	.353	.463	.251	.403		.506	.416	.356	.293
24	.372	.343	.386	.117	.467	.515	.246	.276	.351	.038	.439	.440	.252	.341	.439	.301	.461	.312	.250	.448	.119	.366	.506		.329	.468	.374
25	.375	.228	.310	.251	.407	.406	.279	.282	.313	.240	.330	.439	.371	.330	.428	.314	.402	.346	.264	.389	.258	.328	.416	.329		.535	.320
26	.393	.191	.297	.258	.328	.445	.274	.327	.339	.088	.267	.378	.330	.317	.426	.324	.451	.351	.243	.321	.270	.367	.356	.468	.535		.394
27	.318	.216	.352	.316	.329	.460	.137	.242	.281	.126	.298	.320	.334	.229	.352	.408	.449	.439	.251	.354	.316	.283	.293	.374	.320	.394	

TABLE 5: Factor Loadings for the IUS-C Child Report

	Factor 1
6. Not knowing what will happen in the future makes me uneasy, anxious, or stressed.	.733
12. When it is time to do things, not knowing what could happen keeps me from acting.	.685
17. Not knowing what will happen makes me unhappy or sad.	.672
15. When I am not sure of something, I can't work very well	.670
23. It is not fair that other kids are more sure of things.	.654
24. Not knowing what can happen keeps me from sleeping well.	.648
5. I can't relax if I don't know what will happen tomorrow.	.646
26. Things that are unclear stress me.	.622
25. I must get away from all situations where I don't know what will happen.	.621
20. The smallest doubt can stop me from doing things.	.609
3. Not knowing what will happen in the future makes life hard.	.608
18. I always want to know what will happen to me in the future.	.584
27. I don't like being undecided about the future.	.571
22. Being unclear about things means that I am not confident.	.546
13. Being unsure of things means that I am not great.	.544
14. When I am not sure of something, I can't go forward.	.527
9. Not knowing what could happen keeps me from enjoying life.	.521
11. Plans can be ruined by things you did not think would happen.	.516
8. It frustrates me not to have all of the information I need.	.498
21. I should be able to prepare for everything in advance.	.403
4. It is not fair that we can't predict future.	.398
Extraction Method: Principal Axis Factoring.	
a. 1 factor extracted. 4 iterations required.	

TABLE 6: Correlation Matrix (IUS-C Parent Report)

Parent Report	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1		.261	.411	.196	.314	.368	.308	.334	.420	.292	.286	.441	.284	.383	.346	.474	.356	.315	.331	.465	.308	.487	.334	.417	.366	.358	.321
2	.261		.348	.372	.205	.252	.309	.331	.263	.267	.277	.260	.456	.294	.309	.260	.239	.357	.217	.227	.282	.349	.362	.260	.189	.264	.238
3	.411	.348		.425	.668	.652	.622	.567	.738	.535	.604	.480	.390	.546	.619	.634	.657	.564	.597	.549	.577	.548	.474	.588	.687	.640	.647
4	.196	.372	.425		.407	.390	.492	.395	.376	.453	.457	.323	.404	.434	.462	.342	.413	.464	.332	.269	.374	.293	.400	.397	.395	.374	.312
5	.314	.205	.668	.407		.740	.639	.635	.671	.594	.597	.445	.316	.518	.616	.548	.590	.635	.714	.546	.676	.449	.423	.603	.630	.638	.610
6	.368	.252	.652	.390	.740		.717	.674	.647	.534	.597	.420	.366	.565	.701	.552	.714	.636	.643	.626	.553	.570	.399	.585	.582	.633	.580
7	.308	.309	.622	.492	.639	.717		.657	.601	.564	.640	.460	.387	.605	.696	.557	.688	.698	.635	.579	.602	.481	.483	.586	.612	.623	.560
8	.334	.331	.567	.395	.635	.674	.657		.580	.559	.612	.418	.470	.538	.651	.500	.599	.632	.587	.607	.622	.564	.419	.554	.558	.580	.568
9	.420	.263	.738	.376	.671	.647	.601	.580		.540	.618	.525	.406	.589	.691	.610	.655	.530	.616	.590	.539	.559	.445	.582	.665	.683	.565
10	.292	.267	.535	.453	.594	.534	.564	.559	.540		.568	.430	.384	.520	.575	.363	.493	.644	.585	.404	.626	.470	.432	.444	.499	.521	.512
11	.286	.277	.604	.457	.597	.597	.640	.612	.618	.568		.504	.491	.517	.614	.538	.610	.598	.581	.507	.590	.497	.480	.537	.581	.661	.538
12	.441	.260	.480	.323	.445	.420	.460	.418	.525	.430	.504		.547	.624	.604	.604	.531	.459	.393	.559	.444	.497	.468	.529	.517	.487	.474
13	.284	.456	.390	.404	.316	.366	.387	.470	.406	.384	.491	.547		.552	.537	.340	.447	.409	.311	.464	.394	.606	.590	.372	.360	.411	.436
14	.383	.294	.546	.434	.518	.565	.605	.538	.589	.520	.517	.624	.552		.819	.558	.697	.559	.470	.605	.449	.550	.396	.560	.595	.509	.511
15	.346	.309	.619	.462	.616	.701	.696	.651	.691	.575	.614	.604	.537	.819		.598	.786	.659	.634	.701	.513	.630	.446	.649	.679	.594	.590
16	.474	.260	.634	.342	.548	.552	.557	.500	.610	.363	.538	.604	.340	.558	.598		.688	.529	.462	.643	.523	.560	.406	.580	.626	.564	.487
17	.356	.239	.657	.413	.590	.714	.688	.599	.655	.493	.610	.531	.447	.697	.786	.688		.636	.604	.695	.543	.596	.471	.624	.712	.629	.557
18	.315	.357	.564	.464	.635	.636	.698	.632	.530	.644	.598	.459	.409	.559	.659	.529	.636		.657	.523	.678	.531	.541	.527	.618	.630	.695
19	.331	.217	.597	.332	.714	.643	.635	.587	.616	.585	.581	.393	.311	.470	.634	.462	.604	.657		.592	.616	.477	.452	.573	.644	.662	.662
20	.465	.227	.549	.269	.546	.626	.579	.607	.590	.404	.507	.559	.464	.605	.701	.643	.695	.523	.592		.560	.654	.448	.538	.669	.573	.631
21	.308	.282	.577	.374	.676	.553	.602	.622	.539	.626	.590	.444	.394	.449	.513	.523	.543	.678	.616	.560		.540	.551	.432	.570	.591	.686
22	.487	.349	.548	.293	.449	.570	.481	.564	.559	.470	.497	.497	.606	.550	.630	.560	.596	.531	.477	.654	.540		.535	.491	.545	.515	.545
23	.334	.362	.474	.400	.423	.399	.483	.419	.445	.432	.480	.468	.590	.396	.446	.406	.471	.541	.452	.448	.551	.535		.451	.459	.527	.584
24	.417	.260	.588	.397	.603	.585	.586	.554	.582	.444	.537	.529	.372	.560	.649	.580	.624	.527	.573	.538	.432	.491	.451		.624	.614	.505
25	.366	.189	.687	.395	.630	.582	.612	.558	.665	.499	.581	.517	.360	.595	.679	.626	.712	.618	.644	.669	.570	.545	.459	.624		.666	.673
26	.358	.264	.640	.374	.638	.633	.623	.580	.683	.521	.661	.487	.411	.509	.594	.564	.629	.630	.662	.573	.591	.515	.527	.614	.666		.651
27	.321	.238	.647	.312	.610	.580	.560	.568	.565	.512	.538	.474	.436	.511	.590	.487	.557	.695	.662	.631	.686	.545	.584	.505	.673	.651	

TABLE 7: Factor Loadings for the IUS-C Parent Report

	Factor 1
15. When my child is uncertain, he/she can't function very well.	.847
17. Uncertainty makes my child unhappy or sad.	.832
25. My child tries to get away from all uncertain situations.	.807
7. Unforeseen events upset my child greatly.	.803
6. Uncertainty makes my child uneasy, anxious, or stressed.	.802
9. Uncertainty keeps my child from living a full life.	.791
3. Uncertainty makes my child's life intolerable.	.791
5. My child's mind can't be relaxed if he/she doesn't know what will happen tomorrow.	.788
18. My child always wants to know what the future has in store or him/her.	.786
26. The ambiguities of life stress my child.	.786
20. The smallest doubt can stop my child from acting.	.768
19. My child can't stand being taken by surprise.	.766
27. My child can't stand being undecided about the future.	.765
8. It frustrates my child to not to have all the information he/she needs in a situation.	.759
11. My child believes that a small-unforeseen event can spoil everything, even with the best planning.	.749
14. When my child is uncertain he/she can't go forward.	.737
21. My child feels as though he/she should be able to organize everything in advance.	.737
24. Uncertainty keeps my child from sleeping soundly.	.732
16. Other children seem to be more certain than my child.	.728
22. My child feels as though being uncertain means that he/she lacks confidence.	.700
12. When it is time to act, uncertainty paralyzes my child.	.642
23. My child feels as though it's unfair that other people seem to be sure about their future.	.612
4. My child thinks it's unfair that we can't predict future.	.507
Extraction Method: Principal Axis Factoring.	
a. 1 factor extracted. 3 iterations required.	

TABLE 8: Internal consistencies and correlations of the IUS-C

	α	SCAS(Child)	PSWQ
IUS-C (27 items child report)	0.92	0.75	0.70
IUS-C (21 items child report)	0.91	0.74	0.69
IUS-C (12 items child report)	0.82	0.70	0.64
		SCAS (Parent)	
IUS-C (27 items parent report)	0.97	0.73	-
IUS-C (21 items parent report)	0.97	0.99	-
IUS-C (12 items parent report)	0.94	0.98	-

Chapter 5 – Study 3: Development of a Behavioural Measure to Assess Reactions to Uncertainty in Preadolescent Children: Adaptation of the Beads Task

Manuscript in Preparation for Submission

Osmanağaoğlu, N., Creswell, C. & Dodd, H. F. *Development of a behavioral measure of intolerance of uncertainty in preadolescent children: Adaptation of the beads task*. Manuscript in Preparation.

Please note Tables and Figures, and Appendices referred to in the Paper can be found at the end of the manuscript.

Abstract

Intolerance of Uncertainty (IU) may be important for the development and maintenance of anxiety disorders (Carleton et al., 2012). To date, research with preadolescent children has relied entirely on questionnaire measures to assess IU. Here we aimed to develop a behavioural measure to assess reactions to uncertainty that is appropriate for preadolescent children by adapting the beads task (Jacoby, Abramowitz, Buck, & Fabricant, 2014) and examine associations with the questionnaire measure of IU. Participants were 51 typically developing children (26 female; 7 to 11 years). We examined first whether participants could understand and complete the task. Based on the proportion of participants who completed the task, the accuracy scores across levels of uncertainty, self-reported certainty ratings and ratings of how important it was to participants to answer correctly, we concluded that the task is appropriate for children of this age. We then examined how participants responded to varying levels of uncertainty by examining decision-making time, information requested, and self-reported worry across uncertainty conditions. Finally, we evaluated whether the task captured reactions to uncertainty that are related to questionnaire measures of IU, anxiety and worry. Children reported feeling less certain, more worried, and requested more information as uncertainty increased. Task related worry was significantly associated with self-reported IU and the association between IU and task-related certainty approached significance; however, decision-making time and information seeking showed no significant associations with self-reported IU. Overall, the adapted Beads Task appears suitable for preadolescent children, able to induce uncertainty and can capture at least some IU related processes. Implications and areas for future research are discussed to provide insights into how behavioral tasks examining responses to uncertainty can improve our understanding of IU.

5.1 Introduction

Recent theoretical and empirical work suggests that a fundamental fear of the unknown underpins anxiety (Carleton, 2016a). Individual differences in reactions to uncertainty are captured by the construct Intolerance of Uncertainty (IU). Individuals who are high in IU are described as having "dispositional incapacity to endure an aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016b, p. 32). A significant body of research has shown that IU is associated with worry and anxiety both in clinical and nonclinical samples (e.g.Buhr & Dugas, 2002; Counsell et al., 2017; Holaway, Heimberg, & Coles, 2006; Mathes et al., 2017; Sexton & Dugas, 2009). Although the literature is more extensive with adult populations, there is growing interest in IU in children and young people (e.g. Dekkers, Jansen, Salemink, & Huizenga, 2017; Donovan, Holmes, Farrell, & Hearn, 2017; Hearn, Donovan, Spence, & March, 2017; Sanchez et al., 2017). A recent meta-analysis on IU, anxiety, and worry in children and young people revealed a medium sized association between IU and both anxiety and worry (Osmanağaoğlu, Creswell, & Dodd, 2018).

Although initially thought to be specific to generalized anxiety disorder and worry, evidence suggests that IU is a transdiagnostic factor relevant to a range of anxiety disorders (Carleton, Collimore, & Asmundson, 2010; Carleton et al., 2014; Counsell et al., 2017; Mathes et al., 2017; Tolin, Abramowitz, Brigidi, & Foa, 2003) and a number of other psychiatric disorders including eating disorders and psychosis (Frank et al., 2012; Freeman et al., 2014; Renjan, McEvoy, Handley, & Fursland, 2016; White & Gumley, 2010). IU has also been linked with poor problem solving and maladaptive coping (Dugas, Freeston, & Ladouceur, 1997; Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994; Oglesby, Albanese, Chavarria, & Schmidt, 2015). Importantly, improvements in IU are associated with symptom reduction and positive treatment outcome in adults (Boswell, Thompson-Holland, Farchione, & Barlow, 2013; Dugas & Ladouceur, 2000; Dugas et al., 2003; McEvoy & Mahoney, 2011). Therefore, research that provides insight into the nature of IU and the role of IU in the development and maintenance of anxiety is important as it has the potential to inform interventions for a range of psychiatric problems.

Research has only recently begun to examine IU in children and adolescents. A recent review highlighted that IU research in young people is heavily reliant on self-report questionnaires for measuring IU; of the 31 studies included, 29 used only self-report of IU (Osmanağaoğlu et al., 2018). There are a number of limitations to self-report including socially desirable responding, shared method variance with self-report measures of symptoms and the fact that respondents can only report on behaviors and internal states that they are conscious of and have insight into. In addition, there are some limitations with the most commonly used questionnaire measure of IU in young people (Comer et al., 2009; see chapter 4) including that it is a downward extension of an adult measure of IU (therefore the items may not be developmentally appropriate for children), and some of the items are difficult for younger children and their parents to respond to (Cowie, Clementi, & Alfano, 2016; see chapter 4).

Behavioral tasks that capture responses to uncertainty can overcome many of the limitations of self-report measures and have a number of other benefits. First, reactions to uncertainty under specific circumstances can be simulated. Careful task design has the potential to provide many new insights into the exact parameters under which uncertainty presents difficulties for people who are high in IU and anxiety/worry. Second, it is possible to develop tasks that can be used to capture IU in young children who are not yet capable of providing self-report, enabling examination of the role of early IU in the development of anxiety.

IU related behaviours were described by Sankar, Robinson, Honey, and Freeston (2017) to include avoidance, flip-flopping between decisions, making snap decisions, and seeking more information. Behavioral tasks that have been used in adults to assess reactions to uncertainty have showed that increased uncertainty is significantly associated with increased worry (Ladouceur, Gosselin, & Dugas, 2000), negative expectancy for threat (as measured by skin conductance and self-report) (Grupe & Nitschke, 2011), anticipatory anxiety (Oglesby & Schmidt, 2017), threat bias (Calvo & Castillo, 2001), and a need for more information (Jacoby et al., 2014) or a need to end the uncertainty at the expense of being right (Bensi & Giusberti, 2007). These task variables have also been found to be significantly associated with self-reported IU (Grupe & Nitschke, 2011; Jacoby et al., 2014; Ladouceur et al., 2000; Oglesby & Schmidt, 2017). Although there is still significant work to do in developing tasks that capture

the nuances of IU, together these studies demonstrate how behavioral tasks can be informative for characterizing IU-related responses to uncertainty.

To date, no studies have examined behavioral manifestations of IU in pre-adolescent children; however, two studies have used a behavioral task to examine IU among adolescents aged between 13 and 17 years old. These studies used the same task to examine behavioral and neural responses to certainty and uncertainty in adolescents (Krain et al., 2008; Krain et al., 2006). In the task, participants completed a card game where they had to guess whether a mystery card would be higher or lower than a shown card. Within this paradigm, differing levels of probabilistic uncertainty were created based on the number on the shown card. The task appeared to be successful in measuring behavioral responses to uncertainty, as longer reaction times were found among uncertain conditions. Notably, self-reported IU was significantly associated with task-related anxiety and certainty ratings (Krain et al., 2008); however, not with decision-making time (Krain et al., 2008; Krain et al., 2006).

Here we wanted to use a task where uncertainty could be manipulated and where a range of possible behavioral reactions could be captured, including the different putative behavioural manifestations of IU. We therefore used a task that had previously been used by Jacoby et al. (2014) with adults in the context of IU: 'The Beads Task'. This is a probabilistic inference task with three different levels of uncertainty that involves deciding from which jar a series of beads has been drawn (Jacoby et al., 2014). The beads task has shown that increased uncertainty in adults results in longer decision making time, greater information seeking behaviour and more distress; and these variables showed several significant associations with IU and worry (Jacoby et al., 2014).

The first aim of this study was to adapt The Beads Task and assess its suitability for assessing reactions to uncertainty in preadolescent children. The task was deemed suitable if the following criteria were met: less than 20% of task-related data missing; accuracy of responses significantly different to chance; self-reported 'importance of being accurate' higher than 25 on a scale from 0 to 100, and self-reported task-related certainty decreases as uncertainty level increases. Assuming the task meets the above criteria, the second aim was to explore reactions to uncertainty in children. Based on research with adults, we hypothesized that there would be changes in decision-making time, information seeking

behavior, and task related worry across levels of uncertainty. It is important to note that the beads task is a probabilistic inference task that requires calculation of probabilities and this may be a cognitively resource demanding task for preadolescent children. Children's ability to perform these types of tasks improves with age/ cognitive development (Bryant & Nunes, 2012). As such we also checked whether responses to uncertainty were significantly associated with age and cognitive ability.

The final aim of the study was to investigate whether the task might be able to capture reactions to uncertainty that are related to self-report IU, anxiety, and worry. Anxiety and worry were included alongside IU for two reasons. First, as these two concepts are closely related with IU we would expect task variables to be associated with anxiety and depression as well as IU. Second, because of issues with the self-report measure of IU in children, we did not want to rely entirely on this measure for confirming the construct validity of the task. We hypothesized that there would be main effect of IU, anxiety, and worry on the number of beads requested, decision making time, task-related certainty and worry. Given that associations may vary across levels of uncertainty, interactions between uncertainty level on the one hand and IU, anxiety and worry on the other hand were also examined.

5.2 Method

5.2.1 Participants

Participants were 51 children (26 female) aged between 7.58 and 11.54 years (M=9.42, SD= 1.1) recruited via local advertising through schools, magazines and flyers in public places. All participants lived in the Berkshire area in the U.K. 84.3% of participants identified as White-British, 90.2% were living in a two-parent household, and 72.6% of the parents had at least an undergraduate degree (see Table 1 for more detailed sample demographics, p.144). Note that the sample used in this study and the following study (Chapter 6) is the same. This sample is also included in the psychometric study in chapter 4.

5.2.2 Measures

Intolerance of Uncertainty for Children (IUS-C)-Child & Parent Report. The IUS-C is adapted from

the adult measure of IU, Intolerance of Uncertainty Scale (Freeston et al., 1994), and has been validated for use with children aged between 7 and 17 (Comer et al., 2009). It is a 27-item self-report measure consisting of two parallel forms (child and parent). Responders use a 5 point Likert scale (1 = *Not at all characteristic of me/my child*, 3 = *Somewhat characteristic of me/my child*, 5 = *Entirely characteristic of me/my child*) to indicate how characteristic each item is of themselves/their child. Total scores ranged from 27 to 135, with higher scores reflecting higher IU (Comer et al., 2009). Both the child and parent form have demonstrated strong convergent validity and internal consistency (Comer et al., 2009). IU scores were also calculated based on the items suggested by chapter 4. Internal consistency was high across all versions and reporters in the current study (original version: .94 child report, .96 parent report; 'understandable' items: .93 child report.96 parent report)

Spence Child Anxiety Scale (SCAS) – Child & Parent Report. The SCAS is a measure of child anxiety symptoms comprising 38 items (and 6 filler items in the child report version). Responders use a 4-point Likert scale (*0 = never, 1 = sometimes, 2 = often, 3 = always*) to indicate how often each of the items (e.g. 'I am scared of the dark') happens to them/their child. Total scores range from 0 to 114 with higher scores indicating higher anxiety (Spence, 1998). The internal consistency is excellent and the measure shows convergent and divergent validity (Nauta et al., 2004; Spence, 1998). In this sample, the internal consistency was high (.87 child report; .89 parent report).

