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Jumping to Conclusions and Its Associations With Psychotic Experiences in Preadolescent Children at Familial High Risk of Schizophrenia or Bipolar Disorder-The Danish High Risk and Resilience Study, VIA 11

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Background: **The jumping to conclusions (JTC) bias, ie, making decisions based on inadequate evidence, is associated with psychosis in adults and is believed to underlie the formation of delusions. Knowledge on the early manifestations of JTC and its associations with psychotic experiences (PE) in children and adolescents is lacking.** ***Design:*** **Preadolescent children (mean age 11.9 y, SD 0.2) at familial high risk of schizophrenia (FHR-SZ, *n* = 169) or bipolar disorder (FHR-BP, *n* = 101), and controls (*n* = 173) were assessed with the Beads Task to examine JTC. The number of beads drawn before making a decision, "draws to decision" (DTD) was used as a primary outcome. PE were ascertained in face-to-face interviews. General intelligence was measured with Reynolds Intellectual Screening Test.** ***Results:*** **Children at FHR-SZ took fewer DTD than controls (4.9 vs 5.9, Cohen's *d* = 0.31, *P* = .004). Differences were attenuated when adjusting for IQ (Cohen's *d* = 0.24, *P* = .02). Higher IQ was associated with a higher number of DTD (*B* = 0.073, *P* < .001). Current subclinical delusions compared with no PE were associated with fewer DTD in children at FHR-SZ (*P* = .04) and controls (*P* < .05). Associations between delusions and DTD were nullified when accounting for IQ.** ***Conclusions:*** **JTC marks familial risk of psychosis in preadolescence, not reducible to general intelligence. JTC is associated with subclinical delusions, but this may be an expression of intellectual impairment. Future studies should establish temporality between JTC and delusion formation and examine JTC as a target for early intervention.**

Key words: childhood/adolescence/cognitive bias/delusions/subclinical psychosis

Introduction

Understanding the psychological underpinnings of psychotic experiences (PE), ie, subclinical hallucinations and delusions thought to occur on a continuum with psychotic disorders,[1] in children and adolescents, provides a potential for early identification of at-risk individuals and for informing early prevention and intervention. Cognitive models for positive psychotic symptoms propose that delusions partly arise from biased cognitive processes leading to rapid, erroneous appraisals and interpretations of experiences and to a reduction of capacity for reflecting on and changing beliefs in light of new evidence.[2–4] This is supported by findings that adults with delusions show cognitive biases[5] including the jumping to conclusions (JTC) bias, ie, making decisions based on inadequate evidence.[6] The JTC bias is consistently found in adults with psychosis who require less information before reaching a decision than healthy individuals and individuals with

nonpsychotic mental disorders.[6–8] Little is known of JTC and its associations with PE in children and adolescents. JTC is also found in adult first-degree relatives of individuals with psychosis,[9,10] suggesting that it is a trait marker of psychosis risk. Whether JTC manifests as a marker of familial liability for psychosis as early as preadolescence is, to the best of our knowledge, unexplored.

The majority of evidence suggests that the JTC bias is contingent upon the presence of delusional ideation. In clinical samples of individuals with psychosis, those with current delusions show more JTC than those without delusions.[5–7,11] Additionally, JTC covaries with delusions across the diagnostic spectrum and with delusion proneness in nonclinical adult populations.[5,10–15] In adult first-degree relatives of individuals with psychosis, associations between sibling status and JTC were found in siblings with subthreshold delusions, but not in those with subthreshold hallucinations.[9] Longitudinal findings from clinical populations suggest that the presence of JTC is implicated in the persistence and worsening of delusions in individuals with psychosis[16,17] which, along with meta-analytic evidence,[5,6] suggests that the JTC bias may be causal to the formation and maintenance of delusions. However, studies examining whether JTC precedes delusions in nonclinical populations are lacking. Findings regarding delusions are not entirely unequivocal as some studies have not found associations with JTC or only found them in either individuals with clinical psychosis or controls[7,12,18–21] or found links between JTC and hallucinations.[22]

