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Does intolerance of uncertainty predict child generalised anxiety? A longitudinal study

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ABSTRACT

Intolerance of uncertainty (IU) is the tendency to find uncertainty distressing. IU is related to anxiety in adults and youth but it is unclear whether IU plays a maintenance or causal role, particularly across childhood. Our research examined whether: (1) IU is associated with generalised anxiety in preschool-aged children; (2) IU in preschool-aged children is associated with the trajectory of generalised anxiety into middle childhood; and (3) IU is associated with the trajectory of internalising symptoms and externalising symptoms over time. Parents completed questionnaires (child anxiety, IU, internalising and externalising symptoms) about their children at three timepoints when their child was: 3–4 years old (n = 180); 5–7 years old (n = 162); and 8–10 years old (n = 148). Those with higher IU had higher concurrent generalised anxiety, internalising and externalising symptoms at each measurement point. Preschoolers with higher IU, relative to lower IU, had, on average, higher generalised anxiety across childhood. Unexpectedly though, children who were higher in IU as preschoolers were more likely to show a decrease in generalised anxiety over time. These findings indicate that IU is a consistent correlate of generalised anxiety, internalising and externalising symptoms, but that it may not play a causal role in the onset of generalised anxiety in children.

1. Does intolerance of uncertainty predict child generalised anxiety? A longitudinal study

Some level of uncertainty is common throughout our daily lives. For many people, this uncertainty goes mostly unnoticed. However, for some, uncertainty can be unpleasant and anxiety-provoking. Intolerance of uncertainty (IU) is a construct capturing trait-like individual differences in reactions to uncertainty (Carleton, 2016a). IU is defined as a "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), and is linked with elevated anxiety symptoms in clinical and non-clinical populations in adults and children (Buhr and Dugas, 2002; Counsell et al., 2017; Holaway et al., 2006; Mathes et al., 2017; Osmanağaoğlu et al., 2018; Sexton & Dugas, 2009). Despite robust associations with anxiety, it remains unclear whether IU plays a causal and/or maintenance role in anxiety. In adults, treatments that focus on changing IU lead to a decrease in anxiety symptoms and lower rates of Generalised Anxiety Disorder (GAD) (Dugas et al., 2003; Miller & McGuire, 2023), which is consistent with IU playing at least a maintenance role. Nonetheless, it remains possible that having negative reactions to uncertainty may be characteristic of anxiety rather than causal (Carleton et al., 2012; Carleton, 2012). Although the onset of anxiety disorders often happens during childhood (De Lijster et al., 2017), there is a dearth of developmental research examining whether early IU predicts the emergence of anxiety symptoms.

Elevated anxiety can be problematic across the lifespan, but anxiety in childhood can be particularly problematic as it can have a significant effect on development (Rapee et al., 2009); anxiety during childhood can affect academic performance, family processes, relationships with peers and longer term mental health (Essau, Conradt, & Petermann, 2000; Ezpeleta, Keeler, Erkanli, Costello, & Angold, 2001; Giora, Gega, Landau, & Marks, 2005; Gregory et al., 2007; Strauss, Frame, & Forehand, 1987; Van Ameringen, Mancini, & Farvolden, 2003). Given this, a substantial body of research has examined risk factors for anxiety in children. Some risk factors are now well-established, including

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behavioural inhibition (BI) (Pérez-Edgar et al., 2010), overcontrolling parenting (Hudson & Dodd, 2012; Rapee, 1997), and having a parent with an anxiety disorder (Beidel & Turner, 1997; Ginsburg & Schlossberg, 2002; Hudson et al., 2011a; Hudson et al., 2011b). Understanding and identifying potential risk factors for child anxiety is critical because early intervention can improve a child's quality of life and decrease risk of future mental health problems (Morgan et al., 2016).

IU may be predictive of anxiety over time in adults (Furtado et al., 2019), and there is some evidence that during adolescence, IU and worry have a bidirectional and reciprocal association over time (Dugas et al., 2012). To our knowledge though, there is no longitudinal research evaluating whether IU acts as a risk factor for anxiety in children. Osmanağaoğlu et al. (2018) conducted a meta-analysis of IU research focused on children and young people. This established a strong association between IU and anxiety/worry in young people but highlighted a number of significant limitations within the literature. One limitation was that all research was cross-sectional, and thus could not capture whether IU is associated with trajectories of anxiety over time. Furthermore, the age range in most of the included studies was quite broad, despite the fact that children's cognitions and ability to deal with uncertainty emerge and improve as they develop (Lyons & Ghetti, 2011; Roebers et al., 2007). This means that the relationship between IU and anxiety may change across childhood (Osmanağaoğlu et al., 2018).

Relatedly, no research had considered associations between IU and anxiety in preschool-aged children. This is a particularly important age to examine as early signs of anxiety are present at this age or even earlier (Luby, 2013), and identifying potential risk factors for anxiety could support preventative programmes. Cool Little Kids and the Turtle program are two examples of anxiety prevention programmes for preschool-aged children. Both programmes are designed for children who are BI (Chronis-Tuscano et al., 2022; Ooi et al., 2022). BI is characterised by a tendency to withdrawal or avoid novel and unfamiliar situations (Kagan et al., 1984). Given this definition, it is plausible that there is some overlap between the construct of BI and early manifestations of IU. The lack of research examining IU in young children has prevented this from being examined but Zdebik et al. (2018) found an association between childhood BI and IU in adulthood. They suggest that the heightened reactions to uncertainty brought about by BI may cause the development of an understanding of the environment being uncertain and dangerous (IU). In the same way that BI has been a focus for anxiety prevention programmes, if IU is found to be a precursor to anxiety in children, then it may be useful to investigate IU as a screening mechanism for identifying at-risk children and a target for preventative work.

Although IU is clearly associated with anxiety, it is unclear how specific this association is and whether IU may be associated with broader psychopathology, such as externalising and internalising problems (Lemery-Chalfant et al., 2007). Externalising problems include impulsive, disruptive conduct problems, and internalising problems include symptoms of depression as well as anxiety (Lemery-Chalfant et al., 2007). Some recent work with children suggests that IU may be a transdiagnostic construct that is positively associated with both internalising and externalising psychopathology (Gramszlo et al., 2018; Sadeh & Bredemeier, 2021), but further work is required to establish the nature of these associations.

