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AND DEPRESSION

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Links Between the Mother-Adolescent and Father-Adolescent Relationships and Adolescent
Depression : a Genetically Informed Study

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Abstract

This study examined the unique roles of support and conflict in the relationship with the mother and the father in predicting changes in adolescents' depressive symptoms over a one-year period. Potential moderating effects of genetic factors (gene-environment interaction, GxE) and sex were also investigated. This study utilized a design of twins raised in the same family, based on a sample of 121 monozygotic (MZ) and 88 dizygotic (DZ) same sex twin pairs (418 individuals; 52.2% girls) assessed in grade 8 ($M = 14.09$, $SD = .29$) and in grade 9 ($M = 15.07$, $SD = .26$). Depressive symptoms and the parent-adolescent relationship quality were measured with self-report questionnaires. Multilevel regressions revealed that a lack of support in the father-adolescent relationship predicted increased depressive symptoms amongst all adolescents, whereas conflict in the father-adolescent relationship predicted increased depressive symptoms more strongly as adolescents' genetic vulnerability for depressive symptoms increased. Moreover, a high level of support in the relationship with the mother predicted increased depressive symptoms in boys – but not girls – with a high genetic risk for such problems. In line with a diathesis-stress model of psychopathology, these findings suggest that relationship quality with both parents might impact girls' and boys' depressive symptoms, but that these associations depend to some extent on adolescents' genetic vulnerabilities.

Key words: Parent-Adolescent Relationship, Relationship Quality, Adolescent Depression, Twin study, Gene-environment Interaction

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Adolescence is characterized by significant biological, cognitive and social changes, which alter youngsters' conception of themselves as well as their interactions with others (Smetana, Campione-Barr & Metzger, 2006). These changes, while being normative for many, can also be a great source of turmoil for others and lead to severe adjustment difficulties, including depressive symptoms. The prevalence of depressive symptoms indeed shows a dramatic increase from childhood through adolescence. For example, a large cross-sectional study in the United States based on nearly 10 000 adolescents revealed that 10% of 6th graders, 20% of 7th graders and 24% of 8th graders report depressive cognitions and behaviors (Saluja et al., 2004). These internalizing problems remain relatively stable, as 44% of adolescents with moderate or high depressive symptoms still show elevated levels of distress one year later (Rushton, Forcier, & Schectman, 2002). Some adolescents may be inherently more at risk to suffer from depressive symptoms. In line with this notion, genetically informative studies such as those based on twin designs showed that between 23% to 45% of the variance in adolescents' depressive symptoms is explained by genetic factors (Hicks, DiRago, Iacono & McGue, 2009; Lau & Eley, 2008). Unfortunately, elevated depressive symptoms during adolescence increase the risk for a broad array of subsequent adjustment problems, such as academic and social difficulties, substance use, school drop-out, as well as recurrence of depressive disorders and lower income in adulthood (Avenevoli, Knight, Kessler, & Merikangas, 2008). In light of these severe consequences, understanding the interplay between environmental and genetic risk factors in the development of depressive symptoms during adolescence is critical.

The Parent-Child Relationship and Depressive Symptoms

Whereas non-interpersonal stress factors such as academic difficulties or negative life events (i.e. death in the family, divorce, moving) are believed to explain elevated depressive symptoms in childhood, interpersonal stress factors are considered to become predominant in the development of depressive

symptoms during adolescence (Rudolph & Hammen, 1999; Rudolph, 2000). The parent-child relationship may be of specific significance in this context. Indeed, although peer relations gain in importance during adolescence (Smetana, Campione-Barr & Metzger, 2006), research shows that the relationship with parents continues to be the most crucial source of influence on adolescents' adjustment (Stice, Ragan, & Randall, 2004). The key role of the parent-child relationship in the development of depressive symptoms may be understood in terms of what it offers to promote individuals' health and well-being. According to Weiss' social provisions theory (1974), close relationships offer various critical social provisions such as reliable alliance, enhancement of worth, affection, companionship, instrumental help, intimacy, and nurturance of the other. Up to the age of 14 years, adolescents view their parents as their main source of support for meeting these needs (Furman & Burhmester, 1992). Not surprisingly, a lack of support and other positive attributes in the parent-child relationship has been linked to an increase of depressive symptoms in adolescents (Sheeber, Davis, Leve, Hops, & Tidesley, 2007; Sheeber, Hops, Alpert, Davis & Andrews, 1997).