There are few reports on JTC and its relation to PE in childhood and adolescence. One study showed that the presence of PE increased the odds of JTC in a sample of children and adolescents (aged 5–14 y) referred to child and adolescent mental health services.[23] In an overlapping sample, JTC was associated with PE severity.[24]

IQ is the most commonly examined neurocognitive factor in relation to JTC and appears to be linked with JTC in both clinical and nonclinical populations. The aforementioned study of children and adolescents found that lower IQ increased the odds of JTC.[23] Similarly, evidence from adult populations suggests that IQ deficits are associated with JTC. In a study of adults with first-episode psychosis, IQ accounted for a large part of the variance in JTC suggesting that JTC may be understood as part of a general cognitive impairment in psychosis.[18] Another study found that lower IQ was associated with JTC in individuals with first-episode psychosis and controls and that associations between clinical status and JTC were rendered nonsignificant when accounting for IQ and working memory.[7]

To the best of our knowledge, no previous study has examined the JTC bias in relation to subclinical hallucinations and delusions and IQ in children at familial high risk of schizophrenia and bipolar disorder compared with population-based controls, (2) examine whether PE with and without delusions are associated with JTC in this population, (3) investigate potential differential associations between PE and JTC across familial high risk groups, and (4) ascertain whether IQ affects the associations between familial high risk group, PE, and JTC.

Methods

Participants

The current study is a part of the VIA 11 Study which is the first follow-up of an ongoing, longitudinal cohort study, The Danish High Risk and Resilience Study. The original cohort consisted of 522 seven-year-old children with at least 1 biological parent with a schizophrenia spectrum disorder (FHR-SZ) (n = 202, ICD-10 codes: F20, F22, and F25 or ICD-8 codes: 295, 297, 298.29, 298.39, 298.89, and 298.99), or bipolar disorder (FHR-BP) (n = 120, ICD-10 codes: F30 and F31 or ICD-8 codes: 296.19 and 269.39), and population-based controls (hereafter controls) where neither parent was diagnosed with these disorders (n = 200). The cohort was retrieved from the Danish national registers. The first face-to-face assessments were carried out when the children were 7 years old. Data for the current study stem from the first face-to-face follow-up which took place between March 2017 and June 2020 when the children were 11 years old. Child assessors were blinded to familial risk status. The cohort and study design are described in detail elsewhere.[25]

The study was approved by the Danish Data Protection Agency. The study follows the guidelines of the Danish Committee on Health Research Ethics although ethical approval was deemed unnecessary due to the observational nature of the study. Written informed consent from the parent or other legal guardian and assent from the children were obtained following explanation of the study procedures.

Measures

Jumping to Conclusions. The JTC bias was assessed with a modified version of the Beads Task[26,27] which is the most commonly used paradigm for assessing JTC.[6] A previous study has demonstrated the suitability of the Beads Task for assessing JTC in children and adolescents.[23]

The Danish instructions were devised by the first and third authors (M.G. and J.R.M.J.). In the current study, children were presented with 2 jars containing 100 beads each, of 2 different colors in equal but opposite ratios. To ensure task comprehension, children were presented with a practice trial with 2 jars of beads with ratios of 85:15 and 15:85, before completing 4 trials with ratios of 60:40 and 40:60, and instructions were repeated before each trial. Including practice and several trials reduces miscomprehension and elicits a better reflection of representative performance in

adults.[6] We employed the harder 60:40/40:60 version as it better distinguishes between individuals with schizophrenia and controls as well as between individuals with attenuated biases, eg, at-risk groups, and controls than the easier 85:15/15:85 version.[8,28,29]

For the current study, the sequence of beads for the 85:15/15:85 trial was taken from Hassanali et al's study,[23] whereas the sequences for the four 60:40/40:60 trials were made using a random number generator. The sequences are shown below:

Trial 1 (purple/green):PPPGPPPGPPPGPPGPPPPP
Trial 2 (red/black):RBRRBRRRBRBRBBRBBRRR
Trial 3 (red/black):BRBRBBRBBBRBRBRBRBBR
Trial 4 (red/black):RBBRBRRBBBBRBBBRBRRB
Trial 5 (red/black):BRBRRRBBRBRRBRRBBRRR

On each trial, the child was informed of the number and ratio of beads in each jar and told that the beads would be drawn consecutively from one of the jars in random order. However, the beads were presented in the prespecified sequences. The child was instructed to guess which jar the beads were being drawn from when it felt certain. After the instructions were given, the jars were hidden and the child was presented with the first bead. The child was asked whether it wished to see more beads or make a guess. The bead was then hidden from the child's view. This was repeated until the child made a guess. It was then noted how many beads the child had seen. If the child had not guessed after 20 beads, it was prompted to decide.

The main outcome variable indexing the JTC bias for this study is the number of beads drawn, usually referred to as "draws to decision" (DTD), operationalizing the amount of evidence gathered, ie, the lower the DTD, the more pronounced the JTC bias.[6] For this study, DTD is defined as the average number of beads drawn across the four 60:40/40:60 trials. As a secondary outcome, we examined a categorical, binary JTC variable, hereafter referred to as "extreme JTC." We used a cutoff of guessing after seeing a single bead, in keeping with a previous FHR study showing that this cutoff better distinguishes between groups with different degrees of psychosis liability than less stringent cutoffs.[10] In the current study, extreme JTC was defined as guessing after a single bead on one or more of the four 60:40/40:60 trials.

Psychotic Experiences. PE were assessed with the psychosis supplement from the Kiddie Schedule for Affective Disorders and Schizophrenia—Present and Lifetime version (K-SADS-PL).[30] Children were asked about 9 types of hallucinations and 13 types of delusions. If a symptom received a K-SADS-PL-score of 2 "possible" or 3 "definite," it was reassessed on a scale ranging from 0 = absent to 6 = severe and psychotic. For the analyses, scores were recoded into 0–1 = absent or possible PE and 2–6 = definite PE. Only definite PE were considered. All PE were consensus-rated with a senior research child and adolescent psychiatrist (the second last author, A.A.E.T.). Current PE were defined as occurring within the past 6 months. Methods and results are described in detail elsewhere.[31] PE groups for the current study were defined as children with no current PE, current hallucinations only, or current delusions.

General Intelligence, Pubertal Stage, Global Functioning, and Dimensional Psychopathology. General intelligence (IQ) was measured with Reynolds Intellectual Screening Test.[32] Methods and results are described in detail elsewhere.[33] Pubertal onset was ascertained with self-reported Tanner Stages.[34] Global functioning was assessed with Children's Global Assessment Scale (CGAS).[35] Dimensional psychopathology was measured with the Child Behavior Check List (CBCL)[36] completed by the child's primary caregiver.

Statistical Analyses

Between-group differences in background characteristics were analyzed with chi-square tests and one-way ANOVA. Dropout analyses were performed with chi-square tests and *t*-tests.

Crosstabs were used for calculating frequencies and percentages. Differences in mean DTD were analyzed through ANCOVA, with familial high risk group (FHR group) as independent variable and DTD as dependent variable. Analyses were adjusted for sex of the child and then IQ.

Associations between PE group and DTD were ascertained with ANCOVA with DTD as dependent variable. Analyses were adjusted for sex of the child, then, to control for effect of group, FHR group, and finally IQ. To check for interaction effects, an interaction term with FHR group × PE group was added to the unadjusted model. Due to the relatively low number of children within each PE group, we also report stratified analyses, adjusted for sex then IQ, to avoid type II errors if the interaction analyses are underpowered to detect differential associations. In exploratory analyses, similar multivariable logistic regressions were conducted using the dichotomous measure extreme JTC as outcome.

Alpha was set to <.05. Data were analyzed using SPSS version 25.

Results

Sample Characteristics

In total, 443 children (FHR-SZ: $n = 169$, FHR-BP: $n = 101$, controls: $n = 173$) participated in the Beads Task at age 11 corresponding with 84.7% of the original cohort.