Given the paucity of longitudinal research in this area and the lack of research examining IU and anxiety in young children, our primary aims were to: 1) examine whether IU is associated with anxiety in preschool-aged children; and 2) explore whether IU in preschool children is associated with the trajectory of generalised anxiety symptoms from early to middle childhood. An additional aim was to explore specificity by examining whether IU is associated with the trajectory of internalising symptoms and externalising symptoms over time. We hypothesised that IU would be associated with generalised anxiety when children were preschoolers (and when they were older), and that IU would interact with time to predict trends in generalised anxiety, internalising and externalising scores across early to middle childhood. Specifically, we tentatively expected early IU to be associated with a worsening symptom trajectory over time.

2. Methods

2.1. Participants

Participants (n = 180) were originally recruited as part of a longitudinal study (the 'Watch them Grow' study) via local preschools, advertisements in family magazines, social media and word of mouth. Parents completed time point 1 (TP1) questionnaire measures as two separate cohorts, one in 2017 and one in 2018, when their children were aged 3.46 – 4.67 years (M = 4.00, SD = 0.24). We invited 179 of the original 180 families (one withdrew from further follow ups) to take part at time point 2 (TP2) in Spring 2020 (1.96–3.34 years after TP1 (M = 2.62, SD = 0.45)) and at time point 3 (TP3) in Autumn 2022 (2.52 – 2.72 years after the TP2 (M = 2.59, SD = 0.50)). At TP2, 162 (91 %) participated, with children aged 5.72 – 7.71 years (M = 6.62, SD = 0.54). At TP3, 148 (83 %) participated, with children aged 8.27–10.36 years (M = 9.23, SD = 0.54). The time between TP1 and TP3 was 4.51 – 5.98 years (M = 5.23, SD = 0.45). Further demographic information for participants at each time point is available in Table S1 of Supplementary Materials. Full details of the original sample are provided here: http://reshare.ukdataservice.ac.uk/853813/.

2.2. Procedure

At TP1, Watch Them Grow participants were invited to attend a session at the University of Reading which included a variety of lab-based and observational tasks. The parent in attendance completed a battery of questionnaire measures via Survey Monkey on an iPad whilst the child was taking part in the tasks. This study was approved by the University of Reading Research Ethics committee (UREC 16/56) at TP1, and by the School of Psychology and Clinical Language Sciences Research Ethics committee at TP2 (2019–080-HD) and TP3 (2022–172-RM).

At TP1, parents consented to being contacted for future research. For the purpose of the present study, families were contacted for follow-ups in 2020 and 2022, when we invited them to complete measures online via Survey Monkey. They were offered a £ 5 voucher at each follow-up. Invitations to the first follow up were sent in May 2020.

2.3. Parent report measures

2.3.1. The Preschool Anxiety Scale (PAS; Spence et al., 2001)

Child generalised anxiety was measured at TP1 using the PAS generalised anxiety (GA) subscale. The PAS is a parent report questionnaire designed to measure anxiety in young children (aged 3–6 years). It consists of 28 items answered using a 5-point Likert scale. The GA subscale comprises five items such as '*Has difficulty stopping him/herself from worrying*' or '*Is tense, restless or irritable due to worrying*'. Parents are asked to indicate how true each statement is for their child. The PAS GA subscale has demonstrated good construct validity and adequate psychometric properties (Achenbach, 1992; Spence et al., 2001). Internal consistency for the GA scale in our TP1 data is good with Cronbach's alpha being 0.83.

2.3.2. The Spence Children's Anxiety Scale – Parent report (SCAS-P; Nauta et al., 2004)

Child anxiety, worry and physical symptoms (e.g. fast heartbeat or feeling shaky) were measured at time points 2 and 3 using the SCAS-P Generalised Anxiety (GA) subscale. The SCAS-P is a parent-report questionnaire designed to measure anxiety in children aged 6–18 years. It is an adaptation of the child report SCAS (Spence, 1998). The measure consists of 38 items, answered using a 4-point Likert scale. The

GA subscale comprises six items such as '*My child worries about things*' or '*My child worries that something bad will happen to him/her*'. Parents are asked to indicate the response that best describes their child. The SCAS-P GA subscale score has demonstrated good internal consistency (α =.92) and differentiates well between children with anxiety-disorders and controls (Nauta et al., 2004). In our sample at TP2, the GA subscale had α = .69 and at TP3 Cronbach's alpha was 0.79.

For both the PAS and SCAS we chose to use the GA subscale to capture children's generalised anxiety rather than the total score because it is conceptually closest to our research questions; the total score includes separation anxiety and social anxiety subscales, which were less relevant to the research questions about IU.

2.3.3. The Responses to Uncertainty and Low Environmental Structure (RULES) questionnaire (Sanchez et al., 2017)

Child intolerance of uncertainty (IU) was measured at all time points using the RULES. The RULES is a parent-report measure of child IU comprising 17 items that are rated on a 5-point Likert scale. Parents are asked to rate how much certain statements describe their child, such as '*My child has a hard time coping with even minor changes*' and '*My child complains of physical symptoms (e.g., headaches, stomach-aches) when he/she is about to enter a new situation*'. The RULES has demonstrated strong predictive, convergent and divergent validity and excellent internal consistency with Cronbach's alpha being 0.93, and item-total correlations ranging from 0.47 to 0.81 (Sanchez et al., 2017). Cronbach's alpha was excellent at TP1 (α =.93), TP2 (α =.96) and TP3 (α =.96).

2.3.4. Health Behaviour Questionnaire (HBQ) (Armstrong & Goldstein, 2003)

Internalising and externalising symptoms were captured via the HBQ internalising and externalising scales, respectively. The HBQ is a parent-report measure that includes a range of scales. The internalising symptoms scale consists of 29 items rated on a 3-point Likert scale and captures symptoms of depression (e.g. Feels worthless or inferior) and anxiety (e.g. Worries about things in the future). The externalising symptoms scale consists of 46 items rated on a 3-point Likert scale and captures symptoms of oppositional defiance (e.g. Has temper tantrums or hot temper), conduct problems, hostility, aggression, inattention (e.g. Distractible, has trouble sticking to any activity) and impulsivity. The HBQ has demonstrated good internal consistency (Lemery-Chalfant et al., 2007), good test-retest reliability for both subscales and also good group discriminant validity (Armstrong & Goldstein, 2003). The internal consistency for both scales was good at TP1 (Internalising scale: α =.89; externalising scale: α =.93), and excellent at TP2 (Internalising scale: α =.90; externalising scale: α =.95) and TP3 (Internalising scale: α =.92; externalising scale: α =.95).

