

This is an Accepted Manuscript of an article published by Taylor & Francis in *Journal of Clinical Child & Adolescent Psychology* on 2016/02/20 available online: <http://www.tandfonline.com/10.1080/15374416.2014.987382>

Friendship Experiences and Anxiety among Children: A Genetically Informed Study

Catherine Serra Poirier^{1,2}

Mara Brendgen^{1,2,3}

Alain Girard^{2,3}

Frank Vitaro^{2,3,4}

Ginette Dionne^{5,6}

Michel Boivin^{5,6,7}

¹Department of Psychology, University of Quebec at Montreal, Montreal, Canada; ²Ste Justine Hospital Research Centre, Montreal, Canada; ³Research Unit on Children's Psychosocial Maladjustment, University of Montreal, Montreal, Canada; ⁴School of Psycho-Education, University of Montreal, Montreal, Canada; ⁵Department of Psychology, Laval University, Quebec City, Canada; ⁶Research Unit on Children's Psychosocial Maladjustment, Laval University, Quebec City, Canada; ⁷Institute of Genetic, Neurobiological, and Social Foundations of Child Development, Tomsk State University, Tomsk, Russian Federation

Corresponding Author: Mara Brendgen, Ph.D., Department of Psychology, University of Quebec at Montreal, C.P. 8888 succursale Centre-ville, Montreal, Quebec, Canada, H3C 3P8, email: Brendgen.Mara@uqam.ca.

Funding for this study was provided by the Social Sciences and Humanities Research Council of Canada, the Canadian Institutes of Health Research, and the Fonds de Recherche en Santé du Québec. We thank Jocelyn Malo and Marie-Elyse Bertrand for coordinating the data collection and

Hélène Paradis for data management and preparation. We also thank the twins and their families as well as their classmates for participating in this study.

Abstract

1) Objective. This study examined 1) whether, in line with a gene-environment correlation (rGE), a genetic disposition for anxiety puts children at risk of having anxious friends or having no reciprocal friends, 2) to what extent these friendship experiences are related to anxiety symptoms, when controlling for sex and genetic disposition for this trait, and 3) the additive and interactive predictive links of the reciprocal best friend's anxiety symptoms and of friendship quality with children's anxiety symptoms. 2) Method. Using a genetically informed design based on 521 Monozygotic and Dizygotic twins (264 girls; 87% of European descent) assessed in grade 4 (mean age = 10.04 years, $SD = .26$), anxiety symptoms and perceived friendship quality were measured with self-report questionnaires. 3) Results. Results indicated that, in line with rGE, children with a strong genetic disposition for anxiety were more likely to have anxious friends than non-anxious friends. Moreover, controlling for their genetic risk for anxiety, children with anxious friends showed higher levels of anxiety symptoms than children with non-anxious friends but did not differ from those without reciprocal friends. Additional analyses suggested a possible contagion of anxiety symptoms between reciprocal best friends when perceived negative features of friendship were high. 4) Conclusions. These results underline the importance of teaching strategies such as problem solving that enhance friendship quality to limit the potential social contagion of anxiety symptoms.

Keywords: Gene-environment correlation, anxiety, social contagion, friendship quality

Friendship Experiences and Anxiety among Children: A Genetically Informed Study

Anxiety is one of the most prevalent mental health problems in youth (Lau, Gregory, Goldwin, Pine, & Eley, 2007). Based on a representative sample of 1420 children aged 9 to 13 years, Costello, Mustillo, Erkanli, Keeler and Angold (2003) found that 4.6% of 9 to 10 year-old children suffer from anxiety disorder. Whereas prevalence rates of anxiety disorder are comparable for boys and girls in late childhood, higher rates of anxiety are observed in females starting at around age 12 (Cohen et al., 1993). In addition to causing significant psychological distress, anxiety is associated with adjustment difficulties in school as well as with problematic family and peer relationships (Essau, Conradt, & Petermann, 2000; Ezpeleta, Keeler, Erkanli, Costello, & Angold, 2001; Woodward & Fergusson, 2001). Furthermore, anxiety disorders in childhood and adolescence have been identified as precursors of psychopathology in adulthood (Lau et al., 2007; Woodward & Fergusson, 2001). Given the breadth and severity of the negative consequences associated with anxiety, it is important to understand the mechanisms that lead to its development in order to optimize prevention and intervention efforts. To this end, the present study utilized a classical twin design to examine the role of friendship experience in the development of self-reported anxiety symptoms among children, while taking into account genetic vulnerability for such problems based on the level of genetic relatedness between identical and non-identical twins and the level of anxiety in the co-twin.

The Role of Friendship Experiences in the Development of Anxiety

Already in middle childhood, experiences with peers have been found to play a significant role in the development of internalizing problems, including anxiety (Vitaro, Boivin, & Bukowski, 2011). Until recently, most studies examining the potential impact of friendship on anxiety and related internalizing problems such as loneliness and depression have focused on its positive effects (for a review, see Vitaro et al., 2011). Thus, empirical evidence shows that having at least one reciprocal friend is associated with lower levels of internalizing symptoms, including anxious behavior (Ladd &

Troop-Gordon, 2003; Pedersen, Vitaro, Barker, & Borge, 2007). However, recent studies suggest that the mitigating effects of friendship relations on the development of internalizing problems may vary depending on friends' characteristics. For instance, having depressed friends has been associated with an increased risk of presenting the same emotional difficulties (Brendgen, Lamarche, Wanner, & Vitaro, 2010; Prinstein, 2007; Schwartz-Mette & Rose, 2012; Stevens & Prinstein, 2005). Furthermore, although youth with nondepressed friends show less elevated trajectories of depressed mood than friendless youth, youth with depressed friends show more elevated trajectories (Brendgen et al., 2010). Having depressed friends thus seems to constitute at least as great a risk for the development of depressive symptoms as having no reciprocal friends.

It has been suggested that co-rumination (i.e., excessive and repeated discussion of troubles and worrisome incidences) is one of the principal mechanisms of peer contagion of negative emotions (Rose, Carlson, & Waller, 2007). Schwartz-Mette and Rose (2012) proposed different hypotheses to explain how co-rumination between friends can lead to social contagion of internalizing problems. First, co-rumination could foster "empathetic distress" (Smith & Rose, 2011), which would lead youngsters to strongly share their friend's distress to the point of taking on the distress as their own. Second, since individuals with internalizing problems tend to have a negative view of the world and of the future, they may offer a pessimistic perspective in response to their friend's personal problems, which could cause increased worry and distress. Third, the time spent co-ruminating prevents youngsters from participating in more positive activities that could distract them from their problems. The social contagion of primary emotions such as anger, fear, or sadness is also believed to occur through more subtle non-verbal mechanisms, such as the imitation of facial expressions, posture, voice and behavior of others (Bastiaansen, Thioux, & Keyers, 2009; Hatfield & Rapson, 2000). As such, given that anxiety symptoms such as worry and fear are considered proximal stress responses that are more frequent than - and often precede - depressive symptoms in children and adolescents (Zahn-

Waxler, Klimes–Dougan, & Slattery, 2000), peer contagion of internalizing problems should also be evident in regard to anxiety symptoms. Specifically, friends' fearful and anxious behavior should also augment youngsters' own anxious thoughts and feelings.