There were no significant differences between those who participated in the Beads Task and those who did not regarding sex ($\chi^2(1) = 0.023$, $P = .88$), FHR group ($\chi^2(2) = 0.689$, $P = .71$), or prevalence of any Axis I mental disorder at age 7 ($\chi^2(1) = 2.644$, $P = .10$). Those who did

not participate in the Beads Task had lower global functioning at age 7 (CGAS 69.5, SD 15.9) than those who participated (CGAS 73.6, SD 15.0, $t(512) = -2.164$, Cohen's $d = 0.27$, $P = .03$) and higher levels of dimensional psychopathology at age 7 (CBCL 28.1, *SD* 25.0 vs 21.5, *SD* 17.7, $t(492) = 2.738$, Cohen's d 0.35, $P = .006$).

Within the Beads Task sample, there were no differences between FHR groups regarding age at inclusion, sex, or pubertal onset. Children at FHR-SZ had significantly lower IQs than controls and a higher occurrence of PE than children at FHR-BP and controls. Children at FHR-SZ and FHR-BP had lower current global functioning than controls. Children at FHR-SZ had lower functioning than children at FHR-BP. Children at FHR-SZ and FHR-BP had higher levels of current dimensional psychopathology than controls (table 1).

DTD Across Familial High Risk Groups

Children at FHR-SZ took significantly fewer DTD (estimated mean 4.9, 95% CI 4.5–5.4) to reach a decision compared with controls (estimated mean 5.9, 95% CI 5.4–6.3, Cohen's $d = 0.31$, $P = .004$), whereas children at FHR-BP did not (estimated mean 5.4, 95% CI 4.8–6.0, Cohen's $d = 0.16$, $P = .18$, figure 1, table 2). The difference between children at FHR-SZ and FHR-BP was nonsignificant (Cohen's $d = 0.15$, $P = .26$). Differences between children at FHR-SZ and controls were attenuated when adjusting for IQ (table 2). IQ significantly predicted DTD ($B = 0.073$, 95% CI 0.046–0.101, $P < .001$), ie, higher IQ was associated with a higher number of DTD.

DTD and PE With and Without Delusions

Across the cohort, delusions were associated with fewer DTD, whereas hallucinations were not. Differences remained when adjusting for FHR group. Adding IQ rendered this association nonsignificant (table 3) and higher IQ predicted a higher number of DTD ($B = 0.069$, 95% CI 0.041–0.097, $P < .001$). There was no interaction between PE group and FHR group ($P = .33$). However, in stratified analyses, the associations between PE and DTD were only significant in children at FHR-SZ and controls (table 4). Children with current delusions in

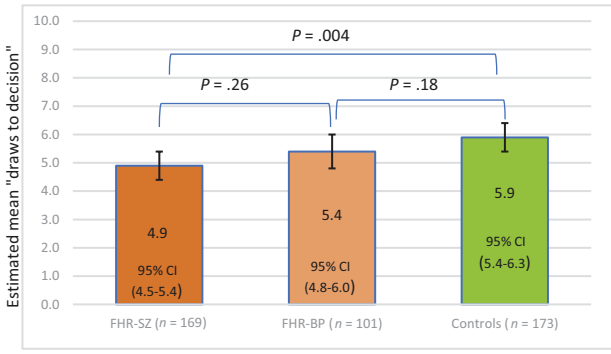

Fig. 1. Draws to decision on the Beads Task in 443 children at FHR-SZ, FHR-BP, and controls in the Danish High Risk and Resilience Study, VIA 11.

Note: Error bars represent 95% CI. FHR-BP, children at familial high risk of bipolar disorder; FHR-SZ, children at familial high risk of schizophrenia spectrum disorders.