2.3.5. Trait scale of Y2 State-Trait Anxiety Inventory (STAI-Y2; Speilberger et al., 1983)

We used the trait scale of the STAI-Y2 to capture parent trait anxiety at all time points (although note that the STAI-Y2 may be better described as a measure of neuroticism (Knowles & Olatunji, 2020)). The STAI-Y2 comprises 20 items such as '*I feel pleasant*' and '*I feel nervous and restless*', rated on a 4-point Likert scale. STAI-Y2 demonstrates good construct validity and internal consistency ranging from.86 to.95 (Speilberger et al., 1983). Cronbach's alpha for this measure in our sample was excellent at TP1 (α =.93), TP2 (α =.94) and TP3 (α =.92).

2.4. Design

This study was a within-subjects repeated-measures observational design. RULES total score was used to capture early childhood IU at three time points. Child anxiety was captured by the GA subscales of the PAS at TP1 and SCAS at TP2 and TP3. These were converted to z-scores based on published norms for each scale, as available on www.scaswebsite.com (Nauta et al., 2004; Spence et al., 2001). Internalising and externalising problems were measured by the HBQ internalising scale score and HBQ externalising scale score respectively, at each time point.

2.5. Data preparation

Child gender, ethnicity, birth order, parental marital status, education level and employment status were examined as potential confounds in relation to TP1 RULES and PAS GA, TP2 and TP3 SCAS GA and HBQ internalising symptoms and HBQ externalising symptoms at all timepoints in advance of conducting the main analyses. Of these, marital status at TP1 was significantly associated with HBQ externalising at TP1 $F(2176) = 5.35$, $p = .006$, TP2 $F(2159) = 3.84$, $p = .024$ and TP3 $F(2145) = 3.41$, $p = .036$, as well as HBQ internalising at TP3 $F(2145) = 4.61$, $p = .012$, where children with two parents at home had lower HBQ internalising and externalising scores than those with one parent at home. Given this, we controlled for marital status in analyses. Parent anxiety as measured by STAI-Y2 total score at each time point was also controlled for in the analysis due to its potential influence on child anxiety.

2.6. Missing data

Of the 180 participants included in the study, one withdrew from further follow-ups and the only further missing data came from those participants who did not take part (TP2 = 18; TP3 = 32). At TP1 one participant did not complete IU and parent anxiety measures. We used mixed models for our longitudinal analyses as this enabled all participants to be retained for analyses, even when data were missing.

2.7. Data analysis

Our analytical approach was to first examine correlations between RULES scores and GA subscale scores, HBQ internalising, HBQ externalising symptoms and parent anxiety scores at each time point. We then ran three hierarchical growth curve analyses to investigate whether RULES scores at TP1 predicted trajectories across the three timepoints of: 1) GA subscale scores; 2) HBQ internalising; 3) HBQ externalising symptoms. In all three analyses, centred RULES scores at TP1 were included as a fixed effect, as were linear and quadratic orthogonal polynomial time terms (poly1 and poly2, respectively), and their interactions with TP1 RULES scores. Subject-specific offsets were included as a random effect. Type III Wald F tests were used to obtain p-values and degrees of freedom were approximated with the Kenward-Rogers method. Significant interactions between continuous variables were probed using the Johnson-Neyman technique (Johnson & Neyman, 1936).

For each analysis, outliers were removed, as detailed below. For transparency we also include results with outliers included in Supplementary Materials.

3. Results

3.1. Descriptive statistics

The descriptive statistics for each of the main variables can be found in Table 1 and Table 2 below, as well as bivariate correlations between the variables. As shown in Table 1, GA subscale scores across the three time points were moderately to highly correlated, RULES total scores across time points were also moderately to highly correlated. Furthermore, RULES and GA subscale scores were moderately to highly correlated with each other at each time point. Table 2 shows that HBQ internalising scores across the three time points were moderately to highly correlated, as were HBQ externalising scores. RULES, HBQ internalising scores and HBQ externalising scores were all moderately to highly correlated with each other at each time point, apart from TP1 RULES and TP3 HBQ externalising scores, which were weakly

Table 1
Means, standard deviations, and correlations with confidence intervals for the RULES, PAS/SCAS GA subscale score and STAI scores at each time point.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. TP1 RULES	35.01	11.48								
2. TP2 RULES	34.38	14.95	.62 * * [.52,.71]							
3. TP3 RULES	35.76	15.62	.51 * * [.38,.62]	.78 * * [.70,.84]						
4. TP1 GA subscale score	0.34	1.11	.74 * * [.67,.80]	.53 * * [.41,.63]	.42 * * [.28,.55]					
5. TP2 GA subscale score	0.19	1.11	.46 * * [.32,.57]	.68 * * [.59,.76]	.53 * * [.40,.64]	.56 * * [.44,.66]				
6. TP3 GA subscale score	0.41	1.39	.34 * * [.19,.48]	.45 * * [.31,.58]	.60 * * [.48,.69]	.38 * * [.23,.51]	.57 * * [.45,.67]			
7. TP1 STAI	40.01	9.84	.26 * * [.12,.39]	.08 [−.07,.23]	.09 [−.07,.25]	.23 * * [.08,.36]	.12 [−.04,.27]	.03 [−.13,.19]		
8. TP2 STAI	42.82	10.36	.10 [−.05,.25]	.19 * [.03,.33]	.16 [−.00,.32]	.12 [−.03,.27]	.13 [−.02,.28]	.16 [−.01,.31]	.66 * * [.56,.74]	
9. TP3 STAI	42.48	9.62	.12 [−.04,.28]	.18 * [.01,.33]	.23 * * [.07,.38]	.18 * [.01,.33]	.18 * [.01,.33]	.28 * * [.12,.42]	.60 * * [.48,.69]	.74 * * [.66,.81]

Note. RULES = Responses to Uncertainty and Low Environmental Structure; PAS/SCAS GA = Preschool/Spence Children's Anxiety Scale Generalised Anxiety subscale; STAI = State-Trait Anxiety Inventory.
Note: * indicates $p < .05$. * * indicates $p < .01$. Child generalised anxiety scores have been z-scored based on the published norms

correlated.