Penn State Worry Questionnaire for Children (PSWQ-C). The PSWQ-C is a 14 item self-report measure. Responders use a 4-point Likert Scale (*0 = not at all true, 1 = sometime true, 2 = often true, 3 = always true*) to indicate how typical each of the items is of them. Total scores range from 0-42 with higher scores indicating more worry (Chorpita, Tracey, Brown, Collica, & Barlow, 1997). The measure demonstrates convergent and discriminative validity (Chorpita et al., 1997; Pestle, Chorpita, & Schiffman, 2008). Consistent with previous studies with has clinical and community samples (Chorpita et al., 1997; Muris, Meesters, & Gobel, 2001; Pestle et al., 2008), the internal consistency was high (.91) in this sample.

Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II). The WASI-II is a reliable and time-efficient assessment of intelligence composed of four subtests (vocabulary, similarities, block design, and matrix reasoning) that can be used with people aged between 6 and 90 years. The WASI demonstrates

good concurrent validity, has excellent internal consistency and good test-retest reliability (McCrimmon & Smith, 2012). Here, only the vocabulary and matrix reasoning subtests were administered. These can be used to provide an estimate of Full Scale IQ (WASI-II; Wechsler, 2011) but raw scores are used here to allow comparison of absolute rather than relative cognitive ability across children of varying ages.

5.2.3 The Beads Task

The aim of this task is for participants to work out which of two jars a selection of beads have been taken from. In the low uncertainty condition beads in the two jars were distributed with a ratio of 85:15 black to red and 85:15 red to black. In the moderate uncertainty condition beads in the 2 jars had a ratio of 60:40 black to red and 60:40 red to black ratio. In the high uncertainty condition there were three jars with a ratio of 50:25:25, 25:50:25 and 25:25:50 black to red to white respectively (see Figure 1 for a visual representative of the beads task, p. 142). There were three trials per uncertainty condition, resulting nine trials in total. The jar to be chosen for each trial and the sequence of bead presentation were predetermined using a random number generator. The order of the trials, the chosen jar, and the bead presentation sequence was the same across all participants. The task was run as a non-computerized task in this study.

Prior to beginning the task, participants were asked to name the colour of the beads that were to be used in the task in order to check their vision. All participants were able to identify the colours successfully. Next, the set of jars described above was introduced to the children and their understanding of the proportions (e.g. which jar has more red beads?) for each set of jar was checked. Participants were told that one jar (low/moderate/high uncertainty) would be used at a time and they were shown the set of jars that was being used. These jars were then hidden from their sight but a picture of the jars was placed in front of the child to ensure that memory didn't affect performance. The participants were informed that the experimenter would take beads out of one of the jars, one at a time, and that their job was to judge which jar had been chosen on the basis of the colour of the beads that they retrieved. After each bead was drawn from the jar and shown to the participant, they were given two options: (1) decide which jar they thought the beads had been drawn from, (2) request another bead. Participants were

informed that they could only make a decision once about the chosen jar and could not then change their decision; therefore, they should be as certain as possible before making a decision. During the task, the participants had a tracking sheet to record the colour of the beads drawn from the jar, again to ensure that memory did not affect performance. They were also informed that the maximum number of beads that could be requested for each trial was 20. When the participants reached the maximum number of beads they were given two options: (1) make a decision or (2): skip making a decision and go on to the next trial.

For each trial, the experimenter recorded (a) the number of beads requested before making a decision (information seeking behaviour), (b) the number of times participants decided to skip a decision at the end of the trial (avoidance), and (c) accuracy of the decision. Decision making time was extracted from audio-recordings of the task, specifically (d) the total time spent to reach a decision from the start of the trial to the decision point and (e) how much time each participant took on average to make a decision (total time taken to make a decision divided by the number of the beads requested). Two postgraduate students (NO & CLP) independently coded the audio data in order to calculate the total decision making time across each trial. If the calculations for the time taken to reach a decision differed by more than one minute between two coders, the reasons for the difference were discussed until consensus was reached. If the difference was less than 1 minute between two coders, the mean of the two estimates was used for analysis. Based on calculations regarding children's decision-making time, the average measure of ICC was .89 at this point. The disagreements more than 1 minute were then discussed and after consensus was reached for the disagreements, the time taken to reach a decision was calculated as the mean value of two coders. This decision making time estimate was divided by the number of beads requested by each participant for that trial in order to get a mean decision making time per bead.

At the end of each trial, before being told the answer, participants were asked to respond to three questions using a scale from 0 (not at all) to 100 (very much): (f) How certain are you about your decision? (g) How anxious/worried do you feel right now? (h) How important it is for you to get the answer right? (to assess participants' engagement in the task). The task was practiced once. Children were asked if they had any questions or needed any clarification about what they were being asked to do.

5.2.4 Procedure

Data were collected in a laboratory at the University of Reading during a 2-hour procedure in which the participants completed several tasks; the beads task, two parallel decision making tasks and an image rating task related to these tasks (discussed in Chapter 6), an IQ test (WASI-II), and completed questionnaire measures. Note that the sample used in this study and the following study is the same. This sample is also included in the psychometric study in chapter 4.

All study procedures were conducted under the approval of the University of Reading Research Ethics Committee. Parents were informed about the study and demographic information was collected prior to their visit to the University of Reading. Based on the demographic information provided, parents of children who are typically developing were invited to take part in the procedure due to the focus of this study. Parental consent and child assent were obtained on their arrival to the University. Parents were compensated with £5 for their time and children were given a small souvenir of £1-2 value for their contribution.

5.2.5 Preparing the Data for Analysis

There was a small amount of missing data (< 6% for any variable) from the beads task due to the audio recorder failure or participant non-compliance. Given the low percentage of missing data and the small sample size, we used an expected maximization (EM) imputation method (Little & Rubin, 1989). Variables were collapsed across trials by calculating the mean for each condition and then the data was checked for outliers. There were two significant outliers (data points 3.29 standard deviation above and below) in the number of beads requested in the low uncertainty condition, one outlier in the decision making time for high uncertainty, and two in the parent-reported SCAS; these were removed from further analysis. 10 cases (19.6%) of task-related certainty and worry ratings were missing as these items were added after data collection had started; therefore, the missing data here cannot be accepted as random or completely random. The analysis regarding the task related self-report variables were thus conducted with 41 participants. No participants took the option of skipping a decision after requesting the maximum number of beads, so no analyses are conducted with that variable.

In relation with the third aim of the study which is to investigate whether the tasks capture reactions to uncertainty that are related with questionnaire measures of IU, anxiety, and worry, the scores on the questionnaire measure were all centred around the mean to improve the interpretability of the results in the general linear model.

5.3 Results

5.3.1 Preliminary analyses

Table 2 (p.145) shows correlations between self-reported variables. Means and standard deviations for questionnaire measures and for cognitive ability as measured by WASI-II are presented in Table 3 (p.146). Neither age nor gender were significantly associated with WASI scores, child self-reported (SCAS, IUS-C, and PSWQ) or parent reported variables (SCAS and IUS-C). Table 4 (p. 147) shows the correlations between age, gender and cognitive ability and each of the four dependent variables (decision making time, the number of beads requested, self-reported certainty, and self-reported worry). There was a significant correlation between gender and decision making time (r=.29, p=. 041), with girls making slower decisions than boys. WASI-II scores were significantly positively associated with the number of beads requested (r=.35, p=.011), and self-reported certainty (r=.42, p=.007). As such, analyses were run controlling for gender and cognitive ability for the relevant dependent variables. The results were consistent irrespective of whether the covariates were included or not. As such, the results are presented without covariates for simplicity.

5.3.2 The suitability of the task

The first aim of the study was to adapt the beads task and to assess its suitability for preadolescent children.

There was a small amount of missing data (5.9 % for parent-reported IUS-C, 3.9% for parent-reported SCAS, 2% of WASI scores due to participant's noncompliance, 1.3% of the beads variables). Note that 10 cases (19.6%) of task-related self-report variables were missing because the task related self-report questions were added to the task after data collection started. Therefore, the missing data was

not due to participants' noncompliance. As expected, participants were less accurate in their responses as uncertainty increased, F (2, 100) =58.94, p<. 001, η^2=. 541. Post-hoc tests revealed that participants were significantly more accurate in the low uncertainty than the moderate (t (50) = 11.64, p<. 001) and high (t (50) =8.32, p<. 001) uncertainty conditions; but there was no significant difference between the high and moderate uncertainty conditions, t (50) =1.06, p=. 29. One sample t-tests also indicated that accuracy was significantly different to chance in the low uncertainty condition; t (50) = 38.28, p<. 001 for the moderate uncertainty condition, t (50) = 12.85, p<. 001, and for the high uncertainty condition, t (50) = 10.85, p<. 001.

On average participants indicated that it was somewhat important for them to get the answer right (M=29.16, SD=31.81 for Low Uncertainty Trials; M=28.07, SD=30.97 for Moderate Uncertainty Trials, and M= 30.05, SD=32.44 for High Uncertainty Trials) on the Beads Task, indicating that the participants were engaged in the task. The main effect of task uncertainty was also significant for self-reported certainty, F (1.267, 50.693) =17.72, p<. 001, η^2=. 307. As expected, post-hoc tests showed that participants felt significantly more certain when uncertainty was at its lowest (M=65.97, SD=24.71) than when uncertainty was moderate (M=52.10, SD=25.36), t (40) =4.35, p<. 001; and when uncertainty was at its highest (M=48.17, SD=26.38), t (40) =4.42, p<. 001]. Participants also reported being more certain on moderate uncertainty trials than on high uncertainty trials, t (40) = 2.18, p=. 035 Overall, these results indicated that the task appears suitable for preadolescent children.

5.3.3 The effect of uncertainty

As the task was deemed suitable for preadolescent children, the second aim was to explore reactions to uncertainty. Table 5 (p. 148) shows the means and standard deviations for each variable measured within the Beads Task. Three repeated measures ANOVAs were conducted to examine the effects of task uncertainty (3 levels; low, moderate, high) on three dependent variables (decision making time, the number of beads requested, and self-reported worry). We used p<. 05 as indicating significance and p <. 1 to indicate approaching significance when the effect size (η_2) was equal or greater than 0.06.

The main effect of uncertainty was significant for task-related worry, F (1.673, 66.913) =12.33, p<.

001, η^2=. 236. Post-hoc tests revealed that the participants reported being significantly less worried on low uncertainty trials (M=15.54, SD=16.44) than on moderate uncertainty trials (M=20.09, SD=21.17), t (40) =2.50, p=. 017, and on high uncertainty trials (M=24.62, SD=23.56), t (40) =4.21, p<. 001. They were also less worried when uncertainty was moderate than when uncertainty was at its highest in the task, t (40) =3.14, p=. 003.

The main effect of task uncertainty for mean decision-making time was not significant, F (2, 98) = 2.38, p=. 098, η^2=. 046; however, it was significant for the number of beads requested, F (1.639, 78.695) = 28.10, p<. 001, η^2=. 369. Post-hoc tests revealed that children asked for more information before making a decision during the high uncertainty trials (M=6.81, SD=3.40) than on moderate (M=5.76, SD=3.13), t (48) =4.05, p<. 001, and low uncertainty trials (M=4.28, SD=1.95), t (48) =6.33, p<. 001. The information requested for moderate uncertainty trials was also higher than low uncertainty trials, t (48) =4.31, p<. 001).

5.3.4 Does the task capture self-reported IU, anxiety, and worry?

The final aim of the study was to investigate whether the task might be able to capture reactions to uncertainty, which are related to questionnaire measures of IU, anxiety, and worry. Main effects of self-reported IU, anxiety, and worry were expected on the number of beads requested, decision making time, task-related worry, and task-related certainty. Because the effect of IU, anxiety and worry may vary across uncertainty levels, interactions between task conditions and self-reported measures were also examined.

There were five variables taken from questionnaire measures: IU as reported by children and parents, anxiety as reported by children and parents, and worry as reported by children. General Linear Models were conducted with uncertainty level as a repeated measures factor (low, moderate, high), as above, and each of these questionnaire measures included independently as a continuous predictor. The models were conducted for: task-related worry, task-related certainty, mean decision making time and number of beads requested.

a. Child and parent-reported IU

For task-related worry there was a significant main effect of child-reported IU, F (1, 39) =7.84,

p=. 008, η^2=. 167. Children who reported greater IU also reported higher levels of task-related worry across task conditions. A similar result was found for parent-reported IU on task-related worry although this effect only approached significance, (F (1.39) =3.01, p=. 091, η^2=. 072). The main effect of child-reported IU on task-related certainty approached significance, F (1, 39) =3.07, p=. 087, η^2=. 073 but this was not supported by parent-reported IU, which had no significant main effect on task-related certainty, F (1, 39) = 0.52 p=. 476, η^2=. 013.

There was no significant main effect of child-reported IU on mean decision-making time, F (1, 48) = 2.73, p= .60, η_2= .081. There was also no significant interaction for child-reported IU and task uncertainty, F (2, 96) = 0.59, p= .56, η_2= .146 on mean decision-making time. Furthermore, there was no significant main effect of parent-reported IU on mean decision-making time, F (1, 48) = 2.48, p= .12, η_2= .399. There was also no significant interaction for parent-reported IU and task uncertainty, F (2, 96) = 1.10, p= .34, η_2= .237 on mean decision-making time.

There was no significant main effect of child-reported IU on the number of beads requested, F (1, 47) = 0.77, p= .38, η_2= .138. There was also no significant interaction for child-reported IU and task uncertainty, F (1.623, 76.293) = 0.64, p= .53, η_2= .143 on the number of beads requested. Furthermore, there was no significant main effect of parent-reported IU on the number of beads requested, F (1, 47) = 0.31, p= .58, η_2= .085. There was also no significant interaction for parent-reported IU and task uncertainty, F (1.638, 76.997) = 0.56, p= .92, η_2= .058 on the number of beads requested.

b. Child and parent-reported anxiety

For task-related worry, a significant interaction was revealed for child-reported anxiety and uncertainty, F (1.730, 67.469) = 3.63, p=. 038, η^2=. 085, indicating the effect of uncertainty on task-related worry depends upon child-reported anxiety. To explore this interaction, anxiety scores were centred at 1SD above and 1SD below the mean. A significant main effect of uncertainty was found when anxiety was high, F (1.730, 67.469) = 14.79, p<. 001, η^2=. 275; however, this effect was not significant when anxiety was low, F (1.730, 67.469) = 2.02, η^2=. 049 (see Figure 2 in which participants were divided into two groups at the cut-off point of the median value (score=26.0) in the SCAS scores, p. 143). The parent-

reported anxiety and uncertainty interaction for task-related worry did not reach significance, F (1.603, 62.503) = 2.42, p= .108, η^2=. 058.

For decision-making time, there was no significant main effect of child-reported anxiety, F (1, 48)= 0.39, p= .53, n_2=. 094; however, there was a significant main effect of parent-reported anxiety, F (1, 48) = 7.53, p=. 009, η^2=. 136. Children with higher anxiety as reported by parents took longer to make decisions across all conditions. In contrast, there was no significant interaction between task uncertainty and both with child-reported anxiety; F (2, 96)= 0.78, p=. 46, n_2=. 179, and parent-reported anxiety; F (2, 96)= 0.52, p=. 59, n_2=134 on decision making time.

Additionally, there was no significant main effect of child-reported anxiety on the number of beads requested, F (1, 47)= 2.60, p= .11, n_2=352. There was also no significant interaction between task uncertainty and child-reported anxiety on the number of beads requested, F (1.677, 78.815)= 2.66, p= .085, n_2= 470. Similarly, there was no significant effect of parent-reported anxiety on the number of beads requested, F (1, 47) = 0.87, p= .38, n_2= 149. There was also no significant interaction between task uncertainty and parent-reported anxiety on the number of beads requested, F (1.677, 78.815)= 2.66, p= .085, n_2= 470. There was also no significant interaction between task uncertainty and parent-reported anxiety on the number of beads requested, F (1.666, 78.284)= 2.65, p= .086, n_2= 467.

c. Child reported worry

There was no significant main effect of worry as reported by PSWQ on task-related worry, F (1, 39) = 1.72, p= .20, η_2= .249. There was also no significant interaction for the scores on PSWQ and task uncertainty, F (1.680, 65.529) = 0.51, p= .57, η_2= .124 on task-related worry.

There was no significant main effect of worry as reported by PSWQ on the mean decision making time, F (1, 48) = 0.10, p= .76, η_2= .061. There was also no significant interaction for the scores on PSWQ and task uncertainty, F (2, 96) = 0.63, p= .54, η_2= .152 on the mean decision-making time.

Furthermore, there was no significant main effect of worry as reported by PSWQ on the number of beads requested, F (1, 47) = 0.88, p= .35, η_2= .151. There was also no significant interaction for the scores on PSWQ and task uncertainty, F (1.639, 77.049) = 0.22, p= .76, η_2= .080 on the number of beads

requested.

5.4 Discussion

This is the first study to examine behavioural reactions to uncertainty in preadolescent children within the context of IU. Our first aim was to adapt the beads task and to examine its suitability for preadolescent children. Overall the results indicated that the task was appropriate; children were able to follow the task instructions, there was minimal missing data, they were more accurate and more certain in conditions where uncertainty was low and the children rated that it was somewhat important for them to be accurate indicating they engaged in the task.

The second aim was to examine reactions to uncertainty in preadolescent children. Based on research with adults, we hypothesized that there would be changes in decision-making time, information seeking behavior, and task related worry across levels of uncertainty. These hypotheses were partially supported. As anticipated, participants were more worried and requested more information as uncertainty increased. However, there was no significant difference in decision-making time across uncertainty conditions. These results are somewhat consistent with the adult literature; Jacoby et al. (2014) found that adults requested more beads and were more distressed under more uncertain conditions but they found that adults took longer time to decide under more uncertain conditions. As the beads task requires probabilistic thinking, which may still be developing in children, we also examined the effect of cognitive ability on task variables. Significant associations between cognitive ability and the number of beads requested as well as certainty ratings were found. This indicates that cognitive ability may need to be considered as a covariate when the beads task is used with preadolescent children.

The final aim was to examine whether the task could capture responses to uncertainty that are related to questionnaire measures of IU, anxiety, and worry. The results suggested some significant associations with IU and anxiety. Taking IU first, task-related worry and certainty on the beads task were both associated with the self-reported IU. Children higher in IU reported greater task-related worry and less certainty. For parent-reported IU the effects were smaller and not significant, although the association between parent-reported IU and task-related worry approached significance. IU was not

associated with decision making time or number of beads requested. This pattern of results could be interpreted as evidence that IU may be associated with a subjective, affective reaction to uncertainty that does not have an impact on behaviour or performance under uncertainty. It is noteworthy that the same pattern of results was found by Krain and colleagues in their studies of IU in adolescents (Krain et al., 2006; Krain et al., 2008); IU was associated with subjective worry and certainty but not decision-making time in these studies. There are however some important considerations. First, it is possible that IU would have an impact on performance on a task with different parameters, perhaps where uncertainty is greater, where the odds are unknown or where there is potential for threat. Second, participants in the present study were recruited from the community. As such, it remains possible that IU may have an impact on behavioural performance in children who have higher levels of IU or who are clinically anxious. Healthy children who are high in IU may have learnt adaptive strategies for coping with their feelings of uncertainty such that it doesn't affect their behaviour.

In contrast to IU, parent-reported anxiety was associated with decision-making time. In addition, a significant interaction was found between uncertainty level and child-reported anxiety in relation to task-related worry. This was driven by uncertainty having a greater effect on task-related worry in participants with higher levels of anxiety than those with lower levels of anxiety. Interestingly, child-reported worry did not correspond to any of the task-related variables. This is surprising given that one of the task variables was a rating of worry. The reasons for this remain unclear but could relate to the children having difficulty completing the PSWQ reliably after having already completed the IUS-C and SCAS. Taken together, the results provide some support for the construct validity of the task as associations were found with both IU and anxiety, albeit not consistently across reporters.

It is important to note that we had anticipated that IU, anxiety and worry might interact with uncertainty level such that stronger effects would be found at higher levels of uncertainty. However, only one interaction was found and instead, main effects of IU on task-related worry and certainty and main effects of anxiety on task performance were found. This lack of interactions is difficult to interpret because the beads task has no certain condition. It could indicate that individuals who are high in IU worry more and feels less certain all the time, rather than only when there is objective uncertainty.

Alternatively, individuals who are high in IU may worry more and feel less certain only when there is uncertainty present, but even a low level of uncertainty is enough to trigger this reaction. Similarly, it is not clear whether participants who are high in anxiety are generally slower to make decisions or whether this only occurs under conditions of uncertainty. The task provides no data on how children react under certainty. It will therefore be important for future research to use tasks that include a certain condition.

As Sankar et al. (2017) highlight, a range of behaviors may be observed when individuals who are high in IU are faced with uncertainty (e.g. avoidance, flip-flopping between decisions, making snap decisions, and seeking more information). As such, we designed the task to capture a range of possible reactions to uncertainty: worry, fast or slow decision-making, avoidance and information seeking. The range of behaviours that can be captured by the task is a clear strength. Most of these appear to have been successfully captured as changes across levels of uncertainty were found. However, for avoidance, we added an option to skip making a decision after requesting the maximum number of beads; an option that no participants took. The reason for this might be that avoidance was only given as an option after all possible information had been sought and uncertainty had therefore decreased. In future it might therefore be better to include the option to avoid making a decision about the jar after each bead has been shown rather than waiting until the maximum number of beads has been reached.