Table 1. Demographic and Clinical Background Characteristics of 443 Children With Data on the Beads Task in The Danish High Risk and Resilience Study, VIA 11

	Familial High Risk Group				*P*-Value for Pairwise Comparisons		
	FHR-SZ ($n = 169$)	FHR-BP ($n = 101$)	Controls ($n = 173$)	*P*-Value	FHR-SZ vs Controls	FHR-BP vs Controls	FHR-SZ vs FHR-BP
Female, *n* (%)	81 (47.9%)	45 (44.6%)	80 (46.2%)	.86[a]	NA	NA	NA
Age at inclusion, years, mean (SD)	12.0 (0.3)	11.9 (0.2)	11.9 (0.2)	.46[b]	NA	NA	NA
IQ[c], mean (SD)	95.0 (10.5)	97.3 (9.7)	98.0 (10.4)	.03[b]	.009	.64	.07
Onset of puberty[d], *n* (%)[e]	138 (87.3%)	87 (90.6%)	152 (94.4%)	.09[a]	NA	NA	NA
Any current psychotic experiences, *n* (%)[f]	44 (26.0%)	13 (13.0%)	24 (14.1%)	.005[a]	.006	.80	.01
CBCL total score, mean (SD)[g]	23.2 (20.6)	20.2 (19.8)	12.6 (12.5)	<.001[b]	<.001	.001	.19
Current global functioning[h], mean (SD)[i]	64.5 (15.6)	68.6 (14.7)	75.0 (14.1)	<.001[b]	<.001	.001	.03

Note: CBCL, Child Behavior Check List—school-age version; FHR-BP, children at familial high risk of bipolar disorder; FHR-SZ, children at familial high risk of schizophrenia spectrum disorders; NA, not applicable.
[a]Chi-square test.
[b]One-way ANOVA test with post hoc Least Significant Difference.
[c]Measured with Reynolds Intellectual Screening Test (RIST).
[d]Measured with self-reported Tanner Stages. Onset of puberty defined as Tanner Stage 2–4 (vs Stage 1).
[e]Includes 158 children at FHR-SZ, 96 children at FHR-BP, and 161 controls.
[f]Includes 169 children at FHR-SZ, 100 children at FHR-BP, and 170 controls.
[g]Includes 160 children at FHR-SZ, 99 children at FHR-BP, and 167 controls.
[h]Measured with Children's Global Assessment Scale (CGAS).
[i]Includes 169 children at FHR-SZ, 101 children at FHR-BP, and 170 controls.

Table 2. Draws to Decision on the Beads Task in 443 Children at FHR-SZ, FHR-BP, and Controls in The Danish High Risk and Resilience Study, VIA 11

	Pairwise Comparisons					
	FHR-SZ vs Controls		FHR-BP vs Controls		FHR-SZ vs FHR-BP	
Mean Draws to Decision	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*
Adjusted for sex[a]	.004	0.31	.18	0.16	.26	0.15
Adjusted for sex and IQ[a,b]	.02	0.24	.20	0.15	.49	0.09

Note: FHR-BP, children at familial high risk of bipolar disorder; FHR-SZ, children at familial high risk of schizophrenia spectrum disorders.
[a]A significant effect of sex was found on draws to decision in this model. Being female was associated with a higher number of draws to decision.
[b]A significant effect of IQ was found on draws to decision in this model. Having higher IQ was associated with a higher number of draws to decision.

Table 3. Draws to Decision on the Beads Task in Children With Psychotic Experiences in The Danish High Risk and Resilience Study, VIA 11: Full Cohort

	All (*n* = 439)			
	Psychotic Experiences Without Delusions (*n* = 34)		Psychotic Experiences With Delusions (*n* = 47)	
Mean Draws to Decision	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*
Adjusted for sex[a]	.15	0.25	.01	0.45
Adjusted for sex and FHR group[b]	.20	0.22	.03	0.34
Adjusted for sex, FHR group, and IQ[c]	.26	0.19	.16	0.22