3.2. Linear mixed effect models and hierarchical growth curve analyses

Growth curve analyses were run to examine the association between TP1 RULES on trajectories of GA subscale score, HBQ internalising and HBQ externalising scores using the lme4 package in R (R Core Team, 2022). Models were run examining RULES and: 1) GA subscale score; 2) HBQ internalising score; 3) HBQ externalising score, all including STAI and marital status as controls. Residuals for all linear mixed-effects models were checked, and these were not normally distributed. A number of outliers were detected using Cook's distance (4/n) (Model 1, n = 19; Model 2, n = 24; Model 3, n = 23). Each model was run with outliers removed, which greatly improved normality of residuals. The results for these models are reported below (see Table 3). For transparency, models without outliers removed, and models without STAI and marital status included, can be found in Supplementary Materials; patterns of results were very similar.

3.3. Model 1 RULES and GA subscale score models controlling for STAI and marital status, 19 outliers removed

TP1 RULES was a significant predictor of GA subscale score across time [$F[1] = 114.85$, $p < .001$], and there was a significant linear [$F[1] = 5.93$, $p = .015$] and quadratic [$F[1] = 6.73$, $p = .010$] effect of time. Marital status was not a significant predictor [$F[2] = 2.14$, $p = .121$], however STAI was [$F[1] = 4.28$, $p = .039$]. There were significant interactions between RULES and the linear effect [$F[1] = 19.03$, $p < .001$] as well as the quadratic effect [$F[1] = 5.05$, $p = .025$] of time. To explore these interactions, the raw data and quadratic curves were plotted (see Fig. 4A). These plots indicate that for children with high RULES scores, anxiety decreased between TP1 and TP2 and then increased slightly between TP2 and TP3, showing a clear quadratic effect along with a linear decrease over time. In contrast, participants with low RULES scores showed a very small increase in anxiety over time. Consistent with this, the Johnson-Neyman technique showed that a higher RULES score was linked to a decrease in GA subscale score over time (Fig. 1A) whereas a low RULES score was linked to an increase in GA subscale score over time, however this was predominantly outside the range of observed data. Further probing of the interaction between RULES and the quadratic effect of time using the Johnson Neyman technique showed that, with high RULES scores, there is a quadratic effect of time which is not present when RULES scores are lower (Fig. 1B). Importantly, GA subscale scores remained lower for those with low RULES scores relative to participants with high RULES scores across all time points.

3.4. Model 2: RULES and HBQ internalising models controlling for STAI and marital status, 24 outliers removed

RULES was a significant predictor of HBQ Internalising [$F[1] = 119.12$, $p < .001$], and there was a significant linear effect of time [$F[1] = 33.49$, $p < .001$]. There was a non-significant trend in the quadratic effect of time [$F[1] = 3.18$, $p = .075$]. There was no significant effect of marital status [$F[2] = 2.29$, $p = .104$], but there was a significant effect of STAI [$F[1] = 29.31$, $p < .001$]. There was a significant interaction between RULES and linear effect of time [$F[1] = 14.06$, $p < .001$], but the interaction between RULES and quadratic effect of time was not significant [$F[1] = 2.75$, $p = .098$]. To explore the interaction, raw data and linear curves are visualised in Fig. 4B. This shows that, although there was a linear increase in HBQ Internalising score overall, HBQ Internalising was relatively stable over the three time points for those with high RULES scores. In contrast, those with low RULES scores had a linear increase in HBQ Internalising across the time points. Across all time points, participants with low RULES scores had lower symptoms levels than those with high RULES scores. Further probing of the interaction between RULES and the linear effect of time using Johnson-Neyman technique supported this; a lower RULES score was linked to an increase in HBQ Internalising scores over time (Fig. 2) whereas a higher RULES score was linked to a decrease in HBQ internalising scores over time, however this was predominantly outside the range of observed data.

Table 2
Means, standard deviations, and correlations with confidence intervals for RULES, HBQ internalising, HBQ externalising and STAI scores at each time point.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. TP1 RULES	35.01	11.48											
2. TP2 RULES	34.38	14.95	.62 * * [.52,.71]										
3. TP3 RULES	35.76	15.62	.51 * * [.38,.62]	.78 * * [.70,.84]									
4. TP1 HBQ Internalising	2.68	2.28	.76 * * [.69,.82]	.52 * * [.40,.62]	.46 * * [.32,.58]								
5. TP2 HBQ Internalising	3.62	2.79	.54 * * [.42,.64]	.77 * * [.70,.82]	.71 * * [.62,.79]	.66 * * [.56,.74]							
6. TP3 HBQ Internalising	4.19	3.15	.37 * * [.22,.50]	.52 * * [.39,.63]	.74 * * [.66,.81]	.43 * * [.29,.55]	.72 * * [.63,.79]						
7. TP1 HBQ Externalising	3.10	1.90	.43 * * [.30,.54]	.36 * * [.22,.49]	.37 * * [.23,.51]	.51 * * [.39,.61]	.46 * * [.33,.57]	.30 * * [.14,.44]					
8. TP2 HBQ Externalising	3.35	2.38	.30 * * [.15,.44]	.55 * * [.44,.65]	.53 * * [.40,.64]	.37 * * [.23,.50]	.60 * * [.49,.69]	.43 * * [.28,.55]	.68 * * [.59,.76]				
9. TP3 HBQ Externalising	3.00	2.37	.19 * [.03,.34]	.43 * * [.29,.56]	.62 * * [.51,.71]	.27 * * [.11,.41]	.54 * * [.41,.64]	.59 * * [.48,.69]	.52 * * [.40,.63]	.76 * * [.69,.83]			
10. TP1 STAI	40.01	9.84	.26 * * [.12,.39]	.08 [−.07,.23]	.09 [−.07,.25]	.31 * * [.17,.44]	.15 [.00,.30]	.17 * [.00,.32]	.30 * * [.16,.43]	.19 * [.04,.34]	.22 * * [.06,.37]		
11. TP2 STAI	42.82	10.36	.10 [−.05,.25]	.19 * [.03,.33]	.16 [−.00,.32]	.15 [−.00,.30]	.24 * * [.09,.38]	.21 * [.05,.36]	.14 [−.02,.29]	.24 * * [.09,.38]	.23 * * [.07,.38]	.66 * * [.56,.74]	
12. TP3 STAI	42.48	9.62	.12 [−.04,.28]	.18 * [.01,.33]	.23 * * [.07,.38]	.23 * * [.07,.38]	.23 * * [.07,.38]	.31 * * [.16,.45]	.17 * [.01,.32]	.24 * * [.07,.39]	.27 * * [.11,.41]	.60 * * [.48,.69]	.74 * * [.66,.81]

Note. RULES = Responses to Uncertainty and Low Environmental Structure; HBQ = Health Behaviour Questionnaire; STAI = State-Trait Anxiety Inventory.