A further consideration regarding the task is that it relies on probabilistic uncertainty. There are many other types of uncertainty. There is uncertainty when information is vague or open to interpretation (ambiguity), when one is aware that information is missing (known unknowns), and when one is not aware that information is missing (unknown unknowns). Uncertainty is also classified into two categories; epistemic uncertainty which resides in the internal world due to the lack of knowledge or ignorance on observer's point of view and physical uncertainty which resides in the external world because either the outcome is not yet known or information is not available to the observer (Robinson, Martin, Beck, Dan, & Apperly, 2006). Robinson and colleagues found that children differentiate these uncertainties and that epistemic uncertainty is more cognitively demanding for 4 to 8 years old children than physical uncertainty. We don't yet know whether individuals high in IU are consistent in their reactions to all types of uncertainty or whether certain types of uncertainty are particularly problematic. Given this and

the range of ways in which an individual who is high in IU might react to uncertainty outlined above, it seems likely that to really characterise IU using behavioural tasks, a battery of tasks that complement one another is likely to be required. If this is the case, various types of uncertainty could be examined along with specific behavioural, emotional and cognitive reactions. This would also enable a range of uncertain contexts to be examined. These could include contexts where there is high probability of a negative outcome compared to relatively benign contexts. Alternatively, contexts could be aligned to different domains of functioning such as social as compared to non-social situations.

Although the study has a number of strengths, the findings need to be considered in the context of limitations related to the sample. We used a community sample and the sample size was relatively low. The reason for the choice of sample was that the primary aim of the study was to develop a behavioural task for children that captured responses to uncertainty. One issue given the sample size is that the study is somewhat underpowered for detecting moderate effects and significantly underpowered for detecting small effects. As such, it is possible that some effects were missed. Given that the task shows some promise, future research could use the task with a larger community sample or compare a clinical sample of anxious children with healthy controls. A further limitation in relation to the sample is that, as indicated by the sample demographics, the sample lacks diversity and may not be representative of wider population.

5.5 Conclusion

This is the first study to measure reactions to uncertainty in the context of IU with preadolescent children and our focus was primarily on developing a behavioural task that can be used with children and young people. Given the increased attention on IU in the context of childhood anxiety disorders, it is timely to develop behavioural measures of IU that are appropriate for this age group. Our findings demonstrated that the task was suitable for preadolescent children and it is suitable for use in future studies, potentially within a battery of tasks examining responses to uncertainty. In future research it would be valuable to use the task to examine differences in reactions to uncertainty in children with and without anxiety disorders.

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5.6 References

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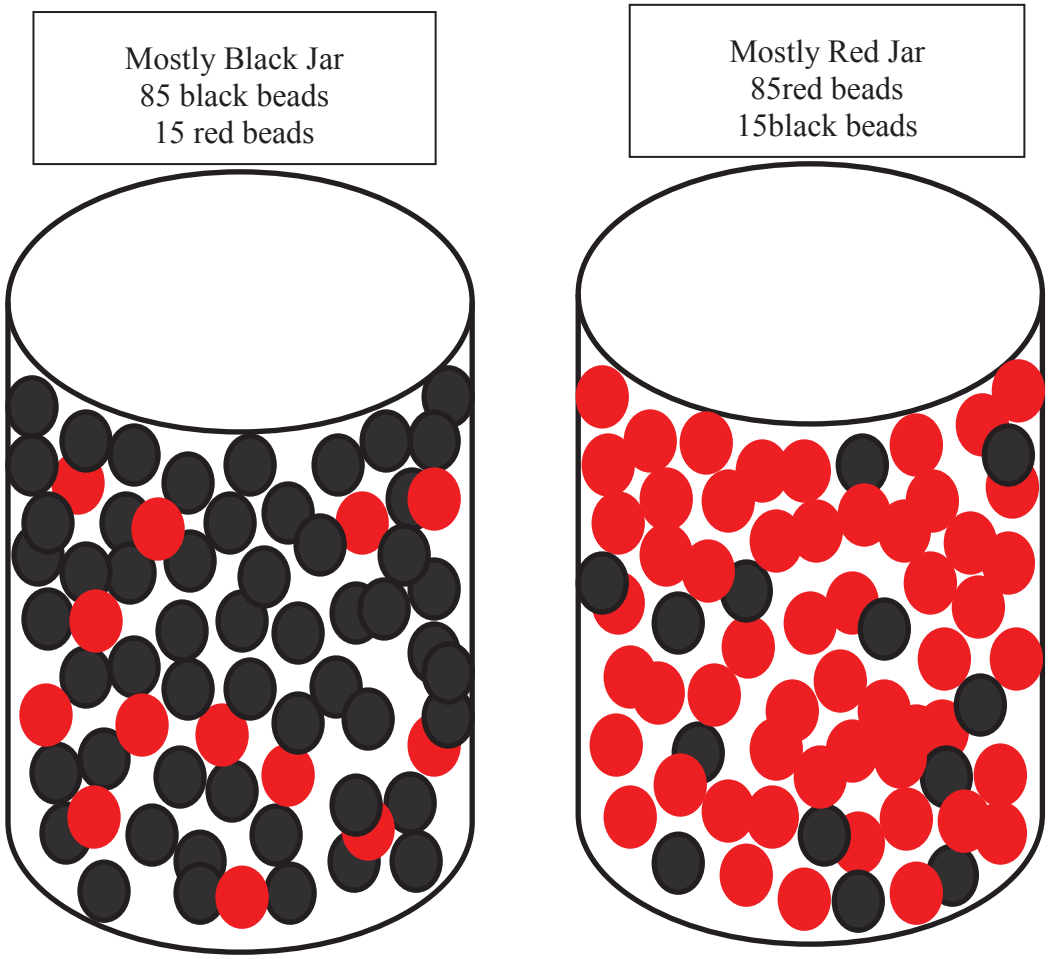

Figure 1: Simple visual of the beads task (low uncertainty condition)

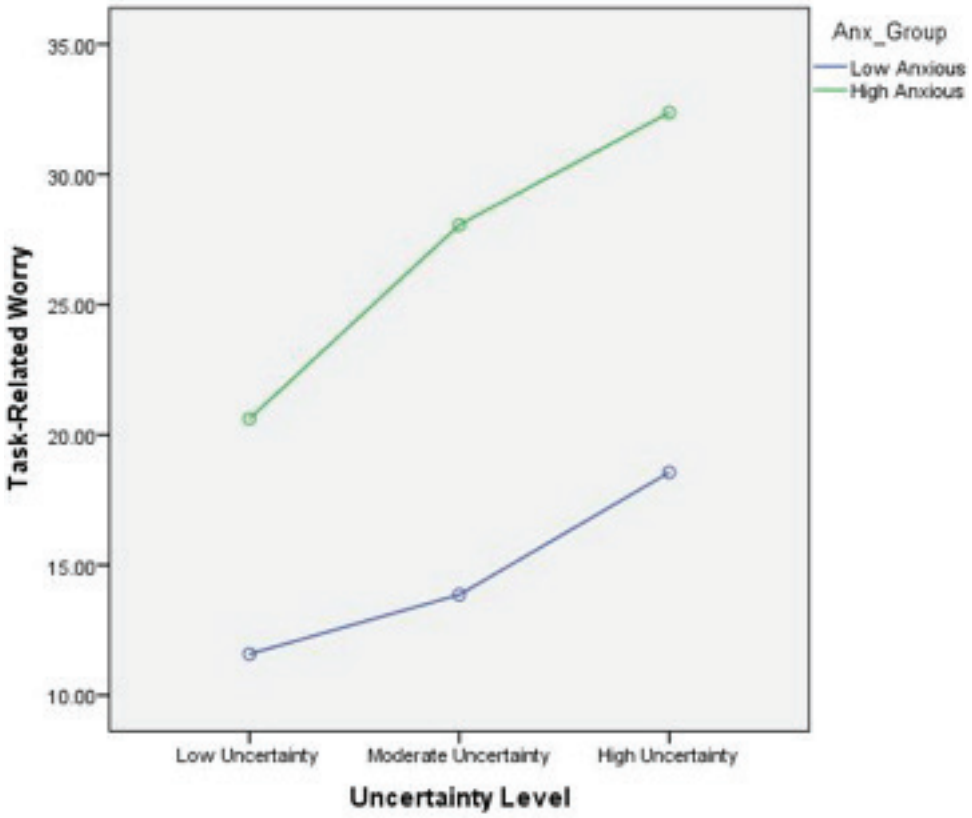

Figure 2: Interaction between uncertainty and anxiety on task-related worry

TABLE 1. Sample Demographics (Parents)

	Total Sample (N=51)
Marital Status (%)	
Married	80.4
Separated	5.9
Never Married	13.7
Living Arrangements (%)	
Two Parent	90.2
Single Parent	5.9
Step or Blended Family	2.0
Other	2.0
Employment Status (%)	
Full-time Employed	27.5
Part-time Employed	56.9
Full or Part-time Student	2.0
Combined Employment & Study	2.0
At home by choice	7.8
Illness/Disability	3.9
Education Level (%)	
Year 10 or equivalent	5.9
Year 12 or equivalent	9.8
Tafe/Apprenticeship	2.0
Certificate/Diploma	9.8
Undergraduate	25.5
Postgraduate	47.1
Origin (%)	
White-British	84.3
African	2.0
Indian	3.9
Other	9.8

TABLE 2. Correlations between self-report measures

	SCAS-Child Report	SCAS-Parent Report	IUSC – Child Report	IUSC-Parent Report
1. SCAS-Child Report	-			
2. SCAS- Parent Report	.170	-		
3. IUSC- Child Report	.758**	.080	-	
4. IUSC-Parent Report	.264	.781**	.273	-
5. PSWQ	.659**	.098	.706**	.311*

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

SCAS: Spence Child Anxiety Scale, IUSC: Intolerance of Uncertainty Scale for Children, PSWQ: Penn-State Worry Questionnaire

TABLE 3. Means & Standard Deviations

		Mean (SD)		t-test
		Females (N=26)	**Males (N=25)**	
SCAS	**Child Report**	26.96 (13.07)	28.47 (13.85)	t(49)=.40, p=.69
	Parent Report	21.75 (7.40)	22.49 (14.06)	t(49)=.72, p=.48
IUS-C	**Child Report**	52.45 (19.16)	55.56 (22.85)	t(49)=.53, p=.60
	Parent Report	56.55 (21.52)	56.33 (25.09)	t(49)=.03, p=.97
PSWQ	**Child Report**	14.98 (7.70)	17.52 (10.54)	t(49)=1.17, p=.25
WASI-II		114.89 (14.92)	116.64 (14.59)	t(49)=.25, p=.80

SCAS: Spence Child Anxiety Scale, IUSC: Intolerance of Uncertainty Scale for Children, PSWQ: Penn-State

Worry Questionnaire, WASI-II: Wechsler Abbreviated Scale for Intelligence (Raw Scores)

TABLE 4. Correlations Between Dependent Variables, Age, Gender, and WASI-II scores

	Age	Gender	WASI-II	Decision-Making Time	Beads Requested	Task-Related Certainty	Task-Related Worry
	-	.046	.177	-.141	.104	.009	-.121
Age		.750	.214	.322	.468	.954	.452
	.046		-.036	.287*	.048	-.233	-.084
Gender	.750	-	.802	.041	.739	.142	.603
	.177	-.036		-.147	.353*	.417**	.000
WASI-II	.214	.802	-	.304	.011	.007	.998
	-.141	.287*	-.147		-.115	-.276	.154
Decision-Making Time	.322	.041	.304	-	.422	.081	.335
	.104	.048	.353*	-.115		-.037	-.083
Beads Requested	.468	.739	.011	.422	-	.817	.604
	.009	-.233	.417**	-.276	-.037		-.013
Task-Related Certainty	.954	.142	.007	.081	.817	-	.938
	-.121	-.084	.000	.154	-.083	-.013	
Task-Related Worry	.452	.603	.998	.335	.604	.938	-

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 5. Means and Standard Deviations for Task Variables

		Mean (SD)
Self-Reported Certainty *	Low Uncertainty	65.97 (24.71)
	Moderate Uncertainty	52.10 (25.36)
	High Uncertainty	48.17 (26.38)
Self- Reported Worry *	Low Uncertainty	15.54 (16.44)
	Moderate Uncertainty	20.09 (21.17)
	High Uncertainty	24.62 23.56)
Decision- Making Time	Low Uncertainty	4.57 (0.76)
	Moderate Uncertainty	4.75 (0.87)
	High Uncertainty	4.57 (0.82)
Beads Requested *	Low Uncertainty	4.28 (1.95)
	Moderate Uncertainty	5.76 (3.13)
	High Uncertainty	6.81 (3.40)
Accuracy *	Low Uncertainty	2.82 (0.43)
	Moderate Uncertainty	1.58 (0.60)
	High Uncertainty	1.72 (0.92)

Note: * indicates that the repeated measure of ANOVA was significant.

Appendix 1: Further analysis with the IUS-C suggested by the study in Chapter 4

Rationale and aim

All analyses that include IU were repeated using the shortened version of the IUS-C, as recommended in chapter 4, to examine whether results would be consistent with the original IUS-C.

Method

The items for this version of the IUS-C are described in Chapter 4.

Results

Table 1 provides the correlations of this version of the IUS-C with the other questionnaire measures used in the study. Unsurprisingly, this version of the IUS-C also showed significant association with the original IUS-C. While the correlation for child report was .99, $p<.001$, it was .98, $p<.001$ for the parent report. Table 2 shows the means, standard deviations, and the results for gender differences in the scores.

TABLE 1. Correlations between self-report measures

	1	2	3	4
1. SCAS-Child Report	-			
2. SCAS- Parent Report	.170	-		
3.IUSC-Child Report (understandable items)	.754**	.078	-	
4.IUSC-Parent Report (understandable items)	.279*	.734**	.276*	-
5.PSWQ	.659**	.098	.702**	.343*

TABLE 2. Means & Standard Deviations

		Mean (SD)		t-test
		Female (N=26)	Male (N=25)	
IUS-C	Child Report	41.58 (15.68)	43.24 (18.83)	t(49)=.34, p=.73
	Parent Report	48.92 (19.45)	48.06 (22.76)	t(49)=.15, p=.89

Using the IUS-C with the understandable items, the results of the general linear model with IU (as measured by the IUS-C with the understandable items) as a continuous predictor was mostly consistent with the results using the original IUS-C. Consistent with the earlier results, there was a significant main effect of child-reported IU on task-related worry F (1, 39) =10.31, p=. 003, η^2=. 209. In the previous results, there were some associations that approached significance; these were not supported here; no significant main effect of IU on task-related certainty was found and there was no main or interaction effect of IU as reported by parents on any task related variables. The interaction between child-reported IU and task uncertainty on task-related worry was approaching significance here, but not with the original IUS-C, F (1.719, 67.055) =2.74, p=. 071, η^2=.066. To explore this interaction, child-reported IU scores were centred at 1SD above and 1SD below the mean. A significant main effect of uncertainty was found when IU was high, F (1.719, 67.055) = 12.80, p<.001, η^2=.247; however, this effect was not significant when IU was low, F (1.719, 67.055) = 2.24, p=.113, η^2=.054. There were no other main effects of IU (as reported by children or parents) or any other interactions between IU and uncertainty level on other task-variables.

Discussion

The consistency in findings across the IUS-C versions, particularly with respect to the results that were reached statistical significance, indicates that these findings are relatively robust and not unduly affected by the problematic items on the IUS-C.

Chapter 6 – Study 4: Reactions to Uncertainty with and without Potential Threat: Developing a Behavioural Measure to Assess Reactions to Uncertainty for Preadolescent Children

Manuscript in Preparation for Submission

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Please note Tables and Figures, and Appendix referred to in the Paper can be found at the end of the manuscript.

Abstract

Intolerance of Uncertainty (IU) is consistently associated with anxiety and worry in children and young people but research has relied almost exclusively on questionnaire measures. Here we aimed to develop two tasks to measure reactions to uncertainty in preadolescent children across two different contexts (low threat and heightened threat). Participants were 52 typically developing children (28 female) aged between 7 and 11 years. They completed the two tasks along with self-report questionnaires. Parents also completed measures of child IU and child anxiety. We first examined the suitability of the tasks for participants of this age. Results indicated that participants had understood the tasks and completed them as intended. Next we examined how uncertainty affected children's worry and reaction times. On both tasks, as uncertainty increased, children reported feeling more worried and had longer decision-making times. Finally, we examined the associations between IU, anxiety and worry and task variables. On the heightened threat task, child-reported IU was significantly associated with task-related worry, and child-reported anxiety was significantly associated with task-related threat expectancy. Child reported worry was significantly associated with task-related worry across both tasks. Overall the results indicate that the tasks are suitable for future research to investigate reactions to uncertainty in children. Future research should consider using the tasks with clinical samples to provide insight into the nature of IU in the context of anxiety disorders.

6.1 Introduction

Uncertainty is an inherent part of life; a social interaction, a financial decision, even a car journey, all involve a level of uncertainty. Individuals differ in their reactions to this uncertainty. Intolerance of uncertainty (IU) is conceptualized as "a dispositional incapacity to tolerate the response triggered by the perception of uncertainty and sustained by the associated perception of uncertainty" (Carleton, 2016, p. 31). IU shows significant links with generalized anxiety disorder (Dugas, Gagnon, Ladouceur, & Freeston, 1998; Dugas & Ladouceur, 2000; Dugas et al., 2003), obsessive compulsive disorder (Gentes & Ruscio, 2011; Holaway, Heimberg, & Coles, 2006; Tolin, Abramowitz, Brigidi, & Foa, 2003), hoarding disorder (Mathes et al., 2017), social phobia (Boelen & Reijntjes, 2009; Carleton, Collimore, & Asmundson, 2010; Mahoney & McEvoy, 2012), panic disorder (Carleton et al., 2014), and depression (Carleton et al., 2012) in adults, suggesting that IU is a trans-diagnostic factor with relevance across internalising disorders.

In contrast to the burgeoning research on IU in adult anxiety, the literature on IU and anxiety in children and young people is relatively limited. However, initial evidence suggests that IU has relevance for anxiety in children and adolescents. For example, IU has been linked with both generalized anxiety disorder (Cowie, Clementi, & Alfano, 2016; Donovan, Holmes, & Farrell, 2016) and social anxiety disorder (Hearn, Donovan, Spence, & March, 2017) in young people. A recent meta-analysis on IU, anxiety, and worry in young people included effect sizes from 31 studies and revealed a medium effect size between IU and both worry and anxiety (Osmanağaoğlu, Creswell, & Dodd, 2018). The same meta-analysis also revealed a heavy reliance on self-report for the measurement of IU (Osmanağaoğlu et al., 2018). Given the limitations of self-report and the potential difficulties children may have in understanding items in commonly used measures of IU (e.g. the IUS-C), for this field to continue to advance, there is a growing need for behavioural tasks that might be able to capture reactions to, and therefore intolerance of, uncertainty in young people.

Behavioural studies measuring reactions to uncertainty primarily use decision-making tasks. IU may affect decision-making in various ways. For example, individuals may make snap decisions to end uncertainty, switch between decisions, experience behavioural paralysis when faced with uncertainty or

may seek more evidence (Sankar, Robinson, Honey, & Freeston, 2017). These heterogeneous behavioural reactions to uncertainty may reflect the multidimensional nature of IU. Careful task design is required to capture these various manifestations of IU. Furthermore, when working with young people it is important to take cognitive development into account in order to establish the extent to which cognitive capacity may influence task responses.

Studies of IU in adults that have manipulated uncertainty suggest that IU is associated with higher state anxiety under uncertain task conditions even after controlling for baseline state anxiety (Oglesby & Schmidt, 2017). Further, significant positive associations have been found between IU and task-related worry (De Bruin, Rassin, & Muris, 2006; Ladouceur, Gosselin, & Dugas, 2000). People with higher IU also recall more words denoting uncertainty and have a tendency to make more threatening interpretations of uncertain situations compared to people with low IU (Dugas et al., 2005). Adults with higher IU have also been found to seek more information under uncertain circumstances (Rosen & Knäuper, 2009) and have difficulty enduring prolonged periods of uncertainty (Luhmann, Ishida, & Hajcak, 2011). Overall, there is evidence from behavioural tasks used with adults that IU manifests in atypical cognitive, emotional and behavioural reactions to uncertainty.