However, close relationships such as those with parents may not only be a source of support but also of conflict (Smetana, Campione-Barr & Metzger, 2006). Indeed, youth between the ages of 9 to 16 years also perceive their parents as their primary source of interpersonal conflict, after their siblings (Furman & Burhmester, 1992). During adolescence, parent-child conflicts mainly revolve around the themes of autonomy and responsibilities (Smetana, 2002). Studies typically report low to medium correlations between the level of support and the level of conflict in the parent-child relationship (Laursen & Mooney, 2008; Jenkins et al., 2002; Furman & Burhmester, 1992). Many scholars therefore stress the importance of considering both positive and negative attributes when evaluating relationship quality (Furman & Burhmester, 1992; Sheeber, et al., 2007; Sheeber, et al., 1997). In line with this notion, both a lack of support and a high level of conflict in the parent-child relationship have been uniquely linked to an increase of depressive symptoms in adolescents (Branje, Hale, Frijins & Meeus, 2010; Sheeber et al., 1997). Still, effect sizes are moderate at best, with the parent-child relationship quality explaining

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only between 5 to 15% of inter-individual differences in adolescents' depressive symptoms. It is thus possible that some other factors, such as sex differences or genetic vulnerability factors, moderate the link between the parent-child relationship quality and depressive symptoms.

The Potential Moderating Role of Sex Differences

The predictive link between parent-child relationship quality and depressive symptoms may first vary according to the sex of the adolescent. Specifically, this link may be stronger for girls than boys, considering girls' higher reactivity to interpersonal stressors (Nolen-Hoeksema, 2001; Zahn-Waxler, Shirtcliff & Marceau, 2008). It has been suggested that girls' self-concept is more defined by their interpersonal relationships, especially during adolescence (Nolen-Hoeksema, 2001; Zahn-Waxler, et al., 2008). This greater emphasis on interpersonal relationships can make girls more vulnerable to developing depressive symptoms when their relationships deteriorate. With respect to the parent-child relationship, this notion is supported by findings that conflicts with parents are more strongly related to depressive symptoms of early adolescent girls than boys, explaining 19% and 6% of the variance, respectively (Jenkins et al., 2002).

The vast majority of published studies on the predictors of depressive symptoms amongst youth did not, unfortunately, distinguish between the quality of the relationship with the mother and the quality of the relationship with the father. Findings from at least one study, however, suggest that the link between parent-child relationship quality and depressive symptoms may also vary according to the sex of the parent. Thus, in a cross-sectional study of 14 to 18 year-old adolescents, the relationship quality with either parent was found to uniquely contribute to depressive symptoms in the offspring (Sheeber, et al., 2007). Specifically, the results showed that the positive and negative attributes in the relationship with the father explained 20% of the variability of adolescents' depressive symptoms, compared to 6% for the relationship with the mother.

Perhaps even more important than the sex of the adolescent or of the parent per se may be the sex-composition of the parent-adolescent dyad. Indeed, some studies indicate a potentially greater importance

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of the relationship with the same-sex parent for adolescents' adjustment (Branje et al., 2010, Furman & Buhrmester, 1992). An empirical test of whether the predictive link between the parent-adolescent relationship quality and adolescents' depressive symptoms varies depending on the sex-composition of the parent-adolescent dyad is still lacking, however.

The Potential Moderating Role of Genetic Factors

As previously stated, and although a majority of studies only considered the role of environmental factors in the development of depressive symptoms, heritable influences also play an important role (Hicks & al., 2009; Johnson, Turkheimer, Gottesman & Bouchard, 2009; Lau & Eley, 2008). In addition to main effects of genetic liabilities on the development of depressive symptoms, genetic vulnerability factors can also interact with environmental factors to predict an increase in depressive symptoms. For instance, a diathesis-stress process of gene-environment interaction (GxE) may occur when a stressful environment exacerbates the expression of a genetic vulnerability, or when the effect of a stressful environment is greater amongst individuals with a genetic vulnerability (Shanahan & Hofer, 2005). Several studies have reported evidence of GxE in regard to adolescents' depressive symptoms that is in accordance with a diathesis-stress process. For example, Lau and Eley (2008) found that genetic vulnerabilities for depressive symptoms are more likely to be manifested when adolescents are exposed to high levels of maternal punitive discipline. Similarly, a genetic vulnerability for depressive symptoms is more readily expressed when adolescents experience a more chaotic family environment (operationalized as the level of routine, noise, and general environmental confusion) or poor parenting (operationalized as overly strict discipline and low levels of warmth toward children) (Wilkinson, Trzaskowski, Haworth & Eley, 2013). However, no study so far has examined a possible GxE in the predictive links between the mother-child or the father-child relationship quality and adolescents' depressive symptoms.