Table 3
LMM Results for models predicting Generalised Anxiety Subscale, HBQ Internalising and HBQ Externalising symptoms.

	GA Subscale Scores			HBQ Internalising			HBQ Externalising		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
Intercept	0.51	0.19 – 0.84	**0.002**	4.05	3.30 – 4.81	**< 0.001**	4.09	3.28 – 4.90	**< 0.001**
RULES	0.58	0.47 – 0.69	**< 0.001**	1.32	1.08 – 1.56	**< 0.001**	0.62	0.36 – 0.87	**< 0.001**
Linear Time	−0.13	−0.24 – −0.03	**0.015**	0.66	0.43 – 0.88	**< 0.001**	−0.14	−0.31 – 0.03	0.101
Quadratic Time	0.14	0.03 – 0.24	**0.010**	−0.20	−0.42 – 0.02	0.075	−0.15	−0.31 – 0.01	0.067
STAI	0.09	0.01 – 0.18	**0.038**	0.53	0.34 – 0.72	**< 0.001**	0.42	0.25 – 0.59	**< 0.001**
Marital Status - Two Parents at home	−0.34	−0.68 – 0.01	0.058	−0.87	−1.66 – −0.07	**0.034**	−1.14	−2.00 – −0.28	**0.009**
Marital Status - Other	−0.15	−0.61 – 0.30	0.505	−0.68	−1.71 – 0.35	0.194	−1.18	−2.29 – −0.07	**0.038**
RULES x Linear Time	−0.23	−0.34 – −0.13	**< 0.001**	−0.43	−0.66 – −0.21	**< 0.001**	−0.13	−0.30 – 0.04	0.143
RULES x Quadratic Time	0.13	0.02 – 0.24	**0.025**	−0.19	−0.42 – 0.04	0.098	−0.20	−0.36 – −0.03	**0.020**
Random Effects									
σ^2	0.42			1.79			0.98		
τ_{00}	0.32 $_{child\_ID}$			1.71 $_{child\_ID}$			2.45 $_{child\_ID}$		
ICC	0.43			0.49			0.71		
N	178 $_{child\_ID}$			178 $_{child\_ID}$			176 $_{child\_ID}$		
Observations	468			463			463		
Marginal R^2 / Conditional R^2	0.370 / 0.642			0.428 / 0.707			0.192 / 0.769		

Note: RULES scores and STAI are centred.
Note. RULES = Responses to Uncertainty and Low Environmental Structure; GA = Generalised Anxiety; HBQ = Health Behaviour Questionnaire; STAI = State-Trait Anxiety Inventory.

3.5. Model 3: RULES and HBQ externalising models controlling for STAI and marital status, 23 outliers removed

RULES was a significant predictor of HBQ Externalising [F[1] = 22.33, $p < .001$] but there was no significant linear effect of time [F[1] = 2.69, $p = .102$], and there was only a non-significant trend in the quadratic effect of time [F[1] = 3.37, $p = .067$]. There was however a significant effect of STAI [F[1] = 23.33, $p < .001$] and a significant effect of marital status [F[2] = 3.48, $p = .033$]. There was no significant interaction between RULES and the linear effect of time [F[1] = 2.15, $p = .143$, but there was a significant interaction between RULES and the quadratic effect of time [F[1] = 5.41, $p = .021$]. To explore this interaction, the raw data and quadratic curves are visualised in Fig. 4C. This shows that, for those with high RULES scores there was a slight increase between TP1 and TP2 and a steeper decrease between TP2 and TP3. In contrast, the HBQ externalising scores were relatively stable over the three time points for those with low RULES scores. HBQ externalising scores remained lower for those with low RULES scores relative to participants with high RULES scores across all time points. Further probing of this interaction using the Johnson-Neyman technique revealed that at higher levels of RULES, there was a stronger quadratic curve over time for HBQ Externalising scores; no significant quadratic curve was found at lower RULES scores (Fig. 3).

4. Discussion

This research aimed to examine whether IU in preschool-aged children is associated with generalised anxiety, and whether IU in preschool-aged children is associated with the trajectory of generalised anxiety from early to middle childhood. An additional aim was to examine whether IU was associated with internalising and externalising symptom trajectories, in order to determine whether IU is linked to generalised anxiety specifically rather than a more general risk factor for psychopathology at this age.

We hypothesised that IU would be associated with generalised anxiety in preschoolers, and across childhood, and that IU would interact with time to predict trends in anxiety over time. The results largely supported these hypotheses, but the pattern of effects over time was not consistent with our predictions. IU and generalised anxiety were significantly associated at each time-point, consistent with Osmanağaoğlu et al. (2018)'s meta-analysis. Limited research has examined associations between IU and anxiety in younger children, so these findings extend the existing literature and indicate that IU is linked to generalised anxiety symptoms even in preschool-aged children. IU interacted with time, indicating that preschool IU predicted trends in generalised anxiety from early to middle childhood. In contrast to what we had expected, higher IU was related to a decrease in generalised anxiety over time rather than an increase. For those with lower IU, generalised anxiety remained relatively stable over time. It is important to note that higher IU at baseline was related to higher overall generalised anxiety across childhood, relative to those with lower IU at baseline. Nevertheless, on average, for those with higher IU as preschoolers, anxiety decreased from early to middle childhood.

These results provide little indication that IU temporally precedes the development of generalised anxiety symptoms in children, as we did not observe that preschool-aged children with high IU show a trajectory of worsening anxiety symptoms over time. The association between IU and generalised anxiety seems to already be established even in preschoolers, and those with high IU (and high anxiety) as preschoolers remain more anxious in middle childhood than those with low IU (and low anxiety). It remains possible that very early difficulties with uncertainty drive anxiety in preschool-aged children but we currently have no established, reliable way to measure IU in very young children. One possible direction for future research is to explore whether existing measures of BI in young children might be suitable for capturing IU.

In relation to internalising symptoms, the results supported the hypothesis that IU would be associated with internalising symptoms at each time point, in line with Carleton et al. (2012). An interaction between IU and time was also found, with lower IU associated with a linear increase in internalising symptoms over time; no significant effects of time were found for high IU. Despite these distinct trajectories, participants with high IU had higher internalising symptoms across all time points relative to those with lower IU. These findings are therefore relatively consistent with the results for generalised anxiety; IU predicts elevated symptoms across childhood, but does not, in our data, precede the development of internalising problems in children.