To our knowledge, there are only two examples of behavioural tasks that measure reactions to uncertainty within young people in the context of IU. One such example is provided in chapter 5 using an adaption of the beads task (Jacoby, Abramowitz, Buck, & Fabricant, 2014) with a community sample of preadolescent children. The beads task involves probabilistic reasoning, with participants making a choice after engaging in an information gathering process under three different levels of uncertainty (low/moderate/high uncertainty). The task successfully induced different levels of uncertainty and task related worry and certainty were significantly associated with self-reported IU. However, IU was not related to objective reactions to uncertainty on the task. One limitation of this task is that all conditions included some level of uncertainty. It is therefore unclear whether individuals with high IU differ from individuals with low IU even when there is no objective uncertainty. The other task that has been used with young people to examine IU and responses to uncertainty was conducted with an adolescent sample (Krain et al., 2008; Krain et al., 2006). In this HiLo task, participants have to guess whether the

number on a mystery card would be higher or lower than the number on a shown card. Importantly, in this task there is a certain condition along with four different levels of uncertainty. With adolescents, the HiLo task successfully induced (un)certainty and associations were found between IU and task-related certainty and anxiety (Krain et al., 2008; Krain et al., 2006).

Reactions to uncertainty may also differ depending on the context within which the uncertainty occurs. One relevant context may be the potential for a negative or threat-relevant outcome following uncertainty. If people who are high in IU hold a belief that any uncertainty is negative, as argued by relevant theory (Buhr & Dugas, 2002; Carleton et al., 2010), then individuals who are high in IU should differ from those low in IU in their reactions to uncertainty even when the uncertainty is experienced within a low-threat context. Alternatively, if individuals who are high in IU have a bias to expect the worst outcome, reactions to uncertainty may be exaggerated when there is a potentially threatening outcome. A task where uncertainty can be manipulated within threat and non-threat contexts would provide a deeper understanding of the nature of IU, informing theory, definition, and models of IU and anxiety.

The present study builds upon previous research examining how IU is associated with reactions to uncertainty in preadolescent children. The tasks used were based on the HiLo task described above (Krain et al., 2008; Krain et al., 2006). Our first aim was to adapt the task and to modify it in order to create two parallel versions that can capture reactions to uncertainty within low and heightened threat contexts respectively. Therefore, we first examined the suitability of the two tasks for use with preadolescent children. Task suitability was determined based on the amount of missing data (<20% was deemed acceptable) and whether accuracy significantly differed from chance to check that the children were not guessing. Task-related certainty in the low threat task and task-related threat expectancy rating in the heightened threat task were also examined. We also evaluated whether children rated the negative stimuli used in the heightened threat task as aversive. If children understand the tasks, we would expect to see certainty decrease as objective uncertainty increases in the low threat task and, in the heightened threat task, threat expectancy increase as the objective likelihood of a threat-relevant outcome increases.

The second aim of the study was to explore reactions to uncertainty in low and heightened threat contexts within preadolescents. We hypothesized that, with increasing uncertainty there would be increases in task-related worry and changes in reaction time (RT); the later hypothesis is not directional as faster RTs or slower RTs could be theorised and there is not enough previous evidence to indicate which is most likely in children. As the task involves probabilistic reasoning, which develops with age, we also examined cognitive ability at this point to determine whether it influences task responses.

The final aim of the study was to investigate whether the tasks capture reactions to uncertainty that are related to self-reported IU, anxiety, and worry. We hypothesized that self-reported IU, anxiety, and worry would be significantly associated with RT and task-related worry as well as task-related certainty (low threat task only) and threat expectancy (heightened threat task only). We included questionnaire measures of anxiety and worry alongside IU for two reasons. First because of concerns about the suitability of self-report questionnaires for preadolescent children, and second because IU is closely linked to anxiety and worry; if the task variables are associated with these measures there will be support for the construct validity of the task. Interactions were also examined to determine whether any associations between task responses and the questionnaire measures differed across certain and uncertain conditions.

6.2 Method

6.2.1 Sample

Participants were 52 children (28 female) aged between 7.58 and 11.54 (M=9.38, SD= 1.07) recruited via local advertising through schools, magazines, and flyers in public areas from the Berkshire area in the U.K. Of the sample, 86.5% identified as White-British; 90.4% were living in a two-parent household, and 71.2% of the parents had at least an undergraduate degree (see Table 1 for more detailed sample demographics, p. 183). Note that the same participants took part in this study and the study discussed in chapter 5. These participants are also included in the psychometric study in chapter 4.

6.2.2 Measures

Intolerance of Uncertainty for Children (IUS-C)-Child & Parent Report. IU was measured using the

IUS-C child and parent form which is a 27 item self-report measure on a 5-point Likert scale (1 = *Not at all characteristic of me/my child*, 3 = *Somewhat characteristic of me/my child*, 5 = *Entirely characteristic of me/my child*) resulting in a total score ranging from 27 to 135, higher scores reflect higher intolerance of uncertainty (Comer et al., 2009). Both the child and parent form demonstrate strong convergent validity and internal consistency (Comer et al., 2009) Given our previous recommendations regarding the IUS-C (Osmanagaoglu, Creswell, Stujifzand, and Dodd (Unpublished paper), we also conducted the analyses with the total score calculated from the 'understandable' items of the IUS-C). Internal consistency was high across all versions and reporters in the current study (original version: .94 child report, 0.96 parent report; 'understandable' items: .94 child report.96 parent report)

Spence Child Anxiety Scale (SCAS) – Child & Parent Report. The SCAS is a measure of anxiety symptoms on a 4-point Likert scale (*0 = never, 1 = sometimes, 2 = often, 3 = always*), resulting in a total score ranging from 0 to 114 with higher scores indicating higher anxiety (Spence, 1998). The child report consists of a 44 item (38 items related to anxiety symptoms and 6 filler items) and parent report consists of 38 items. The internal consistency is excellent and the measure shows convergent and divergent validity (Nauta et al., 2004; Spence, 1998). In this sample, the internal consistency was high (.87 child report; .91 parent report).

Penn State Worry Questionnaire for Children (PSWQ-C). Worry was measured by the PSWQ-C which is a 14 item self-report measure on a 4-point Likert Scale (*0 = not at all true, 1 = sometime true, 2 = often true, 3 = always true*) resulting in a total score ranging from 0-42, higher scores indicating higher worry (Chorpita, Tracey, Brown, Collica, & Barlow, 1997). The measure demonstrates solid psychometric properties including convergent and discriminative validity, and high internal consistency in clinical and community samples (Chorpita et al., 1997; Pestle, Chorpita, & Schiffman, 2008). The internal consistency was .92 in this sample.

Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II). The WASI-II is a reliable and time-efficient assessment of intelligence composed of four subtests (vocabulary, similarities, block design, and matrix reasoning) that can be used with people aged between 6 and 90 years. Here, only the vocabulary and matrix reasoning subtests were administered. These can be used to provide an estimate

of Full Scale IQ (WASI-II; Wechsler, 2011) but here raw scores were used so that we could maintain the ability to make comparisons across participants of different ages. The WASI demonstrates good concurrent validity, has excellent internal consistency with average of .93 for FSIQ-2 in the child sample (6-16 years) and good test-retest reliability (McCrimmon & Smith, 2012).

6.2.3 Decision Making Tasks

The decision-making tasks used in this study were adapted from a task used in previous studies investigating uncertainty processing and IU (Krain et al., 2008; Krain et al., 2006). In the original task, the stimuli consisted of nine cards, numbered from 1 to 9. Out of these 9 cards the participants were shown two cards; a card facing upwards showing the number and a card facing backwards with a question mark on it. Participants were asked to decide whether the number on the card facing backwards would be lower or higher than the number on the card facing upwards. For the present research this task was altered in several ways. First, the stimuli shown on the cards were changed from numbers to circles that differed in size. This was to ensure that number knowledge did not affect performance. Second the number of cards was reduced from nine to seven to reduce the complexity and length of the task. This was to ensure that the task length was appropriate for the attention span of younger children. The sizes of the circles increased linearly such that the diameter difference between size 1 and size 2 is equal to the diameter difference between size 2 and 3 and so on. As per the original version of the task participants were presented with a card displaying a circle along with a card facing backwards with a question mark on it (mystery card). They were asked to make a decision about whether the circle on the mystery card would be bigger or smaller than the circle on the non-mystery card (see Figure 1, p. 182).

Each displayed card was associated with a specific degree of uncertainty. The smallest or largest circles were certain cards because all other cards are larger or smaller respectively. In contrast, the fourth card, or middle card, had the highest level of uncertainty because there was an equal chance of the mystery card being larger or smaller.

Prior to the tasks, children were introduced to the 7 cards and asked to sort them into size order. This was to check that they could correctly identify the size differences. If a child could not correctly

complete this, the experimenter showed them how to do it. The cards were then shuffled and the child was asked to sort them into a size order again.

Once the child was able to sort the cards correctly, the task was practiced using only the certain cards to ensure they understood the procedure, how the cards related to one another and that individual difference in associative learning did not affect the task performance. Participants moved to the full-task only after they had answered correctly on nine out of 10 consecutive trials.

Trials began with a fixation cross for 1000ms. The next screen displayed a card (i.e. the smallest circle) and a mystery card (i.e. '?') along with a size chart showing all seven cards from the smallest to the biggest at the bottom of the screen. This was shown to minimize the effect of memory on performance. Participants were asked to decide whether the circle on the mystery card would be bigger or smaller than the displayed card by pressing a button on a button box. They were informed that the two cards were never equal. Participants had 5 seconds to respond. After that a blank screen appeared for 2 seconds, the value of the mystery card was displayed. To minimize threat, no feedback regarding accuracy was given.

Both tasks were programmed using E-Prime 2.0 (Psychology Software Tools, Inc.). There were six trials for each of the seven cards in addition to 12 more trials for each of the most uncertain (4^{th}) and certain (1^{st} and 7^{th}) cards. Each of the seven cards was paired with all possible combinations for the mystery card. Trials were randomly presented resulting in total of 78 trials that were distributed equally across three blocks. Average trial length was 9.5 seconds.

Task 1-Low threat

As stated previously, we designed two parallel tasks in which reactions to uncertainty were examined with and without heightened threat. The aim of this version of the task was to examine reactions to uncertainty when there was minimal threat. For that reason no feedback was provided regarding the accuracy of the child's response. After completing the task, participants answered two questions to self-report how they felt about each displayed card:

1) How anxious/worried did you feel when you saw this card? (1=not worried at all, 2= a little worried, 3=somewhat worried, 4= a lot worried)

2) How certain/sure were you that you were correct? (1=not sure at all, 2= a little sure, 3= somewhat sure, 4= very sure)

Task 2- Heightened threat

The aim of this version of the task was to examine reactions to uncertainty when threat level was heightened. The task was identical to the task described above except that, when the mystery card was revealed as being larger than the displayed card, an angry face was also shown. This heightened the threat level of the task and meant that each card was associated with a specific degree of threat-related uncertainty. For example, the first card was associated with certain threat, the largest card with certain no threat and the 4th card with absolute uncertain threat. Participants were still asked to make a decision about whether the circle on the mystery card would be larger or smaller than the circle on the displayed card, but they were also informed that an angry face would be shown if the circle on the mystery card was bigger than the circle on the displayed card. An angry face was shown when the mystery card was revealed to them. A practice phase was included as detailed above. Trial numbers and task design, including self-report questions were identical to those above except that participants were also asked:

1) How anxious/worried did you feel when you saw this card? (1=not worried at all, 2= a little worried, 3=somewhat worried, 4= a lot worried)

2) How much did you expect to see an angry face when you saw this card? (1=did not expect at all, 2=expected a little, 3=somewhat expected, 4=expected a lot)

Image Rating Task

The aim of this task was to check whether the images (faces displaying anger) used in the heightened threat decision-making task were perceived as threatening by participants. Children were asked to self-report how the faces made them feel using the Self-Assessed Manakin (Bradley & Lang, 1994) on a scale from 1 (mostly negative) to 5 (mostly positive). The ten faces displaying anger used in the decision making task were included together with ten faces displaying happy affect, ten faces displaying neutral affect, and ten non-face neutral images. All images were taken from Radbound Faces Database which is a standardized database of emotional face stimuli (Langner et al., 2010).

6.2.4 Procedure

Data were collected in the labs of the University of Reading, School of Psychology and Clinical Language Sciences during a 2-hour procedure in which the participants completed several tasks; the beads task (discussed in Chapter 5), two parallel decision making tasks and an image rating task related to these tasks, an IQ test (WASI-II), and completed questionnaire measures. Note that the same participants took part in this study and the study discussed in chapter 5. These participants are also included in the psychometric study in chapter 4.

All study procedures were conducted under the approval of the University of Reading Ethics Committee. Parental consent and child assent were obtained prior to the beginning of the procedure. Parents were invited to complete questionnaires (SCAS and IUS-C) whilst children completed their tasks. Children first took part in the WASI-II test then completed the two parallel decision making tasks. They answered a set of questionnaires (SCAS, PSWQ, and IUS-C) and completed a non-computerized behavioural task, which is not the focus of this paper. The low-threat decision making task and the image rating task were both completed before the heightened threat task in order to control that the reactions to uncertainty in low threat context were not affected by the negative stimuli in the heightened threat context. Parents were compensated with £5 for their time and children were given a small souvenir of £1-2 value for their contribution.

6.2.5 Preparing for Data Analysis

All children were able to sort the cars into the correct order and all completed the practice trials with at least 9 correct answers out of 10 trials. All 52 children completed the Image Rating Task, the low threat decision-making task and the self-report questions related to the low threat task. Due to technical problems with E-prime, only 49 children completed the heightened threat decision-making task and one additional participant did not complete the post-task self-report questions for this task.

Each task yielded four dependent variables. Three of these were identical across the tasks: reaction time (RT); accuracy; task-related worry. For the low threat task, participants also rated task-related certainty and on the heightened threat task they rated expectancy for threat. Children were informed

that they would have 5 seconds to make a decision and were asked to decide as quickly as possible. Although no feedback was given regarding their accuracy, to minimize the perceived threat level in both tasks, accuracy was calculated based on whether the participants got the mystery card right on each trial. RT data includes all completed trials regardless of accuracy. RT data was screened and trials without any response or with RT less than 150 ms. were excluded from the analysis. For each participant any RTs longer or shorter than their own mean ±2 SD were removed. Mean RT was then calculated for each condition.

For the low threat there were four levels of uncertainty; 100% certainty (Card 1 & 7), 83.34% certainty (Card 2 & 6), 66.67% certainty (Card 3 & 5), 50% (un)certainty (Card 4). For the heightened threat task there were three conditions. The first condition (Card 1) indicated with 100% certainty that a threat will appear (certain threat). The second condition (Card 4) indicated with 50% certainty that a threat may or may not appear (uncertain threat). The third condition (Card 7) indicated with 100% certainty that a threat would not appear (certain no threat). Note that cards 2, 3, 5 and 6 were not included in analyses for the heightened threat task because the introduction of the threat meant that cards could not be combined leaving only 6 trials per card.

There was a small amount of missing data. There were no missing cases on the child-report questionnaires but for parent-report, one case was missing in the IUS-C and a further case was missing the SCAS. One child did not assent to completing the WASI-II. Given the small sample size and the low percentage of missing data, we have used an expected maximization (EM) imputation method (Little & Rubin, 1989) for missing data.

Variables were collapsed across trials by calculating the mean for each uncertainty condition. The data were then checked for outliers. We defined outliers as ±3.29 and two significant outliers in the parent-report SCAS were found and removed from relevant analysis. No outliers were found in the task data.

Correlations between task variables and potential covariates such as age, gender, and cognitive ability were examined prior to the main analyses, and further analyses controlled for any variables identified as

potential confounds. We then used the accuracy data to determine whether children had understood the task. Next, we examined the effect of uncertainty on each of the dependent variables for the two tasks separately. Finally, general linear models were used to examine whether anxiety, worry, and IU were associated with task uncertainty on each of the dependent variables for the two tasks separately. We have used <. 05 as indicating significance and <.1 to indicate approaching significance when the effect size was equal or greater than $\eta 2 = 0.06$.

In relation to the third aim of the study (to investigate whether associations between task responses and questionnaire measures of IU, anxiety, and worry were moderated by the level of task uncertainty) the scores on the questionnaire measure were all centred around the mean to improve the interpretability of the results in the general linear model.

6.3 Results

6.3.1 Preliminary analyses

Means and standard deviations for each questionnaire and for cognitive ability as measured by WASI-II are presented in Table 2 (p.184). No significant correlations between self-reported questionnaires and age, gender or cognitive ability were found. Table 3 (p. 185) shows correlations between child self-report and parent report questionnaires.

A series of correlation analyses were then conducted to check whether age, gender, and/or cognitive ability were associated with task variables and, as such, should be included as potential confounds in subsequent analyses (see Table 4, p. 186). Cognitive ability and gender were not significantly correlated with any task variables; however, age significantly correlated with RT on the heightened threat task (r=-.31, p=.031, N=49), and this is controlled for in the relevant analyses.

6.3.2 The suitability of the tasks

The first aim of the study was to adapt the HiLo task in low and heightened threat contexts and to assess their suitability for preadolescent children. There was a small amount of missing data, less than 20% due to the children not being able to do the task. A repeated measures ANOVA was conducted

with accuracy as the dependent variable and uncertainty as the repeated measures factor with four levels (100% certain, 83.34% certain, 66.67% certain, 50% certain – see above). There were significant main effects of uncertainty on accuracy in both tasks. As expected, accuracy differed significantly between uncertainty levels in the low threat task F (2.217, 113.087) =47.92, p<. 001, η^2=. 484 and in the heightened threat task, F (1.562, 74.968) =401.18, p<. 001, η2=. 893. In both tasks, there were significant differences in accuracy between each certainty level (see Table 5 on p. 187 for post-hoc results). One sample t-tests also indicated that accuracy was significantly different to chance in the low threat task; t (51) = 25.53, p<. 001 for the 100% certain condition, t (51) = 9.64, p<. 001 for the 83.34% certain condition, t (51) = 2.40, p= .20 for the 66.67% certain condition, and as expected it was not significant for the 50% certain condition, t (51) = -1.85, p= .07. Similar results were also found for the heightened threat task. Accuracy was significantly different to chance; t (48) = 45.05, p<. 001 for the certain threat condition, t (48) =23.04, p<. 001 for the certain non-threat condition, and as expected it was not significant for the uncertain threat condition, t (48) =-1.92, p= .06.

Children's' image ratings were analysed to examine whether the angry faces used in heightened threat task are perceived as threatening. A repeated measures ANOVA indicated a significant main effect for emotion on image ratings, (F (1.990, 101.467) =92.45, p<. 001, η^2=. 644. Post-hoc analysis showed that the faces displaying anger (M=2.38, SD= 0.77) were, indeed, rated as more negative than the faces displaying happiness (M=4.01, SD=0.75), t (51) = 11.43 p<. 001, neutral faces (M=2.83, SD=0.50), t (51) = 5.58 p<. 001 and non-face neutral images (M=3.28, SD=0.46), t (51) = 9.13 p<. 001. The mean ratings indicate that participants found the angry faces aversive/negative. Based on the criteria stated previously, these results indicate that both tasks appear suitable for preadolescent children, although the lack of difference between uncertain threat and certain no threat on threat expectancy may suggest some difficulty understanding the heightened threat task.

To examine whether self-reported certainty varied across levels of uncertainty on the low threat task (note that it was not measured on the heightened threat task), a repeated measures ANOVA was conducted with certainty ratings as the dependent variable and uncertainty as a factor with four levels for the low threat task and with three levels for the heightened threat task. In the low threat task, the

main effect of uncertainty was significant, F (2.060, 105.084) =52.89, p<. 001, η^2=. 509. Post-hoc tests revealed that participants reported feeling significantly and progressively less certain as task uncertainty increased (see table 5, p. 187). A comparable ANOVA was conducted for the heightened threat task but with threat expectancy as the dependent variable. The main effect of uncertainty was significant for threat expectancy, F (1.659, 79.615) =7.93, p<. 001, η^2=. 142. Post-hoc tests (see table 6, p. 188) revealed that there was no significant difference between Card 4 (uncertain threat) and Card 7 (certain no threat) but significantly higher threat-expectancy for Card 1 (certain threat) than both Card 4 and Card 7.

In summary, the tasks were deemed suitable for preadolescent children on the basis that children were not guessing as indicated by the accuracy data, missing data was less than 20%, task-related certainty ratings decreased as uncertainty increased in the low threat task, threat expectancy ratings differed across threat conditions in the heightened threat task, and the threat stimuli used in the heightened threat task indeed rated as negative by the participants.

6.3.3 The effect of uncertainty

The second aim was to explore preadolescents' reactions to uncertainty in low and heightened threat contexts. To address this aim, analyses focused on the effect of uncertainty on task variables (self-reported worry and reaction time – see Table 5 on p. 187 for the low threat task and Table 6 on p. 188 for the heightened threat task). Data were analysed using repeated measures ANOVAs with uncertainty condition as the repeated measures factor and task-related worry or reaction time as the dependent variables. The uncertainty condition has four levels for the low threat task (100% certain, 83.34% certain, 66.67% certain, 50% certain – see above) and three levels for the heightened threat task (certain threat, uncertain threat, certain no threat).

Low threat task

The main effect of uncertainty on task-related worry was significant F (1.656, 84.475) =24.38, p<. 001, η^2=. 323. Participants were significantly and progressively more worried as uncertainty increased. The results from follow-up paired sample t-tests can be seen in Table 5 (p.187) and show that each uncertainty condition differed from every other uncertain condition.