The Present Study

The first objective of the present study was to examine the unique roles of support and conflict in the relationship with the mother and the father in predicting changes in adolescents' depressive symptoms over a one-year period. We expected that, even when controlling for genetic vulnerabilities, both a lack of support and a high level of conflict perceived in the parent-child relationship would predict an increase in adolescents' depressive symptoms.

Secondly, the present study aimed to investigate whether the predictive link between the parent-child relationship quality and adolescents' depressive symptoms varied depending on the sex of the offspring and the sex-composition of the parent-adolescent dyad. In regard to the sex of the offspring, we expected that the predictive link between the parent-child relationship quality and depressive symptoms would be stronger for girls than boys, considering girls' higher sensibility to relational stressors (Nolen-Hoeksema, 2001; Zahn-Waxler, et al., 2008). Additionally, since adolescents perceive the relationship with their same-sex parent as being more supportive (Branje et al., 2010; Furman & Buhrmester, 1992), it was expected that a problematic relationship with the same-sex parent would play a greater role in the development of adolescents' depressive symptoms.

The third objective was to explore whether the predictive link between the parent-child relationship quality and adolescents' depressive symptoms varied according to youngsters' genetic vulnerability for depressive symptoms (GxE). Based on Wilkinson's study (Wilkinson et al., 2013) on family chaos and poor parenting, and on Lau and Eley's study (2008) on harsh parental discipline, we expected to find a GxE in line with a diathesis-stress process in the link between individuals' genetic vulnerability for depressive symptoms and the parent-child relationship quality.

These associations were examined while controlling for pubertal status and family adversity. Indeed, several studies reported that hormonal changes and many aspects of the familial context, such as marital satisfaction and socioeconomic status, can affect adolescents' depressive symptoms and the quality of their relationship with parents (Conger, Conger & Martin, 2010; Thapar, Collishaw, Pine & Thapar, 2012). It is therefore essential to control their effects.

Method

Participants

The present study utilized a genetically informative design based on a sample of 121 monozygotic (MZ) and 88 dizygotic (DZ) same-sex twin pairs (i.e., a total of 418 individuals; 52.2% girls) assessed in grade 8 ($M = 14.09$, $SD = .29$) and in grade 9 ($M = 15.07$, $SD = .26$). They were part of a population-based sample of 467 MZ and same-sex dizygotic DZ twin pairs from the greater Montreal area, 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, 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). The sample was followed longitudinally in the first years of their life, then in preschool and elementary school, as well as in high school. Regarding socioeconomic characteristics, 84% percent of the families were of European descent, 3% were of African descent, 2% were of Asian descent, and 2% were Native North Americans. The remaining families (9%) 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 centres in the province of Quebec (SantéQuébec, Jetté, Desrosiers, & Tremblay, 1998). The same percentage (95%) of parents in both samples lived together at the time of birth of their child(ren); 44% of the twins compared to 45% of the singletons were the firstborn children in the family; 66% of the mothers and 60% of the twins' fathers were between 25 and 34 years old, compared to 66% of mothers and 63% of fathers for the singletons; 17% of the mothers and 14% of the twins' fathers had not finished high school, compared to 12% and 14% of mothers and fathers, respectively, for the singletons; the same proportion of mothers (28%) and fathers (27%) in both samples

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held a university degree; 83% of the twin parents and 79% of singleton parents were employed; 10% of the twin families and 9% of the singleton families received social welfare or unemployment insurance; and, finally, 30% of the twin families and 29% of the singleton families had an annual total income of less than Can\$30,000, 44% and 42% had an annual total income between Can\$30,000 and Can\$59,999, and 27% and 29% had an annual total income of more than Can\$60,000.

