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ORIGINAL PAPER

Intolerance of Uncertainty as a Framework for Understanding Anxiety in Children and Adolescents with Autism Spectrum Disorders

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Abstract Anxiety is a problem for many children diagnosed with Autism Spectrum Disorders (ASDs). There is a paucity of models of the cognitive processes underlying this. Intolerance of Uncertainty (IU) has utility in explaining anxiety in neurotypical populations but has only recently received attention in ASD. We modelled the relationship between anxiety and IU in ASD and a typically developing comparison group, using parent and child self-report measures. Results confirmed significant relationships between IU and anxiety in children with ASD which appears to function similarly in children with and without ASD. Results were consistent with a causal model suggesting that IU mediates the relationship between ASD and anxiety. The findings confirm IU as a relevant construct in ASD.

Keywords Autism Spectrum Disorders · Anxiety · Intolerance of Uncertainty · Children · Adolescents

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Introduction

Anxiety is common in children with Autism Spectrum Disorders (ASD) and a significant source of distress (White et al. 2009; Wood and Gadow 2010). Developing ways to understand and characterise anxiety in this population with the ultimate aim of developing effective, theoretically robust treatments is therefore of critical importance and a priority for current research. This study aims to take the first steps towards examining the relevance of the construct of Intolerance of Uncertainty (IU), which has proven utility in the formulation and treatment of anxiety disorders in neurotypical populations, to the understanding of anxiety and its presentation in children with ASD.

Intolerance of Uncertainty (IU) is defined as a 'broad dispositional risk factor for the development and maintenance of clinically significant anxiety' in neurotypical populations (Carleton 2012, p. 939). The construct of IU was initially postulated as a key construct in generalised anxiety disorder (Dugas et al. 1998; Freeston et al. 1994). Since it's inception it has received increasing attention in a wide range of contexts both within clinical psychology and in other areas of applied psychology (see Carleton 2012). Indeed Carleton et al. (2012b) using taxometric analysis suggests that IU is a dimensional construct across non-clinical and clinical samples and not simply an aspect of anxiety. Grupe and Nitscke (2013) support this position positing an interconnected set of neurobiological and psychological processes which are involved in adaptive anticipatory responding under conditions of uncertainty, and that it is deficits in one or more of these processes underlie maladaptive responses in anxious individuals. Among adults, evidence from large clinical studies has also linked IU to symptoms of GAD, OCD, social anxiety disorder, agoraphobia and panic disorder, and depression (e.g.

McEvoy and Mahoney 2011, 2012; Carleton et al. 2012). IU involves the 'tendency to react negatively on an emotional, cognitive, and behavioral level to uncertain situations and events' (Buhr and Dugas 2009, p. 216). Individuals who are intolerant of uncertainty find uncertain situations stressful and upsetting due to beliefs that unexpected events are negative and should be avoided; have a tendency to interpret all ambiguous information as threatening; and find it difficult to function in the face of uncertainty (Buhr and Dugas 2002, 2009; Laugesen et al. 2003). Indeed, uncertainty in itself is perceived as threatening by people high in IU, contributing to significant somatic stress responses in the face of novel or uncertain situations (see Carleton 2012).

IU is a multidimensional construct. Although there has been disagreement in the literature regarding the factor structure of measures of IU, recent research suggests that two key dimensions underlie the overall IU construct (Bredemeier and Berenbaum 2008; Carleton et al. 2012a, b; 2007a; Birrell et al. 2011). These factors have been named *Desire for Predictability*, referring to a dislike of unexpected events and need to make the future as certain as possible, and *Uncertainty Paralysis*, referring to the sense of feeling cognitively or behaviourally 'stuck' in the face of uncertainty (Berenbaum et al. 2008; Birrell et al. 2011).

IU has been most specifically linked to the development and maintenance of worry and Generalised Anxiety Disorder (GAD) (Buhr and Dugas 2012, 2006, 2009; Dugas et al. 1997, 2005; Freeston et al. 1994) but has also been proposed as a key underlying process in Obsessive Compulsive Disorder (OCD) (Holaway et al. 2006; Sookman and Pinard 2002; Tolin et al. 2003). More recently, IU, has been linked to other disorders, including social anxiety disorder (Boelen and Reijntjes 2009; Carleton et al. 2010), major depressive disorder (Gentes and Ruscio 2011), Panic disorder (Boswell et al. 2013) and anxiety sensitivity more generally (Carleton et al. 2007b).

While most research into IU has focussed on adults, recent headway has been made in investigating its role in TD children and adolescents. The positive relationship between IU and worry evident in adults has now been found in adolescents (Laugesen et al. 2003) and children (Fialko et al. 2012; Kertz and Woodruff-Borden 2013). In addition, the level of IU has been found to distinguish between clinically anxious and non-anxious children (Comer et al. 2009). While the majority of studies investigating IU in children and adolescents specifically focussed on the applicability of a model developed to explain worry and GAD, March (2011 unpublished dissertation) demonstrated that in a non-clinical adolescent sample, IU showed positive correlations with scales measuring symptoms of different disorders. Boelen et al. (2010) also found that IU was associated with social anxiety as well as worry, but not with depression in adolescents. They also confirmed the presence of the two dimensions of IU within their sample.