Finally, in relation to externalising symptoms, the results supported the hypothesis that IU would be significantly associated with externalising symptoms at each time point. The cross-sectional findings support previous research by Gramszlo et al. (2018) and Sadeh and Bredemeier (2021). In addition, there was a significant interaction between IU and quadratic time indicating that IU predicted trends in externalising symptoms over time. The findings suggest that early IU may be associated with some initial increased risk for externalising symptoms, although these then return to baseline levels. IU is not typically examined in relation to externalising symptoms and there is, to our knowledge, no theoretical work focused on IU and externalising symptoms. This makes these findings difficult to interpret with any confidence. It is

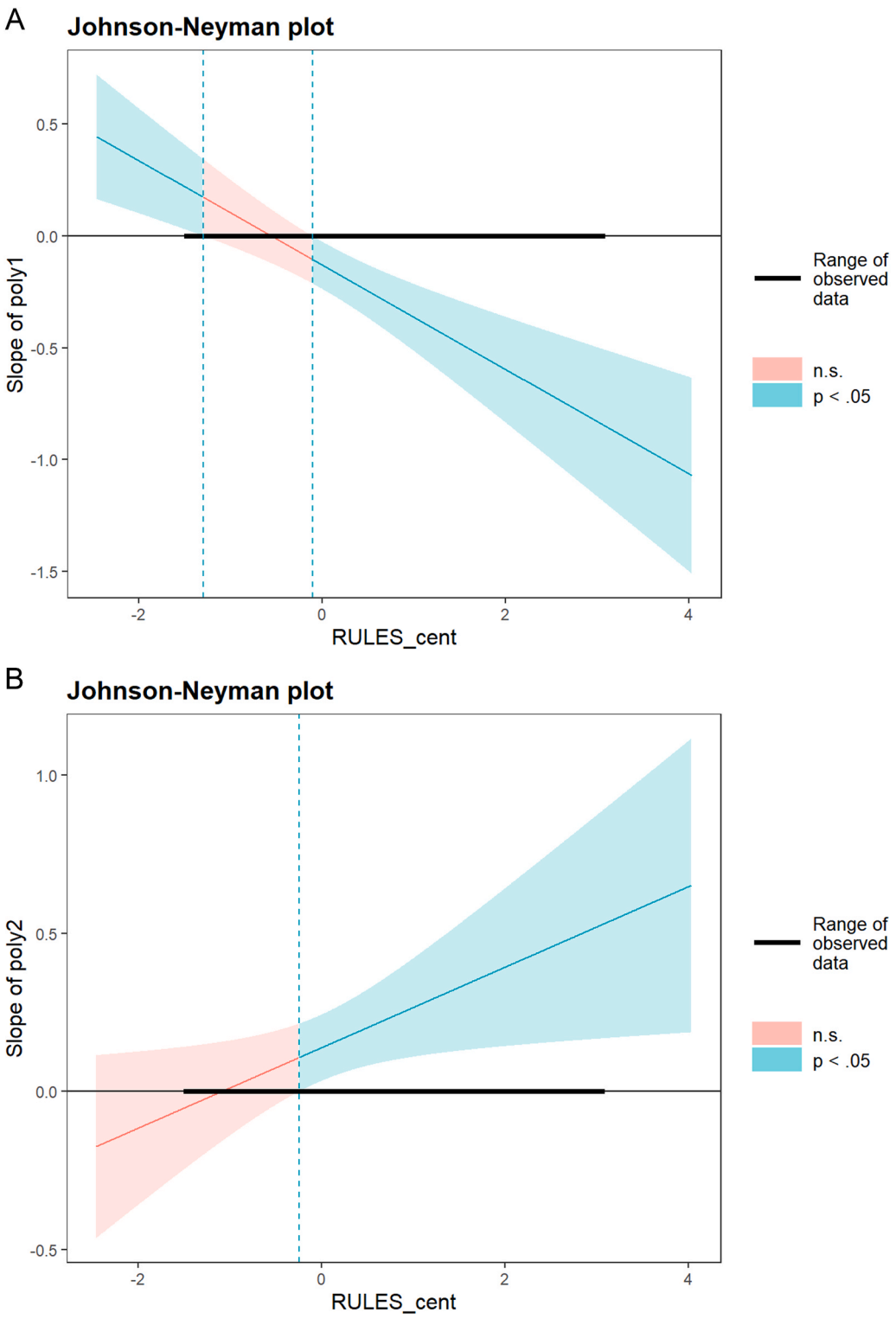

Fig. 1. RULES and GA subscale score, controlling for STAI and marital status with outliers removed. A & B show Johnson-Neyman plots illustrating the significant interaction effects. Plot A shows the relation between RULES scores and linear slope of GA subscale score over time. Plot B shows the relation between RULES and the quadratic slope of GA subscale score over time. The range of observed data is shown by the bold black horizonal line, the blue shaded areas show where the slopes were significant ($p < .05$), and the red shaded areas show where the slopes were not significant (n.s). RULES moderated a decrease of GA subscale score over time (A); when RULES scores were $\geq$ -0.11, the linear decrease of GA subscale score over time differed significantly from zero. The higher the RULES, the stronger the linear decrease of GA subscale score over time. The opposite was found with low RULES scores. Where RULES $\leq$ -1.30, there was a linear increase in GA subscale score over time, however this lay predominantly outside of the range of observed data. Plot B shows that when looking at the quadratic effects of time, RULES moderated an increase of GA subscale score; when RULES was $\geq$ -0.24, the quadratic effect of time differed significantly from zero.