To date, very few studies have specifically examined social contagion of anxiety symptoms in youth (Mariano & Harton, 2005; Schwartz-Mette & Rose, 2012; Van Zalk, Van Zalk, Kerr, & Stattin, 2011). In a sample of 234 4th to 9th grade students, Mariano and Harton (2005) found that friends were more similar than nonfriends on a variety of behavioral and psychopathological characteristics, including self-reported anxiety. Moreover, using social network analysis, a study by Van Zalk and colleagues (2011) suggests that seventh to twelve graders socialize each other into becoming more socially anxious over time independently of sex and age. Finally, based on a sample of 548 children and pre-adolescents (third and fifth graders) and 230 adolescents (seventh and ninth graders), findings by Schwartz-Mette and Rose (2012) suggest a contagion effect of anxiety among girls (as well as a contagion effect of depression for both girls and boys). Results also indicated that co-rumination significantly mediated the social contagion of anxiety and depression. Together, these studies suggest that contagion of anxiety may occur among children as young as nine or ten years of age (i.e., third and fourth grade). It has been proposed that the cognitive representations of reciprocity in friendship already emerge at around age 8-10 years (Laursen & Hartup, 2002), which may explain why this contagion effect has been observed at such a young age. Nevertheless, the overall effect sizes linking friends' and youngsters' own anxiety have been relatively modest, suggesting the possibility of important moderating factors. One such moderating factor may be youth's genetic vulnerability for anxiety, another may be friendship quality.

Genetic Vulnerability for Anxiety

Quantitative genetic research such as twin studies indicates that anxiety in children and adolescents is partly explained by genetic factors. Estimates of genetic effects vary considerably,

however, ranging from 4% to 62% (Eley et al., 2003; Eley & Lau, 2005; Franić, Middeldorp, Dolan, Ligthart, & Boomsma, 2010; Gregory & Eley, 2007; Hettema, Neale, & Kendler, 2001; Lau et al., 2007). Part of the large variability of genetic effect estimates may stem from gender differences, as girls may be more vulnerable to the genetic transmission of internalizing problems than boys (Lau & Eley, 2008). Another important source of variability may be due to the fact that genetic effects on anxiety may interact with environmental influences, a phenomenon called Gene-Environment Interaction (GxE) (Shanahan & Hofer, 2005). In support of GxE, findings from quantitative and molecular genetic studies suggest that negative life events such as the death of a parent or father losing his job as well as a lack of parental support exacerbate anxiety particularly in genetically vulnerable youth - in line with a diathesis-stress mechanism of psychopathology (Fox et al., 2005; Lau, et al., 2007; Nugent, Tyrka, Carpenter, & Price, 2011; Silberg, Rutter, Neale, & Eaves, 2001).

In contrast to GxE interaction involving global life events or family-related environments in predicting anxiety or related internalizing problems, the potential interaction of genetic risk with the peer environment – particularly friendships – has rarely been studied. One study conducted by Brendgen and colleagues (2013) examined whether having reciprocal friends could mitigate the genetic vulnerability for depressive symptoms in children. The results showed that the beneficial effect of having at least one close friend in terms of reduced depression symptoms was much more pronounced for girls who were at a high genetic risk for depression than for girls at low genetic risk. For boys, only moderate main effects of - but no interaction between - genetic vulnerability and friendship participation were found. However, that study did not focus on anxiety and, importantly, did not examine friends' internalizing characteristics as a predictor of similar problems in youth.

A genetic disposition for anxiety may not only interact with friendship experiences in predicting anxiety. In addition, these genetic and environmental factors may also be correlated with each other because individuals can influence their environment as a function of heritable traits, a phenomenon

called Gene-Environment Correlation (rGE) (Scarr & McCartney, 1983). *Passive rGE* arises when the environment parents provide for their children (e.g., via their parenting style) is influenced by the parents' own genetically determined characteristics (e.g., a genetic disposition for internalizing problems). The children's genotype, inherited from the parents, thus becomes correlated with the parental environment through passive association. Whereas passive rGE is brought about by parents' genetically influenced characteristics, evocative rGE and selective rGE involve environments that are shaped by an individual's own genetically determined characteristics. *Evocative rGE* occurs when the individual's genetically influenced characteristics provoke a specific reaction from the environment, for example, if youth with a genetic disposition for anxiety were rejected by their peers or less likely than others to establish reciprocal friendships. *Selective rGE* arises when individuals, based on their genetically influenced personal characteristics, deliberately select or actively model their own environments (e.g., if they are more likely to choose friends who are similar to themselves on a genetically influenced characteristic such as anxiety).

Controlling for such possible rGE is important when examining GxE to avoid biased conclusions (Purcell, 2002). Findings from non-genetically informative studies suggest that anxious and withdrawn youths are just as likely as their non-anxious and non-withdrawn peers to have friends (Ladd & Troop-Gordon, 2003; Rubin, Wojslawowicz, Rose-Krasnor, Booth-LaForce, & Burgess, 2006). However, such research also suggests that youths tend to choose friends who have a similar level of (social) anxiety as themselves (Van Zalk et al., 2011). Similarly, studies of younger children show that shy or anxious-withdrawn children tend to affiliate with friends presenting the same characteristics (Güroğlu, Van Lieshout, Haselager, & Scholte, 2007; Rubin et al., 2006). These findings may indicate a possible active selection process based on heritable anxious characteristics. Evidence of rGE from genetically informed studies, which would provide even stronger support of the

presence of individual effects on friendship experiences among anxious youth (Bates & Lewis, 2012), is still lacking, however.

Friendship Quality

Another important moderating factor of the link between friends' and youngsters' own anxiety symptoms may be friendship quality. Friendship quality is generally divided into two broad dimensions: positives features (e.g., intimacy, companionship) and negatives features (e.g., rivalry, conflict) (Vitaro et al., 2011). Numerous studies have shown that a low level of friendship quality is related to poor emotional adjustment (Bukowski, Buhrmester, & Underwood, 2011). More specifically, a study by La Greca and Harrison (2005) indicated that high levels of negative features and low levels of positive features of friendship quality are related to increased anxiety symptoms. In addition to having a direct effect, friendship quality could also moderate the effects of social contagion of anxiety symptoms. Indeed, some authors believe that social contagion of emotions is stronger when the quality of the relationship is high (Hatfield & Rapson, 2000). However, results from a study examining the social contagion of depression show that especially boys are more likely to be affected by the contagion of negative emotions when the positive features of friendship quality such as companionship, intimacy, affection, etc. are perceived as low (Prinstein, 2007). The author suggests that, because excessive reassurance-seeking is related to a deterioration in friendship quality over time and an increase in negative emotions (Prinstein, Borelli, Cheah, Simon, & Aikins, 2005), this mechanism may explain the moderating role of low friendship quality on the social contagion of depression. He also suggests that being exposed to a friend's depressive symptoms in addition to the stress associated with the deterioration of the friendship quality could lead to an increase in depressive symptoms. Excessive reassurance-seeking is also likely to occur in regard to anxiety (Cogle et al., 2012) and interacting with anxious friends could thus foster anxiety symptoms especially when the friendship quality is low.

To our knowledge, however, no study has examined the potential moderating role of friendship quality on the social contagion of anxiety symptoms.

The Present Study

Using a classical twin design, the main objective of the present study was to examine whether affiliation with anxious friends is related to increased anxiety symptoms among children while controlling for genetic risk for anxiety and whether this association is moderated by youngsters' genetic risk for anxiety or by friendship quality or sex. To this end, we first aimed to compare the level of anxiety symptoms of children with anxious friends to the level of anxiety symptoms of youth without reciprocal friends and those with non-anxious friends. Based on the previously mentioned findings from depression research, it was expected that youth with anxious friends would exhibit more anxiety symptoms than youth with non-anxious friends and that they would be similarly or perhaps even more anxious than friendless youth. This association was expected to hold even when controlling for children's genetic risk for anxiety (as assessed based on genetic relatedness between twins and the level of anxiety in the co-twin). However, the potential "emotional contagion" by anxious friends was expected to be especially strong for youth with a high genetic vulnerability for anxiety – in line with a diathesis-stress process of (GxE). We also examined whether a genetic disposition for anxiety puts children at risk of having anxious friends or having no reciprocal friend (rGE). Based on the evidence reviewed above, we expect that youth with a strong genetic disposition for anxiety are at increased risk of having anxious friends but they should not be more at risk of having no reciprocal friend than other youngsters.