The concept of IU has utility not only to theoretically inform understanding of factors underlying development and maintenance of anxiety, but has also been shown to be a beneficial target for treatment. Research has shown that experimental manipulation of intolerance of uncertainty can affect levels of worry in non-clinical participants (e.g. Ladouceur et al. 2000b). Cognitive behavioural treatments for clinically anxious patients, particularly for individuals with GAD, have been developed which emphasise treating the cognitive *process* rather than the cognitive *content* of anxiety, specifically by aiming to increase patients' tolerance for uncertainty and thereby achieving more sustainable change (Wilkinson et al. 2011).

Research has confirmed the utility of such CBT protocols in reducing worry and GAD both in individual (Dugas and Ladouceur 2000; Ladouceur et al. 2000a) and group formats (Dugas et al. 2003). Case series have also demonstrated the successful use of this intervention with minor amendments with children and adolescents with GAD (Leger et al. 2003; Payne et al. 2011). The importance of addressing IU in treatment has also been argued for OCD (Grayson 2010). Boswell et al. (2013) recently showed that reductions in IU over the course of a transdiagnostic intervention were significantly related to reduced post-treatment symptom levels across diagnoses.

Given the demonstrated contribution of the construct of IU to the understanding and treatment of anxiety in neurotypical adults, children and adolescents, it would appear expedient to investigate this construct in the ASD population, where anxiety is a recognised problem. Beyond the evident appropriateness of applying models found to be useful in TD populations, the concept itself resonates clinically with some of the core characteristics of the disorder (Rodgers et al. 2012). In particular, higher order restricted and repetitive behaviours such as insistence on sameness, inflexible adherence to routines and difficulty tolerating change and unexpected events, which have been linked with anxiety since the earliest descriptions of the disorder (Kanner 1943), bear a conceptual resemblance to IU, with its associated avoidance of unexpected events and the wish to make life as predictable as possible (Rodgers et al. 2013). To date, we know of just one previous study of IU in autism. Chamberlain et al. (2013) found moderate to strong negative correlations between psychophysiological response to unpredictable threats (uncertainty) and questionnaire measures of generalized anxiety, intolerance of uncertainty, and repetitive behaviour.

It was the aim of this study to begin to develop an understanding of the role of IU in the presentation of anxiety in children and adolescents with ASD. In doing so,

it aimed to make a first step towards the development of a cognitive model of anxiety in ASD. The study objectives were:

1. To replicate previous findings of higher levels of anxiety in children with ASD than in those without.
2. To replicate the relationship between IU and anxiety in TD children and adolescents and establish whether this relationship is also in evidence in children with ASD. It was hypothesised that there would be a positive relationship between IU and anxiety in both groups.
3. To compare the relationship between IU and anxiety in the ASD and TD samples. As this was the first study to investigate IU in this population, no hypotheses were made as to the presence or nature of any differences in the strength of the relationships between groups.

Method

Participants

Archival data from two sources were available for analysis as part of an international research collaboration between Brigham Young University in the United States and the Newcastle University in the United Kingdom. This archival dataset was supplemented with data collected for an additional study. The resulting set consisted of data from a total of 224 children and adolescents (See Table 1).

Participants were children and adolescents (age range 8–18 years) with diagnoses of Autism or Asperger's syndrome, and their parents. In the USA, ASD participants were recruited from a university-based community mental health clinic and from an existing research database; all met research diagnostic criteria for an ASD according to the Autism Diagnostic Observation Schedule (Lord et al. 2000). In the UK, ASD participants were diagnosed through multidisciplinary team assessment according to guidelines of the UK National Autism Plan for Children (Le Couteur 2003) and were recruited through the 'Database of Children with Autism Spectrum Disorder Living in the North East' (Dasl^{n}e) (McConachie et al. 2009).

Table 1 Participant numbers from each source

Data source	ASD	TD	Total
Archival			
Study A (Brigham Young University, USA)	73	95	168
Study B (Newcastle University, UK)	19	15	34
New			
Study C (Newcastle University, UK)	22	–	22
Total sample	114	110	224

The children and adolescents in the archival dataset were all high functioning children with IQs within the normal range (i.e. FSIQ >75), as assessed by the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler 1999). IQ was not assessed in the data collected for 22 of the participants. The IUS-P and SCAS data were obtained from these parents as part of an additional study which included a parent interview which focusses on child IU. As such this study did not aim to recruit child participants and therefore the child data were not gathered. The inclusion/exclusion criteria were the same however as for the main datasets and therefore we are confident that these children were not markedly different. Indeed there were no significant differences between IUS-P, SCAS-P and SRS scores for this group and the UK or US ASD samples. Demographic information for participants in the combined dataset is summarised in Table 2.