To be included in the analyses of the present study, participants had to have valid data on the dependent variable (i.e. depressive symptoms) in grades 8 and 9. Occasional missing data on other variables (14.54% of data points) were imputed using multiple imputations based on 20 imputed data sets, resulting in the aforementioned total study sample of 418 individuals. Multilevel regression analyses showed that participants included in the final study sample did not differ from those lost due to attrition or due to missing data regarding family status, parents' age at the birth of the twins and parents' level of education. However, family income was higher amongst participants included in the present study.

Measures

Relationship quality. In grade 8, adolescents' perception of the relationship quality with their mother and their father was assessed with ten items from the *Network of Relationships Inventory* (NRI; Furman & Buhrmester, 1985, 1992). Six items referred to positive relationship attributes related to support (i.e. "How much does this person like or love you?" "How much does this person treat you like you're good at many things?" "How much does this person help you figure out or fix things?") and four items referred to negative relationships attributes related to conflict (i.e. "How often do you and this person get mad at or get in fights with each other?" "How often do you and this person disagree and quarrel with each other?" "How much do you and this person get annoyed with each other's behavior?"). The participant had to score each item on a 5-point Likert-type scale ranging from 1 "little or never" to 5 "most of the time". For each child, individual item scores were averaged to compute scale scores, separately for support and for conflict in the relationship with each parent (support from the mother: $\alpha =$

.88, $M = 3.53$, $SD = .89$; support from the father: $\alpha = .88$, $M = 3.21$, $SD = .99$; conflict with the mother: $\alpha = .86$, $M = 2.09$, $SD = .76$; conflict with the father: $\alpha = .84$, $M = 1.92$, $SD = .74$).

Depressive symptoms. In grades 8 and 9, adolescents completed the short version (10 items) of the Children's Depression Inventory (CDI; Kovacs, 1992). The excellent validity and fidelity of the CDI have been demonstrated many times (Smucker, Craighead, Craighead & Green, 1986). The CDI assesses a variety of different depressive symptoms dimensions such as disturbed mood, hedonic capacity, vegetative functions, self-evaluation, and interpersonal behaviors. Participants had to choose, amongst a group of three sentences, the sentence that represents them most accurately. For example: "*Since the last two weeks...0) I am sad once in a while 1) I am sad many times 2) I am sad all the time*" and "*Since the last two weeks...0) I succeed in almost everything I do 1) I fail at lots of things 2) I fail at everything*". Each item had a response score ranging from 0 to 2 (2 being the score related to higher depressive symptoms). Four of the 10 items were reversed before averaging individual item scores to create individual scale scores of depressive symptoms (grade 8: $\alpha = .78$, $M = .25$, $SD = .27$; grade 9: $\alpha = .78$, $M = .27$, $SD = .27$).

Genetic risk for depressive symptoms. When data are collected on twins, an ordinal score of each individual's genetic risk for depressive symptoms can be estimated as a function of his or her co-twin's level of depressive symptoms and the pair's genetic relatedness (Andrieu & Goldstein, 1998). 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., 2013; Guimond & al., 2014; Jaffee et al., 2005). 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. Next, to calculate the presence or absence of depressive symptoms in the co-twin, the continuous depressive symptoms scale in grade 8 ($M = 14.09$, $SD = .29$) was dichotomized using 1 SD above the mean as the cut-off, which corresponds to a score of 6 on 20 on the short version of the CDI. This cut-off score allowed us to identify elevated levels of depression

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For each individual, the information about depressive symptoms in his or her co-twin was then combined with information on the pair's degree of genetic relatedness into an index of genetic risk for depressive symptoms. Thus, the target twin's genetic risk for depressive symptoms was considered to be highest (coded as 3; 9.1% of the sample) when he/she was part of an MZ twin pair (who share 100% of their genetic material) and when the co-twin's depressive symptoms were 1 SD or more above the mean. The target twin's genetic risk for depressive symptoms was somewhat lower, but still relatively high (coded as 2) when he/she was part of a DZ twin pair (who on average share 50% of their genes) and when the co-twin's depressive symptoms were 1 SD or more above the mean (4.5%). The target twin's genetic risk for depressive symptoms was even lower (coded as 1) when he/she was part of a DZ twin pair and when the co-twin's depressive symptoms were below 1 SD (37.6%). The target twin's genetic risk for depressive symptoms was lowest (coded as 0) when he/she was part of an MZ twin pair and when the co-twin's depressive symptoms were below 1 SD. Nine percent of the sample were at highest genetic risk for depressive symptoms, 5% were at high genetic risk for depressive symptoms, 38% were at low genetic risk for depressive symptoms, and 49% were at lowest genetic risk for depressive symptoms.