Second, for those participants with at least one reciprocal friend, we examined whether the predictive association between the best friend's level of anxiety symptoms and youngsters' own anxiety symptoms is moderated by friendship quality, again while controlling for youngsters' genetic risk for anxiety and sex. Since only one study has examined the moderating effect of friendship quality

on the contagion of internalizing problems (Prinstein, 2007) and that the results did not confirmed the theoretical model of emotional contagion (Hatfield & Rapson, 2000) we can only make tentative assumptions. . Thus, a high level of friendship quality may accentuate the predictive link between the best friend's level of anxiety symptoms and youngsters' own anxiety symptoms, but the reverse is also possible. Moreover, given the disparities in the research findings regarding potential sex moderation on social contagion of emotion, (Prinstein, 2007; Rose et al., 2007; Schwartz-Mette et al., 2012) no clear expectations could be formulated.

Method

Sample

The 521 children (257 males, 264 females) participating in this study were part of a population-based sample of 467 monozygotic (MZ) and same-sex dizygotic (DZ) twin pairs from greater Montreal, Canada, who were recruited at birth between November 1995 and July 1998. Zygosity was assessed by genetic marker analysis of 8-10 highly polymorphous genetic markers and twins were diagnosed as MZ when concordant for every genetic marker. When genetic material was insufficient or unavailable due to parental refusal (43% of cases), zygosity was determined based on physical resemblance questionnaires at 18 months and again at age 9 (Goldsmith, 1991; Spitz et al., 1996). The comparison of zygosity based on genotyping with zygosity based on physical resemblance in a subsample of 237 pairs revealed a 94% correspondence rate, which is extremely similar to rates obtained in other studies (Magnusson et al., 2013; Spitz et al., 1996). Eighty-seven percent of the families were of European descent, 3% were of African descent, 3% were of Asian descent, and 1% were Native North Americans. The remaining families did not provide ethnicity information. The demographic characteristics of the twin families were comparable to those of a sample of single births representative of the urban centers in the province of Quebec. At the time of their child(ren)'s birth, 95% of parents lived together; 44% of the twins were the first born children; 66% of mothers and 60%

of fathers were between 25 and 34 years old; 17% of mothers and 14% of fathers had not finished high school; 28% of mothers and 27% of fathers held a university degree; 83% of the parents held an employment; 10% of the families received social welfare or unemployment insurance; 30% of the families had an annual income of less than \$30,000.

The sample was followed longitudinally at 5, 18, 30, 48, and 60 months focusing on a variety of child-related and family-related characteristics. New data collections were completed when the children were in kindergarten, grade one, and grades three and four. The present paper describes findings from the grade four data collection (mean age = 10.04 years, $SD = .26$). Attrition in the sample was approximately 6% per year, such that 307 twin pairs participated in grade four. Participants included in the present study were those for which data on friendship status (i.e., having reciprocal friends or not) and on friends' anxiety symptoms were available ($n = 521$ individuals from 261 twin pairs; see description of measures below). In 209 of these twin pairs, the two twins did not attend the same classroom. The participants in the final study sample did not differ from those who were lost through attrition in regard to family status, parental education or parents' age, although family revenue was higher in the remaining study sample.

Measures

Friendship nominations. Participants were asked to nominate up to three close friends in the classroom (excluding the co-twin, when he/she was in the same class). Limiting close friendship nominations to the classroom does not seem to overly restrict selection of friends because the vast majority of elementary school children select friends from among their classmates even when they can nominate a friend from outside the classroom (Parker & Asher, 1993). Moreover, classroom composition remained stable throughout the year and students spent all day together. A participant was considered to have a reciprocal friend when the peer the participant had nominated had in turn rated the participant as one of his/her three close classroom friends. Of the participating twins, 451 (85%) had at least one

reciprocal friend in the class (154 had one reciprocal friend, 175 had two reciprocal friends, and 122 three reciprocal friends). Participants were also asked to identify their best friend among their nominated close friends. A participant was considered to have a reciprocal best friend when the peer the participant had nominated as the best friend had in turn rated the participant as one of his/her three best classroom friends. Of the participating twins, 364 individuals (70%) had at a reciprocal best friend in the class. These percentages were similar to those reported in research with singletons (Parker & Asher, 1993).

Perceived friendship quality. Participants were asked to evaluate the perceived friendship quality with their nominated best friend based on items from the *Friendship Quality Questionnaire (FQQ)* (Parker & Asher, 1993). Five items focussing on positive features (e.g., “My friends and I always pick each other for work/play” ; “My friend tells me that my ideas are good” ; “My friend and I help each other a lot with school work”) and three items focusing on negative features (e.g., “My friend and I are often angry with each other”; “My friend has said mean things about me to other children”; “My friend and I fight a lot”). Each item was rated on a 5-point Likert scale ranging from 1 ‘not true at all’ to 5 ‘very true’. For each twin child, individual item scores were averaged to compute scales scores (Positive features scale: Cronbach’s alpha = 0.79, $M = 3.79$, $SD = 0.85$, min = 1.20, max = 5, skewness = -0.69, kurtosis = -0.04, and Negative features scale: Cronbach’s alpha = .72, $M = 1.44$, $SD = 0.67$, min = 1, max = 5, skewness = 2.00, kurtosis = 4.70).

Anxiety symptoms. Anxiety symptoms of each twin child and of his or her reciprocal friends were assessed via self-reports of each twin and of each friend using 10 items selected from the Revised Children’s Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1985), which focused on worry/oversensitivity and physical anxiety (e.g., ‘I am nervous’; ‘I worry about something bad happening to me’; ‘I feel sick in my stomach’). Items were selected based on content and strength of factor loadings in the standardization sample of the RCMAS (Reynolds & Richmond, 1985) and were embedded in a larger questionnaire on child adjustment in school. Each item was rated on 4 point Likert type scale

ranging from 1 'never occurring' to 4 'occurring very often'. A global anxiety score was created for each participant by averaging the 10 item scores (Cronbach's $\alpha = .84$, $M = 1.66$, $SD = 0.50$, $\min = 1.0$, $\max = 3.5$, skewness = 1.03, kurtosis = 0.94).

Genetic risk for anxiety symptoms. When data are collected on twins, a continuous score of each child's genetic risk for anxiety can be estimated as a function of his or her co-twin's level of anxiety symptoms and the pair's zygosity (Andrieu & Goldstein, 1998). This estimation is based on a comparison of the degree of phenotypic (i.e., behavior or trait) within-pair similarity between MZ twins (who share 100% of their genetic material) with the degree of phenotypic within-pair similarity between DZ twins (who on average share 50% of their genetic material). Genetic effects on the phenotype are indicated if the degree of phenotypic similarity is higher in MZ twins than in DZ twins. This method has been used in several studies to test gene-environment interactions and correlations with an epidemiological twin design (e.g., Brendgen et al., 2008; Jaffee et al., 2005; Wichers et al., 2009). Specifically, one twin from each twin pair was selected as the "target twin" and the second twin as the "co-twin." Each twin pair was represented in the data set twice, with each twin of a pair serving once as the target twin and another time as the co-twin. An ordinal score of genetic risk for anxiety was computed as a function of (a) zygosity and (b) the presence or absence of anxiety symptoms in the co-twin. To this end, the global anxiety score was dichotomized using the 75th percentile as the cut-off. This cut-off corresponded to a score of 2 in the anxiety variable and indicated, for example, that seven out of ten anxiety symptoms were endorsed as occurring several times (70%). This cut-off point was chosen (a) because of the intrinsic interpretability of its value and (b) because it ensured a sufficient number of subjects in each group to perform subsequent analyses. A similar cut-off was used in studies on depression symptoms (Brendgen et al., 2013; Brendgen, Vitaro, Turgeon, & Poulin, 2002). It is also worth noting that the percentage of endorsement reflected in our cut-off is similar to that of the clinical range cut-off of the RCMAS (i.e., a T score of 60 or 1 SD above the mean). This T score corresponds to

a cut-off score of 19 on the 28 items of the RCMAS, which indicates that 68 % of items are endorsed (Reynolds & Richmond, 1985).