Measures

Intolerance of Uncertainty Scale: Child and Parent Versions; (IUS-C; Walker 2009; IUS-P; Rodgers et al. 2012)

The IUS-C is a 12-item questionnaire assessing IU in children. It was adapted from the 12-item version of the Intolerance of Uncertainty Scale (IUS-12; Carleton et al. 2007a), which in turn was a short form of the original 27-item Intolerance of Uncertainty Scale (IUS; Freeston et al. 1994). Items on the IUS-C obtained scores (80–100) on the Flesh Reading Ease index, demonstrating suitability for use with children (Walker 2009).

The scale assesses IU by asking respondents to rate the extent to which statements relating to emotional, cognitive and behavioural responses to uncertainty are like them, or in the case of the IUS-P, like their child. The IUS-C has been found to have acceptable internal consistency and convergent validity (Walker 2009). The IUS-P is a recent adaptation of the IUS-C for use with parent informants. Previous data assessing the psychometric properties of

Table 2 Demographic information for combined dataset

	ASD	TD	Total sample
Mean age (SD) (years)	12.7 (2.9)	13.0 (3.0)	12.8 (2.9)
Age range (years)	8–18.7	8.3–18.6	8–18.7
Gender			
Male	100 (87.7 %)	83 (75.5 %)	183 (81.7 %)
Female	14 (12.3 %)	27 (24.5 %)	41 (18.3 %)
Mean IQ (SD)	108.5 (13.8)	112.07 (9.0)	110.5 (13.3)
IQ range	83–140	75–142	75–142

N = 224 except for IQ, where N = 193

these scales in an ASD population were unavailable. The items are (formatted here for parent version) (1) When things happen suddenly, s/he gets very upset; (2) It bothers him/her when there are things they don't know; (3) S/he would think that "People should always think about what will happen next. This will stop bad things from happening"; (4) S/he would think that "Even if you plan things really well, one little thing can ruin it"; (5) S/he always want to know what will happen to them in the future; (6) S/he can't stand it when things happen suddenly; (7) S/he needs to always be prepared before things happen; (8) Feeling unsure stops him/her from doing most things; (9) When s/he's not sure what to do they freeze; (10) When s/he doesn't know what will happen, they can't do things very well; (11) The smallest worry can stop them from doing things; (12) S/he tries to get away from all things that they are unsure of.

Spence Children's Anxiety Scale Child and Parent Versions (SCAS-C; Spence 1998; SCAS-P, Nauta et al. 2004)

The SCAS questionnaires measure overall anxiety symptomatology in children and adolescents. There are also six subscales assessing specific anxiety disorders based on DSM-IV (APA 2000) classifications. Child self-report and parent-report versions are available. Respondents rate the frequency of anxiety behaviours using a four point Likert scale ranging from 'never' to 'always.' Both versions have 38 core items; the child version includes 6 additional filler items. Both parent and child versions are well validated and reliable measures of anxiety in TD children (Nauta et al. 2004; Spence 1998; Spence et al. 2003). The SCAS is widely used as a measure of anxiety in ASD and research generally supports its reliability (Russell and Sofronoff 2005) and its validity in this population), whilst there may be some margin for improvement with regard to the factor loadings of individual items (Jamieson 2011; unpublished doctoral thesis, Glod et al. submitted).

Social Responsiveness Scale (SRS; Constantino 2002)

All ASD participants had a confirmed clinical diagnosis. The Social Responsiveness Scale (SRS) was used to confirm diagnosis in the ASD group, and ensure no diagnostic crossover in the TD group. It is a 65-item parent or teacher rating scale that ascertains autistic symptoms with regards to social impairment and their severity. Items are rated on a four point scale from 'never true' to 'almost always true'. The SRS has good established reliability and validity (Constantino 2002). Mean SRS raw score for the ASD group was 111 (SD 25), mean t score was 88.68 (SD 13.6), for the TD mean SRS raw score was 22.15 (SD 15.9), mean t score was 39.46 (SD 8.81).

Not all participants completed all measures. In some cases only child self-report data was available, while in others only parent-report data was available. Table 3 breaks down data availability into source and measure.

Sensitivity Considerations

Conservative a priori sensitivity analysis conducted using G*Power (Faul et al. 2007), demonstrated that a covariate analysis with the achieved sample size of (at least) 122 would be able to achieve a power of 0.8 ($\alpha = 0.05$), if effect sizes were at least medium ($f = 0.26$).

