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CHILD DEVELOPMENT

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Developmental associations between risk-taking and anxiety symptoms across ages 8–12 years

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Abstract

This study explored the transactional association between anxiety symptoms and risk-avoidance in Dutch elementary schoolchildren (N = 1200; 50% girls) across ages 8–12. Anxiety symptoms were obtained using self-, peer-, and teacher-reports. Risk-avoidance was measured using the Balloon Analogue Risk Task—Youth Version. Random-intercept cross-lagged panel models showed that, across informants, increases in anxiety symptoms predicted decreases in risk-taking. Apart from minor exceptions, this effect was similar across sexes. For peer-reports, the reverse path from decreases in risk-taking to increased anxiety was also found. Overall, this study gives insight into the developmental link between symptoms of anxiety and risk-avoidance which is important for early signaling and prevention as well as for our understanding of the consequences of childhood anxiety symptoms.

Anxiety problems are common in young children. The worldwide prevalence rate of children who are suffering from anxiety problems is estimated to lie between 3% and 24% (Cartwright-Hatton et al., 2006). Children with symptoms of anxiety show long-lasting disabilities into adolescence and adulthood ranging from lower academic achievements (Mychailyszyn et al., 2010) to substance abuse and suicide attempts (Woodward & Fergusson, 2001). Moreover, it has been shown that symptoms of anxiety in childhood, in many instances, can lead to a full blown anxiety disorder and other psychiatric disorders in adulthood (Cartwright-Hatton et al., 2006). Therefore, there is an urgent need to better understand the development and maintenance of anxiety symptoms. In adults, anxiety problems have been linked to the general tendency to avoid risks (Lorian & Grisham, 2010; Maner & Schmidt, 2006; Maner et al., 2007), making some to suggest that interventions targeting anxiety could focus on risk-avoidant behavior (Lorian et al., 2012). An underlying assumption here is that risk-avoidance is a predictor of the development of anxiety symptoms. However, longitudinal studies into the nature of the developmental link between anxiety symptoms and risk-avoidance in children are lacking. Therefore, we will investigate the—possibly sex-specific—developmental associations between anxiety symptoms and risk-avoidance in mainstream elementary schoolchildren followed across ages 8–12 years.

Risk-taking behavior is defined as voluntary behavior that involves a certain chance of negative outcomes, such as danger, harm, or loss of resources, but also provides the opportunity to obtain a reward (Aklin et al., 2005). Children may differ in their general tendency to take risks (MacPherson et al., 2010; Tieskens et al., 2018). That is,

Abbreviations: BART–Y, Balloon Analogue Risk Task—Youth Version; BI, behavioral inhibition; CBT, cognitive behavioral therapy; CFI, comparative fit index; GAD, generalized anxiety disorder; RI-CLPM, random-intercept cross-lagged panel model; RMSEA, root mean square error of approximation; SES, socioeconomic status; SRMR, standardized root mean square residual.

some children have a propensity to take risks while others mostly avoid those risks. It is known that a balanced level of risk-taking behavior is important for exploration and healthy development (Sandseter & Kennair, 2011). Yet, heightened risk-taking behavior has been associated with externalizing outcomes such as antisocial behavior and attention deficit disorder (Humphreys & Lee, 2011; Tieskens et al., 2018). In contrast, the avoidance of risk-taking has been related to internalizing symptoms, including anxiety symptoms, in adolescents and adults (Broman-Fulks et al., 2014; Eisenberg et al., 1998; Giorgetta et al., 2012; Lorian & Grisham, 2010; Maner & Schmidt, 2006; Maner et al., 2007). However, research into the link between childhood anxiety symptoms and risk-avoidance is lacking.

Anxiety problems are marked by excessive worry, fear, and avoidance behavior (Olatunji et al., 2010). According to the diagnostic and statistical manual of mental disorders (DSM)-5 (American Psychiatric Association, 2013), symptoms of anxiety can be subdivided into different types of anxiety disorders, such as generalized anxiety, panic disorder, social anxiety, separation anxiety, and other specific phobias. However, certain anxiety symptoms, such as avoidance behaviors, are present in all types of anxiety disorders. Although children with specific forms of anxiety symptoms may show disorder-specific avoidance behavior such as the avoidance of public places in agoraphobia and the avoidance of social interactions in social phobia (Eaton et al., 2018), underneath those specific avoidance behaviors, a general tendency to avoid risks may be present in all individuals with anxiety symptoms. In children, there is limited knowledge on the link between general symptoms of anxiety and risk-avoidance. It is important to get more knowledge on the nature of the developmental link between risk-avoidance and early general anxiety symptoms in elementary school children. Namely, if risk-avoidance is a precursor for the development of anxiety, this knowledge is important to improve intervention and prevention programs to reduce anxiety symptoms. Second, if anxiety symptoms predict increases in risk-avoidance, targeting risk-avoidance might help prevent or diminish the negative consequences of anxiety symptoms. Therefore, in this research, we will focus on general symptoms of anxiety and a global tendency to avoid risks in children attending mainstream elementary schools.

Theoretically, there is evidence suggesting that general risk-avoidance plays a role in the development and maintenance of anxiety problems. However, on the nature of this developmental link, there are different perspectives. Some theories indicate a directional link where risk-avoidant-related behavior is seen as a precursor for anxiety development (Lahat et al., 2011). Others suggest the reverse path where anxiety symptoms predict later risk-avoidant behavior (Hartley & Phelps, 2012). Lastly, some suggest a bidirectional link between risk-avoidance and anxiety symptoms (Lorian & Grisham, 2010; Maner et al., 2007). Below, those three theoretical perspectives will be further described.