Children whose anxiety symptoms score was at or above the 75th percentile value of the sample distribution were considered as having an elevated anxiety symptom score. Children whose anxiety symptoms score was below the 75th percentile value of the sample distribution were considered as having few anxiety symptoms. This information about anxiety symptoms in the co-twin was then combined with information on the pair's zygosity into an index of genetic risk for anxiety. Thus, the target twin's genetic risk for anxiety was considered to be highest when he/she was part of an MZ pair and when anxiety symptoms were elevated in the co-twin (11% of the sample, 62% girls). The target twin's genetic risk for anxiety was somewhat lower when he/she was part of a DZ pair and when anxiety symptoms were elevated in the co-twin (7% of the sample, 78% girls). The target twin's genetic risk for anxiety was even lower when he/she was part of a DZ pair and when the co-twin showed few anxiety symptoms (35% of the sample, 53% girls). The target twin's genetic risk for anxiety was lowest when he/she was part of an MZ pair and when the co-twin showed few anxiety symptoms (47% of the sample, 57% girls).

Procedure

All instruments were administered in either English or French, depending on the language spoken by the children. Instruments that were administered in French but were originally written in English were first translated into French and then translated back into English. Bilingual judges verified the semantic similarity between the back-translated items and the original items. Participants' parents were contacted by letter and children's verbal assent as well as active written consent from the parents of all children in the classroom was obtained. Data collection took place in the spring to ensure that the children knew each other and took approximately 45 minutes per class. As compensation, all

participating children received a small gift with a 5 \$ value. The instruments were approved by the Institutional Review Board of the University of Quebec at Montreal.

Analyses and Results

Gene-Environment Correlation

In the first set of analyses, we examined whether a genetic disposition to anxiety predicts friendship experiences and whether this association was moderated by sex. To this end, we calculated the average level of a target child's reciprocal friends' anxiety symptoms, which was then dichotomized using the 75th percentile to identify youth with anxious friends (25%), youth with nonanxious friends (60%) and those without any reciprocal friends (15%). This procedure ensured that children who had reciprocal friends but who did not have a reciprocal best friend would not be considered friendless or excluded from the analyses. This approach also has the advantage of providing a more inclusive assessment of the anxiety characteristics of children's friendships (Brendgen et al., 2010). These analyses were performed using Multinomial Logistic Regression with the MPlus software Version 6.11 (Muthén & Muthén, 1998-2010), with friendship experiences as the categorical dependent variable and 'anxious friends' as the reference group. Full Information Maximum Likelihood estimation with robust standard errors (FIMLR) was used to include cases with missing data on genetic risk due to incomplete anxiety information in some twin pairs (1.2% missing data points) and to control for data interdependency due to twinning. To facilitate interpretation of effects, the genetic risk variable was z-standardized prior to analyses. Main effects of sex and genetic disposition to anxiety were tested in a first model step, followed by the interaction between sex and genetic disposition entered on the second step. Statistical significance of specific effects can be evaluated based on the associated Wald statistic. The relative effect size of each predictor is provided by the associated Odds Ratio, which indicates the amount of increase (or decrease) in the odds of having a nonanxious friends or having no reciprocal friend relative to having anxious friends. As can be seen in Table 1, the results from the first

model step showed that children with a high genetic disposition to anxiety were more likely to have anxious friends than to have non anxious friends, $b = -0.22$, $p < 0.05$, OR = 0.80, but were not more likely to have no reciprocal friends, $b = -0.12$, *ns*, OR = 0.89. Moreover, boys were more likely to have no reciprocal friend than to have anxious friends, $b = -0.64$, $p = 0.05$, OR = 0.53. The interaction between genetic disposition to anxiety and sex (entered on step 2) was not significant. Results from this first set of analyses thus suggest the presence of a significant rGE between genetic disposition to anxiety and having anxious friends.

Predictive Links of Friendship Experience and Genetic Disposition With Anxiety Symptoms

In the next set of analyses, we examined whether friendship experience predicts children's level of anxiety symptoms and whether this association was moderated by genetic disposition to anxiety and sex. Again, these analyses were performed using Full Information Maximum Likelihood estimation with robust standard errors (FIMLR). Specifically, a series of consecutive Multiple Regression models of increasing complexity were fitted to the data. Each model was compared to the preceding one to evaluate whether the inclusion of additional predictors provided a better fit to the data. The Satorra-Bentler scaled Chi-Square Difference test for robust estimation was used to evaluate the difference in fit between subsequent models (Bryant & Satorra, 2012). Table 2 presents the results from these analyses.

In the first model, three predictors were entered to the equation: sex, genetic disposition to anxiety, and friendship experience. Because friendship experience was a categorical variable with three levels (i.e., having no reciprocal friend, having anxious friends, or having nonanxious friends), two dummy-coded variables were created with 'anxious friends' as the reference group. Two of the four predictors were significantly associated with children's level of anxiety symptoms. Specifically, children with a greater genetic disposition to anxiety were more anxious than others, $b = 0.15$, $p < 0.05$, and children with non anxious friends were less anxious than those with anxious friends, $b = -0.26$, p

< 0.01. No differences were found between youth with anxious friends and friendless youth. Five two-way interactions terms were included in the second step to test whether friendship experience interacted with child sex or with genetic disposition to anxiety. However, none of these interactions had a significant effect on anxiety symptoms.

Predictive Links of Best Friend's Level of Anxiety Symptoms, Perceived Friendship Quality and Genetic Disposition With Anxiety Symptoms

Data on friendship quality were only collected for the best nominated friend. Therefore, in the third series of model tests (Table 3), we focused only on those twin children whose best friendship nomination was reciprocated ($n = 364$ individuals). Specifically, we examined whether the perceived friendship quality with the best friend adds to and interacts with the best friend's level of anxiety symptoms to predict children's level of anxiety symptoms while controlling for genetic disposition to anxiety and sex. These analyses were performed using Multiple Regression with Full Information Maximum Likelihood estimation with robust standard errors (FMLR) to include cases with occasional missing data (1.4% missing data points) and to control for data interdependency due to twinning. In the first model (Model 1), five predictors were included in the equation: sex, genetic disposition to anxiety, best friend's level of anxiety symptoms and perceived negative and positive features of friendship quality. Only one of the five predictors was significantly associated with children's level of anxiety symptoms. Specifically, children with greater genetic disposition to anxiety were more anxious than others, $b = 0.19$, $p < 0.001$. Potential interactions were added next in two separate and reciprocally exclusive subseries, one subseries with interactions involving positive friendship features and another subseries with interactions involving negative friendship features.

In the first subseries (pertaining to positive friendship features), we first tested two-way interactions between perceived positive features of the friendship quality, best friend's level of anxiety symptoms and genetic disposition to anxiety. Next, two-way interactions between perceived positive

features of the friendship quality, best friend's level of anxiety symptoms and child sex were examined. All of these interactions were extremely small (i.e., with absolute estimates of around .02) and nonsignificant. For parsimony, the results from this first subseries are not reported in Table 3. In the second subseries (pertaining to negative friendship features), we first tested two-way interactions between perceived negative features of the friendship quality, best friend's level of anxiety symptoms, and genetic risk for anxiety. Finally, two-way interactions between perceived negative features of the friendship quality, best friend's level of anxiety symptoms and child sex were tested. One of these two-way interactions (friend's level of anxiety symptoms X perceived negative features of friendship quality) was significantly associated with children's level of anxiety symptoms, $b = 0.10$, $p < 0.05$. Probing of this interaction showed a predictive effect of the best friend's level of anxiety symptoms on children's own anxiety symptoms only for youth who perceived a higher level (i.e., 1 SD above the mean) of negative features in the relation with their best friend, $b = 0.19$, $p = 0.09$, but not for those who perceived a low level (i.e., 1 SD below the mean) of negative features in the relation with their best friend, $b = -0.02$, *ns*. Thus, among children with a reciprocal best friend, affiliation with anxious friends was related to increased anxiety symptoms only when the negative features in the relationship with that friend were perceived as high.