Results

Cronbach's Alpha coefficients were calculated for the parent and child versions of each measure separately for the ASD and TD groups. The IUS-C showed acceptable internal consistency both in the ASD ($\alpha = 0.78$) and the TD group ($\alpha = 0.76$) and the reliability of the scale would not be substantially improved by deleting any items. These levels are similar to those reported by previous research with TD children and adolescents (Walker 2009; March 2011 unpublished dissertation). The total IUS-P scale showed excellent internal consistency in both ASD ($\alpha = 0.90$) and TD groups ($\alpha = 0.91$). The SCAS-C showed excellent internal consistency in both the children with ASD ($\alpha = 0.90$) and TD children ($\alpha = 0.90$). The SCAS-P showed very high Cronbach's alpha in both groups (ASD group $\alpha = 0.93$; TD group $\alpha = 0.91$). Table 4 shows means and standard deviations for the main outcome measures and their subscales. The SCAS is not a diagnostic measure and therefore it is not possible for us to

Table 3 Number of data available for measures of IU and anxiety by source and informant

Data source		IUS		SCAS	
		Child	Parent	Child	Parent
Archival					
Study A	ASD	65	48	70	41
	TD	93	51	94	46
Study B	ASD	17	19	17	19
	TD	15	15	15	15
New					
Study C	ASD	–	22	–	22
Full dataset	ASD	82	89	87	82
	TD	108	66	109	61

Table 4 Means and standard deviations for measures and subscales

	ASD Mean (SD)	TD Mean (SD)
Child		
IUS-C total	33.82 (8.64)	29.06 (7.62)
SCAS-C total	28.00 (14.83)	23.04 (12.43)
Partent		
IUS-P total	38.3 (10.94)	22.39 (8.62)
SCAS-P total	29.13 (16.92)	11.7 (9.25)

state how many children is our sample had clinical anxiety. Although there is no formal clinical cut-off for the SCAS-P a score of 24 or above has been suggested as an indicator of clinical caseness being one standard deviation above the mean in a community sample (Nauta et al. 2004, mean 14.2, sd 9.7). Using a score of 24 as an indicative cut-off 60 % of the ASD sample had a score indicating clinical caseness on the SCAS-P, this compares to 12 % of the TD sample. Hypotheses were examined using the General Linear Model > Univariate Procedure in the IBM® SPSS® Statistics Version 21 software package. Identical analyses were carried out on child self-report and parent data.

Child-Report Data

For the child self-report data a three-way between-subjects Analysis of Variance (ANOVA) was carried out, examining differences between diagnostic groups (ASD vs. TD) in levels of anxiety, and entering research site (i.e. USA vs. UK) and gender as blocking variables. Interactions between site and gender and diagnosis were also examined. The analysis confirmed a significant main effect of diagnosis on overall SCAS-C scores ($F(1,190) = 7.98$, $p = 0.005$, partial-$\eta^2 = 0.04$), when controlling for the effects of site and gender. As predicted, children with ASD showed significantly higher levels of anxiety than TD children.

There was no significant effect of research site ($F(1,190) = 1.61$, $p = 0.21$, partial-$\eta^2 = 0.01$), nor a significant interaction between site and diagnosis ($F(1,190) = 1.57$, $p = 0.21$, partial-$\eta^2 = 0.01$). There was a trend towards girls reporting more anxiety than boys across diagnostic groups ($Mean_{girls} = 27.50$, $SD = 12.81$; $Mean_{boys} = 24.54$, $SD = 13.36$), but this main effect did not reach statistical significance ($F(1,190) = 3.54$, $p = 0.06$, partial-$\eta^2 = 0.02$). There was no significant interaction between gender and diagnosis ($F(1,190) = 0.23$, $p = 0.63$, partial-$\eta^2 < 0.01$).

IUS total scores were then entered into the model as a covariate to examine whether the variance in anxiety accounted for by group was better accounted for by IU. The analysis showed a significant main effect for IU ($F(1,183) = 100.39$, $p < 0.001$, partial-$\eta^2 = 0.35$). After entering IU into the model, the main effect of diagnosis was reduced almost to zero ($F(1,183) = 0.05$, $p = 0.88$, partial-$\eta^2 < 0.001$), indicating that the difference in anxiety observed in the two diagnostic groups was in fact better accounted for by IU.

Research site still showed no significant main effects or interaction with diagnosis. However, the main effect of participant gender now reached statistical significance ($F(1,183) = 5.12$, $p = 0.03$, partial-$\eta^2 = 0.03$), indicating that girls reported higher levels of anxiety than boys and this difference was not accounted for by IU or ASD. The interaction of gender and diagnosis remained non-significant.