First, theories on behavioral inhibition (BI) indicate that risk-avoidance might be a precursor for anxiety problems (Lahat et al., 2011). BI is a temperament characterized by withdrawn and restraint behavior toward the unfamiliar (Kagan et al., 1984) and has been suggested to be related to risk avoidant behavior (Lorian & Grisham, 2010). Moreover, Elliot and Thrash (2010) describe BI as a trait within a broader temperamental construct, namely avoidance temperament, which is marked by a neurobiological sensitivity to negative—possibly threatful—stimuli and by avoidant and withdrawn behavior toward such stimuli. Studies have shown that children and adolescent with BIs or avoidance temperaments have a greater risk of developing anxiety problems (Biederman et al., 1993; Hirshfeld et al., 1992; Hudson & Dodd, 2012; Liew et al., 2014; Paulus et al., 2015). However, not all children with such temperamental characteristics develop anxiety symptoms (Fox et al., 2001) and it has been proposed that several cognitive processing biases, which have been linked to risk-avoidance (Hartley & Phelps, 2012), may play a role in the link between BI or avoidance temperament and anxiety symptoms. It has been shown, for example, that behaviorally inhibited children who exhibit an attentional bias toward threat are at greater risk to develop anxiety symptoms (Dodd et al., 2020; Nozadi et al., 2016; White et al., 2017). Others have proposed that altered sensitivity to rewards or the excessive focus on avoiding errors may be a possible mechanism explaining the link between BI and anxiety symptoms (Bar-Haim et al., 2009; Guyer et al., 2006; Lahat et al., 2018), Also, some suggest that specifically those behaviorally inhibited children who exhibit an overall negative interpretation of possible threatful situations have an increased risk to develop anxiety symptoms (Dodd et al., 2012). Lastly, Sheynin et al. (2014) showed that avoidance learning is faster in individuals high in BI which may predispose them to develop anxiety symptoms. Taken together, it is suggested that in individuals with an avoidance temperament or BI temperament, biases in information processing of threats and facilitated avoidance learning may predispose them to develop anxiety symptoms. The biases in information processing may increase their avoidance behavior and by the excessive avoidance of risks (i.e., possible threats), adaptive learning of how to deal with possible threatful situations may be hindered which may increase anxiety symptoms.

Second, there are cognitive behavioral theories that suggest a reverse effect from anxiety symptoms to later risk-avoidance in that they regard risk-avoidance to be a consequence of anxiety symptoms. They propose that cognitive mechanisms that have been described above, such as attentional biases toward threat and increased error monitoring present in those with anxiety problems are likely to impact risk avoidant decision-making

(Hartley & Phelps, 2012) and that more severe anxiety symptoms will therefore lead to increased risk-avoidant decision-making. In line with this, studies have shown that anxious children showed an increased tendency to interpret situations as threatful and that this tendency increased over time in those anxious children (Creswell & O'Connor, 2011). Also, in the school test-anxiety literature, it has been proposed that avoidance temperament may be related to evaluative threat and that this evaluative threat, in turn, may induce information processing biases and allocate attentional resources to threat-related stimuli (Liew et al., 2014; Putwain et al., 2020).

Lastly, Maner et al. (2007) propose a bidirectional link between risk-avoidance and anxiety symptoms. They suggest that, in line with the theories mentioned in the previous paragraph, anxious people have a heightened perception of the severity of negative outcomes (i.e., pessimistic risk appraisal). This pessimistic risk appraisal may cause risk-avoidant decision-making. This risk-avoidant decision-making, in turn, may increase a pessimistic risk appraisal and increase anxiety symptoms, maintaining a vicious cycle. Taken together, there is a theoretical foundation to expect a developmental—possible bidirectional—link between risk-avoidance and anxiety symptoms in children. However, to date, longitudinal empirical studies describing the link between risk-avoidance and anxiety development in children are scarce and studies have mainly been focused on adolescent and adult samples.

Studies in adults and adolescents have indeed provided empirical support for an association between risk-avoidance and anxiety symptoms in both clinical and non-clinical populations (Broman-Fulks et al., 2014; Eisenberg et al., 1998; Giorgetta et al., 2012; Lorian & Grisham, 2010; Maner & Schmidt, 2006; Maner et al., 2007). However, the direction of the developmental association remains uncertain as none of these studies included repeated measures of risk-avoidance or anxiety symptoms in a developmental sensitive design. In one recent longitudinal study among adults into general avoidance behavior (not specifically risk-avoidance), it was found that stronger avoidance behavior predicted both the increased risk of onset and increased risk of a chronic course of anxiety disorders, suggesting that avoidance, and possibly also risk-avoidance, may precede anxiety problems (Struijs et al., 2018). The role of risk-avoidance in the course of anxiety symptoms and its possible role as a target for treatment has been investigated in another study (Lorian et al., 2012). This study showed that adults with generalized anxiety disorder (GAD) who received internet-delivered cognitive behavioral therapy (CBT) showed increased risk-taking behavior, relative to people who did not receive CBT, as well as decreases in anxiety symptoms. However, mediation analyses did not confirm that the increases in risk-taking mediated the beneficial effects of CBT on GAD symptomatology. Thus, the role of risk-taking behavior in anxiety development is still unclear, and—to our knowledge—is not studied in childhood samples. This seems a serious limitation in our knowledge as anxiety symptoms often originate during childhood (Cartwright-Hatton et al., 2006; de Lijster et al., 2017) and it is important to intervene as early as possible to prevent long-term negative consequences.

When studying the developmental link between risk-avoidance and anxiety symptoms, potential sex differences should be considered. During the elementary school years, girls show higher levels of anxiety symptoms than boys (Zahn-Waxler et al., 2008). Also, some evidence suggests that during these years, girls take less risks than boys (Morrongiello et al., 2010), although others could not confirm such sex differences (MacPherson et al., 2010; Tieskens et al., 2018). However, despite potential similarities in the level of risk-taking behavior of boys and girls, the association of anxiety symptoms and risk-avoidance may differ between the sexes. For instance, it has been suggested that society may reinforce avoidance behavior in females with anxiety symptoms while males are encouraged to face their fears and control their anxiety (for review, see Craske, 2003). Indeed, a previous study among adults showed that the association between fear and avoidance behavior was stronger for females than for males (Stoyanova & Hope, 2012). Whether such sex differences in the link between anxiety symptoms and risk-avoidance are also found among children needs further investigation.

The objective of this study is to investigate the direction of the developmental associations between risk-taking and anxiety symptoms in mainstream elementary schoolchildren followed across ages 8–12 years. Because reports on childhood anxiety symptoms may vary between informants (Miller et al., 2014), children themselves, their teachers, and their classmates are included as informants in this study. Furthermore, general symptoms of anxiety such as worry and general fear symptoms were measured. Based on the outlined theory above and limited previous research, we expected to find transactional, negative associations between risk-taking and anxiety symptoms in that higher levels of anxiety symptoms would predict decreases in risk-taking, which, in turn, would predict increases in anxiety symptoms. Although we expected that girls would score higher on anxiety symptoms than boys, we cannot, based on prior work, make a clear hypothesis on potential sex-specific developmental associations. The analysis of the association between risk-taking and anxiety symptoms represents a confirmatory test and the investigation of gender differences in these associations should be considered exploratory.