The main effect of uncertainty on reaction time (RT) was also significant F (3, 153) = 56.67, p<. 001, η^2=. 526. As shown in Table 5 (p.187), there was a linear increase in RT as uncertainty increased and at all levels RT was significantly different with one exception (no significant difference between 50% and 66% certainty conditions).

Heightened threat task

To analyse the main effect of condition on task-related worry, a repeated measures ANOVA was conducted. The main effect of condition on task-related worry was significant F (1.611, 77.335) =26.17, p<. 001, η^2=. 353. Participants were significantly more worried when they were faced with Card 4 (uncertain threat) than when they were faced with Card 1 (certain threat) and Card 7 (non-threat). However, there was no significant difference regarding their task-related worry between certain threat and non-threat conditions. The results can be seen in Table 6 (p. 188).

The main effect of condition on reaction time (RT) was significant F (1.484, 71.221) =41.46, p<. 001, η^2=. 463 and the main effect of condition remained significant even after controlling for age F (1.474, 69.295) =40.71, p<. 001, η^2=. 464. As revealed by follow-up t-tests, there was a significant RT difference between all conditions (see Table 6, p. 188). The participants had the longest RT to Card 4, which indicated uncertain threat, and the shortest RT to Card 1, which indicated certain threat.

6.3.4 Are task responses affected by self-reported IU, anxiety, and worry?

The third aim was to investigate whether the tasks capture reactions to uncertainty that are associated with questionnaire measures of IU, anxiety, and worry. If the tasks do capture similar constructs, we would expect significant effects of the questionnaire measures on task variables. If the effect of questionnaire measures on task variables varies across uncertainty conditions, significant interactions between questionnaire measures and uncertainty condition on task variables would be expected. To address this aim, a series of general linear model analyses were conducted with uncertainty condition as a repeated measures factor and each of the questionnaire measures as a continuous factor. Interactions between each questionnaire measure and condition were also included. Task-related worry and RT for each version of the task were dependent variables. In addition, for the low threat task, task-related

certainty was included as a dependent variable and in the heightened threat task; threat expectancy was included as a dependent variable. There were five variables taken from questionnaire measures: IU as reported by children and parents, anxiety as reported by children and parents, and worry as reported by children. Each questionnaire measure was included in an independent general linear model because they are highly correlated with one another. The first analyses reported focus on IU, the next on anxiety, and the last focus on worry.

Low threat task

The main effect of IU (child-report) on task-related certainty approached significance, F (1, 50) =3.11, p=. 084, η_2=. 06. Children who reported greater IU also reported lower levels of certainty. However, we did not find the same main effect for parent-reported IU, F (1, 50)= 0.25, p= .617, $n_{2.}$ = .005. There was no interaction between task uncertainty and both with child-reported IU (F (2.012, 100.591)= 1.29, p= .281, n_2= .025) and parent-reported IU (F (2.755, 74.468)= 1.85, p= .162, n_2= .036) on task-related certainty. There was no significant main effect of child-reported IU (F (1,50)= 2.50, p= .121, n_2=. 048) or parent-reported IU (F (1, 50)= 0.05, p= .824, n_2= .001) on task-related worry. Similarly, no significant interactions were found for child-reported IU (F (1.605, 80.244)= 1.34, p= .263, n_2= .026) or parent-reported IU (F (1.657, 82.845)= .65, p= .497, n_2=. 013) on task-related worry. Furthermore, there was no main effect of child-reported IU (F (1, 50)= 0.11, p= .740, n_2= .002) or parent-reported IU (F (1, 50)= 1.38, p= .246, n_2= .027) on RT. There was also no interaction between task-uncertainty and both with child-reported IU (F (3, 150)= 0.84, p= .472, n_2= .002) and parent-reported IU (F (3, 50)= 0.78, p= .508, n_2=. 015) on RT. (See Appendix 1 for the results with IU based on the items suggested in chapter 4; the results were the same across versions of the IUS-C).

The main effect of child-reported anxiety on task-related certainty was approaching significance, F (1, 50)= 3.44, p= .070, n_2= .064; however, the same main effect was not found for the parent-reported anxiety, F (1, 48)= 0.14, p= .706, n_2= .003. There was no interaction between task uncertainty and both with child-reported anxiety (F (1.971, 98.566)= 1.95, p= .149, n_2= .037) and parent-reported anxiety (F (1.992, 67.808)= 1.41, p= .242, n_2= .029) on task-related certainty. Similarly main effect of child-

reported anxiety was approaching significance for task-related worry, F (1, 50)= 3.04, p= .087, n_2= .057; however, the same effect was not found for the parent-reported anxiety, F (1, 48)= 0.27, p= .609, n_2= .006. There was no significant interaction between task uncertainty and both with child-reported (F (1.616, 80.807)= 0.76, p= .444, n_2=. 015) and parent-reported anxiety (F (1.664, 79.884)= 0.16, p= .926, n_2= .003) on task-related worry. Furthermore, there was no significant main effect of child (F (1, 50)= 0.10, p= .749, n_2=. 002) or parent reported anxiety (F (1, 48)= 0.21, p= .649, n_2= .004) on RT. There was also no interaction between task uncertainty and both with child-reported (F (3, 150)= 0.50, p= .685, n_2= .010) and parent-reported anxiety (F (3, 144)= 0.46, p= .708, n_2= .010) on RT.

The main effect of worry as reported by PSWQ was approaching significance on task-related certainty, F (1, 50)= 2.95, p= .092, n_2=. 056 and was significant on task-related worry, F (1, 50) =7.57, p=. 008, η^2=. 132. However it was not significant on RT, F (1, 50)= 0.75, p= .390, n_2= .015. There was no significant interaction on task uncertainty and worry as reported by PSWQ on task-related certainty (F (1.982, 99.125)= 1.53, p= .209, n_2= .030, on task-related worry (F (1.656, 82.821)= 1.33, p= .268, n_2= .026), and on RT (F (3, 150)= 0.99, p= .401, n_2= .019.

Heightened threat Task

There was a significant positive effect of IU (child-report) on task-related worry, F (1, 46) =4.88, p=. 032, η^2=. 096. However, parent-reported IU did not significantly affect task-related worry, F (1, 46)= 1.87, p= .179, n_2= .039. There was no interaction of task uncertainty both with child (F (1.621, 74.562)= 0.22, p= .760, n_2= .005) or parent reported IU (F, (1.617, 74.392)= 0.02, p= .983, n_2= .000) on task-related worry.

There was no main effect of child (F (1, 46)= 0.16, p= .693, n_2=. 003) or parent reported IU (F (1,46)= 0.16, p= .694, n_2= .003) on task-related threat expectancy. Similarly no interaction of task uncertainty both with child (F (1.639, 75.378)= 0.71, p= .471, n_2= .015) and parent reported IU (F (1.676, 77.100)= 0.78, p= .440, n_2= .017) was detected on task-related threat expectancy.

For RT, the interaction between uncertainty and IU as reported by parents was significant, F (1.497, 70.346) =3.74, p=. 041, η^2=. 074. The interaction remained significant even after controlling for age, F

(1.500, 69.013) =4.09, p=. 031, η^2=. 082. To explore this interaction further, parent-reported IU scores were centred 1 SD above and below the mean. After controlling for age, the main effect of condition was significant when parent-reported IU was low, F (1.500, 69.013) = 14.75, p<. 001, η^2=. 243 and when parent-reported IU was high, F (1.500, 69.013) = 31.48, p<. 001, η^2=. 406; however the effect size was larger when parent-reported IU was high. Figure 2 (p. 182) shows a simple visual of this interaction between task condition and parent-reported IU for RT (for the purposes of this figure, participants were divided into two groups (high IU vs low IU) using the median score of 51). (See Appendix 1 for the results with IU based on the items suggested in chapter 4; the results were consistent across versions of the IUS-C except that the interaction between condition and parent-reported IU was only approaching significance for the shortened IUS-C as suggested in chapter 4). However, there was no main effect of child reported IU (F (1,47)= 0.31, p= .581, n_2= .007) or an interaction between task uncertainty and child reported IU (F (1.484, 69.737)= 0.29, p= .684, n_2= .007) on RT.

There was no main effect of child reported anxiety (F, (1, 46)= 2.71, p= .107, n_2= .056) or an interaction of task uncertainty with child reported anxiety (F (1.636, 75.273)= 1.32, p= .270, n_2= .028) on task-related worry. There was a significant positive effect of anxiety as reported by children on threat expectancy, F (1, 47) =4.94, p=. 031, η^2=. 095. However, there was not a significant effect of parent-reported anxiety on threat expectancy, F (1, 44)= 0.54, p= .468, n_2= .012. There was also no interaction of task uncertainty both with child (F (1.663, 76.487)= 0.63, p= .506, n_2= .014) and parent reported anxiety (F (1.688, 74.277)= 0.06, p= .923, n_2= .001) on threat expectancy.

The main effect of anxiety as reported by children (F (1, 46)= 1.00, p= .322, n_2= .021) and parents (F (1, 44)= 0.001, p= .978, n_2= .000) were not significant on RT after controlling for age. Similarly there was no significant interaction of task uncertainty both with child (F (1.474, 67.819)= 0.05, p= .911, n_2= .001) and parent reported anxiety (F (1.463, 64.387)= 0.66, p= .473, n_2= .015) on RT after controlling for age.

The main effect of worry as reported by PSWQ was approaching significance on task-related worry, F (1, 46) =3.32, p=. 075, η^2=. 067. However, there was no significant interaction between task uncertainty and worry as reported by the PSWQ on task-related worry, F (1.620, 74.500)= 0.13, p= .849, n_2= .003. There was no significant main effect of worry as reported by PSWQ on threat expectancy (F (1, 46)= 1.17,

p= .285, n_2= .025) and on RT after controlling for age (F (1, 46)= 0.48, p= .490, n_2= .010). There was also no significant interaction of task uncertainty and worry as reported by PSWQ either on threat expectancy (F (1.661, 76.403)= 0.70, p= .474, n_2= .015) or RT after controlling for age (F (1.472, 67.715)= 0.50, p= .553, n_2= .010).

6.4 Discussion

This is the first study to examine reactions to uncertainty within the context of low and heightened threat in preadolescent children. The first aim of the study was to adapt a task used in previous studies (Krain et al., 2008; Krain et al., 2006) for use with preadolescent children. A low threat and heightened threat version of the task were created to examine reactions to uncertainty in different contexts. We examined whether the tasks were suitable for preadolescent children based on a number of criteria. Overall, the results indicated that the tasks were suitable. All children were able to complete the tasks, there was less than 20% missing data, accuracy data indicated that children were not simply guessing. The image-rating task indicated that participants found the angry faces used in the heightened threat task aversive, suggesting that these stimuli were suitable. Task-related certainty decreased as uncertainty increased in the low threat task, indicating that children understood this task. There was also a significant difference between threat expectancy on the certain threat and both the uncertain threat and certain no threat conditions, as would be expected if children understood when to expect threat. However, the difference between threat expectancy on the uncertain threat and no threat conditions did not reach significance. This may suggest that participants could not entirely follow the reasoning regarding when a threat would be shown. Otherwise, there is strong support for the suitability of the tasks.

The second aim was to explore reactions to uncertainty in low and heightened threat contexts. We hypothesized that, with increasing uncertainty, there would be increases in task-related worry and changes in reaction time (RT) across both tasks. These hypotheses were all supported, with linear relationships clear; when uncertainty was greatest, worry was heightened and RTs were longer. These results are consistent with previous studies using the same task in which adults and adolescents were found to have longer RTs and more task-related anxiety as uncertainty increased (Krain et al., 2008;

Krain et al., 2006). This consistency may imply that longer RTs under conditions of uncertainty are found regardless of age. However, the only other behavioural study to have examined reactions to uncertainty with preadolescent children indicated that decision-making time was not significantly different across uncertainty levels (see chapter 5). This inconsistency in findings may be due to differences in the tasks used. While the beads task used in chapter 5 provided an opportunity for participants to seek information to decrease their uncertainty, the task used here did not provide this option. Thus, the decision-making times recorded for the tasks are for slightly different decisions; whether to seek more information versus a binary judgement about the mystery card.

The final aim of the study was to investigate whether the tasks can capture reactions to uncertainty that are related to questionnaire measures of IU, anxiety, and worry. We hypothesized that IU, anxiety, and worry would be significantly associated with RT and task-related worry as well as task-related certainty on the low threat task and threat expectancy on the heightened threat task. There was some support for these hypotheses. No significant associations between IU and task variables were found for the low threat task, although the association between IU and task-related certainty approached significance. However, on the heightened threat task, child-reported IU was associated with task-related worry and parent-reported IU interacted with certainty condition to affect RT. Uncertainty had a greater effect on RT when parent-reported IU was high than when parent-reported IU was low. Overall, these results provide some indication that the heightened threat task at least captures some processes linked to IU.

Considering individual differences in child anxiety, on the low threat task, again no significant associations between anxiety and task responses were found. However, on the heightened threat task, greater child-reported (but not parent-reported) anxiety was associated with greater threat expectancy and somewhat longer RTs. For worry, higher child reported worry on the PSWQ was associated with higher task-related worry across both tasks but not any other task-related variables.

Our findings are somewhat consistent with previous research. For example, Krain et al. (2008) included a sample of adolescents and found that greater IU was associated with lower certainty. On the low threat task, the effect of IU on certainty approached significance. The study was underpowered to assess this effect but the effect size suggests that, with a larger sample, it may well be found to be

statistically significant. It is also noteworthy that the effect of IU on certainty rating in our previous research using the beads task (chapter 5) similarly approached significance. This may indicate that children who are high in IU feel less certain than those who are low in IU. Thus, IU may not be only about reactions to uncertainty but also about detection of uncertainty, Further, Krain et al. (2008) found no evidence of an association between IU and task performance variables, which also resembles our findings for the low threat task. However, in our heightened threat task there was evidence for an effect of IU on reaction time under uncertainty. As the task used by Krain and colleagues did not include a threat condition, this may indicate that IU has a greater effect on task-related performance when there is a threat context. This conclusion is somewhat supported by the finding that IU had a significant effect on task-related worry on the heightened threat task but not on the low threat task. It is important to keep in mind however that this effect was not found consistently across parent and child report and that the two tasks have not been compared statistically.

Importantly, both versions of the HiLo task used here included a certain condition as well as a number of uncertain conditions. We had therefore examined interactions between questionnaire measures and task condition, anticipating that IU in particular might only be associated with reactions to uncertainty and not to the certain trial. However, as noted above, only one significant interaction was found; the interaction between task condition and parent-reported IU was significantly associated with RT on the heightened threat task. Previous research examining behavioural reactions to uncertainty within preadolescent children also found no significant interactions between IU and task conditions (see chapter 5). One reason for the lack of interaction in previous research (see chapter 5) may have been that the task used did not have a certain condition. However, the fact that few significant interactions were observed here indicates that children high in IU may feel less certain and more worried than their peers even when there is objective certainty. It is not clear whether this would be predicted by theoretical definitions of IU which tend to focus on responses to uncertainty only (e.g. Dugas, Gosselin, & Ladouceur, 2001; Ladouceur, Talbot, & Dugas, 1997). As mentioned above, it seems plausible that individuals high in IU may be biased to perceive more uncertainty than is present. This is somewhat captured by the latest definition of IU provided by (Carleton (2016), p. 31) and will be an interesting question to follow-up in future research using tasks specifically designed to capture uncertainty perception bias.

A strength of this study is that reactions to uncertainty were studied within two different threat contexts. This is important, as it is unclear whether IU leads to distinct reactions to uncertainty when uncertainty occurs within in a heightened threat context as compared to when it occurs in a low threat context. The results provide some indication that IU may have a stronger effect on feelings and behaviours when uncertainty occurs in a heightened threat context. However, it is important to note that the low threat task still included an element of threat. Even though the participants were not given feedback regarding their accuracy, their responses were either correct or incorrect and they were shown the answer. Getting an answer wrong could be perceived as a threat, which is implicit. One way to overcome this might be to not show participants the correct answer. Another would be to design a task in which decision-making does not involve an element of being right or wrong. One example could be a task where participants have to make a subjective choice between various options presented on a screen, for example they might be shown two types of drink (e.g. orange juice and coffee) and asked which they prefer. This could be compared to trials where the decision might be more difficult due to the similarity of options and/or number of options (e.g. coca-cola, diet coke, coke zero, pepsi, pepsi max).

Another difficulty with the two versions of the task was that the low threat task was always completed before the heightened threat task to ensure that there were not any carryover effects regarding threat. However, this meant that comparisons between tasks were not possible because any task differences could have been due to order effects. There may be a number of ways around this in future research. With older children and adults it may be possible to include high threat and low threat trials randomised within one task as long as there was a clear indicator at the start of each trial of what trial type it was. This would probably be too complex for younger children though. Another option would be to use different cards for the high and low threat versions, which may prevent any carryover effects regarding threat learning. For example, one task could use the circles we have here, another could use squares. The tasks could then be counterbalanced and compared. If either of these designs were used in future research, it would be advisable to collect certainty ratings across both tasks. We only asked for certainty ratings on the low threat task because we wanted to ask about threat expectancy in the heightened threat task but with hindsight the certainty ratings on the high threat task would also have been useful. Given

how similar the two tasks are, we can be reasonably confident that participants' certainty would have decreased as uncertainty increased on the heightened threat task but it would be more robust to have measured this on both tasks.

Additional limitations of the research should be noted. First, we used a sample that consisted of community participants because our aim was to develop behavioural tasks for preadolescents to capture reactions to uncertainty within low and heightened threat contexts. However, the nature of the sample meant that participants had a limited range of IU, anxiety, and worry scores. A sample comprising participants selected to have low or high trait anxiety or children with and without an anxiety diagnosis may have yielded stronger effects regarding individual differences in IU, anxiety and worry. Second, the sample size was also relatively small for detecting interactions between individual differences in task parameters and anxiety, worry, and IU. Third, the sample lacked diversity and the results may not be generalizable to a wider population.

6.5 Conclusion

To our knowledge this study is the first to design age-appropriate tasks to explore reactions to uncertainty across two contexts that differed in threat level. The findings demonstrated that the tasks are suitable to use with preadolescent children. Reactions to uncertainty were significantly different across task conditions as indicated by increased RT and task related-worry under uncertainty. Furthermore, significant effects of task-related variables and self-reported IU, anxiety, and worry on the heightened threat task were found, indicating the task is able to capture some aspects of these dimensions as measured by self-report questionnaires. These effects were less convincing for the low threat task, suggesting that a threat-relevant context may result in larger effects of IU. Future work should attempt to replicate these findings as well as testing whether the results are applicable to the children with clinically significant levels of anxiety.

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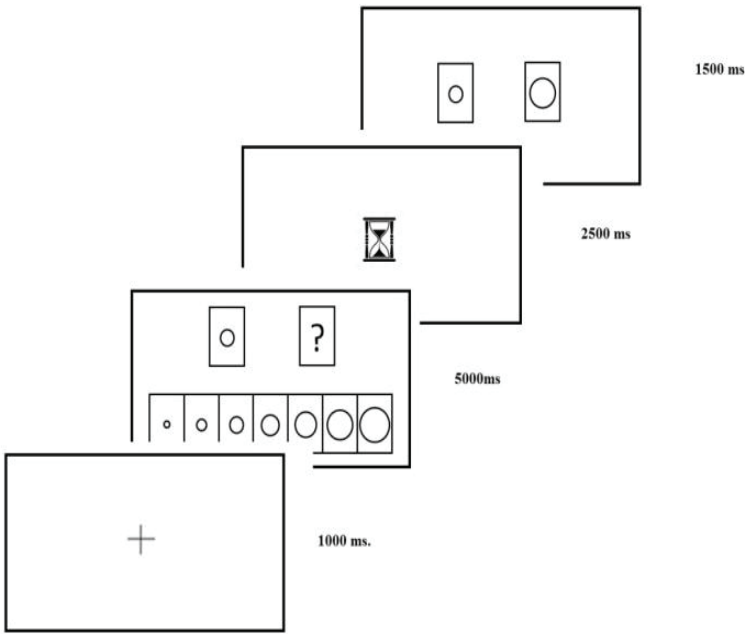

Figure 1: Visual example of low threat HiLo task

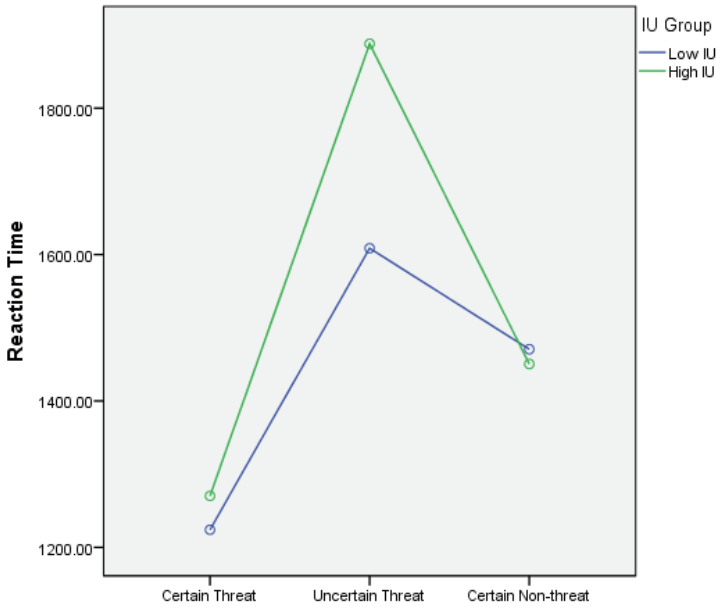

Figure 2: Interaction between parent-reported IU and task condition on reaction time.