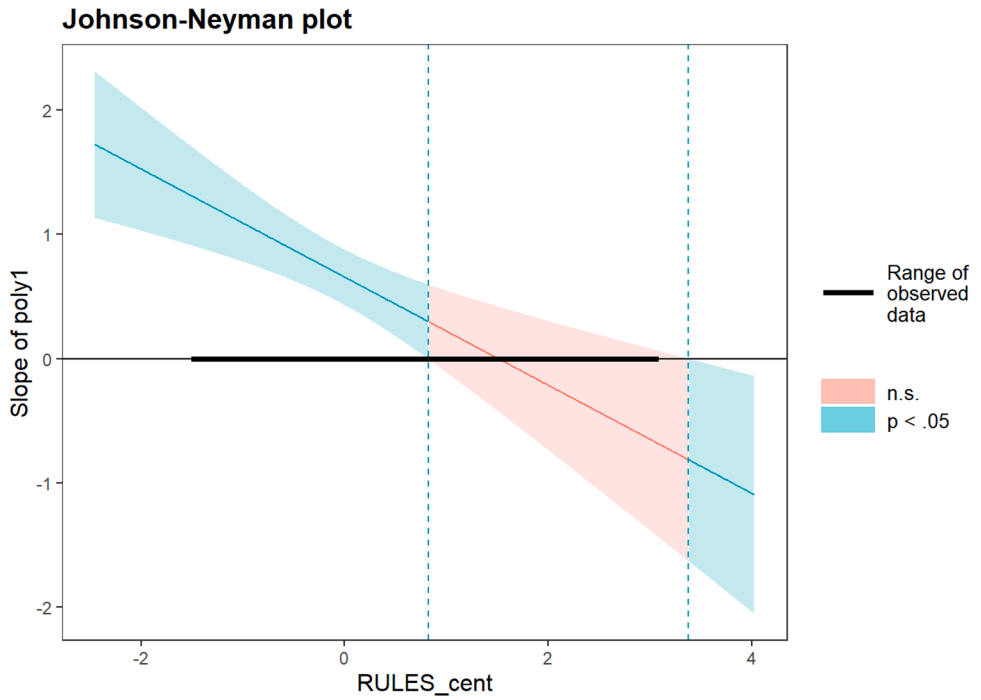

Fig. 2. RULES and HBQ Internalising controlling for STAI and marital status with outliers removed. Fig. 2 shows a Johnson-Neyman plot illustrating the significant interaction effects. It shows the relation between RULES scores and linear slope of HBQ Internalising over time. The range of observed data is shown by the bold black horizonal line, the blue shaded areas show where the slopes were significant ($p < .05$), and the red shaded areas show where the slopes were not significant (n.s). RULES moderated an increase of HBQ internalising over time; when RULES scores were ≤ 0.82, the linear increase of HBQ internalising over time differed significantly from zero. The lower the RULES, the stronger the linear increase of HBQ internalising over time. The opposite was found with high RULES scores. Where RULES ≥ 3.38, there was a linear decrease in HBQ internalising over time, however this lay predominantly outside of the range of observed data.

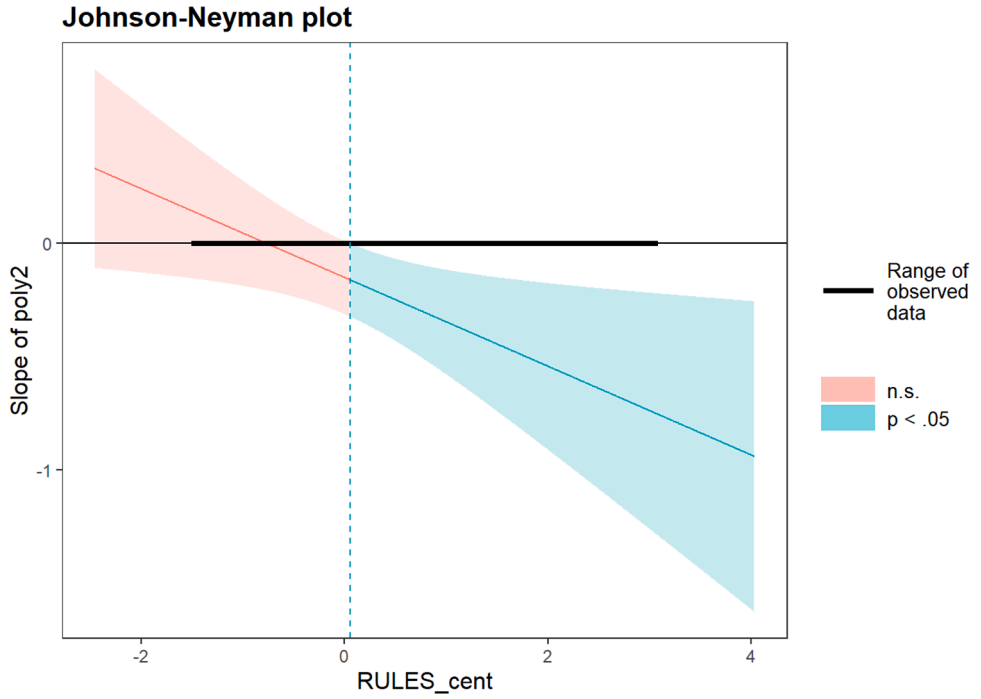

Fig. 3. RULES and HBQ Externalising controlling for parental anxiety and marital status with outliers removed. This figure shows a Johnson-Neyman plot illustrating significant interaction effects. It shows the relation between RULES and the quadratic slope of HBQ externalising over time. The range of observed data is shown by the bold black horizonal line, the blue shaded areas show where the slopes were significant ($p < .05$), and the red shaded areas show where the slopes were not significant (n.s). Fig. 3 shows that when looking at the quadratic effect of time, RULES moderated an decrease in HBQ Externalising; when RULES was ≥ 0.06, the quadratic effect of time differed significantly from zero.