METHODS

Participants

This study was part of the larger project 'Happy children, happy adolescents?' which is focused on behavioral, cognitive, social-emotional, and biopsychological

development in elementary schoolchildren. Participating schools (N = 14) were mainstream Dutch elementary schools situated in both urban and rural areas in the central and eastern part of *the Netherlands*. Parents were informed about the project and active consent was obtained for their child to participate. Parents could revoke their consent and children could decline participation at any time during the study. Of the parents whose children were invited to participate, 93.1% consented to their child's participation (de Wilde, Koot, & van Lier, 2016). Data used in the present study were collected in three consecutive age-cohorts of children, across grades 2–6 of elementary school (ages 8–12). Children were assessed annually, in the spring of 2014 (T1), 2015 (T2), 2016 (T3), 2017 (T4), 2018 (T5), and 2019 (T6). The youngest and middle cohort were assessed across grades 2–6 and the oldest cohort was assessed across grades 3–6. Of the 1355 children, 155 children had valid data on only one assessment across the studied period. Given our focus on examining within-person change of risk-taking and anxiety, we excluded the data of these children, leaving a total of 1200 children included in the study. At baseline, excluded children did not differ from included children with regard to sex ($\chi^2(1) = 0.31$, $p = .58$), risk-taking scores ($t(1, 902) = 0.79$, $p = .43$), peer-reported anxiety ($t(1, 1192) = 0.15$, $p = .88$), or self-reported anxiety ($t(1, 903) = 0.13$, $p = .90$). However, excluded children had higher scores on teacher-reported anxiety ($t(1, 1017) = 2.47$, $p < .05$, $\eta^2 = .01$). To get an idea of the nature of the missing data in the sample, included children having missing data on one or more timepoints (apart from missing by design) were compared with children who have complete data on all timepoints. At baseline, the groups did not differ with regard to sex ($\chi^2(1) = 0.22$, $p = .64$), risk-taking scores ($t(1, 846) = 0.09$, $p = .93$), or self-reported anxiety ($t(1, 855) = 0.35$, $p = .54$). However, the included children with missing data points had higher scores on teacher-reported anxiety ($t(1, 949) = 2.79$, $p < .05$, $\eta^2 = .01$) and on peer-reported anxiety ($t(1, 1094) = 2.38$, $p < .05$, $\eta^2 = .01$).

Because of the inclusion of multiple cohorts, we restructured our data according to the age of the child at the time of assessment and used an accelerated longitudinal design to analyze our data. See Table 1 for a detailed description of included participants per wave, per cohort, per age. Moreover, before using the accelerated longitudinal design in our study, we tested for possible cohort effects. This was done by comparing a model where the autoregressive, within-time correlations, and the cross-lagged path coefficients at similar ages across the cohorts were held to be equal to a model in which these paths were freely estimated between cohorts. Parameter constraints across cohorts did not significantly impair model fit in the three models (self-report, $\Delta\chi^2 = 7.51$, $p = .19$; peer-report, $\Delta\chi^2 = 20.90$, $p = .40$; and teacher-report, $\Delta\chi^2 = 16.06$, $p = .71$), suggesting that there are no significant cohort effects, and interpreting the accelerated longitudinal design over developmental age is allowed.

The percentage of children that had a non-Dutch ethnic background was 20%. This is comparable to the Dutch population, with 22.6% (Statistics Netherlands, 2017a). 11.3% of the children in the sample came from low socioeconomic status (SES) households. This percentage is lower compared to the overall Dutch population, where 21.1% is from a low SES household (Statistics Netherlands, 2017b).

Procedure

Data were obtained annually in schools. Children completed peer-nominations of anxiety and a self-reported anxiety questionnaire on tablet computers in their classroom. Children were placed in an exam setting to avoid contact with peers during the assessment. A computerized risk-taking task was completed in a quiet room outside their own classroom. Children were supervised by trained research assistants at all times. Teachers completed online questionnaires on children's anxiety symptoms in the same month the child- and peer-assessments were completed.

Measures

Self-reports of anxiety symptoms

Children's self-reports of anxiety were obtained via the Revised Child Anxiety and Depression Scale (Chorpita

TABLE 1 Sample size per age for each cohort

	Cohort 1		Cohort 2		Cohort 3		Total
Age	**Wave**	***n***	**Wave**	***n***	**Wave**	***n***	***N***
8			T1	385	T2	303	688
9	T1	408	T2	390	T3	330	1128
10	T2	415	T3	384	T4	330	1129
11	T3	405	T4	380	T5	319	1104
12	T4	392	T5	359	T6	300	1051
Total		424		410		366	1200
Sex (%girls)		56%		50%		47%	50%

et al., 2000). Self-reports of anxiety were obtained at all assessment waves except at T2. The GAD subscale was used, consisting of six items such as *I worry that something awful will happen to someone in my family* and *I worry that bad things will happen to me*. Items were rated on a 4-point Likert scale ranging from 0 (never) to 3 (always). Cronbach's alphas ranged from .80 to .87 across assessments. We calculated mean anxiety scores to use in the analyses.

Peer-reports of anxiety symptoms

Peer-perceived anxiety of the child was assessed annually at all assessment waves via peer nominations. Each participating child was instructed to nominate an unlimited number of classmates who they thought fitted the description *this classmate is easily anxious*. The peer-nominated anxiety score per child is obtained by dividing the number of nominations each child received by the total number of (participating) children in the classroom minus 1 (because self-nominations were not allowed). This resulted in scores ranging from 0 (no one nominated the child) to 1 (the child was nominated by all classmates).

Teacher-reports of anxiety symptoms

Teacher-perceived anxiety of the child was assessed with the Problem Behavior at School Interview-short version (Erasmus, 2000). During all assessments, teachers were asked to rate emotional and behavioral problems of the children in their classroom on a 5-point Likert scale ranging from 0 (never applicable) to 4 (often applicable). Anxiety was assessed using five items (e.g., *this child is anxious* or *this child worries about a lot of things*). Cronbach's alphas ranged from .82 to .86 across the six assessments. We calculated mean anxiety scores to use in the analyses.

Risk-taking

The tendency of a child to take risks was assessed annually with the Balloon Analogue Risk Task-Youth Version (BART-Y; Lejuez et al., 2002, 2007). Children could gain points by inflating a balloon that was shown on the tablet screen. Every child had to inflate 15 balloons and was instructed to gain as many points as possible. With every inflation the balloon became larger and a point was added to a virtual saving box. The total accumulated points that were earned up to that point were shown next to the saving box. However, they were also told that over-inflation causes the balloon to explode and when this happened the points earned for that specific balloon were retracted. The maximum number of pumps before explosion differed per balloon and was unknown to both the child and research assistant. Children were told that they could decide at any moment before the explosion to stop inflating, and cash the points. The reward consisted of the total number of points earned over all trials. In line with the developer's recommendations and previous studies, risk-taking behavior was assessed by the average number of pumps per balloon for balloons that did not explode (i.e., adjusted average; Lejuez et al., 2002, 2007). Scores on the BART-Y have previously been linked to real-world risk-taking behaviors such as addictive, health, and safety risk behaviors (Lejuez et al., 2003, 2007; MacPherson et al., 2010).