Finally, homogeneity of slope was tested by entering the interaction between diagnosis and IU scores into the model. This aimed to identify potential differences in the relationship between IU and anxiety between children with ASD and TD children. The analysis showed no significant interaction between IUS-C scores and diagnostic group ($F(1,182) = 1.328$, $p = 0.25$, partial-$\eta^2 = 0.01$). As can be seen in Fig. 1, the slopes are almost identical. The main effect of IU remained highly significant ($F(1,182 = 101.02$, $p < 0.001$, partial-$\eta^2 = 0.36$). Diagnosis alone accounted for only a small amount of the variance ($F(1,182) = 1.31$, $p = 0.25$, partial-$\eta^2 = 0.01$). This indicates that the strong relationship between IU and anxiety, which is more important in explaining differences in anxiety than ASD diagnostic status, appears to be the same in children with and without ASD. Figure 1 shows the relationship between anxiety and IU in the two groups. Gender differences continued to explain a significant amount of variance in anxiety in this final model ($F(1,182) = 4.72$, $p = 0.03$, partial-$\eta^2 = 0.03$), independently of diagnosis or IU (Fig. 2).

Parent Report Data

The same analyses were then conducted on parent-report data. It was noted that there was significant heterogeneity of variance across groups (ratio of variances 3.19:1). However, to maintain comparability between parent and child data, it was decided that violating the homogeneity of variance assumption was preferable to attempting complex transformations of data or using different analyses for parent data. This is borne in mind as an important caveat in the following analyses.

Analyses revealed a significant main effect of ASD diagnostic group on total anxiety scores after controlling for research site and child's gender ($F(1,137) = 48.97$, $p < 0.001$, partial-$\eta^2 = 0.26$). Parents of children with ASD reported higher levels of anxiety in their children than parents of TD children. There was a significant main effect of gender ($F(1,127) = 8.3$, $p = 0.005$, partial-$\eta^2 = 0.06$), with parents

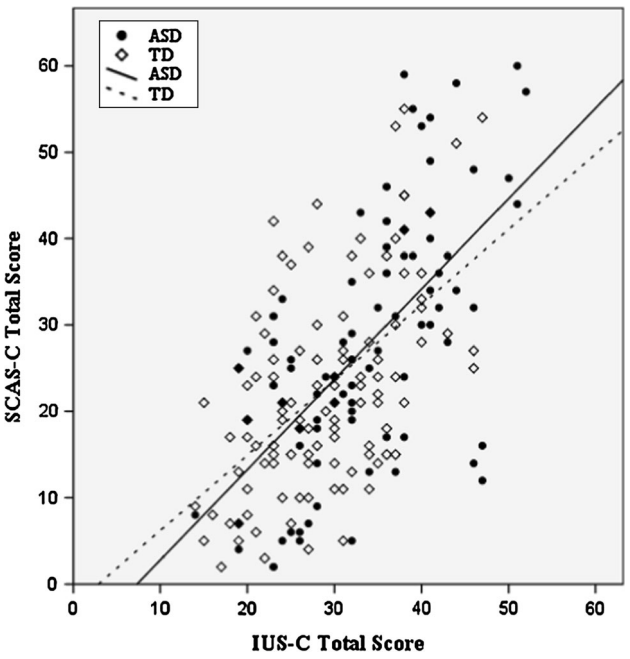

Fig. 1 Relationship between anxiety and IU by ASD diagnostic group—child-report

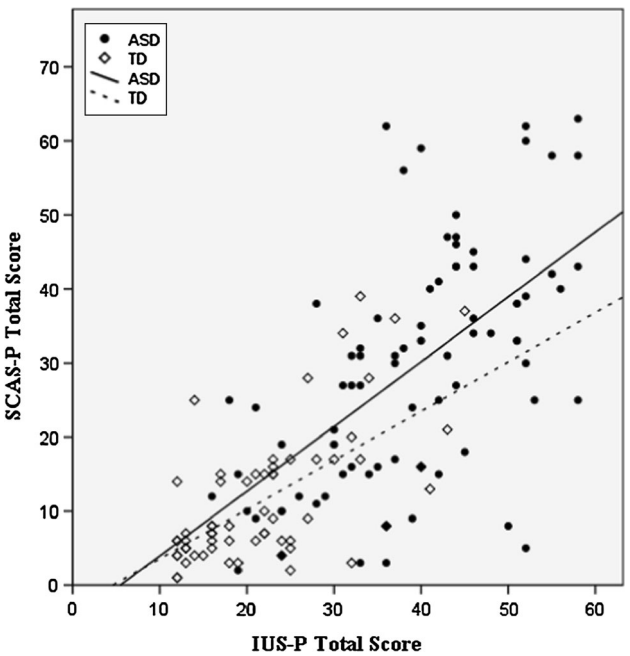

Fig. 2 Relationship between anxiety and IU by ASD diagnostic group—parent-report

reporting higher levels of anxiety in girls (Mean = 24.14, SD = 17.32) than in boys (Mean = 20.99, SD = 16.05). Gender did not significantly interact with diagnosis. Study site did not explain significant amounts of variance in anxiety either on its own ($F(1,137) = 0.44$, $p = 0.51$, partial-$\eta^2 = 0.003$) or in interaction with diagnosis ($F(1, 127) = 1.81$, $p = 1.18$, partial-$\eta^2 = 0.01$).