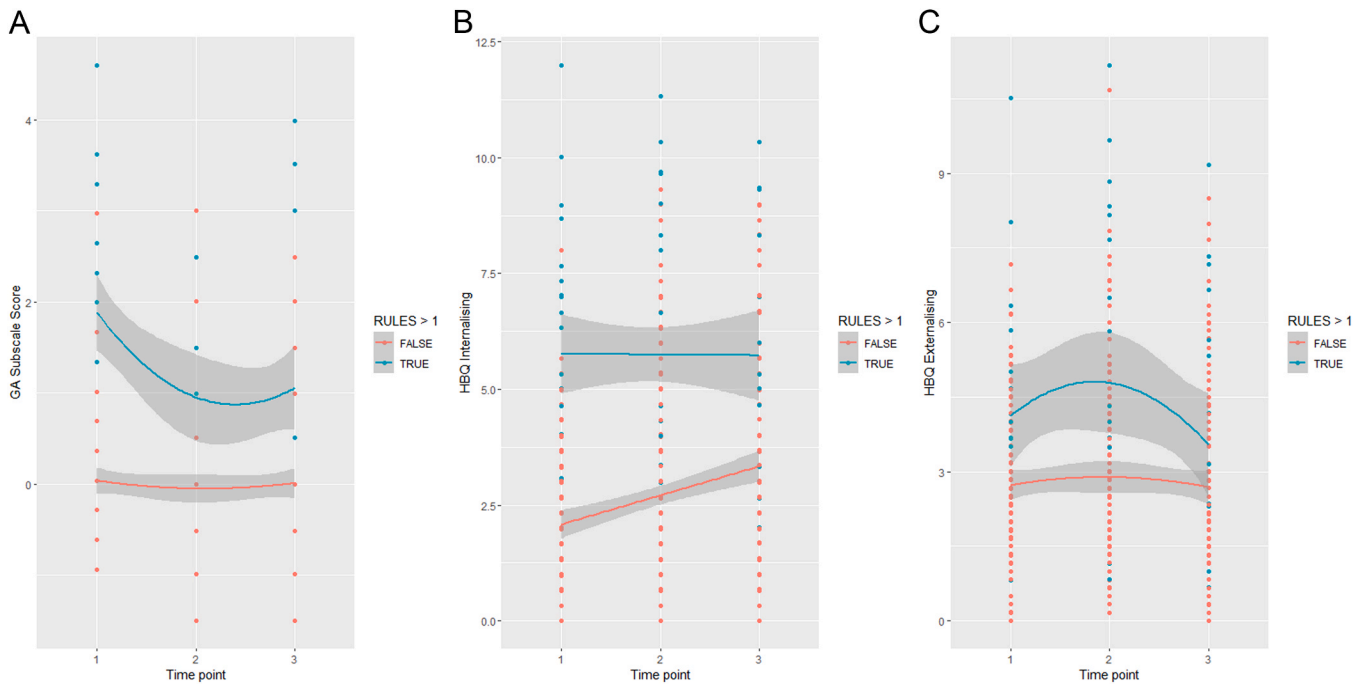

Fig. 4. Data and quadratic fit for models 1 and 3 and linear fit for model 2. 4 A shows child GA subscale score data, 4 B shows HBQ Internalising score data and 4 C shows HBQ Externalising score data, all plotted over three time points with RULES split into higher and lower RULES for plotting only. The red line in each figure reflects lower RULES scores (with RULES scores over 1 which is 1 SD over the mean) and the blue line higher scores of RULES (RULES scores under 1).

also noteworthy that the second time point happened during the Covid-19 UK-wide lockdown, which could have affected externalising behaviours. These findings therefore need to be treated with caution, but they suggest that IU may be associated with a broader range of psychopathology than is often assumed. It would be of interest to further explore links between IU and externalising psychopathology in future research.

As noted earlier, the second timepoint occurred during the UK-wide lockdown which began in March 2020. We collected responses in May 2020. It seems plausible that by this stage of lockdown there was less uncertainty in children's day to day lives than would be typical because most children were not attending school or any of their regular activities. This lowered uncertainty may have led to lower generalised anxiety symptoms in children with high IU during this period. At the third timepoint, data were collected at a point where children's lives had returned to relative normality, which may explain this relative increase in generalised anxiety back towards levels seen at the first timepoint. As we did not assess the level of perceived uncertainty in children's lives at each time point this interpretation is speculative. The quadratic trend was relatively subtle and does not impact the conclusions of the study in relation to the primary aims.

One potential interpretation regarding the unexpected pattern of results (with higher IU at the first timepoint being associated with a decrease in anxiety over time) is a regression to the mean effect. There is a chance that those with more extreme scores at the first timepoint had less extreme scores at follow up. This issue is somewhat, but not entirely, alleviated by removal of outliers. Other factors could have influenced generalised anxiety (and its relationship with IU) over time, such as peer relationships and bullying, as well as the parent-child relationship, and parenting styles. It is also worth considering that generalised anxiety could have decreased after the natural exposure of starting school, which occurred for all children in our sample between baseline and the first follow-up. In addition, those who had higher IU in pre-school may have received additional services such as therapy or interventions that could have reduced their anxiety over time and thus may have influenced the trajectory of generalised anxiety symptoms.

This study has a number of strengths. It is the first longitudinal study of its kind, examining IU and mental health symptoms from preschool age through to middle childhood. This allowed us to examine associations between IU and generalised anxiety at three time-points. Although children's cognitive and emotional skills develop rapidly across this period, the associations between IU and generalised anxiety at each time-point remain strong and consistent. There was a relatively low attrition rate which was favourable. The use of parent-report questionnaires to examine IU represents a limitation. Following on from Osmanağaoğlu et al. (2021), there have been discrepancies between findings from parent-report and child-report related to IU. Nevertheless, parent-report was necessary at least at the first time point because participants were too young to provide reliable self-report. Methods that allow IU to be evaluated in young children are needed to move this field forward and reduce reliance on parent report. As previously discussed, examining whether existing measures of BI, particularly observational methods, can be used to measure IU in young children is a possibility for future research. Since we began the study a new measure of IU has been developed: the Youth Intolerance of Uncertainty – Parent Report (YIU – PR) (Wong & Caporino, 2023). This measure may be more sensitive to developmental changes but still relies on parent report. Nevertheless, it would be useful to replicate and extend the present research using this measure. A further limitation of this study is that information regarding treatment or interventions that participants may have received was not collected. Extension of longitudinal research into adolescence would also be informative and contribute significantly to the literature.

5. Conclusion

Our findings suggest that IU is related to concurrent generalised anxiety across childhood, including in preschool-aged children. High IU during the preschool years was associated with higher generalised anxiety symptoms across childhood. Surprisingly, trajectory analysis showed that higher IU predicted a decrease in children's generalised anxiety over time rather than the expected increase. Due to the design of the study, it is not possible to make claims about any causal role IU may

play in the onset of generalised anxiety in preschool-aged children, however IU may be a consistent correlate of generalised anxiety across childhood. In addition, there was a consistently strong association across all time-points between IU and internalising and externalising symptoms, suggesting that IU is associated with a range of psychopathologies.

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CRediT authorship contribution statement

Ryan Zoe Jane: Writing – original draft, Visualization, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Morriss Jayne:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Rayson Holly:** Writing – review & editing, Visualization, Supervision, Investigation, Formal analysis, Data curation, Conceptualization. **Dodd Helen F.:** Writing – review & editing, Validation, Supervision, Software, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Helen Dodd reports financial support was provided by UK Research and Innovation Economic and Social Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.janxdis.2025.103004.

Data availability

Data is available here: http://reshare.ukdataservice.ac.uk/853813/.

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