TABLE 1. Sample Demographics (Parent)

	Total Sample (N=51)
Marital Status (%)	
Married	80.4
Separated	5.9
Never Married	13.7
Living Arrangements (%)	
Two Parent	90.2
Single Parent	5.9
Step or Blended Family	2.0
Other	2.0
Employment Status (%)	
Full-time Employed	27.5
Part-time Employed	56.9
Full or Part-time Student	2.0
Combined Employment & Study	2.0
At home by choice	7.8
Illness/Disability	3.9
Education Level (%)	
Year 10 or equivalent	5.9
Year 12 or equivalent	9.8
Tafe/Apprenticeship	2.0
Certificate/Diploma	9.8
Undergraduate	25.5
Postgraduate	47.1
Origin (%)	
White-British	84.3
African	2.0
Indian	3.9
Other	9.8

TABLE 2. Means & Standard Deviations

		N	Mean (SD)
Child Report (Whole Sample)	SCAS	52	27.40 (13.79)
	PSWQ	52	16.11 (9.55)
	IUS-C	52	54.05 (21.64)
	WASI	52	114.63 (15.29)
Males	SCAS	24	27.91 (14.58)
	PSWQ	24	17.58 (10.76)
	IUS-C	24	55.00 (23.90)
	WASI	24	115.42 (15.22)
Females	SCAS	28	26.97 (13.31)
	PSWQ	28	14.85 (8.38)
	IUSC	28	53.24 (19.92)
	WASI	28	113.95 (15.59)
Parent Report (Whole Sample)	SCAS	52	24.09 (14.28)
	IUS-C	52	56.67 (23.71)
Males	SCAS	24	21.49 (13.08)
	IUS-C	24	55.36 (25.02)
Females	SCAS	28	26.32 (15.12)
	IUS-C	28	57.80 (22.93)

TABLE 3. Correlations between self-report questionnaires (IUSC with original items

	IUSC-child report	IUSC-parent report	SCAS-child report	SCAS-parent report
IUSC-child report	-			
IUSC-parent report	r=.32, p=.021, N=52	-		
SCAS-child report	r=.78, p<.001, N=52	r=.30, p=.029, N=52	-	
SCAS-parent report	r=.24, p=.09, N=50	r=.76, p<.001, N=50	r=.18, p=.20, N=50	-
PSWQ	r=.73, p<.001, N=52	r=.39, p=004, N=52	r=068, p<.001, N=52	r=.30, p=.035, N=50

SCAS: Spence Child Anxiety Scale, IUS-C: Intolerance of Uncertainty Scale for Children, PSWQ: Penn-State Worry Questionnaire

TABLE 4. Correlations of task variables with age, gender, and the cognitive ability

		Age	Gender	WASI-II	Low Threat Reaction Time	Low Threat Task-related Worry	Low Threat Task-related Certainty	Heightened Threat Reaction Time	Heightened Threat Task-related Worry	Heightened Threat Threat Expectancy
Age	Pearson Correlation	-	.074	.180	-.110	-.109	.103	-.308*	.071	.088
	Sig. (2-tailed)		.603	.202	.437	.441	.466	.031	.633	.551
Gender	Pearson Correlation	.074		-.035	-.016	-.047	-.180	-.191	-.019	-.037
	Sig. (2-tailed)	.603	-	.803	.908	.739	.202	.189	.899	.800
WASI-II	Pearson Correlation	.180	-.035		-.032	-.001	.021	-.069	.096	-.244
	Sig. (2-tailed)	.202	.803	-	.823	.995	.880	.637	.517	.095
	N	52	52		52	52	52	49	48	48
Low Threat Reaction Time	Pearson Correlation	-.110	-.016	-.032		-.013	-.005	.630**	.024	-.344*
	Sig. (2-tailed)	.437	.908	.823	-	.928	.971	.000	.872	.017
Low Threat Task-related Worry	Pearson Correlation	-.109	-.047	-.001	-.013	-	-.189	.101	.588**	.301*
	Sig. (2-tailed)	.441	.739	.995	.928		.180	.492	.000	.038
Low Threat Task-related Certainty	Pearson Correlation	.103	-.180	.021	-.005	-.189		-.058	-.185	.001
	Sig. (2-tailed)	.466	.202	.880	.971	.180	-	.693	.207	.993
Heightened Threat Reaction Time	Pearson Correlation	-.308*	-.191	-.069	.630**	.101	-.058	-	.069	-.244
	Sig. (2-tailed)	.031	.189	.637	.000	.492	.693		.640	.094
Heightened Threat Task-related Worry	Pearson Correlation	.071	-.019	.096	.024	.588**	-.185	.069		.134
	Sig. (2-tailed)	.633	.899	.517	.872	.000	.207	.640	-	.365
Heightened Threat Threat Expectancy	Pearson Correlation	.088	-.037	-.244	-.344*	.301*	.001	-.244	.134	
	Sig. (2-tailed)	.551	.800	.095	.017	.038	.993	.094	.365	-

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

TABLE 5. Post-hoc t-test results for Task 1

		Mean (SD)	*100% Certainty*	*83% Certainty*	*66% Certainty*
Self-Reported Certainty	***100% Certainty***	3.60 (0.76)			
	83% Certainty	3.04 (0.55)	t (51) = 5.58, p<.001		
	66% Certainty	2.45 (0.70)	t (51) = 8.87, p<.001	t (51) = 5.99, p<.001	
	50% Certainty	1.94 (1.04)	t (51) = 8.89, p<.001	t (51) = 6.89, p<.001	t (51) = 3.56, p<.001
Self-reported Worry	***100% Certainty***	1.38 (0.79)			
	83% Certainty	1.75 (0.77)	t (51) = 3.24, p=.002		
	66% Certainty	2.08 (0.80)	t (51) = 5.34, p<.001	t (51) = 4.43, p<.001	
	50% Certainty	2.56 (1.23)	t (51) = 5.512, p<.001	t (51) = 5.34, p<.001	t (51) = 3.467, p<.001
Reaction Time	***100% Certainty***	1406.8571 (308.71)			
	83% Certainty	1623.2837 (479.80)	t (51) = 5.178, p<.001		
	66% Certainty	1842.7483 (516.97)	t (51) = 9.71, p<.001	t (51) = 5.55, p<.001	
	50% Certainty	1872.8212 (470.98)	t (51) = 11.21, p<.001	t (51) = 5.94, p<.001	t (51) = 0.889, p=.38
Accuracy	***100% Certainty***	0.74 (0.07)			
	83% Certainty	0.67 (0.13)	t (51) = 3.757, p<.001		
	66% Certainty	0.56 (0.17)	t (51) = 7.709, p<.001	t (51) = 3.666, p<.001	
	50% Certainty	0.48 (0.09)	t (51) = 16.707, p<.001	t (51) = 8.537, p<.001	t (51) = 2.818, p=.007

Note: condition 1= 100% certainty, condition 2= 83% certainty, condition 3= 66% certainty and condition 4=50% certainty.

TABLE 6. Post-hoc t-test results for Task 2

		Mean (SD)	*Card 1*	*Card 4*
	Card 1	3.14 (1.29)		
Expectancy for Threat	***Card 4***	2.33 (0.80)	t (48) = 3.26, p=.002	
	Card 7	2.10 (1.43)	t (48) = 3.14, p=.003	t (48) = 0.96, p=.342
	Card 1	1.31 (0.82)		
Self-reported Worry	***Card 4***	2.51 (1.14)	t (48) = 5.96, p<.001	
	Card 7	1.33 (0.85)	t (48) = 0.15, p=.883	t (48) = 5.35, p<.001
	Card 1	1246.7222 (293.12)		
Reaction Time	***Card 4***	1745.4694 (531.99)	t (48) = 8.467, p<.001	
	Card 7	1460.7908 (367.30)	t (48) = 5.93, p<.001	t (48) = 4.35, p<.001
	Card 1	0.97 (0.07)		
Accuracy	***Card 4***	0.47 (0.12)	t (48) = 30.33, p<.001	
	Card 7	0.91 (0.13)	t (48) = 3.53, p<.001	t (48) = 18.49, p<.001

Appendix 1: Further Analysis with the Modified IUS-C

Rationale and aim

Further Analyses were conducted with the IUS-C as suggested in chapter 4 to explore whether the same pattern of findings that was found as reported for the original IUS-C.

Method

The IUS-C with the understandable items is described in Chapter 4.

Results

Table 1 provides the correlations between the shortened IUS-C and the other questionnaire measures used in the study. This version of the IUS-C also showed significant associations with the original IUS-C. Both the correlation for child report and parent report was .99, p<. 001, with the original IUS-C forms.

TABLE 1: Correlations between self-report questionnaires

	IUSC-child report	IUSC-parent report	SCAS-child report	SCAS-parent report
IUSC-child report	-			
IUSC-parent report	r=.30, p=.029	-		
SCAS-child report	r=.77, p<.001	r=.30, p=.032	-	
SCAS-parent report	r=.22, p=.13	r=.77, p<.001	r=.18, p=.20	-
PSWQ	r=.72, p<.001	r=.39, p=005	r=068, p<.001	r=.30, p=.035

Using the shortened IUS-C, the results of General Linear Models were consistent with the results of the IUS-C with the original items.

1. *Low threat*

The main effect of IU as reported by children on task-related certainty approached significance, F (1, 50) =3.13, p=. 083, η^2=. 059; however, the same main effect was not found for parent-reported IU. No significant main or interaction effects were found on task-related worry and RT in the low threat task.

2. *Heightened threat*

There was a significant main effect of IU (child-report) on task-related worry F (1, 46) =4.139, p=. 048, η^2=. 083. Children who reported greater IU also reported greater task-related worry. However, the same main effect was not found for the parent-reported IU. For RT, the interaction between uncertainty and IU as reported by parents approached significance even after controlling for age, F (1.493, 68.684) =3.923, p=. 057, η^2=. 067. This interaction was also consistent with the original IUS-C, although it was significant with the original measure.

Discussion

These results suggest that the findings presented in the study are robust across different versions of the IUS-C.

Chapter 7- General Discussion

Four papers have been presented that together further understanding of IU in young people in the context of anxiety. The thesis had two overarching aims. The first was to review evidence for associations between IU, anxiety, and worry in children and young people and to identify an agenda for future research. The second was to begin to address an important issue for the field by providing new insights and ideas for the assessment of IU in preadolescent children. The first aim was addressed by Study 1. The remaining three studies all focused on IU assessment. Specifically, study 2 aimed to evaluate the only existing measure of IU in children by examining the psychometric properties of the IUS-C for preadolescent children. Studies three and four report on behavioural tasks designed to capture IU-related reactions to uncertainty in preadolescent children.

In this final chapter, the findings from each of the studies presented in this thesis will be summarised. This will be followed by reflection on the thesis aims and what the thesis as a whole contributes to the field. The implications for further research and the limitations of the work will also be included along with how these issues can be addressed in future work.

7.1 Overview of Findings

7.1.1 Study 1: Intolerance of Uncertainty, anxiety, and worry in children and adolescents: A meta-analysis

This study reviewed the existing evidence on IU, anxiety, and worry in children and adolescents. IU is strongly associated with worry and anxiety in adults (e.g. Boelen & Reijntjes, 2009; Carleton et al., 2012; Tolin, Abramowitz, Brigidi, & Foa, 2003) and there has been increasing interest in IU in young people in this last decade. The objectives were (i) to estimate the mean association between IU and anxiety, (ii) to estimate the mean association between IU and both anxiety and worry, (ii) to examine whether these associations were moderated by several possible variables such as age and gender.

Consistent with the adult literature, IU was strongly and positively associated with worry and anxiety in young people. There was insufficient evidence to conclude whether age moderated either association, due to the fact that most of the studies included in the meta-analysis included participants across a broad age range. Gender and the proportion of sample from a clinical population did not significantly moderate

either association. The review revealed that the existing literature consisted of relatively homogeneous studies. Typically, participants were children and young people from community samples, designs were cross-sectional, and anxiety, worry, and IU were measured using self -report questionnaires only. In addition, a limited number of studies had been conducted with clinical samples and those that had focused on Generalised Anxiety Disorder only. A further limitation was that half of the studies included in the review used an adult measure of IU to measure IU in children and adolescents. Nevertheless, the meta-analysis provided convincing evidence for the association between IU and both anxiety and worry in young people. The study called for more longitudinal and experimental research to identify the direction of these associations and for studies with clinical samples consisting of children and young people with a range of anxiety disorders in order to clarify whether IU is a transdiagnostic risk factor among children and young people.

7.1.2 Study 2: Evaluating the psychometric properties of the Intolerance of Uncertainty Scale for Children in a preadolescent sample

The measurement of IU in children is relatively new with the first questionnaire developed less than a decade ago (Comer et al., 2009). This study investigated the psychometric properties of the IUS-C in preadolescent children aged 7-12 years. The IUS-C is a downward extension of the adult measure of IU and the study therefore also evaluated whether any items were difficult to respond to. A relatively narrow age band was used as there are marked cognitive changes in understanding and responses to uncertainty during childhood and adolescence (e.g.Weil et al., 2013) which may influence the appropriateness of the measure for children and young people at different ages. The objectives of the study were to (i) investigate the items that may present a challenge for children and parents to understand and respond to, (ii) use exploratory factor analysis to draw hypotheses regarding the structure of IU in preadolescent children, (iii) examine the test-retest reliability of the IUS-C, and (iv) examine the agreement between child and parent forms of the IUS-C.

The results showed that there were common items that presented a challenge for both children and parents to understand and respond to. The factor analysis revealed a one factor structure for the IUS-C

child and parent form within this preadolescent sample indicating that IU may not be as crystallized for preadolescents as it is in adults. Test-retest reliability of both forms within two-weeks was high; however, there was a poor agreement between child and parent forms. Together these findings suggest that it would also be timely to think about different ways to measure IU especially with more reliance on behavioural and objective measures that would help to overcome the issues of self-report and shared variance method.

7.1.3 Study 3: Exploration of the Beads Task as a behavioural measure of Intolerance of Uncertainty in preadolescent children

Study 2 indicated that the questionnaire measure of IU presents challenges for children and concluded that there may be advantages to using behavioural measures of IU. Study 3 therefore aimed to develop a behavioural assessment capable of capturing IU in preadolescent children**.** The beads task has been used in adult studies of IU (Jacoby, Abramowitz, Buck, & Fabricant, 2014; Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013) and was adapted for use with preadolescent children.

The results indicated that the task was suitable for children of this age; there was minimal missing data, they were able to follow the instructions and give meaningful answers that differed significantly from chance. As uncertainty increased, the participants were less certain, more worried, and requested more information. There was however no significant difference in decision making time across levels of uncertainty. The task-related self-report variables (certainty and worry) showed associations with IUS-C scores, however associations with parent reported IU (IUS-C Parent Report) were not significant. IU was not associated with decision making time or number of beads requested. This pattern of findings may suggest that the IUS-C captures an affective state rather than behavioural responses to uncertainty. In contrast, parent-reported child anxiety was associated with decision-making time. In addition, a significant interaction was found between uncertainty level and child-reported anxiety in relation to task-related worry, reflecting a greater effect of uncertainty on worry in participants with higher levels of anxiety than those with lower levels of anxiety. Child-reported worry did not correspond to any of the task-related variables.

7. 1.4 Study 4: Reactions to uncertainty with and without potential threat: developing a behavioural measure of intolerance of uncertainty for preadolescent children

Study 4 presents the development of a second behavioural task for capturing IU in preadolescent children. This study builds upon Study 3 in two ways. First, the task developed for this study included a certain condition whereas the task in study 3 only included three levels of uncertainty. Second, this study included two parallel tasks that assess reactions to uncertainty within a low and heightened threat context. Two parallel tasks (low threat and heightened threat) were developed by adapting the HiLo task that has been used with adults and adolescents previously (Krain et al., 2008; Krain et al., 2006).

Both tasks appeared to be suitable for use with preadolescent children as the children were able to follow the instructions and provide meaningful answers that differed significantly from chance. As uncertainty increased, the participants were less certain, more worried, and had longer RTs. There was some indication that the heightened threat task may have been a little challenging for participants to understand as no differences were found between threat expectancy on the uncertain threat trials (when there was a 50% chance of seeing an angry face) and threat expectancy on the certain no threat trails (when there was no chance of seeing an angry face). The results also indicated that self-reported IU was significantly associated with task-related worry on the heightened threat task and approached significance for task-related certainty on the low threat task. In addition, parent-reported IU interacted with condition such that for participants high in IU there was a greater effect of uncertainty level on RT than for those low in IU. Anxiety was associated with higher threat expectancy and worry as reported by PSWQ was significantly associated with task related worry across both tasks. These results suggest that clearer effects of IU may be apparent under heightened threat contexts and that self-reported IU is primarily associated with subjective feelings of worry and certainty rather than behavioural responses to uncertainty.

7.2 The implications for Theoretical Models

IU was initially conceptualized as a central part of GAD; however, in recent years IU has been found to have a significant role across anxiety disorders. Despite the accumulated evidence suggesting

IU as a transdiagnostic risk factor, there is no clearly articulated, empirically supported model of IU in the context of anxiety disorders. The measurement of IU is in its infancy in children and adolescents compared to the measurement of anxiety and worry. Given the lack of theoretical model to draw from, the implicit model underlying the thesis is outlined here (see Figure 1 on page 216). In this implicit model, IU can be captured through the perception of and reactions to uncertainty in behavior, cognition, and psychophysiology. It is hypothesized that the perception of uncertainty triggered by IU may contribute to anxiety through cognitive biases and the absence of safety or insensitivity to safety cues as well as directly affecting anxiety and worry. The studies conducted in this thesis except from the meta-analysis partially support this implicit model.

Following this implicit model people who have higher IU may have a lower threshold for perceiving uncertainty regardless of threat level in the situation. As the association of child-reported IU with task-related certainty was approaching significance in low-threat task discussed in Chapter 6, the results support that the perception of uncertainty may be linked with IU; children with higher levels of IU were less certain even when there is no uncertainty in the context of low threat. Lower threshold for perceiving uncertainty and beliefs about uncertainty (e.g. uncertainty is unsafe or threatening) may in turn trigger a range of cognitive biases, including more attention to threat cues, inability to identify safety cues, insensitivity to safety cues and interpretation bias. This leads to an overall perception of threat, which activates the autonomous nervous system leading to anxiety and worry.

To give an example, an individual with high IU has to wait a month for their University exam results. Based on their previous marks it is almost certain that they will get a 2:1. They already have the graduate job they wanted, and the outcome won't affect their job. Because they are high in IU, they feel really uncertain about what results they will get (threshold of perception of uncertainty). They hold beliefs that feeling uncertain is bad (beliefs about uncertainty) and so they try to become more certain by testing out how different exam results affect their overall mark (behavioral coping). This shows them that they are almost certain to get a 2:1 but they continue to feel uncertain. They know that the result doesn't objectively matter hugely because of their job but they have problems identifying this as a safety cue. This leads to a heightened state of arousal, setting off the chain of worrying thoughts and anxiety. This

state may also be accompanied by interpretation and attention bias. The support for cognitive biases mentioned in the implicit model underlying the thesis cannot be concluded via the studies conducted in the thesis; however, the pathways from IU to worry and anxiety through cognitive biases are quite intertwined. It is quite important to test individual differences in non-clinical samples to separate the processes, which may be a risk factor for anxiety disorders when combined with high IU.

The behavioral tasks presented in this thesis can assess various aspects of IU-related behaviors and some implicit IU-related processes. For example, the Beads Task can be used to assess how much evidence is required for people with high and low IU to make a decision under different levels of uncertainty. Within the Beads paradigm, some people with high IU may engage in excessive information seeking, some may jump to a conclusion in order to end the uncertainty and both of them can be IU-related behaviors yet indicating different IU-related processes. People with high IU that manifest the former behavior may be more attentive to the uncertain situation, safety and threat cues and engaging in uncertainty in order to establish some control over the situation. Attempting to reach certainty and to establish control in the situation can be problematic in relieving anxiety as some external situations cannot be controlled by gathering more information and gathering more information may not lead to certainty. On the other hand, people with high IU that manifest the latter behavior may be more avoidant, feel less in control of the situation. Avoiding uncertain situations can also be problematic because it removes the opportunity for the individual to learn that uncertainty does not always lead to negative results. Either way, these IU-related processes increase the likelihood that the individual will experience anxiety; however, the former one may benefit more from mindfulness interventions such as letting go of things that one cannot control and the latter one may benefit more from behavioral interventions such as exposure to uncertainty.