Note: Children with no psychotic experiences during the past 6 months (*n* = 358) were used as reference. FHR, familial high risk.
[a]A significant effect of sex was found on draws to decision in this model. Being female was associated with a higher number of draws to decision.
[b]A significant effect of sex and FHR group was found on draws to decision in this model. Being female was associated with a higher number of draws to decision. Being at FHR-SZ (familial high risk of schizophrenia spectrum disorders) was associated with a lower number of draws to decision.
[c]A significant effect of sex, FHR group, and IQ was found on draws to decision in this model. Being female and having higher IQ were associated with a higher number of draws to decision. Being at FHR-SZ was associated with a lower number of draws to decision.

the FHR-SZ group took significantly fewer DTD (estimated mean 3.9, 95% CI 2.9–5.0) than those without PE (estimated mean 5.2, 95% CI 4.7–5.6, Cohen's $d = 0.46$, $P = .04$). This was not the case for children with current hallucinations (estimated mean 4.8, 95% CI 3.6–6.1) compared with those without PE (Cohen's $d = 0.14$, $P = .68$, table 4). In the FHR-BP group, there were no differences between children with delusions (estimated mean 5.8, 95% CI 3.8–7.8) or hallucinations (estimated mean 5.8, 95% CI 2.8–8.8) and those without PE (estimated mean 5.3, 95% CI 4.7–6.0. For comparison with delusions and hallucinations, respectively: Cohen's $d = 0.17$, $P = .64$ and Cohen's $d = 0.17$, $P = .75$). Among controls, having delusions was associated with a lower number of DTD (estimated mean 4.2, 95% CI 2.2–6.1) than having no PE (estimated mean 6.2, 95% CI 5.6–6.7, Cohen's $d = 0.60$, $P = .05$) whereas having hallucinations was not (estimated mean 4.6, 95% CI 2.7–6.5, Cohen's $d = 0.47$, $P = .12$ table 4). Differences between children with delusions and those without PE were rendered nonsignificant in the FHR-SZ group and among controls when adding IQ to the model (table 4). Higher IQ significantly predicted a higher number of DTD in both groups (FHR-SZ: $B = 0.073$, 95% CI 0.034–0.111, $P < .001$; controls: $B = 0.074$, 95% CI 0.023–0.124, $P = .004$; table 4). In the FHR-BP group, differences between PE groups remained nonsignificant in the model adjusted for IQ which was not significantly associated with DTD within this group (table 4).

Exploratory Analyses of Extreme JTC

Of children at FHR-SZ, 21.9% showed extreme JTC. The same was true of 17.8% of children at FHR-BP and 14.5% of controls. Between-group differences were nonsignificant (supplementary table S1). There was no

Table 4. Draws to Decision on the Beads Task in Children With Psychotic Experiences in The Danish High Risk and Resilience Study, VIA 11: Stratified by Familial High Risk Group

	FHR-SZ (n = 169)				FHR-BP (n = 100)				Controls (n = 170)			
	Psychotic Experiences Without Delusions (n = 18)		Psychotic Experiences With Delusions (n = 26)		Psychotic Experiences Without Delusions (n = 4)		Psychotic Experiences With Delusions (n = 9)		Psychotic Experiences Without Delusions (n = 12)		Psychotic Experiences With Delusions (n = 12)	
Mean Draws to Decision	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*	*P*-Value	Cohen's *D*
Adjusted for sex[a]	.68	0.14	.04	0.46	.75	0.17	.64	0.17	.12	0.47	.05	0.60
Adjusted for sex and IQ[a,b]	.66	0.10	.14	0.32	.68	0.20	.52	0.23	.15	0.41	.17	0.42

Note: Children with no psychotic experiences during the past 6 months in each group (FHR-SZ: n = 125, FHR-BP: n = 87, controls: n = 146) were used as reference. FHR-BP, children at familial high risk of bipolar disorder; FHR-SZ, children at familial high risk of schizophrenia spectrum disorders.
[a]A significant effect of sex was found on draws to decision in children at FHR-SZ in this model. Being female was associated with a higher number of draws to decision.
[b]A significant effect of IQ was found on draws to decision in children at FHR-SZ and controls in this model. Having higher IQ was associated with a higher number of draws to decision.

interaction between PE group and FHR group (P = .98). Extreme JTC was not associated with PE across the cohort or in stratified analyses (supplementary tables S2 and S3). Results remained nonsignificant when adding IQ (supplementary tables S1–S3).