Discussion

The present study examined 1) whether, in line with a gene-environment correlation (rGE), a genetic disposition for anxiety puts children at risk of having anxious friends or having no reciprocal friends, 2) to what extent children's friendship experiences (i.e., having no reciprocal friend, having non anxious friends, and having anxious friends) is related to anxiety symptoms when controlling for or in interaction with genetic risk for this trait (in line with GxE) and 3) whether, for those youth with a reciprocal best friend, the best friend's level of anxiety symptoms is related to children's own level of

anxiety symptoms and whether this association is moderated by the quality of the friendship relation or by children's genetic disposition for anxiety.

Genetic Disposition to Anxiety Predicts Affiliation with Anxious Friends

As expected, although a genetic disposition for anxiety did not increase the risk of having no reciprocal friends, children with a strong genetic disposition for anxiety had overall more anxious friends than non-anxious friends. This is in line with results from non-genetically informed studies that anxious-withdrawn youth are not less likely than others to establish friendships, but that they are likely to affiliate with friends with similar behavioral characteristics (Ladd & Troop-Gordon, 2003; Rubin et al., 2006). The present study is the first to show rGE linking friendship experiences with anxiety symptoms in children, thus providing strong evidence of friendship affiliation based on a personal disposition for anxiogenic thoughts and behaviors. Interestingly, a similar, albeit weaker rGE ($r = .09$) for friendship affiliation has been documented in regard to social-withdrawn behavior in kindergarten children (Guimond et al., 2014). Together, these findings suggest that children with a tendency towards internalizing behavior tend to "flock together" from an early age. This rGE may reflect an active selection process. It is also possible, however, that anxious children affiliate with similar friends by default rather than by choice, either because they are ignored by less fearful peers (i.e. evocative rGE) or because their equally anxious parents, who have passed their genes to the child, shape their child's friendship relations (i.e. passive rGE). In either case, it is interesting to note that a similarly increasing rGE for friendship affiliation over the course of development has been found with respect to externalizing behavior (for a review, see Brendgen, 2012). Also noteworthy is that our finding of rGE equally applied to girls and boys, which was also the case in the Guimond and colleagues (2014) study. The absence of gender difference in this regard may be related to the relatively young age of the participants; a distinct gender-specific selection process favoring girls may emerge during adolescence,

as sex differences in the prevalence of anxiety disorders increase (Cohen et al., 1993; Costello et al., 2003; Dumas, 2007).

Predictive Links Between Friends' Anxiety Symptoms and Children's Own Anxiety Symptoms

As expected, children with anxious friends reported an overall higher level of anxiety symptoms than children with non anxious friends. This result is in line with findings by Schwartz-Mette and colleagues (2012) who found that, at least among girls, friends' anxiety was related to increased anxiety. Our findings are also in line with studies showing contagion of depression symptoms among friends (Brendgen et al., 2010; Prinstein, 2007; Stevens & Prinstein, 2005). Moreover, our results indicated that children with anxious friends were as likely as friendless youth to present anxiety symptoms. Therefore, having anxious friends seems to constitute at least as great a risk for the development of anxiety symptoms as having no reciprocal friends. Brendgen and colleagues (2010) also came to the same conclusion in regard to depressive symptoms in a (nongenetically informative) singleton sample. Therefore, friends who suffer from internalizing problems such as anxiety or depressive symptoms not only seem unable to protect youth from internalizing symptoms but instead might contribute even further to the development of these negative emotions.

Controlling for genetic disposition for anxiety and for rGE, a high level of negative features such as conflict in the friendship was positively associated with children's anxiety symptoms. This is in line with previous findings showing that low friendship quality is related to poor emotional adjustment (Bukowski et al., 2011; La Greca & Harrison, 2005). More importantly, although we did not find a moderating effect of perceived positive friendship features on the predictive association between best friends' and children's own anxiety symptoms, we did find a significant moderating effect of perceived negative friendship features: The predictive link between best friends' anxiety symptoms and children's own anxiety symptoms was only observed when the negative features of the friendship relation were perceived as high. This finding is similar to the results from a study by Prinstein (2007) who found

social contagion of depressive symptoms among male adolescent (11th grade) friends who perceived few positive features in their friendship. However, it is important to note that Prinstein (2007) did not specifically examine the moderating role of perceived negative friendship features, which could be the main aspect of friendship quality moderating the social contagion process. The present findings thus qualify previous results that a lack of positive friendship features is associated with a stronger predictive link between friends' and children's own anxiety symptoms and suggest that the negative features of the friendship also need to be taken into account. Prinstein (2007) suggests that the interaction between perceived low friendship quality and best friend's level of depression may be explained by excessive reassurance-seeking by the friend, which is not only particularly frequent in friendships of low quality (Prinstein et al., 2005) but also especially prevalent among depressed individuals (Parrish & Radomsky, 2010). A similar mechanism is also likely to occur in regard to the social contagion of anxiety. Indeed, excessive reassurance seeking is also observed in highly anxious individuals, even when controlling for depression (Cogle et al., 2012). Moreover, anxious individuals' excessive reassurance seeking has been found to lead to negative emotions in their interaction partners (Heerey & Kring, 2007). Therefore, being exposed to a close friend's high anxiety symptoms in addition to the stress associated with the deterioration of the friendship quality could lead to an increase in anxiety symptoms among children.

Notably, the predictive link between friends' and children's own anxiety symptoms was independent of genetic risk for anxiety. This may be due to the relatively strong rGE linking genetic disposition to anxiety with affiliation with anxious friends. Finding GxE in the presence of significant rGE is often difficult (Purcell, 2002). Moreover, given that the cognitive representations of reciprocity in friendship emerge at around age 8-10 years (Laursen & Hartup, 2002), children may have difficulties to disengage from the anxiogenic processes in these relationships. Finally, it is noteworthy that the predictive link between friends' and children's own anxiety symptoms equally applied to girls and

boys. Past studies on social contagion of internalizing problems have reported inconsistent results, with some finding no sex moderation (Stevens & Prinstein, 2005), and others finding emotional contagion only in boys (Prinstein, 2007) or only in girls (Schwartz-Mette & Rose, 2012). More research is needed to examine potential sex moderation of emotional contagion within friendships.

Strengths, Limitations, and Conclusions

The present study is the first to examine the potential social contagion of anxiety symptoms within children friendships using a genetically informed design. By disentangling genetic from environmental effects, the use of a behavioral genetic design allowed a better test of transactional processes between individual, potentially heritable characteristics and environmental factors that are difficult to test unequivocally without an experimental design (Lahey & D’Onofrio, 2010; Moffitt, 2005). Specifically, this design helped investigate 1) to what extent heritable personal characteristics can explain anxious peer affiliation (as indicated by rGE) and 2) to what extent affiliation with anxious friends is associated with anxiety while controlling for genetic risk for anxiety (and thus implicitly also controlling for rGE) or in interaction with genetic risk for anxiety. Thus, although our study cannot provide conclusive proof of causation, it offers advantages compared to correlational studies using singletons for testing important questions of friendship selection and friendship socialization processes in regard to anxiety. Nevertheless, the addition of short term longitudinal data to a genetically informed design would provide an even more complete picture on how friendship experiences may impact children’s anxiety symptoms and vice versa. An important additional strength of the study rests on the fact that the presence or absence of close friendships was assessed based on the reciprocity of the friendship nomination. The present study is also one of the very few to include a measure of reciprocal friends’ self-reported anxiety, thus avoiding potentially inflated estimates due to shared source variance.