The low-threat and heightened threat decision-making tasks used in the final study can be used to assess the role of threat perception in the context of uncertainty and IU. These tasks can be used to assess reactivity towards increased threat in the context of uncertainty and may help to separate the IU-related processes that are linked with threat and safety, as discussed in the implicit model underlying this thesis. The HiLo paradigm also allows examining reactions (e.g. decision making time) to certainty along

with different levels of uncertainty (stg that cannot be examined in the beads paradigm as the beads paradigm does not include certain condition). Therefore, this paradigm allows to examine and compare whether individuals with high IU reacts to certainty in a different way than they react to different levels of uncertainty. HiLo paradigm also allows for examining cognitive biases indicated in the implicit model. For example, expectancy bias can be measured in the task with a question of threat expectancy or expectancy for being correct right after participants make their decision but before the answer is shown to them. Similarly, an eye-tracker can be incorporated into the task to examine how participants orient their attention.

Overall, this model is provided as an implicit model guiding the dissertation. The results supported that individuals with high IU perceive uncertainty more than individuals with low IU, even when there is no uncertainty. Although no association between IU and the reactivity towards uncertainty in behavior was captured in the studies, the participants with high IU reported being more worried and less certain. This effect of may not show up due to the low sample size. The tasks can be used or adapted in further studies to test the implicit model discussed; however, a paradigm in which no decision is required (e.g. preference) may be needed to examine uncertainty within no threat context in order to examine safety perception in the context of IU. Similarly a paradigm that allows preference instead of attempting to be right/correct would also be more suitable to examine interpretation bias in the context of IU.

7.3 Reflection on Thesis Aims

Study 1 addressed the first aim to examine the literature on IU, anxiety, and worry in children and young people. The meta-analysis provided evidence for a significant association between IU and both anxiety and worry in children and young people. This is line with the literature on IU, anxiety, and worry in adults (e.g. Boelen & Reijntjes, 2009; Carleton et al., 2014). Studies 2, 3, and 4 addressed the second aim, to provide insight into the assessment of IU in preadolescents considering the notable gaps in the literature identified by Study 1. The focus here is on bringing together the findings across studies 2, 3 and 4.

Study 2 examined the items and psychometric properties of the IUS-C. The results revealed that some IUS-C items are difficult to understand for preadolescent children. Indeed younger children in this sample (7-8 years) had a more difficulty understanding IUS-C items, indicating that some items need to be dropped from the IUS-C or a new measure of IU needs to be developed for younger children. Factor analysis of the IUS-C also revealed a one factor structure for this sample which is inconsistent with the two-factor structure suggested for adult IU measure. This may suggest that sub dimensions of IU may emerge with development and may not be present yet in younger children. As this is the first study to examine the IUS-C with an exploratory factor analysis in order to draw hypotheses regarding the nature of IU in preadolescents, more factor analytic research is needed in order to understand the nature of IU in preadolescents (also see future directions below).

Studies 3 and 4 present examples of how IU can be assessed by relying on methods other than self-report questionnaires. These studies focused on developing age-appropriate tasks in which reactions to uncertainty can be measured and associations with self-reported IU can be examined. Studies 3 and 4 are the first examples of how uncertainty can be manipulated and how different reactions to uncertainty can be measured using well-controlled lab-based paradigms with preadolescent children. Because the focus was on developing behavioural tasks that might capture IU, a community sample was used. This allowed for the normal range of reactions to uncertainty to be examined and for the tasks to be evaluated before being used with clinical samples. These studies represent the first step to move beyond self-report questionnaires for the assessment of IU in children.

Both study 3 and 4 examined subjective and objective reactions to uncertainty. Across studies, there was evidence that children are increasingly less certain, more worried, seek more information, and take longer to make decisions as uncertainty increases. The latter effect was not consistently found across tasks; uncertainty condition did not significantly affect decision making time on the beads task but it did significantly affect decision making time on both versions of the HiLo task. One explanation for why this effect was not found for the beads task may be that children were allowed to ask for more information on the beads task; however, on the HiLo task there was no opportunity to seek more information. As such the decision making time on the beads task reflects the time to make a decision regarding whether or

not to ask for more information whereas on the HiLo task the decision relates to giving an answer to the question posed (which may be right or wrong). Another possible explanation may relate to the different contexts, which may elicit different coping strategies in the different tasks. Specifically, children were aware that more external information was available in the beads task (so they asked for it rather than pondering over a decision) but this information was not available in the HiLo task.

There are other notable differences between the beads task and the HiLo tasks. For example, the beads task did not have a certain condition. Therefore, this task cannot provide information about whether children with different levels of IU react differently under certainty or only under uncertainty. The HiLo tasks were therefore designed to have a certain condition but no significant interactions between IU and task uncertainty on subjective ratings of certainty were found. This indicates that children with high IU feel less certain even when there is no objective uncertainty. Few interactions between IU and uncertainty level were found across either study 3 or 4. This may indicate that IU affects subjective and objective reactions under certain as well uncertain conditions. Alternatively, if individuals high in IU detect uncertainty when there is objective certainty then the lack of interactions may be expected; even certain conditions feel uncertain to a child who is high in IU and they therefore respond as if they were uncertain. This will be an interesting area for consideration in further research. An alternative reason for the lack of interactions is that the studies were designed primarily to develop the tasks not to examine how task performance is related to IU and as such they are underpowered to evaluate these interactions. Now that the tasks have been developed, future research could utilise these tasks to more specifically examine how task variables relate to IU.

Despite the lack of interaction, there was some indication that the tasks developed in studies 3 and 4 were able to capture some IU-related responses. Self-reported IU was significantly associated with task related worry on the beads task and on the heightened threat HiLo task. Furthermore, the effect of self-reported IU on task-related certainty was approaching significance on the beads task and low threat HiLo task. Taken together self-reported IU appeared to be related only with subjective task variables, indicating that the IUS may measure an affective state or feeling rather than a behavioural state. Given that a community sample was used, it is possible that these children have adapted ways of coping with

the affective state associated with IU and uncertainty such that it doesn't affect their behaviour. Further work with clinically anxious samples may reveal IU-related effects on task-related behaviour.

There are a number of ways that the tasks could be improved for more detailed measurement of reactions to uncertainty. For example, incorporating eye-tracking methods into computerized versions of the tasks would provide information about looking behaviour. For example, examining gaze duration to the size chart used in HiLo task would provide an additional measure of information seeking. Pupil size could also be used to provide a measure of emotional arousal associated with sympathetic activity (e.g. Partala & Surakka, 2003; Preuschoff, Hart, & Einhauser, 2011). Similar to the pupil size measure, heart rate and galvanic skin response could also be used to provide information about autonomic responses to uncertainty. Furthermore, incorporating EEG or fMRI to the research when the participants are completing the tasks may provide insight into the brain mechanisms involved in processing and responding to uncertainty and IU. In addition, the reactions to uncertainty could also be examined in different contexts. The HiLo tasks used in Study 4 provide an example of this by examining the reactions to uncertainty in low and heightened threat contexts. It would also be possible to examine the reactions to uncertainty in a positive context. For example, the heightened threat HiLo task could be modified so that participants are taught to expect a happy face instead of an angry face. This was not done here as this did not address the specific aims of the thesis, however, there is evidence to suggest that uncertainty not only intensifies reactions to unpleasant events but also to pleasant events (Bar-Anan, Wilson, & Gilbert, 2009) although the extent that this would capture reactions to uncertainty that are related to IU, anxiety, and worry is unknown.

7.4 Strengths and Limitations

This thesis identifies limitations of standard self-report measures of IU and makes initial steps towards the assessment of IU in preadolescent children using objective measures. The studies specifically focused on pre-adolescent children, between 7 and 12 years, in order to provide results that are specific to this developmental period due to the marked cognitive changes in understanding and responses to uncertainty across childhood and adolescence.

There are also some limitations that apply to the work included in this thesis. First, while there are advantages with focusing on a narrow age band, this also restricts the extent to which findings can be generalised to other age groups. In addition, the sample sizes were relatively small for some of the analyses across studies. For example, in Study 2, a sample size of 66 pairs of child and parent was necessary to detect a minimum correlation of r = .50 (α= 0.05 and □= 0.80) between the child and parent report. However, after removing participants where matched data was not available, this analysis was conducted with data from 61 matched sets. In studies 3 and 4, where the focus was on developing behavioural tasks that capture reactions to uncertainty, a sample size of 28 was needed to have 80% power for detecting a medium effect size for a repeated measure, within subjects F-test when employing the traditional .05 criterion. However, a sample size of at least 80 is required to detect an interaction with a continuous predictor (α= 0.05 and □= 0.80).

The recruitment process of the participants and the procedure of the studies also require a discussion. The studies included in chapters 5 and 6 consist of the same group of participants that are recruited through local advertising. The participants recruited this way were pre-screened before their visit to the lab in terms of demographics and developmental disorders. Children who were eligible to participate were invited to the lab with their parent. During their visit, parents completed SCAS and IUS-C; and the children completed the beads task (chapter 5), IQ test (WASI-II), low-threat and heightened threat decision making tasks and image-rating task (chapter 6) along with questionnaire measures of SCAS, IUS-C, and PSWQ. As this same group of participants completed the questionnaire measures used in the psychometric chapter, they are also included in the sample used in the psychometric study (chapter 4) and their data is included as an unpublished study in the meta-analysis. However, the rest of the sample (N= 174 in child data and N=143 in parent data) used in the psychometric study was recruited through local schools (children) and online advertising (parents). The fact that the same participants contributed data to all studies may raise an issue of non-independence. Both the beads task and HiLo task used in the final two studies measure reactions to uncertainty and the results are derived from the same sample. Although the nature of the tasks may slightly vary, the data points may still be representing the same variable. Although this allows for a more precise comparison of the results across two studies, it also

raises an issue regarding any bias that comes from the participants regardless of the sample size and the statistical power. Put simply, if this relatively small group of participants were not representative of the larger population then this might affect conclusions across both studies. If this non-independence is not acknowledged then the findings across studies may be interpreted as indicating a replication across samples and tasks, whereas in fact only the task differs across studies.

The initial plan was to recruit parents and children for the psychometric study though local schools and then to send invitation to the parents for the studies discussed in Chapters 5 and 6; however, the participation rate from parents was quite low via this way. Therefore, in order to amend and increase the sample size, parents were recruited though online advertising for the psychometric study and through local advertising for the studies discussed in the latter two studies. Overall, the samples used in the studies, especially in the latter two studies, were self-selecting sample, which raises questions about parents' motivation regarding the participation in the study. Considering the difficulty recruiting parents and children for these studies, parents may have entered the study due to their concern or interest in anxiety

A further limitation that applies across studies is lack of diversity in the sample. Children and parents included in the studies were predominantly from White British ethnic backgrounds and more than 50% of the parents had at least an undergraduate education; therefore, the results may not be generalizable to individuals from other ethnic and socio-economic backgrounds. A further limitation is that the samples were all community samples and there was limited variance in self-reported IU, anxiety, and worry; this may also have limited the ability to detect significant interactions between these variables and task conditions. Inclusion of children with and without anxiety disorders would be helpful to provide a deeper insight about reactions to (un)certainty across a sample which provide greater variability in IU, anxiety and worry. This would also be helpful to confirm if the findings are applicable to children with clinically significant levels of anxiety. Finally, the cross-sectional nature of studies also means that the direction of associations, between for example responses to uncertainty and anxiety or worry, cannot be established.

It is important to keep in mind that the behavioural tasks used in these studies manipulate the level of uncertainty rather than manipulating the level of IU. Future studies would benefit from the inclusion of longitudinal methods and through intervention studies such as randomized control studies in order to examine the effect of changing IU (or specific aspects of IU) on anxiety. Longitudinal work that assesses IU, anxiety, and worry at different time points over years and examining them with multilevel mediational analyses would be helpful to provide an insight into these directional relationships. Similarly, treatment studies that track changes in IU and anxiety between the pre- and post-intervention after an intervention targeting tolerance of uncertainty would be helpful to establish a direction of the effect between IU and anxiety (see directions for future research section).

7.5 Directions for Future Research

7.5.1 The importance of Age and Development

Studies of IU in children and young people have typically included samples of children and young people across broad age-range yet few have examined age-related differences in IU and the association between IU and anxiety or worry. The finding from the studies presented in this thesis highlight the importance of taking age and development into account when measuring IU. First, because children may struggle to understand top-down adaptations of self-report IU measures; second because IU may present in different ways across development (for example, a one factor structure for the IUS was found here, in contrast to the typical two-factor structure found in adults (Birrell, Meares, Wilkinson, & Freeston, 2011)); and, third, because both age and cognitive ability were found to be associated with some responses to uncertainty in the beads and HiLo tasks. To date, there has been no research to examine the applicability of the IUS-C in this way with an adolescent sample. Studies that examine responses to the IUS-C across development appear to be warranted.

There is currently little research in to how IU manifests at different developmental periods, and whether similar associations are found between reactions to uncertainty with self-reported IU, anxiety, and worry at different developmental phases. The literature on this area is limited with the studies 3 and 4 presented in this thesis and with two studies that used a version of a HiLo in small adolescent samples.

Consistent with studies 3 and 4, studies with adolescent samples (Krain et al., 2008; Krain et al., 2006) showed that participants had longer RTs and task-related anxiety, and were less accurate and endorsed less certainty under uncertain condition. Furthermore, self-reported IU was also significantly correlated with task-related subjective measures (task-related anxiety and certainty) but not with objective task variables (Krain et al., 2008). Together these studies may suggest that IU questionnaire measures assess an affective state rather than a behavioural state across both childhood and adolescence but further research is warranted.

Overall, the assessment of IU will be improved by considering age and development and research examining associations between IU, anxiety, and worry in children and young people will be limited without age-appropriate measures to assess IU.

7.5.2 Developing a better understanding of IU mechanisms in children and young people in the context of anxiety disorders

Uncertainty is inherent in our lives and most people learn to live and cope with it yet some do not. It is therefore important to identify specific mechanisms of IU that contribute to the development and maintenance of IU and its relationship with anxiety disorders. Only one theoretical model of IU has been rigorously examined and this is centred around GAD only (e.g. Dugas, Gagnon, Ladouceur, & Freeston, 1998) not across all anxiety disorders. This model suggests that IU is central to the exaggeration of "what if..?" questions leading to worry, and this worry is maintained by positive beliefs about worrying, cognitive avoidance, and negative problem orientation (Dugas, Freeston, & Ladouceur, 1997; Dugas et al., 1998). Models of IU that apply across broader anxiety disorders have been recently developed (Einstein, 2014; Grupe & Nitschke, 2013; Hirsh, Mar, & Peterson, 2012; Miceli & Castelfranchi, 2005) however research evidence to support these models is limited. To date there is no theoretical model of IU in the context of anxiety disorders specifically for children young people and only one study has evaluated the applicability of the Dugas et al. (1998) model to children and young people (Fialko, Bolton, & Perrin, 2012). This study found support for the applicability of the Dugas model within a community sample of children (7-12 years old) and adolescents (13- 19 years old) with some modifications. For

adolescents, IU was a higher order vulnerability factor for cognitive avoidance and positive beliefs about worry, all of which independently contributed to frequency of worries, with worry increasing risk of anxiety. Positive beliefs about worry had to be dropped from the child model (Fialko et al., 2012). IU was a higher order vulnerability factor for cognitive avoidance, both independently contributed to frequency of worries, and IU and worry (but not cognitive avoidance) together increase risk of anxiety. Notably, the results revealed different pathways from IU to anxiety and worry for both children and adolescents than those seen in adults. As such these results are consistent with the proposition that the nature of the association between IU and anxiety may be different at different developmental periods. Developmentally appropriate models of IU and anxiety are now required in order to drive research that may have the potential to improve treatments for children and young people with anxiety disorders. It will be important that these models and future studies address broader mechanisms, associated with IU, as proposed in adult models, including negative problem orientation, rumination, and cognitive avoidance.

7.5.3 Examining associations with IU

All the work presented in the thesis that examines associations between responses to uncertainty and anxiety or worry is cross-sectional; therefore, where significant associations are found it cannot be concluded that they demonstrate a causal relationship. To understand the role of uncertainty and IU in anxiety and worry, longitudinal and further experimental work is needed, as discussed above. So far few studies have taken this approach however there is some evidence that significant reductions in IU are found following CBT interventions for anxiety, despite these interventions are not directly targeting IU (e.g. Bomyea et al., 2015; Boswell, Thompson-Holland, Farchione, & Barlow, 2013; Mahoney & McEvoy, 2012). These studies may suggest that a reduction in anxiety may lead to changes in IU, or potentially that particular aspects of the CBT protocols bring about changes in IU (which may then lead to reductions in anxiety). Future studies will need to more directly target IU and/or assess the temporal associations between changes in IU and anxiety over the course of treatment in order to delineate the nature of this association.

In addition, very little is known regarding the origin and development of IU. Zdebik, Moss, and Bureau (2017) reported that insecure attachment and behavioural inhibition (BI) assessed by observational measures in childhood at the age of 6 independently predicted IU as assessed by the IUS-12 in adulthood at the age of 21. BI is a temperament style defined by fear towards novelty, which is identified early in childhood and has been linked with increased risk for anxiety disorders (Chronis-Tuscano et al., 2009; Fox, Henderson, Marshall, Nichols, & Ghera, 2005). It is possible that IU may be a later manifestation of BI; however, before making any preliminary assumption it is also possible that inhibitory IU (as one of the two consistent factors of the IUS) may correspond to BI. Inhibitory IU is simply more present-focus aspect of IU and have been found to be associated specifically with social anxiety (Carleton, Collimore, & Asmundson, 2010) and recent meta-analysis also revealed that half of the children who have high BI eventually develop social anxiety disorder (Clauss & Blackford, 2012). Prospective IU (the other consistent factor of the IUS) is the future focused aspect of the IU and considering the children's understand of future develops significantly between the ages of 4 and 10 (Lagattuta & Sayfan, 2011), BI may show more similarities with the inhibitory IU. Longitudinal research assessing BI earlier in life and following these participants throughout childhood and adolescence by assessing their BI and IU at several time points would help to clarify the nature of the association between BI and IU. However, as revealed by the Study 2 in this thesis, IU has a unitary factor structure in preadolescents and factors may not show the same pattern as it showed in the adults (e.g. inhibitory IU, prospective IU). Still longitudinal research would also be able to reveal the extent of continuity and discontinuity in IU across development. Similar studies looking at associations between IU and other potential risk factors for anxiety, such as cognitive biases, are also warranted on the basis of studies that suggest that cognitive biases may drive elevated levels of IU. For example, Oglesby, Allan, and Schmidt (2017) used a brief computerized IU-focused CBM (Cognitive Bias Modification). The intervention group completed an intervention component where they have seen an ambiguous phrase (e.g. doctor called) followed by either a neutral (e.g. appointment reminder) or negative (e.g. I have a terrible disease) sentence whereas control group have only seen neutral statements followed by an ambiguous phrase. Then they were asked to judge the relatedness of the phrase with the sentence. The results showed that there was a significant reduction in self-reported

IU from pre to post test in the intervention group compared to a control group.

7.5.4 Research with Clinical Samples

As demonstrated in Study 1, the majority of the studies examining IU, anxiety, and worry in young people are based on community samples. Community samples provide a helpful starting point towards understanding clinical disorders, and provide information about the population at large; however, the extent that these results can be generalised to clinical populations remains unclear. To date, and as highlighted in Study 1, the only studies to examine IU in clinical samples of children and adolescents have focused on participants who have a diagnosis of GAD. Research with adults indicates that IU may play a role in numerous mental health problems that have an anxiety element but the transdiagnostic nature of IU across anxiety disorders in children and adolescents remains unclear. To confirm the transdiagnostic nature of IU in mental health problems with an anxiety element, more research is needed with samples of children who have a range of anxiety disorders not just GAD. The tasks developed in this study have promise as useful tools for use with clinical populations; however, it will be important to ensure that the specific stimuli that are used (particularly in threat contexts) reflect not only the child's developmental stage, but also their specific anxiety disorder. While children with social anxiety disorder may perceive angry faces, which are used in the HiLo task as threating, children with specific phobia or GAD may not.

Although it has not been the focus here, it is relevant to point out that IU is also getting attention in the context of autism spectrum disorders. Significant relationships between IU and anxiety have been observed for children with autism spectrum disorders (ASD) (Boulter, Freeston, South, & Rodgers, 2014) and self-reported IU has been found to be a significant predictor of startle response during uncertainty in children with ASD (Chamberlain et al., 2013).Considering the variation in cognitive ability across children who have autism spectrum disorders, the use of child self-report IU measures may be limited in this population. Although the recently developed parent IU measure (Sanchez et al., 2017) may be another option, behavioural IU assessments would also benefit this area of research. Although the tasks presented in this thesis focused on typically developing children, it would be possible to develop such measures to assess IU in children with autism by considering appropriate stimuli, task duration, and

sensory motor abilities.

The studies examining reactions to uncertainty and the IU presented in this thesis provides a helpful starting point for researchers to develop models that are generalizable to the population at large; however, there were issues of power, considering the sample size and nonindependence, that may have influenced the results. With this in mind, the results can be replicated with different samples and broader sample size in order to increase the confidence in the results. Furthermore, the generalizability of the results to clinical populations also needs further research considering the implicit model discussed in section 7.2. The next step in this line of study can be conducted with bigger samples on threshold for perceiving uncertainty in the presence and absence of safety and associations with IU as people with high IU may become more anxious or worried in the absence of safety. The absence of safety may, in turn, trigger cognitive biases leading to anxiety.