Children's sex

Children's sex was dummy coded as 0 = girls and 1 = boys.

Statistical analysis

The longitudinal associations between risk-taking and anxiety were examined by means of random-intercept cross-lagged panel models (RI-CLPM; for a detailed description, see Hamaker et al., 2015). An advantage of RI-CLPM over conventional cross-lagged panel model is that it decomposes time-invariant "trait-like" differences between individuals, from within-individual changes in anxiety and risk-taking (Hamaker et al., 2015). With this approach, we are able to test how within-person changes in risk-taking and anxiety are related over time while controlling for possible time-invariant associations between risk-taking and anxiety. Three separate RI-CLPMs (one per informant) were modeled.

A graphical representation of the RI-CLPM is shown in Figure 1. The random intercepts (between-person level) capture the time-invariant, trait-like stability of risk-taking and anxiety. The latent factors, in which the variance of the observed variables is loaded on its latent variable, capture the within-person, state-like fluctuations around its own expected score. Subsequently, autoregressive paths between the latent factors are added. For the purpose of studying developmental association (our study hypotheses), the cross-lagged paths between risk-taking at T_x and anxiety at T_{x+1} and vice versa were included. In addition, the within-time correlations between risk-taking and anxiety are estimated as well as the correlation between the random intercepts of risk-taking and anxiety at the between-person level. Sex differences were tested using a multiple-group comparison, where we first freed all structural model parameters between girls and boys. Subsequently, we tested whether the

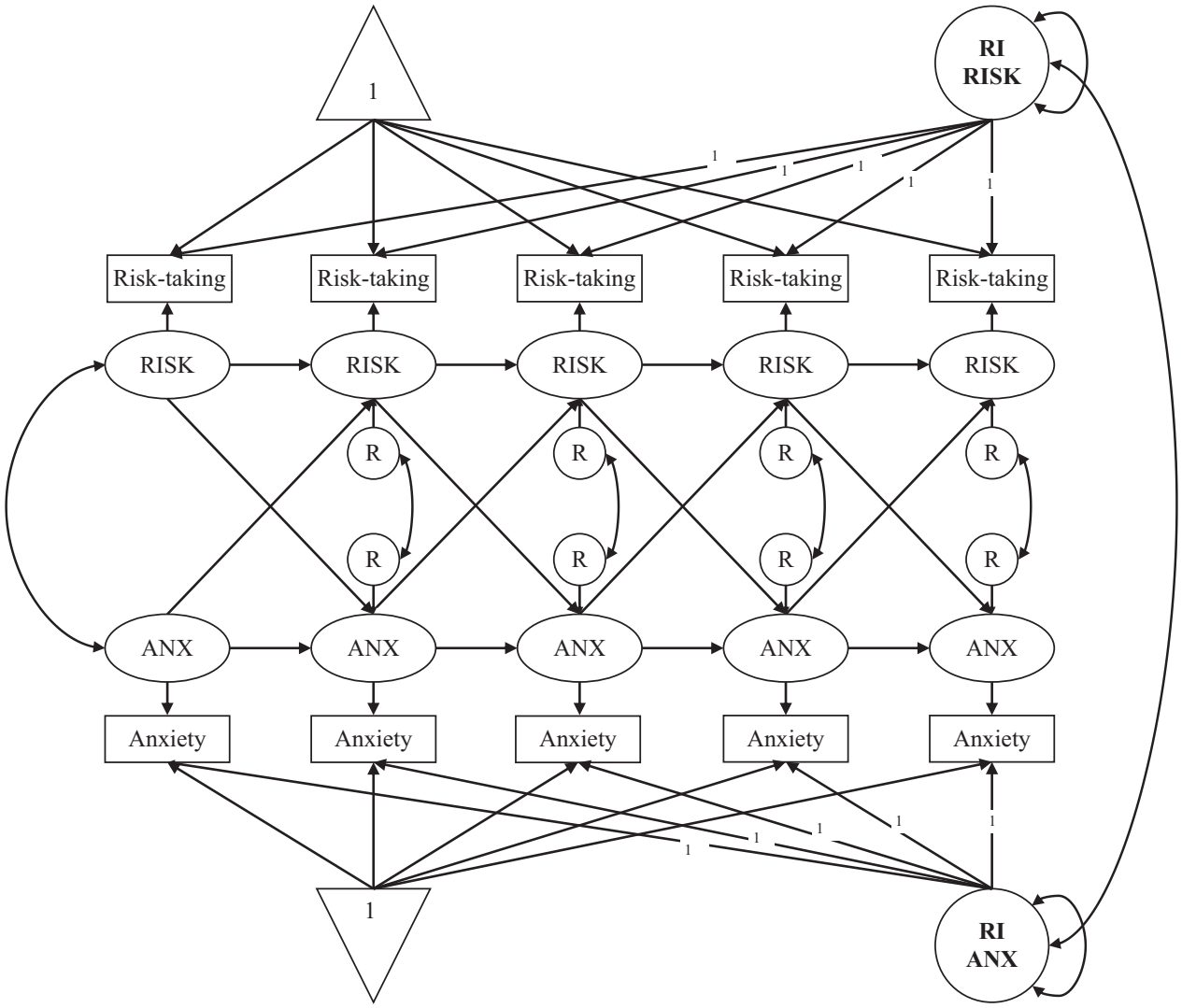

FIGURE 1 Graphical representation of the full RI cross-lagged panel model. R, residual variance; RI ANX, random intercept anxiety; RI RISK, random-intercept risk-taking

estimated paths differed between boys and girls and we constrained all parameters that did not differ significantly between girls and boys to be equal.

Models were fitted in Mplus version 7.1. Los Angeles, CA (Muthén & Muthén, 1998–2012) using full information maximum likelihood to account for occasional missing data (see Table 1 for an overview) and the robust maximum likelihood estimator to account for non-normal distributions of study variables. Standard errors were adjusted to account for clustering of the data within schools using a sandwich estimator (Williams, 2000). Goodness-of-fit indices included the root mean square error of approximation (RMSEA, critical value < .06), the standardized root mean square residual (SRMR, critical value < .08) and the comparative fit index (CFI, critical value > .95; Hu & Bentler, 1999). Model comparisons of nested models were performed using the Satorra–Bentler chi-square difference test (Satorra & Bentler, 2001).