When IU was entered into the model as a covariate, it explained a significant amount of variance ($F(1,132) = 61.54$, $p < 0.001$, partial-$\eta^2 = 0.32$) and the main effect of diagnosis was no longer significant ($F(1,132) = 2.75$, $p = 0.10$, partial-$\eta^2 = 0.02$). The main effect of gender no longer reached significance after IU was entered into the model ($F(1,132) = 3.36$, $p = 0.7$, partial-$\eta^2 = 0.025$). Thus, IU accounted better for levels of parent-reported anxiety than did either diagnosis or gender.

When the interaction between Diagnosis and IU was entered into the model, it did not explain a significant amount of the variance ($F(1,131) = 0.90$, $p = 0.35$, partial-$\eta^2 = 0.01$). The only significant effect in the final model was the main effect of IU ($F(1,131) = 50.87$, $p < 0.001$, partial-$\eta^2 = 0.28$), indicating that the strong relationship between IU and anxiety as identified by parent report shows a similar pattern across children with ASD and TD children.

Additional analyses were carried out to examine whether IU mediates the relationship between ASD diagnosis and anxiety according to the model shown in Fig. 3, where c' denotes the direct effect of ASD diagnostic status on anxiety, and the a and b paths elucidate how the relationship between ASD and anxiety is mediated by IU.

This was investigated following Baron and Kenny's causal steps logic (Baron and Kenny 1986; Kenny 2012). According to this logic, four steps are necessary to establish mediation.

Step 1: The c-Path

The initial variable must be shown to be related to the 'outcome' variable. In other words, there is an effect that may be mediated. In the present analysis, this had already been demonstrated by the highly significant difference in anxiety between children with ASD and those without (partial $\eta^2 = 0.04$ and 0.26 for child and parent data respectively).

Step 2: The a-Path

The initial variable must be shown to be related to the mediator. In order to test this, a three-way between-subjects ANOVA was run, comparing diagnostic groups (ASD vs. TD) on levels of IU, and entering research site (i.e. USA vs. UK) and gender as blocking variables.

For the child self-report data the analysis confirmed a significant but modest (medium effect size) between-group difference in IU ($F(1,184) = 14.66$, $p < 0.001$, partial $\eta^2 = 0.07$), with children with ASD reporting higher IU than those without. Neither gender nor research site showed a significant main effect; effect sizes were trivial (partial $\eta^2 < 0.001$ for both).

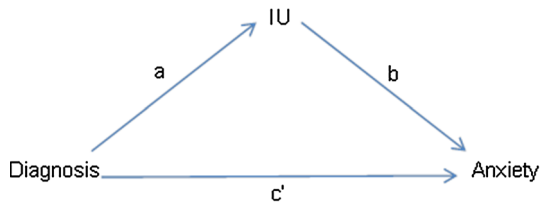

Fig. 3 Causal mediational model of IU mediating anxiety in relation to diagnosis (ASD vs. TD)

The parent-report data also showed a significant and very large between group difference ($F(1,151) = 95.27$, $p < 0.001$, partial $\eta^2 = 0.39$). There was no significant effect of study or gender (partial $\eta^2 = 0.001$ and 0.03 respectively).

Overall, both child- and parent reports demonstrated the existence of the a-path by showing significant between-group differences in IU.

Step 3: The b-Path

The mediator must be shown to be related to the 'outcome' when the predictor variable (in this case ASD diagnosis) is in the model. This had already been demonstrated by the highly significant relationship between anxiety and IU when IU was added to the between groups analysis as a covariate (partial $\eta^2 = 0.35$ and 0.32 respectively for child- and parent-report).

Step 4: The Extent of Mediation

The effect of the initial variable on the outcome variable must substantially decrease or be eliminated when controlling for the mediating pathway. The present results are consistent with this, in that, for both child- and parent-report, once IU was entered into the model, the amount of variance explained by diagnosis was very small and non-significant (partial $\eta^2 < 0.001$ for child self-report and partial $\eta^2 = 0.02$ for parent report). The results from a causal steps approach are therefore consistent with a causal mediational model in which the relationship between anxiety and ASD is almost entirely mediated by IU.

Discussion

Our analyses confirmed previous findings that children with ASD showed higher levels of anxiety than TD children. This difference was significant across both parent- and child self-report data. It was, however, more pronounced in parents' reports of their children's anxiety than in children's self-reports, with small to medium effect sizes in the child self-reports and large effect sizes in the parent-reports. Review of the means suggests that this appears to be due to the fact that TD children reported much higher levels of anxiety than reported by the parents in this group. Parent–child disagreement in the assessment of anxiety is well-known in children both with and without ASD (Barbosa et al. 2002; Choudhury et al. 2003; Storch et al. 2012; White et al. 2012; Lopata et al. 2010; De Los Reyes et al. 2011). In the present study, disagreement appears to have been more pronounced in the TD group than in the ASD group, though this was not further formally investigated because the number of matched pairs was insufficient for this analysis. Despite the discrepancy between TD parents and children, the pattern of results was consistent across both parent and child report and confirmed the association of ASD with higher levels of anxiety.