The sample used for the behavioural task in this thesis consisted of preadolescent with broad range of anxiety level. Although samples of this nature quite informative and provided helpful starting point, group designs would be more informative regarding the extreme ends of the IU or anxiety spectrum. For example, the design can include participants with high IU vs low IU or non-anxious vs clinically anxious participants to examine whether the threshold of perceiving uncertainty in the absence and presence of safety is different across groups.

7.6 Conclusion

The studies presented in this dissertation summarise the literature on IU, anxiety, and worry in children and young people and provide insights into the limitations of and steps forward for IU assessment in typically developing preadolescent children. There is a consistent association between IU and both anxiety and worry in children and adolescents but many questions remain. The development of behavioural assessments of IU stands to, not just overcome the limitations of self-report in mid-childhood, but also provides a potential means to assess IU in children younger than 7 years old and for children who are not yet capable of providing self-reports, thus paving the way for studying IU even in much younger children and atypically developing children. Further research to develop the behavioural

assessment of IU should (i) examine reactions to uncertainty among children who have clinically significant anxiety, (ii) work towards developing a battery of behavioural tasks that allow the assessment of a range of possible reactions to uncertainty and that are suitable for children and adolescents across age ranges and across different anxiety disorders.

Overall, the studies presented in this thesis present a clear direction for future research to improve IU assessment in preadolescent children. These results not only have implications for IU assessment in children and young people, but also for all future work on IU in children in which reliable assessment is required. The improvement of tools to measure IU in children and young people is required to investigate whether adult IU models are applicable to children and young people and to establish IU-related models that are developmentally appropriate for children and young people. This would bring potential to inform the development of specific treatment techniques to address specific needs of children and adolescents with anxiety disorders.

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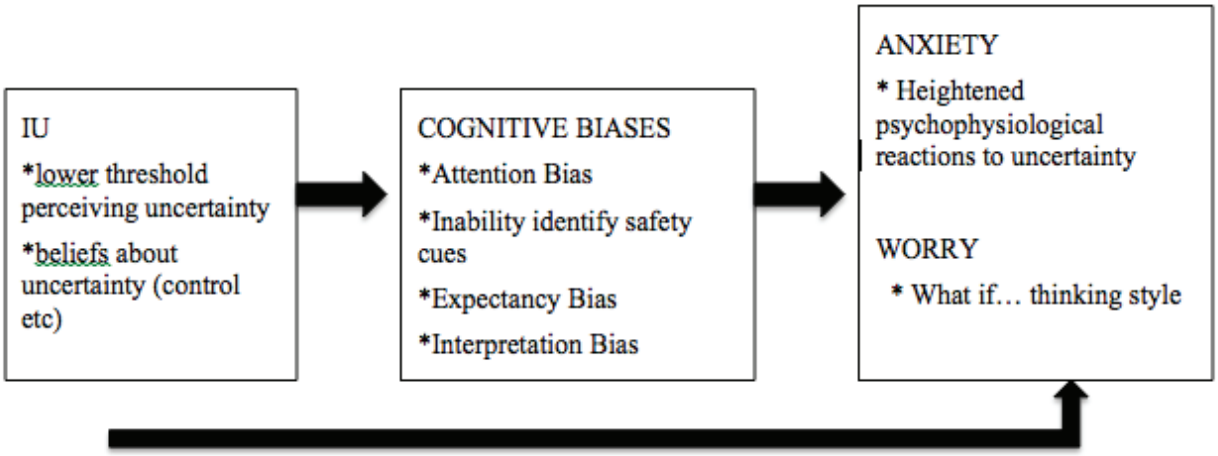


Figure 1: The implicit model underlying the thesis

8. Appendices

8.1 Appendix 1: Information sheets used in study 2

School of Psychology &
Clinical Language Sciences

University of Reading

Get Involved:

Boys and Girls aged 7-11!

Your child can be a part of some research to help us understand anxiety in children. We want to know how anxiety is associated with the ability to cope with uncertainty.

At the University of Reading we're interested in what causes these differences between children who are shy, nervous and worry a lot, whereas others are confident, outgoing and nothing seems to faze them. To learn about this we want to hear from your children!

What will be asked from your child?

We will ask your children to complete some questionnaires along with other children at school. This will take no more than 20 minutes.

We also want to examine the stability of one of the questionnaires; therefore, your child will be asked to complete one of these questionnaires again after 10-15 days.

If you would like to take a look at the questions that your child will be asked, you can follow the link below:
https://www.surveymonkey.co.uk/r/IUandANXIETYinCHILDREN

For further information, contact:
Nihan Osmanagaoglu

07475131213
N.Osmanagaoglu@pgr.reading.ac.uk

YOUR CHILD'S INFORMATION WILL BE KEPT CONFIDENTIAL, ONLY RESEARCHERS WILL HAVE ACCESS TO ANY IDENTIFYING INFORMATION ABOUT YOUR CHILD.

ALL INVESTIGATORS ARE STUDENTS COMPLETING THEIR DEGREE AT THE UNIVERISTY OF READING, HAVE HAS CRIMINAL RECORDS CHECK.

THE STUDY HAS BEEN GIVEN FAVORABLE OPINION FOR CONDUCT BY THE ETHICS COMMITTEE.

School of Psychology &
Clinical Language Sciences

University of Reading

Wanted:

Boys and Girls aged 7-11!

Some children are shy, nervous and worry a lot, whereas others are confident, outgoing and nothing seems to faze them.

At the University of Reading we're interested in what causes these differences between children.

To learn about this we want to hear from you!

What does it involve?

- The first stage is to complete quick online questionnaires about your child's fears or worries. To thank you for answering the question you will be entered into a prize draw.
- You might then be invited to come to the Psychology department at the University of Reading so that your child can play some **puzzle games!**
- To get involved just visit our website!

To thank you for taking part in these puzzle games, we will give your child an awesome souvenir for their participation and £5 to cover your travel costs. You never know you might also win our prize draw!

https://www.surveymonkey.com/r/iuandchildanxiety2

For further information, contact:
Nihan Osmanagaoglu

07475131213
N.Osmanagaoglu@pgr.reading.ac.uk

8.2 Appendix2: Consent forms used in study 2

a. Opt-in Consent

Parental Consent Form

University of Reading

We will be carrying out research in your child's school. Details about this research are contained in the information leaflet you have received along with this form.

Before any research is undertaken, researchers have to obtain permission from the individuals involved. This is done by you signing this consent form, which indicates that you agree for your child to take part in this research. The research study will be carried out by students who are completing their degree in the University of Reading, and all investigators on the project have had their criminal records checks and have been approved to work with children. *(Please put your initials in the boxes provided)*

☐ I have read the information sheet.

☐ I agree for my child to take part in this research.

☐ I have been told that the information I give will be kept confidential.

☐ I understand that my child is free to withdraw from the study at any time.

Data protection:

I agree to the university processing personal data which I have supplied. I agree to the processing of such data for any purposes connected to the Research Project as outlined to me.

Name of parent/carer:

Name of the child involved in this study:

Signature:

Primary researcher: Nihan Osmanagaoglu
n.osmanagaoglu@pgr.reading.ac.uk

Research supervisors: Dr Helen Dodd
h.f.dodd@reading.ac.uk
0118 378 5285

Prof. Cathy Creswell
c.creswell@reading.ac.uk
0118 378 6798

School of Psychology and Clinical Language Science
University of Reading
Earley Gate
Whiteknights Road
Reading
RG6 6AL

b. Opt-out Consent

Parental Consent Form

University of Reading

We will be carrying out research in your child's school. Details about this research are contained in the information leaflet you have received along with this form. The research study will be carried out by students who are completing their degree in the University of Reading, and all investigators on the project have had their criminal records checks and have been approved to work with children.

If you have concerns about the nature of the research or the use of the data we urge you to contact the researcher (contact details found in the information leaflet and at the bottom of this form).

IF THE FORM IS NOT SIGNED AND RETURNED, WE WILL ASSUME CONSENT AND ASK YOUR CHILD IF THEY WOULD LIKE TO TAKE PART IN OUR RESEARCH.

(You may withdraw your consent and child's data from the research at any point during or after the research if you wish (contact details are on the information sheet and below).)

If you still have reservations and do not wish for your child to take part, **please put your initials in the boxes provided, sign and return** this form to the school indicating that you **do not wish your child to take part.**

☐ I have been told that the information I give will be kept confidential.

☐ I understand that my child is free to withdraw from the study at any time.

☐ However, I **do not** wish for my child to take part in this research.

Name of parent/carer: .....Signature:

Name of the child involved in this study: .....

Primary researcher: Nihan Osmanagaoglu
n.osmanagaoglu@pgr.reading.ac.uk

Research supervisors: Dr Helen Dodd
h.f.dodd@reading.ac.uk
0118 378 5285

Prof. Cathy Creswell
c.creswell@reading.ac.uk
0118 378 6798

School of Psychology and Clinical Language Science
University of Reading
Earley Gate
Whiteknights Road
Reading
RG6 6AL

8.3 Appendix 3: Debriefing form used in study 2

Dear Parent/Guardian,

Following the leaflet we sent home, today your child helped with some research about dealing with uncertainty, and anxiety and worry. S/he was then given a set of questionnaires and was asked to answer questions about their feelings, thoughts, beliefs, and behaviours such as 'I am scared of dark' and 'I don't like being taken by surprise'. It is hoped that through this kind of research we can improve our understanding about the nature of anxiety and worry in children.

Your child's results will remain confidential. If you have any further questions, concerns or wish to withdraw your child's data from the results you may contact me at n.osmanagaoglu@pgr.reading.ac.uk, or my supervisor at h.f.dodd@reading.ac.uk or on 0118 378 5285. If you have any concerns about your child's anxiety, your GP is the best person to speak to first. If you would like more information about anxiety in general, please see www.anxiety.org.uk or our own website www.andyresearchclinic.com.

As part of this same study, we would also like to invite you to complete two questionnaires. They are attached to this letter and you can return them to your child's school. If you would prefer you can complete them online by following this link by entering the ID number we have provided.
https://www.surveymonkey.com/r/IntoleranceofUncertaintyandChildAnxiety

We have included an information sheet for you about the questionnaires that we are asking you to complete. This also includes information about a follow-up study we will be conducting with some families at the University. At the end of the questionnaires there will be a question asking whether you might be interested in this follow-up study. If you do not wish to take part, just select no; your questionnaire answers will still be useful to us.

If you would like to receive a copy of the final report of this study (or a summary of the findings) when it is completed or if you have any questions or concerns regarding this study, its purpose or procedures, or if you have a research-related problem, please feel free to contact us.

Thank you to your child for helping us today!

Contact Information:

Researcher (principal): Dr. Helen Dodd
Email: h.f.dodd@reading.ac.uk
Phone: (0)118 378 5285

Researcher (principal): Prof. Cathy Creswell
Email: c.creswell@reading.ac.uk
Phone: (0)118 378 6798

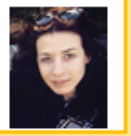
Researcher (investigator): Nihan Osmanagaoglu
Email: n.osmanagaoglu@pgr.reading.ac.uk

Contact Details

Principal Investigators:
Dr. Helen Dodd
Email: h.f.dodd@reading.ac.uk
Tel: 0118 378 5285

Prof. Cathy Creswell
Email: c.creswell@reading.ac.uk
Tel: 0118 378 6798

Researcher:
Nihan Osmanagaoglu
Email: n.osmanagaoglu@pgr.reading.ac.uk



University of Reading

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RG6 6AL

Dealing with Uncertainty and Childhood Anxiety

Why is that some children are not comfortable and cannot stand even a small amount of uncertainty, while others are comfortable and able to cope with it?

We are looking for families to help with our research who have children aged between 8 and 11 years. We need to see children who show a range of anxiety levels, so we are keen to meet confident relaxed children, as well as children with more worries and fears.

What is the study about?

Dealing with uncertainty is an unavoidable part of daily life because we cannot see the future. What exactly is going to happen day to day is never 100% certain and people vary in their ability to cope with uncertainty.

At the University of Reading we are hoping to learn about the relationship between how children react to uncertainty and childhood anxiety.

With this information we hope to improve prevention and treatment of anxiety in children.

What will we be asking your child to do?

The whole visit will take max. 2.5 hrs

1. We will ask you and your child will fill out a set of questionnaires.
2. We will play a set of games where your child will identify and name pictures and find missing pieces to complete a pattern.
3. Your child will play a game with jars of beads where they have to guess which jar the beads are from **while being audio recorded.**
4. Your child will play two games on a computer while we track your child's eye-movements using a camera on the computer. The computer games are both card games where they have to guess what 'mystery card' will be when revealed.

Things you need to know!

- Taking part is voluntary! You, nor you child have to take part if you don't want to.
- You are free to withdraw yourself and your child at any point. We will stop and you are free to go. You are also free to decide to only take part in some of the tasks, that is up to you. Withdrawing won't affect the compensation offered to you.
- We store all consent forms locked within the University and they are destroyed after 5 years.
- **Audio recorded data will be downloaded within 24 hours, identified using a record number (i.e. anonymously), stored securely on a university drive, and will only be accessed by the research team.**
- All paper copies of the questionnaires are destroyed after the data is entered into an electronic spreadsheet. Electronic data will be stored on the secure University server and destroyed when no longer needed.

University of Reading

For taking part you child will go home with souvenirs. We will also compensate your time for your help.

ALL INVESTIGATORS ARE STUDENTS WHO ARE COMPLETING THEIR DEGREE IN THE UNIVERISTY OF READING, HAVE HAD CRIMINAL RECORDS CHECK, AND HAVE BEEN APPROVED TO WORK WITH CHILDREN.

The university of Reading Ethics Committee has given this study a favorable opinion for conduct.

If this raises any concerns you can contact any member of the research team (details on the back) who can provide you with appropriate contacts for support.

Your information will be kept confidential!

Your information be kept confidential.

We store all consent forms locked within the University and they are destroyed after 5 years.

All paper copies of the questionnaires are destroyed after the data is entered into an electronic spreadsheet. Electronic data will be stored on the secure University server and destroyed when no longer needed.

Who will see the Results?

The results form part of Nihan Osmanagaoglu's PhD. This may include publications in scientific journals and presentations to other interested academics.

None of the data presented will be identifiable to you or your child!

If you would like a report of what we find let us know!

8.5 Appendix 5: Consent form used in studies 3 and 4

Consent Form

University of Reading

I,.....have read and understood the accompanying information sheet relating to the project on Dealing with Uncertainty and Childhood Anxiety.

I have had explained to me the purposes of the project and what will be required of me, and any questions I have had have been answered to my satisfaction. I agree to the arrangements described in the information sheet in so far as they relate to my participation.

I understood that participation is entirely voluntary and that I have right to withdraw from the project any time, and that this will be without detriment.

This application has been reviewed by the University Research Ethics Committee and has been given a favourable ethical opinion for conduct.

The research study is carried out by students who are completing their degree in the University of Reading, and all investigators on the project have had their criminal records checks and have been approved to work with children.

I have received a copy of this Consent Form and the accompanying information sheet.

Signing this form allows use your anonymised answers in our study.

Your name: .....

Child's name: .....

Child's DoB: .....

Child's Gender: .....

Signed: .....

Date: .....

8.6 Appendix 6: Debriefing form used in studies 3 and 4

University of Reading

Dear Parent/ Guardian,

Today you and your child helped with some research about dealing with uncertainty, anxiety, and worry. Your child was given a set of questionnaire that asks about his/her feelings, thoughts, and behaviors as well as got to play a set of games with jars of beads, cards and solved some puzzles. It is hoped that through this kind of research we can improve our understanding about the nature of anxiety and worry in children.

You and your child's results will remain confidential. If you have any further questions, concerns or wish to withdraw your child's data from the results you may contact me at n.osmanagaoglu@pgr.reading.ac.uk, or my supervisor at h.f.dodd@reading.ac.uk or on 0118 378 5285. If you have any concerns about your child's anxiety, your GP is the best person to speak to first. If you would like more information about anxiety in general, please see www.anxiety.org.uk or our own website www.andyresearchclinic.com.

If you or your child feel upset after having completed the study or find that some questions or aspects of the study triggered distressed, please let us know. You can find information about the resources and support for anxiety at our website: www.andyresearchclinic.com

If you would like to receive a copy of the final report of this study (or a summary of the findings) when it is completed or if you have any questions or concerns regarding this study, its purpose or procedures, or if you have a research-related problem, please feel free to contact us.

Thank you to you and your child for your participation!

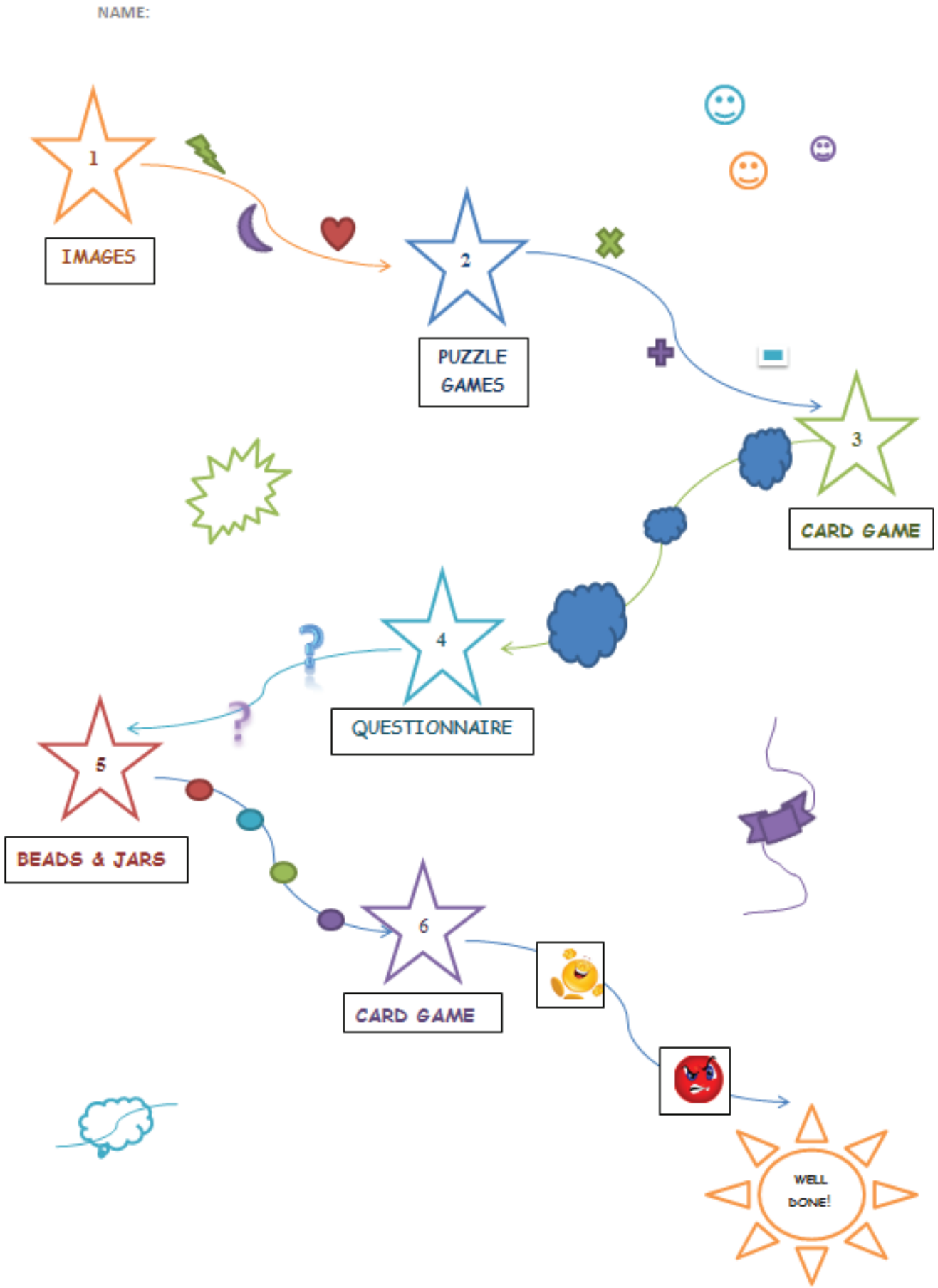
Contact Information:

Researcher (principal): Dr. Helen Dodd
Email: h.f.dodd@reading.ac.uk
Phone: (0)118 378 5285

Researcher (principal): Prof. Cathy Creswell
Email: c.creswell@reading.ac.uk
Phone: (0)118 378 6798

Researcher (investigator): Nihan Osmanagaoglu
Email: n.osmanagaoglu@pgr.reading.ac.uk

8.7 Appendix 7: Example of a reward chart used in studies 3 and 4



8.8 Appendix 8: Certificate given to children at the completion of behavioural tasks

8.9 Appendix 9: Example of faces used in image-rating and heightened threat HiLo tasks