RESULTS

Descriptive statistics

Table 2 provides means, standard deviations, and ranges for all study variables for girls and boys separately. Girls reported higher levels of anxiety than boys from ages 10 to 12. Peers reported more anxious behavior in girls compared to boys across ages 8–12. Teachers did not report sex-specific level differences in anxiety symptoms. At most ages, levels of risk-taking did not differ between sexes. The correlations between anxiety symptoms reported by the different informants were weak (*r*s = .10–.24). Furthermore, intra-class correlations of our study variables were calculated before running the RI-CLPMs. Across waves, 32.3%–40.1% of the variance of risk-taking was explained by differences between children (between-person variance) while the remainder of the variance was explained by fluctuations

TABLE 2 Means and standard deviations of all study variables for boys and girls separately

	Risk-taking					Self-reported anxiety					Peer-reported anxiety					Teacher-reported anxiety				
	Girls		Boys		Test	Girls		Boys		Test	Girls		Boys		Test	Girls		Boys		Test
Age	*M* (*SD*)	Range	*M* (*SD*)	Range	*t*	*M* (*SD*)	Range	*M* (*SD*)	Range	*t*	*M* (*SD*)	Range	*M* (*SD*)	Range	*t*	*M* (*SD*)	Range	*M* (*SD*)	Range	*t*
8	11.43 (9.41)	1.13–59.89	10.21 (7.64)	1.43–43.00	−1.69†	0.60 (0.52)	0–2.5	0.64 (0.46)	0–2.0	0.72	0.1 (0.1)	0–0.59	0.03 (0.07)	0–0.53	−11.07**	0.95 (0.76)	0–3.0	0.96 (0.75)	0–3.8	0.19
9	12.78 (8.36)	1.92–57.45	12.47 (9.76)	1.33–71.20	−0.53	0.78 (0.56)	0–2.8	0.76 (0.61)	0–3.0	−0.37	0.17 (0.15)	0–1	0.05 (0.1)	0–0.75	−15.34**	0.9 (0.71)	0–2.8	0.94 (0.69)	0–3.0	1.16
10	14.55 (9.30)	1.93–60.36	14.12 (9.65)	1.20–61.00	−0.74	0.83 (0.64)	0–3.0	0.75 (0.66)	0–3.0	−1.66†	0.16 (0.14)	0–0.78	0.05 (0.1)	0–0.71	−13.89**	0.86 (0.69)	0–3.4	0.87 (0.69)	0–3.8	0.21
11	15.87 (9.36)	1.07–54.90	16.74 (10.68)	1.20–62.29	1.42	0.76 (0.54)	0–3.0	0.63 (0.54)	0–3.0	−3.86**	0.15 (0.15)	0–0.80	0.05 (0.11)	0–0.82	−12.40**	0.78 (0.66)	0–3.6	0.81 (0.70)	0–4.0	0.79
12	17.8 (10.01)	2.60–70.14	20.03 (12.28)	2.46–78.00	3.18*	0.78 (0.61)	0–3.0	0.56 (0.55)	0–3.0	−6.06**	0.14 (0.16)	0–0.88	0.04 (0.09)	0–0.71	−13.00**	0.75 (0.64)	0–3.6	0.80 (0.74)	0–3.8	1.18

Note: *t* values regard tests of sex differences.

†$p < .10$.

*$p < .05$; **$p < .001$.

within a child over time (within-person variance). These percentages were 44.4%–56.6%, 46.9%–57.4%, and 26.1%–34.9% for self-, peer-, and teacher-reported anxiety, respectively.

Developmental associations of risk-taking and anxiety symptoms

Results of all parameter estimates across informants are depicted in Table 3. Figure 2 depicts the main results for self-, peer-, and teacher reports. Across informants, results showed negative within-person associations of anxiety predicting decreases in risk-taking, across ages 8–12 (for self-reported anxiety across ages 9–12). Negative reverse effects of risk-taking predicting decreases in anxiety the next year were only found for peer-rated anxiety. All significant cross-lagged paths were stable over time across the studied period. Specific results per informant are listed below.

Self-reported anxiety symptoms

Across the studied period, increases in anxiety predicted decreases in risk-taking behavior 1 year later ($\beta = -.04$ to $-.06$, $p < .05$; see Figure 2). These associations were similar for boys and girls ($\Delta\chi^2(1) = 0.27$, $p = .61$) and stable across ages 9–12. Risk-taking did not predict anxiety symptoms across age 9–12 ($p = .78$). Model fit was acceptable with RMSEA = .04, SRMR = .07, CFI = .95.

Peer-reported anxiety symptoms

Similar to self-reported anxiety, results for peer-reported anxiety showed that increases in anxiety predicted decreases in risk-taking behavior 1 year later (βs = $-.03$ to $-.10$, p = <.001) and this effect was stable across age 8–12. In addition, and contrary to self-reported anxiety, decreases in children's risk-taking behavior also predicted increases in peer-reported anxiety 1 year later (βs = $-.03$ to $-.07$, $p < .05$), which was also stable across ages 8–12. Again, no sex differences were found ($\Delta\chi^2(2) = 4.21$, $p = .12$) and model fit was acceptable with RMSEA = .05, SRMR = .06, CFI = .95.

Teacher-reported anxiety symptoms

For teacher-reported anxiety, a sex-specific link of anxiety predicting risk-taking was found. That is, only girls ($\Delta\chi^2(1) = 9.70$, $p < .01$) who are perceived as more anxious by their teacher, showed less risk-taking 1 year later (βs = $-.06$ to $-.08$, $p < .05$), which was a stable effect across ages 8–12. Similar to the self-reported anxiety model, risk-taking was not associated with subsequent anxiety development in the next

TABLE 3 Unstandardized and standardized coefficients for all estimated paths for the three separate random-intercept-cross-lagged panel models