However, after the effect of IU was taken into account, there was no longer any difference of note between the diagnostic groups. Furthermore, children with ASD had significantly higher levels of IU. IU therefore accounted for the increased levels of anxiety in the children with ASD. Thus, the results not only confirmed the hypothesis that a relationship between IU and anxiety is present in children with ASD, but furthermore indicate that IU may mediate the relationship between ASD and anxiety. These results are consistent with a causal model in which ASD is associated with higher levels of IU, which in turn leads to higher levels of anxiety.

The slope of the association between IU and anxiety was shown to be the same across diagnostic groups. That the relationship between IU and anxiety was the same in both children with ASD and those without, indicates that similar processes may be at work within both populations.

Overall, the results from this first examination of the relationship between ASD, IU and anxiety lend support to the importance of considering IU in examining anxiety in children with ASD. IU appears to be as important a factor in the expression of anxiety in children with ASD as in TD children. What is more, IU appears to mediate the association of ASD with anxiety. The equivalence of the relationship between anxiety and IU across diagnostic groups points to similarity of the underlying processes.

Part of the appeal of examining IU as an explanatory factor in the development and maintenance of anxiety in this population is its resonance with the restricted and repetitive behaviour (RRB), including insistence on sameness, deemed to be part of the core characteristics of ASD (Rodgers et al. 2012; Chamberlain et al. 2013). It is well established that a strong relationship exists between anxiety and RRB in ASD (Rodgers et al. 2011; Sukhodolsky et al. 2008). Given the potential conceptual overlap, it could be argued that the association found between anxiety and IU in ASD may have been due to the measure of IU capturing insistence on sameness, routine and other features of RRB, rather than 'true' IU. However, the

finding of homogeneity of slope of the relationship between IU and anxiety across children with ASD and TD children points towards similar processes being at work in both groups. This is contrary to the idea of a significantly different construct being measured in the ASD group.

This is not to say that IU operates in a vacuum unaffected by ASD. Indeed, ASD may influence the degree of uncertainty perceived to be associated with some situations and their tolerability. For example, the social skills deficits and difficulties with understanding social communication characteristic of ASD are likely to increase uncertainty surrounding social situations, which may underlie the association of social skills deficits with anxiety severity (Bellini 2004).

Similarly, uncertainty over the presence of overwhelming sensory experiences is unlikely to feature prominently in IU amongst TD children. However, overall, the results are highly consistent with IU as a distinct concept, whose expression and impact are influenced by and interact with, but are distinct from core ASD features.

With regards to RRB in particular, the introduction of the IU concept provides a new theoretical viewpoint on the role of these behaviours for children with ASD. At present, 'Restricted repetitive and stereotyped patterns of behaviour, interests and activities' are part of the diagnostic criteria for ASD in both major classification systems (World Health Organisation 1992; American Psychiatric Association 2013) and indeed in the newly released DSM-5, emphasis on RRB has been increased, by requiring at least two types of RRBs instead of one as previously (American Psychiatric Association 2013). The criteria encompass both low-level sensory-motor behaviours and more complex, higher order features such as insistence on sameness, repetitive language and routine, despite the fact that these appear conceptually quite distinct, in their nature and the requisite cognitive abilities (Turner 1999). While suggestions as to the function of low-level RRB have been made, including modulation of sensory input and arousal and serving a soothing function in the face of anxiety (Joosten et al. 2009; Leekam et al. 2011), the origins and function of the higher order restricted interest and insistence on sameness appear unclear (Leekam et al. 2011). Given the high levels of IU in ASD shown by this study, the application of the IU construct to this population may open up a new avenue for understanding these phenomena, in that high-level RRB may represent attempts by children to make life as predictable as possible in the face of the intolerability of uncertainty. Restricting life to set routines and insisting on sameness limits opportunity for uncertainty and therefore feels safer. Anecdotally, it can be observed clinically, that high IU, particularly in GAD, makes TD patients develop fairly rigid routines, deviations from which can be associated with significant distress. Perhaps the routines observable in ASD follow the same logic. Similarly, knowing all there is to know about a specific restricted interest means that there is little room for unwelcome and uncertain surprises, which may be comforting in a world inherently full of uncertainty.

According to this view, RRB may be an epiphenomenon, a consequence of other cognitive processes, rather than a core feature of the neurodevelopmental ASD phenotype itself. Given the early stage of this research, further focussed investigations of the relationship between RRB and IU across both TD and ASD populations may shed light on whether a reconsideration of the centrality of RRBs to the diagnosis of ASD is necessary.