Despite these strengths, our study also has several limitations. One limitation is the relatively small sample size. Attrition analysis suggested that the final sample was not overly biased with respect to the study variables. However, while we were able to detect significant two-way interaction, the small sample size offered insufficient statistical power to test for three-way interactions. In a related vein, the rather large number of analyses to address the role of friendship quality (i.e., with separate regression steps for two-way interactions involving positive and negative friendship quality) likely increased the family-wise error rate. Future studies therefore need to replicate the present findings with larger samples, which will not only allow more stringent control of overall error rates but also allow testing for potential higher-order moderating effects of sex and genetic disposition for anxiety. In regard to sample characteristics, generalization could be limited given that data were based on a twin sample. However, empirical evidence suggests that twins' peer relations (e.g., the number of friends, friendship features) do not differ from that of non-twin children (i.e., singletons) (Thorpe, 2003). Moreover, twin samples and singleton samples do not differ with respect to social-psychological adjustment, including aggression and internalizing symptoms, during childhood (Bekkhuis, Staton, Borge, & Thorpe, 2014).

A further limitation is that our anxiety measure was part of a more global assessment of developmental adjustment and time constraints prevented us from administering the full RMASC. The limited number of anxiety items provided only a general evaluation of anxiety symptoms. Future studies need to replicate the present findings using a more extensive measure of anxiety with additional reporting sources and include a clinical sample to better understand the role of friendship experiences in the development of anxiety disorder. It would also be interesting to evaluate the unique role of parental anxiety versus friends' anxiety in this regard while controlling for genetic risk for anxiety in future research. Finally, it needs to be noted that our study cannot provide unanimous indication of selection (i.e., selective rGE), since passive or reactive rGE processes cannot be ruled out. Similarly, the link between friends' and own anxiety symptoms does not provide unanimous indication of

socialization (even when controlling for genetic risk and rGE), as other potential confounds (e.g., an anxiety-provoking school environment) that equally affect target children and their friends were not controlled.

Notwithstanding these limitations, our study provides important information on the role of friendship experience in the development of anxiety symptoms in children. The results provide evidence of children's affiliation with anxious friends based on their own genetic disposition for anxiety symptoms. By the same token, even youth without a genetic disposition for anxiety seem to be vulnerable toward a potential contagion effect of anxiety from their friends when friendship quality is low. Even though some studies based on singletons have examined selection and socialisation associated with anxiety, the potentially confounding effect of genetic risk for anxiety and the role friendship quality have been unclear. As such, our findings are important because they support and extend those from previous studies based on singletons. Our results underline the importance of teaching strategies, such as problem solving, to enhance friendship quality in order to limit the social contagion of anxiety symptoms.

Table 1

Multinomial Logistic Regression to Predict Friendship Experiences

Model	Predictors	Non anxious friends	No reciprocal friends	Loglikelihood	Δ Chi-square (df)
		vs. Anxious friends	vs. Anxious friends		
		Fixed effect (SE)	Fixed effect (SE)		
		[95% CI]	[95% CI]		
1	Sex	-0.35 (0.23)	-0.64 (0.31)*	-1880.30	
		[-0.81 ; 0,11]	[-1.26 ; -0.02]		
		OR = 0.70	OR = 0.53		
	Genetic disposition to anxiety	-0.22 (0.11)*	-0.12 (0.17)		
		[-0.43 ; -0,01]	[-0.41 ; 0,18]		
		OR = 0.80	OR = 0.89		
2	Sex X Genetic disposition to anxiety	-0.11 (0.23)	-0.36 (0.31)	-1879.13	2.28 (2)
		[-0.57 ; 0.34]	[-0.97 ; 0.26]		
		OR = 0.89	OR = 0.70		

Note. n = 521. Sex is coded 0 = boys, 1 = girls. OR = Odds ratio. CI = Confidence Interval. *p ≤ .05, **p ≤ .01. Differences in fit between subsequent models were tested using a -2 Loglikelihood difference test, which is equivalent to a Chi-square difference test. The scaled Satorra-Bentler Chi-square difference test for robust estimation was used for this purpose. Δ = Difference. df = degrees of freedom.

Table 2

Multiple Regression to Predict Anxiety Symptoms

Model	Predictors	Fixed effect	SE	95% CI	Chi-square	Δ Chi-square (df)
1	Sex	0.10	0.09	-0.07 ; 0.28	-2239.00	
	Genetic disposition to anxiety	0.15**	0.06	0.03 ; 0.26		
	Friendship experience					
	Non anxious friends vs. Anxious friends	-0.26*	0.11	-0.47 ; -0.04		
	No reciprocal friends friends vs. Anxious friends	-0.19	0.16	-0.49 ; 0.12		
2	Sex X Friendship experience				-2238.39	0.82 (5)
	Non anxious friends vs. Anxious friends	-0.03	0.23	-0.48 ; 0.42		
	No reciprocal friends friends vs. Anxious friends	-0.24	0.31	-0.85 ; 0.37		
	Genetic disposition to anxiety X Friendship experience					
	Non anxious friends vs. Anxious friends	-0.03	0.12	-0.26 ; 0.21		
	No reciprocal friends friends vs. Anxious friends	-0.08	0.20	-0.48 ; 0.32		
	Sex X Genetic disposition to anxiety	0.03	0.12	-0.20 ; 0.25		

Note. n = 521. Sex is coded 0 = boys, 1 = girls. *p ≤ .05, **p ≤ .01. Differences in fit between subsequent models were tested using on a -2 Loglikelihood difference test, which is equivalent to a Chi-square difference test. The scaled Satorra-Bentler Chi-square difference test for robust estimation was used for this purpose. CI = Confidence Interval. Δ = Difference. df = degrees of freedom.

Tableau 3

Predictive Links of Best Friend's Anxiety, Perceived Friendship Quality and Genetic Disposition to Anxiety With Anxiety Symptoms

Model	Predictors	Fixed effect	SE	95% CI	Loglikelihood	Δ Chi-square (df)
1	Sex	-0.11	0.10	-0.08 ; 0.31	-4022.07	
	Genetic disposition to anxiety	0.19**	0.06	0.07 ; 0.31		
	Best friend's level of anxiety	0.09	0.08	-0.01 ; 0.18		
	Positive features	-0.01	0.05	-0.11 ; 0.09		
	Negative features	0.10	0.08	-0.004 ; 0.21		
2	Negative features X Best friend's level of anxiety	0.10*	0.05	0.01 ; 0.20	-4020.12	3.95 (1)*
3a	Genetic Risk X Best friend's level of anxiety	-0.03	0.05	-0.12 ; 0.06	-4709.14	2.50 (2)
	Genetic Risk X Negative features	0.07	0.05	-0.02 ; 0.17		
3b	Sex X Best friend's level of anxiety	-0.02	0.10	-0.21 ; 0.17	-4019.65	0.91 (2)
	Sex X Negative features	0.10	0.11	-0.11 ; 0.31		

Note. n = 364. Model 3a and Model 3b are each compared to model 2. As described in the text, further two-way interactions between positive friendship features, genetic risk for anxiety, best friend's level of anxiety and child sex were tested but were not significant and are thus not reported in this table for parsimony. CI = Confidence Interval. Δ = Difference. df = degrees of freedom.