	Self-report						Peer-report	
	Girls			Boys			Girls	
	B	*β*	95% CI (*β*)	*B*	*β*	95% CI (*β*)	*B*	*β*
Within-person								
Stability paths								
AN 8 → AN 9							−0.09	−.05
AN 9 → AN 10	0.25**	.21**	[.12, .30]	0.25**	.23**	[.11, .34]	0.23*	.25*
AN 10 → AN 11	0.25**	.31**	[.17, .45]	0.25**	.31**	[.16, .46]	0.47**	.40**
AN 11 → AN12	0.25**	.21**	[.10, .33]	0.25**	.25**	[.12, .39]	0.47**	.45**
RT 8 → RT 9	0.04	.05	[−.13, .24]	0.04	.03	[−.07, .14]	0.05	.06
RT 9 → RT 10	0.22*	.18*	[.06, .31]	0.22*	.23*	[.05, .41]	0.21*	.17*
RT 10 → RT 11	0.39**	.38**	[.26, .49]	0.39**	.34**	[.24, .44]	0.39**	.38**
RT 11 → RT 12	0.39**	.37*	[.28, .46]	0.39**	.33**	[.23, .43]	0.39**	.37**
Cross-lagged paths								
AN 8 → RT 9	1.46	.09	[−.15, .34]	1.46	.06	[−.11, .06]	−6.10**	−.07*
AN 9 → RT 10	−0.91*	−.05*	[−.10, −.002]	−0.91*	−.06†	[−.11, .001]	−6.10**	−.10**
AN 10 → RT 11	−0.91*	−.06*	[−.12, −.004]	−0.91*	−.05*	[−.11, −.001]	−6.10**	−.09**
AN 11 → RT 12	−0.91*	−.05*	[−.09, −.001]	−0.91*	−.04*	[−.07, −.003]	−6.10**	−.10**
RT 8 → AN 9	−0.01	−.06	[−.18, .04]	−0.004	−.05	[−.12, .02]	−0.001*	−.03*
RT 9 → AN 10	−0.001	−.01	[−.04, .03]	−0.001	−.01	[−.05, .04]	−0.001*	−.03*
RT 10 → AN 11	−0.001	−.01	[−.07, .05]	−0.001	−.01	[−.07, .05]	−0.001*	−.03*
RT 11 → AN 12	−0.001	−.01	[−.06, .04]	−0.001	−.01	[−.08, .06]	−0.001*	−.03*
Within-time corr.								
AN 8 with RT 8	0.15	.04	[−.09, .17]	0.15	.06	[−.12, .25]	−0.08*	−.13*
Within-time res. Corr.								
AN 9 with RT 9	−0.06	−.02	[−.06, .03]	−0.06	−.01	[−.05, .02]	−0.08*	−.09*
AN 10 with RT 10	−0.06	−.01	[−.05, .02]	−0.06	−.01	[−.05, .02]	−0.08*	−.08*
AN 11 with RT 11	−0.06	−.02	[−.06, .03]	−0.06	−.02	[−.05, .02]	−0.08*	−.08*
AN 12 with RT 12	−0.06	−.01	[−.05, .02]	−0.06	−.01	[−.04, .02]	−0.08*	−.08*
Between-person								
Random intercept corr.								
AN with RT	−0.24†	−.17*	[−.32, −.01]	−0.24†	−.17*	[−.32, .−01]	−0.004	−.01

Note: The equality constraint over time and between gender was imposed on the unstandardized coefficients; therefore, the reported standardized coefficients can still slightly differ over time and between gender.

Abbreviations: AN, anxiety; corr, correlation; res, residual; RT, risk-taking.

†$p < .10$.

*$p < .05$.; **$p < .001$.

year ($p = .52$), across the studies period. Model fit was good with RMSEA = .03, SRMR = .05, CFI = .97.

DISCUSSION

The goal of this study was to investigate the nature of the developmental associations between risk-avoidance and anxiety symptoms in elementary schoolchildren across ages 8–12 years. Specifically, we examined whether within-person changes in risk-taking were related to within-person changes in anxiety and vice versa. We found that, across informants (self-, peer-, and teacher-reports), increases in anxiety symptoms predicted decreases in risk-taking in the next year. This developmental link was found while accounting for the static association between anxiety symptoms and risk-taking. We found only limited support for decreases in risk-taking preceding increases in anxiety symptoms, as this association was found only for peer-reported anxiety symptoms. Most associations were similar for boys and girls, except for teacher rated

				Teacher-report					
	Boys			Girls			Boys		
95% CI (β)	*B*	β	95% CI (β)	*B*	β	95% CI (β)	*B*	β	95% CI (β)
[−.30, .20]	−0.09	−.05	[−.30, .19]	0.32**	.32**	[.16, .47]	0.10	.10	[−.06, .27]
[.06, .44]	0.23*	.18*	[.03, .34]	0.03	.03	[−.12, .19]	0.03	.03	[−.12, .18]
[.30, .51]	0.33**	.32**	[.20, .43]	0.09	.09	[−.11, .29]	0.09	.08	[−.11, .27]
[.30, .60]	0.33**	.44**	[.28, .60]	0.19*	.20*	[.02, .37]	0.41**	.38**	[.22, .54]
[−.13, .25]	0.05	.04	[−.08, .15]	0.06	.07	[−.13, .27]	0.06	.05	[−.08, .17]
[.05, .30]	0.21*	.21*	[.04, .39]	0.21*	.18*	[.05, .31]	0.21*	.22*	[.04, .40]
[.27, .49]	0.39**	.34**	[.26, .43]	0.39**	.38**	[.26, .50]	0.39**	.34**	[.25, .44]
[.29, .46]	0.39**	.33**	[.23, .43]	0.39**	.37**	[.27, .47]	0.39**	.33**	[.23, .44]
[−.11, −.03]	−6.10**	−.03*	[−.05, −.01]	−0.90*	−.08*	[−.14, −.02]	0.69	.05	[−.02, .12]
[−.15, −.05]	−6.10**	−.05**	[−.08, −.02]	−0.90*	−.07*	[−.12, −.01]	0.69	.05	[−.02, .12]
[−.13, −.05]	−6.10**	−.06*	[−.10, −.02]	−0.90*	−.06*	[−.11, −.01]	0.69	.04	[−.02, .10]
[−.15, −.05]	−6.10**	−.05*	[−.08, −.02]	−0.90*	−.06*	[−.09, −.02]	0.69	.04	[−.02, .09]
[−.06, −.003]	−0.001*	−.05*	[−.09, −.01]	−0.001	−.02	[−.08, .04]	−0.001	−.02	[−.06, .03]
[−.06, −.002]	−0.001*	−.05*	[−.10, −.003]	−0.001	−.02	[−.07, .04]	−0.001	−.02	[−.09, .04]
[−.06, −.004]	−0.001*	−.07*	[−.09, −.01]	−0.001	−.02	[−.09, .05]	−0.001	−.02	[−.08, .04]
[−.06, −.003]	−0.001*	−.03*	[−.13, −.02]	−0.001	−.02	[−.10, .05]	−0.001	−.02	[−.09, .04]
[−.23, −.04]	0.03	.12	[−.05, .30]	0.25	.05	[−.04, .14]	0.25	.06	[−.06, .18]
[−.13, −.05]	−0.03†	−.05†	[−.10, .01]	−0.05	−.01	[−.06, .03]	−0.05	−.01	[−.05, .03]
[−.12, −.05]	−0.03†	−.04*	[−.07, −.01]	−0.05	−.01	[−.06, .03]	−0.05	−.01	[−.05, .03]
[−.12, −.04]	−0.03†	−.04*	[−.07, −.001]	−0.05	−.01	[−.05, .03]	−0.05	−.01	[−.04, .03]
[−.12, −.03]	−0.03†	−.04†	[−.09, .002]	−0.05	−.01	[−.06, .03]	−0.05	−.01	[−.04, .02]
[−.12, .09]	−0.004	−.01	[−.12, .09]	−0.10	−.06	[−.21, .09]	−0.44**	−.25**	[−.39, −.11]