Discussion

Main Findings

In the current cohort, children at FHR-SZ had more hasty decision-making, ie, showed more JTC, measured with the continuous outcome from the Beads Task, than controls. This was not the case for children at FHR-BP. Differences were attenuated when adjusting for IQ. In the model with FHR group, higher IQ predicted less JTC.

When examining the entire cohort, delusions predicted more JTC. Interaction between FHR group and PE group was nonsignificant. Yet, stratified analyses revealed that JTC and delusions were only significantly associated in the FHR-SZ group and among controls. In these groups, the presence of PE with subclinical delusions was associated with more hasty decision-making than no PE. Presence of subclinical hallucinations was not. Associations between delusions and JTC became nonsignificant when adjusting for IQ. In the stratified analyses, higher IQ predicted less JTC in children at FHR-SZ and controls.

In exploratory analyses, the higher occurrence of the extreme JTC bias in the FHR-SZ group compared with the control group was nonsignificant. Extreme JTC was not associated with PE with or without delusions. Adjusting for IQ did not change these results.

Interpretation

To the best of our knowledge, this is the first study to examine JTC and its associations with subclinical delusions and hallucinations and IQ in children at FHR-SZ or FHR-BP. We found that JTC is a vulnerability marker for familial risk of psychosis in preadolescence extending previous findings from older populations,[9,10] whereas JTC does not appear to be an early vulnerability marker for familial risk of bipolar disorder. Of the few studies on JTC in bipolar disorder, one did not find more JTC in adults with bipolar disorder than in controls.[37] Another study, examining affective disorders broadly, found that JTC was more frequent only if affective disorders and PE co-occurred and that JTC increased with the number of PE and psychosis-related help-seeking behavior, supporting the specificity with psychosis.[38] More studies are needed to understand the potential role of JTC in bipolar disorder. Considering the previous evidence, studies on JTC in children born to parents with lithium responsive vs lithium nonresponsive bipolar disorder, the latter being associated with psychotic illness features and elevated rates of psychosis in offspring,[39] would be relevant to examine JTC as an early marker of psychosis risk in bipolar disorder.

Corroborating the previous sparse evidence from children and adolescents,[23,24] we found that JTC was associated with PE in preadolescence. We provide evidence that JTC is contingent upon delusional ideation in both children at FHR-SZ and controls, suggesting that the presence of hasty decision-making may serve as a vulnerability marker of delusion proneness both inside and outside the context of familial risk of psychosis in preadolescence. This extends previous findings of JTC and

subclinical delusions in older populations[9,10,12,14] and supports the hypothesis that PE lie on a continuum with psychotic disorders.[1] In line with this, factors usually associated with psychosis in adults, including JTC, accounted for a substantial part of the variance in PE in adolescence in the previously mentioned sample of children and adolescents.[40]

In the current cohort, higher IQ was linked with less JTC across models, similarly to the findings of others.[7,10,18,23] When taking IQ into account, differences between FHR groups were attenuated in accordance with the reduced associations between clinical status and JTC observed in other studies when including IQ, adding to the proposition that JTC may be part of a broader cognitive impairment.[7,10,18] Although differences between FHR groups were attenuated, they remained significant, suggesting that the more hasty decision-making among children at FHR-SZ was not entirely attributable to between-group differences in IQ. Associations with subthreshold delusions were rendered nonsignificant when adding IQ. Previous findings are inconsistent as to whether associations between delusions and JTC remain[7] or are reduced or nullified[10,41] when adding IQ. There is evidence that low IQ is associated with a higher risk of PE in preadolescence,[42] thus our findings may suggest that JTC in children with subthreshold delusions denotes underlying impairments in general intelligence which are also associated with increased risk of schizophrenia.[43]

We did not find the extreme JTC bias to be associated with FHR group or PE at this early stage, suggesting that the continuous measure of JTC may be better suited for detecting early, subtle differences.