References

- Andrieu, N., & Goldstein, A. M. (1998). Epidemiologic and Genetic approaches in the study of gene-environment interaction: An overview of available methods. *Epidemiologic Reviews*, *20*(2), 137-147.
- Bastiaansen, J. A. C. J., Thioux, M., & Keysers, C. (2009). Evidence for mirror systems in emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1528), 2391-2404. doi: 10.1098/rstb.2009.0058
- Bates, T. C., & Lewis, G. J. (2012). Towards a genetically informed approach in the social sciences: Strengths and an opportunity. *Personality and Individual Differences*, *53*(4), 374-380. doi: <http://dx.doi.org/10.1016/j.paid.2012.03.002>
- Bekkhuis, M., Staton, S., Borge, A. I. H., & Thorpe, K. (2014). Do twins differ from single-born children on rates of behavioral difficulty in early childhood? A study of sibling relationship risk factors. *Twin research and human genetics : the official journal of the International Society for Twin Studies*, *17*(4), 288-295. doi: 10.1017/thg.2014.39
- Boivin, M., Brendgen, M., Dionne, G., Dubois, L., Pérusse, D., Robaey, P., et al. (2013). The Quebec Newborn Twin Study Into Adolescence: 15 Years Later. *Twin Research and Human Genetics*, *16*(Special Issue 01), 64-69. doi: doi:10.1017/thg.2012.129
- Brendgen, M. R. (2012). Genetics and Peer Relations: A Review. *Journal of Research on Adolescence*, *22*(3), 419-437. doi: 10.1111/j.1532-7795.2012.00798.x
- Brendgen, M. R., Boivin, M., Vitaro, F., Girard, A., Dionne, G., & Pérusse, D. (2008). Gene-environment interaction between peer victimization and child aggression. *Development and Psychopathology*, *20*(02), 455-471. doi: doi:10.1017/S0954579408000229

- Brendgen, M. R., Lamarche, V., Wanner, B., & Vitaro, F. (2010). Links between friendship relations and early adolescents' trajectories of depressed mood. *Developmental Psychology, 46*(2), 491-501. doi: 10.1037/a0017413
- Brendgen, M. R., Vitaro, F., Bukowski, W. M., Dionne, G., Tremblay, R. E., & Boivin, M. (2013). Can friends protect genetically vulnerable children from depression? *Development and Psychopathology, 25*(02), 277-289. doi: doi:10.1017/S0954579412001058
- Brendgen, M. R., Vitaro, F., Turgeon, L., & Poulin, F. (2002). Assessing aggressive and depressed children's social relations with classmates and friends: A matter of perspective. *Journal of Abnormal Child Psychology, 30*(6), 609-624. doi: 10.1023/a:1020863730902
- Bryant, F. B., & Satorra, A. (2012). Principles and Practice of Scaled Difference Chi-Square Testing. *Structural Equation Modeling: A Multidisciplinary Journal, 19*(3). doi: 372-398. doi: 10.1080/10705511.2012.687671
- Bukowski, W. M., Buhrmester, D., & Underwood, M. K. (2011). Peer relations as a developmental context. In M. K. Underwood & L. H. Rosen (Eds.), *Social development: Relationship in infancy, childhood and adolescence* (pp. 153-179). New-York: Guilford Press.
- Cohen, P., Cohen, J., Kasen, S., Velez, C. N., Hartmark, C., Johnson, J., et al. (1993). An Epidemiological Study of Disorders in Late Childhood and Adolescence—I. Age- and Gender-Specific Prevalence. *Journal of Child Psychology and Psychiatry, 34*(6), 851-867. doi: 10.1111/j.1469-7610.1993.tb01094.x
- Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*(8), 837-844. doi: 10.1001/archpsyc.60.8.837
- Cogle, J. R., Fitch, K. E., Fincham, F. D., Riccardi, C. J., Keough, M. E., & Timpano, K. R. (2012). Excessive reassurance seeking and anxiety pathology: Tests of incremental associations and

directionality. *Journal of Anxiety Disorders*, 26(1), 117-125. doi:

<http://dx.doi.org/10.1016/j.janxdis.2011.10.001>

Dumas, J. E. (2007). *Psychopathologie de l'enfant et de l'adolescent* (3 ed.). Bruxelles, Belgique:

Édition De Boeck.

Eley, T. C., Bolton, D., O'Connor, T. G., Perrin, S., Smith, P., & Plomin, R. (2003). A twin study of anxiety-related behaviours in pre-school children. *Journal of Child Psychology and Psychiatry*,

44(7), 945-960. doi: 10.1111/1469-7610.00179

Eley, T. C., & Lau, J. Y. F. (2005). Genetics and the family environment. In J. L. Hudson & R. M.

Rapee (Eds.), *Psychopathology and the family* (pp. 3-19). Oxford: Elsevier.

Essau, C. A., Conradt, J., & Petermann, F. (2000). Frequency, comorbidity, and psychosocial

impairment of depressive disorders in adolescents. *Journal of Adolescent Research*, 15(4), 470-481. doi: 10.1177/0743558400154003

Ezpeleta, L., Keeler, G., Erkanli, A., Costello, E. J., & Angold, A. (2001). Epidemiology of psychiatric disability in childhood and adolescence. *Journal of Child Psychology and Psychiatry*, 42(7),

901-914. doi: 10.1111/1469-7610.00786

Fox, N. A., Nichols, K. E., Henderson, H. A., Rubin, K., Schmidt, L., Hamer, D., et al. (2005).

Evidence for a Gene-Environment Interaction in Predicting Behavioral Inhibition in Middle Childhood. *Psychological Science*, 16(12), 921-926. doi: 10.1111/j.1467-9280.2005.01637.x

Franić, S., Middeldorp, C. M., Dolan, C. V., Ligthart, L., & Boomsma, D. I. (2010). Childhood and

Adolescent Anxiety and Depression: Beyond Heritability. *Journal of the American Academy of Child & Adolescent Psychiatry*, 49(8), 820-829. doi:

<http://dx.doi.org/10.1016/j.jaac.2010.05.013>

Goldsmith, H. (1991). A zygosity questionnaire for young twins: A research note. *Behavior Genetics*,

21(3), 257-269. doi: 10.1007/bf01065819

- Gregory, A., & Eley, T. (2007). Genetic influences on anxiety in children: What we've learned and where we're heading. *Clinical Child and Family Psychology Review*, *10*(3), 199-212. doi: 10.1007/s10567-007-0022-8
- Guimond, F.-A., Brendgen, M., Vitaro, F., Forget-Dubois, N., Dionne, G., Tremblay, R. E., et al. (2014). Gene–environment interplay in the link of friends' and nonfriends' behaviors with children's social reticence in a competitive situation. *Developmental Psychology*, *50*(3), 956-967. doi: 10.1037/a0034354
- Güroğlu, B., Van Lieshout, C. F. M., Haselager, G. J. T., & Scholte, R. H. J. (2007). Similarity and Complementarity of Behavioral Profiles of Friendship Types and Types of Friends: Friendships and Psychosocial Adjustment. *Journal of Research on Adolescence*, *17*(2), 357-386. doi: 10.1111/j.1532-7795.2007.00526.x
- Hatfield, E., & Rapson, R. L. (2000). Emotional contagion. In W. E. Craighead & C. B. Nemeroff (Eds.), *The Corsini encyclopedia of psychology and behavioral science* (pp. 493-495). New York: John Wiley & Sons.
- Heerey, E. A., & Kring, A. M. (2007). Interpersonal consequences of social anxiety. *Journal of Abnormal Psychology*, *116*(1), 125-134. doi: 10.1037/0021-843x.116.1.125
- Hettema, J. M., Neale, M. C., & Kendler, K. S. (2001). A review and meta-analysis of the genetic epidemiology of anxiety disorders. *The American journal of psychiatry*, *158*(10), 1568-1578. doi: 10.1176/appi.ajp.158.10.1568
- Jaffee, S. R., Caspi, A., Moffitt, T. E., Dodge, K. A., Rutter, M., Taylor, A., et al. (2005). Nature × nurture: Genetic vulnerabilities interact with physical maltreatment to promote conduct problems. *Development and Psychopathology*, *17*(01), 67-84. doi: doi:10.1017/S0954579405050042