anxiety symptoms, which predicted less risk-taking over time only among girls.

Our finding that decreases in risk-taking are preceded by increases in symptoms of anxiety is in line with theories proposing that anxiety may increase risk-avoidance (Creswell & O'Connor, 2011; Hartley & Phelps, 2012; Maner & Schmidt, 2006) and with previous studies that showed an association between risk-avoidance and anxiety symptoms in adolescence and adults (Broman-Fulks et al., 2014; Eisenberg et al., 1998; Giorgetta et al., 2012; Lorian & Grisham, 2010; Maner & Schmidt, 2006; Maner et al., 2007). Our study extends these previous findings in several ways. First, we decomposed within-person changes over time from between-person (level) differences (Hamaker et al., 2015). We thus showed that increases from one's own previous level of anxiety symptoms predicted subsequent decreases in one's own level of risk-taking. Second, we showed that this directional association was consistently found across informants. Third, we studied this link among a large sample of mainstream elementary schoolchildren. Our results thus suggest a robust development link of childhood anxiety

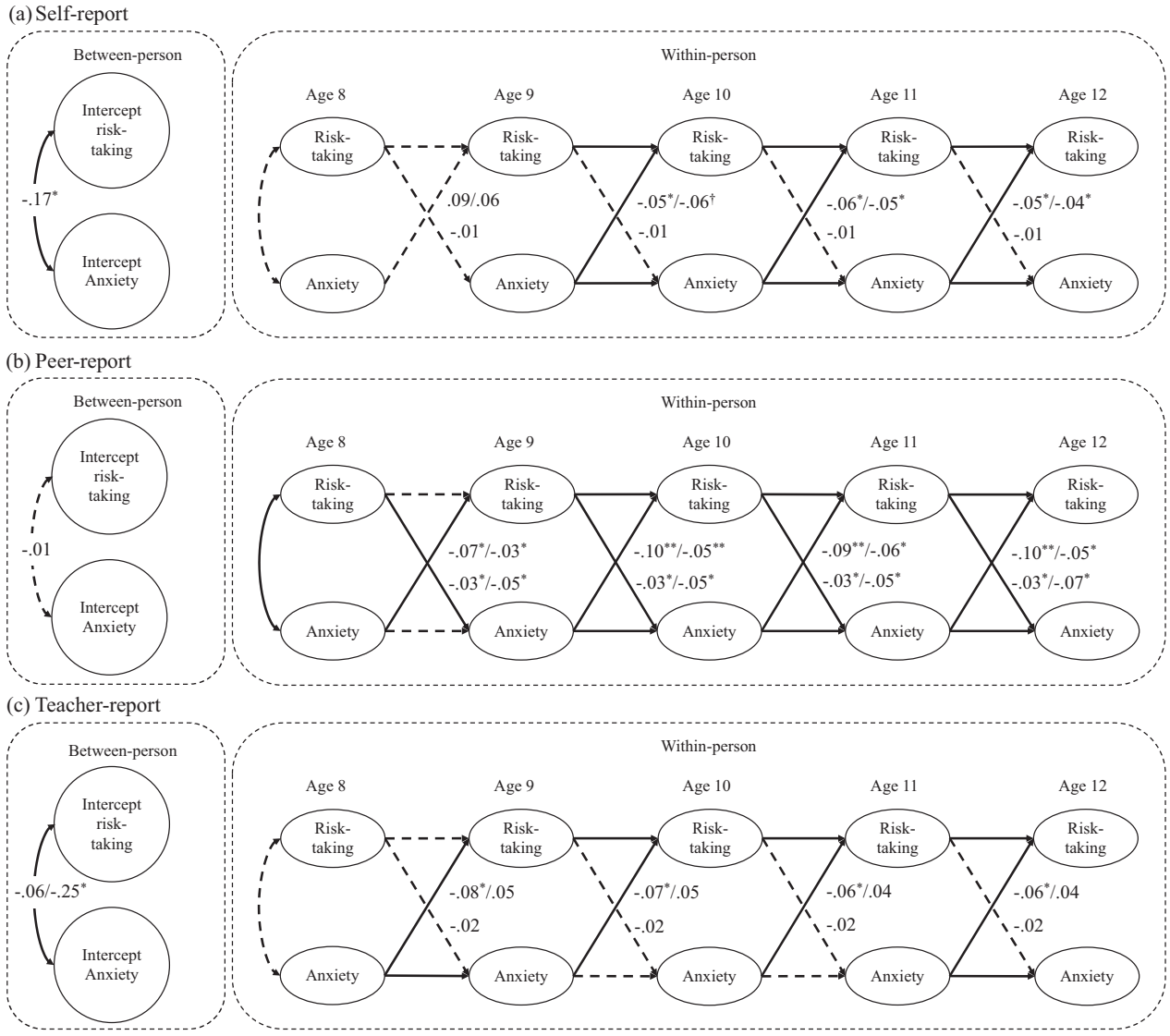

FIGURE 2 Simplified graphical representation of main results the random-intercept cross-lagged panel model of risk-taking and anxiety for self-reported (a; top) peer-reported (b; middle) and teacher-reported (c; bottom) anxiety. Path estimates (β) are presented as girls/boys (e.g., −.05*/−.06*). Solid arrow = significant at $p < .05$; dashed arrow = non-significant. Note that self-reported anxiety was not assessed at T2, resulting in omiting the within-person autoregressive path from age 8 to 9. $^{\dagger}p < .10$, $*p < .05$, $**p < .001$

symptoms preceding the subsequent reductions in risk-taking across ages 8–12 years.