JTC may be a key cognitive process in delusion formation and has been referred to as a core vulnerability in clinical and subclinical delusions.[44] In adults, in addition to neurocognitive impairments,[7,18,22] JTC is associated with higher-order cognitive functioning deficits such as poorer emotion recognition, a biased attributional style,[45,46] and reduced belief flexibility, ie, the capacity for reviewing and changing beliefs.[4] JTC likely contributes to delusions through a dynamic interplay with other cognitive, affective and emotional processes, and environmental exposures.[2,4,44,47] Studies examining correlates of JTC in preadolescence and establishing temporality between JTC and delusion formation are warranted to further understand the potential role of JTC in an early causal pathway toward delusions. Additionally, the continuum between PE and psychosis within the current FHR population should be explored further by examining JTC along with other putative risk factors for psychosis as predictors of PE.

Interventions targeting the JTC bias, such as computerized reasoning training and metacognitive training, show promise for delusion reduction in individuals with psychosis.[48–52] Evidence for the efficacy of psychological interventions for psychosis in children and adolescents is sparse[53] and to the best of our knowledge, no intervention studies have included JTC. Considering the associations documented in the current cohort, future studies should examine the efficacy of including JTC in preventive interventions in children and adolescents with PE. However, a recent study of adults with psychosis showed that a digitally supported intervention reduced delusions through improvement of belief flexibility, rather than through JTC which did not substantially diminish.[54] Considering this, it should be explored whether early interventions could also benefit from additionally focusing on compensatory strategies for JTC.

Strengths and Limitations

Our findings should be interpreted in light of the strengths and limitations of the study. Same-aged children were examined by trained mental health professionals using commonly employed methods for measuring JTC and PE. Interviewers were blinded to children's FHR status and previous data. The study design allowed examination of hallucinations and delusions separately and examination of current symptoms, which enabled extension of previous findings of JTC and specific associations with current delusional ideation. We employed several trials of the Beads Task to increase task comprehension and representativity of the findings.

Some limitations should also be considered. The FHR-BP group was smaller than the other groups which weakens estimates of differences and no firm conclusions should be drawn regarding this group. The discrepancy between the nonsignificant interaction analyses and the stratified analyses suggests that the interaction analyses were underpowered to detect differential associations between PE and JTC across FHR groups. Furthermore, the number of children with current hallucinations or delusions were low across groups, and we cannot rule out that this may have affected the results. Ideally, future studies should replicate our findings in a larger preadolescent FHR sample. The design did not enable distinction between children of parents with lithium responsive vs lithium nonresponsive bipolar disorder potentially constituting subgroups with varying psychosis liability and JTC. Moreover, since very few children had more than one type of current delusion, which could be used as a proxy for delusion severity, it was not possible to examine the relation between JTC and delusion severity. Additionally, PE were measured dichotomously, not taking into account the resulting distress or impairment which could potentially have enabled restriction to more severe symptoms. Data for this study were cross-sectional precluding causal inferences about the relation between JTC and delusion formation. Presence of mental disorders, which were more common among children at FHR-SZ and FHR-BP than controls[55] and were associated with PE,[31] and other factors likely to be more

common in children at FHR, such as impulsivity, could also affect JTC. Future studies should examine these associations. Finally, dropout was skewed toward those with better functioning and less dimensional psychopathology remaining in the study making it plausible that the remaining sample was less heterogeneous than the original sample.

Conclusions

This study provides the first evidence that the JTC bias is a marker of familial liability for psychosis in preadolescence and extends previous findings of the link between JTC and subthreshold delusions to include a preadolescent FHR population, supporting the continuum theory for psychosis. Future studies should further explore the underpinnings of PE in preadolescence within this population and examine the potential causal role of the JTC bias in relation to delusion formation and conversion to clinical psychosis with the potential for informing early prevention and intervention.

Supplementary Material

Supplementary material is available at *Schizophrenia Bulletin* online.

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