Analyses showed, across both parent and child report data, a pattern of results provide preliminary evidence for a model which suggests that the widely recognised association of ASD with high levels of anxiety (White et al. 2009; Wood and Gadow 2010) is mediated by IU. In other words, this model suggests that anxiety is not associated with ASD per se, but providing that IU is a pre-existing vulnerability feature in ASD as it is believed to be in typically developing (TD) populations (Carleton 2012), anxiety would be the outcome of higher IU in ASD. Of course at this early stage of the research cycle caution must be undertaken with interpretation with regards to the causality of the model. This is especially the case because the data are not longitudinal. It could be that anxiety for children with ASD leads to higher levels of IU, resulting from the need to exert more control a strategy to cope with anxiety. Clearly then as key question is not 'Why are children with ASD so anxious?' but rather: 'What makes children with ASD so intolerant of uncertainty?'

The study has several limitations. Utilising data from three datasets across two countries may, potentially, have introduced variations in recruitment or data collection. Furthermore, ASD diagnostic practices may vary between the UK and the US, raising the possibility of systematic differences between the two samples of children with ASD. However, sample site was entered into the analyses as a blocking variable with no significant results, indicating that merging of these datasets was appropriate.

Due to the demands of the source studies, participants were required to have ability within the normal range (i.e. IQ above 70). This means that results are based almost solely on high functioning children and adolescents with ASD. Where the design of empirical investigations necessitate participants with a certain level of ability, an assumption is commonly made that the underlying cognitive mechanisms are applicable to ASD more generally (Scheurich et al. 2010). However, caution must be applied in generalising conclusions to all children with ASD, including those with concurrent learning disabilities.

The additional analyses investigating the mediational model used a Baron and Kenny (1986), Kenny (2012) causal steps approach. Given the non-experimental nature of the data used, the analysis can only show that results are *consistent* with the causal model presented, in which high IU arises as a consequence of ASD and acts as a vulnerability factor for anxiety, it is not proof of a causal model (Warner 2013). In the absence of a design that can test causality, causal models are only as good as the theory supporting them. While the relationship of IU and anxiety is widely believed to be causal, and past and present evidence is consistent with this position (see Carleton 2012), further work is required to elucidate the nature of the relationship between ASD and IU, before the causal model presented here can be judged with confidence.

The results from the present study have a number of important implications for clinical practice. The finding that IU appears to be an important explanatory factor in anxiety in children and adolescents with ASD indicates that assessment of IU in children with ASD presenting to services with anxiety related difficulties is likely to be of value for deriving an appropriate formulation of their presenting problems. Given that CBT paradigms have demonstrable utility for treating anxiety in children with ASD, and the growing evidence for CBT interventions targeting IU both adult and adolescent TD populations (Dugas et al. 2003, 2009; Leger et al. 2003; Payne et al. 2011), it follows from the present results, that development of anxiety interventions targeting IU, specifically for children with ASD is an important next step.

The results may also have theoretical implications. A developmentally sensitive conceptualisation of anxiety in ASD will have direct application to clinical practice. It will counteract a 'one size fits all' approach to treatment and allow the development of tailor-made interventions based on individualised formulations. The first step in this process is the identification of an appropriate model of anxiety which is relevant to individuals with ASD. In doing so we need to consider the contribution of a range of autism related characteristics to the presence of anxiety, including ASD characteristics as well as the significant social and environmental challenges faced by young people with ASD, including loneliness, peer rejection and bullying. Our proposal is that IU may have a key role within this model and tentatively propose an integrated cognitive model of anxiety for ASD (see Fig. 4) for further evaluation and refinement.

In conclusion Intolerance of Uncertainty is a known dispositional risk factor for the development of anxiety. The study presented here has provided a valuable first insight into the role of this important construct in the presentation of anxiety in children and adolescents with ASD. What is more, IU may in fact be the key construct in understanding the high prevalence of debilitating anxiety in this group of children and to developing more effective interventions in the future.

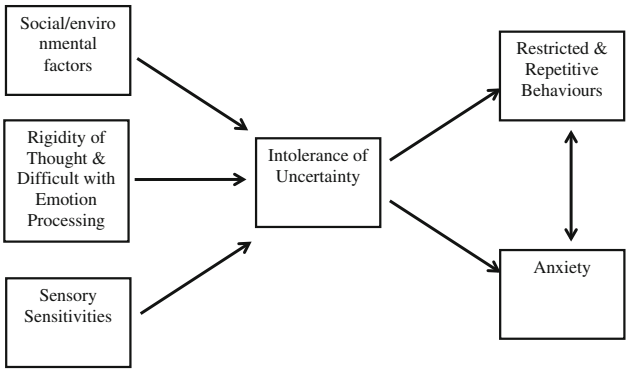

Fig. 4 A proposed model of anxiety in ASD

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