Our finding of a directional link from anxiety symptoms to risk-avoidance provides support for the hypothesis that risk-avoidant behavior is reinforced by anxiety. Previous studies have shown that anxious children show an increased tendency to interpret situations as threatful and may be more likely to expect a negative outcome in a risky situation (Creswell & O'Connor, 2011). A possible explaining mechanisms of the directional link that we have found from anxiety to risk-avoidance could be related to this negative interpretation bias. However, further research into possible explaining mechanisms is needed to draw a conclusive interpretation. Moreover, our results suggest that children with anxiety symptoms may increasingly refrain from new exploratory situations that may be essential for healthy development (Allen & Badcock, 2003). Moreover, risk-avoidant behavior has been implicated in the development of depression (Allen & Badcock, 2003) and a lower willingness to seek help (Lorian & Grisham, 2011). Therefore, targeting risk-avoidant behavior may be an important element in the intervention of children with anxiety symptoms, especially to prevent negative consequences of anxiety symptoms.

In addition to the uniform effect that was found across informants, we also found some differences between informants for specific pathways. Specifically, for peer-reported anxiety symptoms, we found a bidirectional negative link between anxiety symptoms and risk-taking, indicating that children who according to their peers had increased levels of anxiety showed decreased risk-taking behavior over the next years which,

in turn, was associated with increases in anxiety symptoms. This is in line with the bidirectional link proposed by Maner and Schmidt (2006) and Lorian and Grisham (2010). Although we can only speculate, an explanation for this bidirectional link found specifically for peer-reported anxiety and not for self- and teacher-reported anxiety might be related to perspectives of peers on anxiety symptoms of classmates. Peers might be specifically aware of social-evaluative threat or other *social* anxiety symptoms as they are privy to social behavior of their peers. Furthermore, given that our research was conducted in the school context, this social-evaluative threat could partly be due to children's anxiety about school performance. Children may care about what their peers think of them and how their peers would evaluate them also in the context of their school performance. Therefore, our results could indicate that the effect of early risk-avoidance on later anxiety symptoms is specific for social-evaluative threat and that more general symptoms of anxiety (as were reported by teachers and children themselves in this study) predict later risk-avoidant behavior. This is in line with earlier research on the link between temperamental characteristics associated with risk-avoidance, such as BI and avoidance temperament, and anxiety symptoms. In those studies, most evidence is shown in support of BI and avoidance temperament predicting *social* anxiety disorder later (Biederman et al., 2001) and test-anxiety (Liew et al., 2014). In addition, Lorian and Grisham (2010) also emphasize the role of risk-avoidance in the development of specifically *social* anxiety symptoms. From a clinical perspective, this would indicate that specifically *social* anxiety symptoms may be prevented by targeting risk-avoidance behavior. However, as our research was not focused on the differences between anxiety symptoms, future research focusing on the specific types of anxiety symptoms and their association with risk-avoidance is needed before a conclusive interpretation is warranted.

In addition, we found for teacher-reported anxiety that the developmental link of increased anxiety symptoms to decreased risk-taking was significant for girls but not for boys. This finding is in line with previous findings among adults where it was shown that the association between fear and avoidance behavior was stronger for females than for males (Stoyanova & Hope, 2012). However, our results on the link between risk-avoidance and peer- and self-reports among both girls and boys contradicts this interpretation. An alternative explanation could be that teachers were more accurate in identifying anxiety symptoms in girls compared to boys. In a previous study among elementary school teachers, it was shown that teachers were more accurate in identifying anxiety symptoms in girls compared to identifying anxiety symptoms in boys (Loades & Mastroyannopoulou, 2010). Subtle changes in anxiety over the years in boys might have been overlooked and therefore a developmental link between risk-avoidance and anxiety in boys is not found when teachers reported on anxiety. However, our findings on this sex difference need replication before a conclusive interpretation is warranted.

This study is not without limitations. First, our sample consisted primarily of children of European descent from relatively high SES households, attending mainstream elementary schools. Also, children who were excluded from this study as well as children who had non-complete data had somewhat higher scores on teacher-reported anxiety and peer-reported anxiety, indicating potential selective attrition and potentially limiting generalizability to more diverse populations. Second, anxiety symptoms as assessed in this study might be limited to the school context. Peer- and teacher-perspectives of anxious behavior are likely most related to the child's behavior at school. However, we also obtained self-reports on anxiety. Although assessed when children were at school, the self-reported questions involve general situations not specific for the school context. In addition, as our research was not designed to investigate specific types of anxiety disorders, we cannot draw firm conclusions on the link between risk-avoidance and the specific types of anxiety symptoms. However, our findings of a reverse effect only between risk-avoidance and *peer*-reported anxiety indicate that future research into specific types of anxiety and the link between risk-avoidance might be fruitful to better understand this link. Finally, although the BART-Y is a validated measure of risk-taking behavior (Lejuez et al., 2007), it is not fully known how scores on the BART-Y are related to other risk-taking and risk-avoidance domains in children. For instance, BART-Y scores have been related to child self-reported risk-taking scores, but not to physical risk-taking or avoidance behavior on the playground (Morrongiello et al., 2012). Additional measures of risk-taking and risk-avoidance, as well as additional measures on specific symptoms of anxiety should therefore be included in future studies to further investigate the relation between anxiety symptoms and risk-avoidance in children. Also, more insight in the link between different domains of risk-avoidance and specific symptoms of anxiety may aid the interpretation of our unique bidirectional finding between risk-avoidance and specifically peer-reported anxiety.

Overall, our study provides unique insight in the developmental association between anxiety symptoms and risk-taking in a sample of typically developing elementary schoolchildren. Parents, clinicians, and school mental health workers should be aware of the possibility that children who show increased anxiety symptoms might become more risk-aversive, possibly also hindering them to express a need for help. This makes monitoring of early signs of anxiety symptoms in the elementary school years important. In addition, negative consequences of anxiety symptoms might be prevented by stimulating healthy exploratory behavior in children with anxiety symptoms. However, future studies on the mechanisms

that may explain how anxiety symptoms lead to risk-avoidance as well as on the further consequences of risk-aversion in children are necessary to augment our knowledge on the impact of anxiety symptoms and risk-avoidance in children.

ETHICS

This study was approved by the Medical Ethical Committee of The Vrije Universiteit Medical Centre (protocol number NL37788.029.11).

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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