- La Greca, A. M., & Harrison, H. M. (2005). Adolescent Peer Relations, Friendships, and Romantic Relationships: Do They Predict Social Anxiety and Depression? *Journal of Clinical Child & Adolescent Psychology, 34*(1), 49 - 61.
- Ladd, G. W., & Troop-Gordon, W. (2003). The role of chronic peer difficulties in the development of children's psychological adjustment problems. *Child Development, 74*(5), 1344-1367. doi: 10.1111/1467-8624.00611
- Lahey, B. B., & D'Onofrio, B. M. (2010). All in the Family: Comparing Siblings to Test Causal Hypotheses Regarding Environmental Influences on Behavior. *Current Directions in Psychological Science, 19*(5), 319-323. doi: DOI: 10.1177/0963721410383977
- Lau, J. Y. F., & Eley, T. C. (2008). New behavioral genetic approaches to depression in childhood and adolescence. In J. R. Z. Abela & B. L. Hankin (Eds.), *Handbook of depression in children and adolescents* (pp. 124-148). New York, NY, US: Guilford Press.
- Lau, J. Y. F., Gregory, A. M., Goldwin, M. A., Pine, D. S., & Eley, T. C. (2007). Assessing gene–environment interactions on anxiety symptom subtypes across childhood and adolescence. *Development and Psychopathology, 19*(04), 1129-1146. doi: doi:10.1017/S0954579407000582
- Laursen, B., & Hartup, W. W. (2002). The Origins of Reciprocity and Social Exchange in Friendships. *New Directions for Child and Adolescent Development, 2002*(95), 27-40. doi: 10.1002/cd.35
- Magnusson, P. K. E., Almqvist, C., Rahman, I., Ganna, A., Viktorin, A., Walum, H., et al. (2013). The Swedish Twin Registry: Establishment of a Biobank and Other Recent Developments. *Twin Research and Human Genetics, 16*(Special Issue 01), 317-329. doi: doi:10.1017/thg.2012.104
- Mariano, K. A., & Harton, H. C. (2005). Similarities in aggression, inattention/hyperactivity, depression, and anxiety in middle childhood friendships. *Journal of Social and Clinical Psychology, 24*(4), 471-496. doi: 10.1521/jscp.2005.24.4.471

- Moffitt, T. E. (2005). The new look of behavioral genetics in developmental psychopathology: Gene-environment interplay in antisocial behaviors. *Psychological Bulletin, 131*(4), 533-554. doi: 10.1037/0033-2909.131.4.533
- Muthén, L. K., & Muthén, B. O. (1998-2010). *Mplus User's Guide*. Sixth Edition
- Nugent, N., Tyrka, A., Carpenter, L., & Price, L. (2011). Gene-environment interactions: early life stress and risk for depressive and anxiety disorders. *Psychopharmacology, 214*(1), 175-196. doi: 10.1007/s00213-010-2151-x
- Parker, J. G., & Asher, S. R. (1993). Friendship and friendship quality in middle childhood: Links with peer group acceptance and feelings of loneliness and social dissatisfaction. *Developmental Psychology, 29*(4), 611-621. doi: 10.1037/0012-1649.29.4.611
- Parrish, C. L., & Radomsky, A. S. (2010). Why do people seek reassurance and check repeatedly? An investigation of factors involved in compulsive behavior in OCD and depression. *Journal of Anxiety Disorders, 24*(2), 211-222. doi: <http://dx.doi.org/10.1016/j.janxdis.2009.10.010>
- Pedersen, S., Vitaro, F., Barker, E. D., & Borge, A. I. H. (2007). The timing of middle-childhood peer rejection and friendship: Linking early behavior to early-adolescent adjustment. *Child Development, 78*(4), 1037-1051. doi: 10.1111/j.1467-8624.2007.01051.x
- Prinstein, M. J. (2007). Moderators of peer contagion: A longitudinal examination of depression socialization between adolescents and their best friends. *Journal of Clinical Child and Adolescent Psychology, 36*(2), 159-170. doi: 10.1080/15374410701274934
- Prinstein, M. J., Borelli, J. L., Cheah, C. S., Simon, V. A., & Aikins, J. W. (2005). Adolescent girls' interpersonal vulnerability to depressive symptoms: a longitudinal examination of reassurance-seeking and peer relationships. *Journal of Abnormal Psychology, 114*(4), 676-688. doi: 10.1037/0021-843X.114.4.676

- Purcell, S. (2002). Variance components models for gene-environment interaction in twin analysis *Twin Research*, 5(6), 554-571. doi: 10.1375/136905202762342026
- Reynolds, C. R., & Richmond, B. O. (1985). *Revised Children's Manifest Anxiety Scale (RCMAS)*. Los Angeles, CA: Western Psychological Services.
- Rose, A. J., Carlson, W., & Waller, E. M. (2007). Prospective associations of co-rumination with friendship and emotional adjustment: Considering the socioemotional trade-offs of co-rumination. *Developmental Psychology*, 43(4), 1019-1031. doi: 10.1037/0012-1649.43.4.1019
- Rubin, K., Wojslawowicz, J., Rose-Krasnor, L., Booth-LaForce, C., & Burgess, K. (2006). The Best Friendships of Shy/Withdrawn Children: Prevalence, Stability, and Relationship Quality. *Journal of Abnormal Child Psychology*, 34(2), 139-153. doi: 10.1007/s10802-005-9017-4
- Scarr, S., & McCartney, K. (1983). How People Make Their Own Environments: A Theory of Genotype - Environment Effects. *Child Development*, 54(2), 424-435. doi: 10.2307/1129703
- Schwartz-Mette, R. A., & Rose, A. J. (2012). Co-rumination mediates contagion of internalizing symptoms within youths' friendships. *Developmental Psychology*, No Pagination Specified. doi: 10.1037/a0027484
- Shanahan, M., & Hofer, S. (2005). Shanahan, M., & Hofer, S. (2005). Social context in gene-environment interactions: Retrospect and prospect. *Journal of Gerontology: Series B*, 60B, 65-76.
- Silberg, J., Rutter, M., Neale, M., & Eaves, L. (2001). Genetic moderation of environmental risk for depression and anxiety in adolescent girls. *British Journal of Psychiatry*, 179, 116-121.
- Smith, R. L., & Rose, A. J. (2011). The "cost of caring" in youths' friendships: Considering associations among social perspective taking, co-rumination, and empathetic distress. *Developmental Psychology*, 47(6), 1792-1803. doi: 10.1037/a0025309

- Spitz, E., Carlier, M., Vacher-Lavenu, M. C., Reed, T., Moutier, R., Busnel, M. C., et al. (1996). Long-term effect of prenatal heterogeneity among monozygotes. *Cahiers de psychologie cognitive*, *15*(3), 283-308.
- Stevens, E. A., & Prinstein, M. J. (2005). Peer contagion of depressogenic attributional styles among adolescents: A longitudinal study. *Journal of Abnormal Child Psychology*, *33*(1), 25-37. doi: 10.1007/s10802-005-0931-2
- Thorpe, K. J. (2003). Twins and friendship.
- Van Zalk, N., Van Zalk, M., Kerr, M., & Stattin, H. (2011). Social anxiety as a basis for friendship selection and socialization in adolescents' social networks. *Journal of Personality*, *79*(3), 499-526. doi: 10.1111/j.1467-6494.2011.00682.x
- Vitaro, F., Boivin, M., & Bukowski, W. M. (2011). The role of friendship in child and adolescent psychosocial development. In K. H. Rubin, W. M. Bukowski & B. Laursen (Eds.), *Handbook of peer interactions, relationships, and groups* (pp. 568-585). New York: Guilford Press.
- Wichers, M., Schrijvers, D., Geschwind, N., Jacobs, N., Myin-Germeys, I., & Thiery, E. (2009). Mechanisms of gene-environment interactions in depression: evidence that genes potentiate multiple sources of adversity. *Psychological Medicine*, *39*(07), 1077-1086. doi: 10.1017/S0033291708004388
- Woodward, L. J., & Fergusson, D. M. (2001). Life course outcomes of young people with anxiety disorders in adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(9), 1086-1093. doi: 10.1097/00004583-200109000-00018
- Zahn-Waxler, C., Klimes-Dougan, B., & Slattery, M. J. (2000). Internalizing problems of childhood and adolescence: Prospects, pitfalls, and progress in understanding the development of anxiety and depression. *Development and Psychopathology*, *12*(03), 443-466. doi: doi:null