Importantly, because potential mean differences in depression symptoms due to zygosity would be confounded with the genetic risk index, it was important to ensure that MZ and DZ twins showed no mean level differences in regard to their depressive symptoms. Multilevel regressions revealed no differences between MZ and DZ twins regarding depressive symptoms in grade 8 ($B = -.07, SE = .11, p = .52$) or in grade 9 ($B = -.01, SE = .11, p = .90$).

Pubertal status. Pubertal Status was assessed in grade 8 with the Pubertal Development Scale (Petersen et al., 1987). Participants rated their physical development on a 4-point scale (1 “no development” to 4 “development is complete”) on several characteristics, including: growth spurt in

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height, pubic hair, and skin change for boys and girls; facial hair growth and voice change in boys; breast development and menarche in girls. An overall pubertal development score was computed by summing across the 5 items to obtain a total score; the sum of the scores on the 5 indicators was then divided by 5 in order to preserve the original (1-4) metric ($M = 2.4$, $SD = .49$, $\min = .80$, $\max = 3.60$).

Family Stress. Three distinct family stressors were used as control variables: a) Marital Satisfaction, which was computed by calculating the mean of both mothers' and fathers' responses to eight items from the Dyadic Adjustment Scale (Spanier, 1976), with a high value suggesting a high level of marital satisfaction ($\alpha = .88$, $M = 4.77$, $SD = .60$, $\min = 2.38$, $\max = 6$); b) Family Income, which ranged from 0 (no employment income) and 10 (employment income of more than 80 000\$) ($M = 7.92$, $SD = 2.03$, $\min = 1$, $\max = 10$); c) Mother's Education, which ranged from 0 (no high school diploma) to 20 (MD / PHD diploma) ($M = 12.63$, $SD = 2.92$, $\min = 0$, $\max = 20$).

Procedure

All instruments were administered in paper-and-pencil format in either English or French, depending on the language spoken by the families. The French version of the CDI was drawn from the validated French questionnaire (Saint-Laurent, 1990). For all other instruments, following the procedure suggested by Vallerand (1989), 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. Parents were contacted by letter and active written consent from parents and adolescents was obtained. Data collection took place in the spring during home interviews and took approximately one hour. The instruments, which were embedded in a larger questionnaire on adolescents' developmental adjustment, were approved by the Institutional Review Board of the University of Quebec at Montreal.

Analyses and Results

Preliminary Analysis

Prior to the main analysis, bivariate correlations between all study variables were examined (see Table 1). As shown, depressive symptoms in grade 9 were positively correlated with being a girl, with a higher genetic risk for depressive symptoms, with the level of depressive symptoms in grade 8, and with conflict with the mother and with the father. Moreover, depressive symptoms in grade 9 were negatively correlated with support from the mother and from the father. Genetic risk for depressive symptoms was negatively correlated with support and positively correlated with conflict within the mother-adolescent and father-adolescent relationship. Finally, as for the control variables, marital satisfaction was negatively correlated with conflict in the mother-adolescent relationship and with adolescents' depressive symptoms in grade 8.

Main Analysis: Analytical Rationale

Using the Mplus software, Generalized Estimation Equation (GEE) regressions were performed to examine the predictive links between adolescents' genetic vulnerability for depressive symptoms, conflict and support in the relationship with the mother and the father, on the one hand, and change in adolescents' depressive symptoms from grade 8 to grade 9, on the other hand. Interactive effects with sex and genetic risk for depressive symptoms were also examined using simple slopes (Jaccard & Turrisi, 2003). The GEE procedure allows analysis of correlated observational measures, such as those drawn from a twin sample, through Maximum Likelihood Estimation with robust standard errors. A series of consecutively more complex multiple regressions models were specified, which included the previously mentioned control variables (see Table 2). The overall fit of each model was tested using the coefficient of determination statistic (R^2), which indicates the proportion of the variance in the dependent variable predicted from the independent variables. To facilitate the interpretation of results, all variables, except adolescents' sex and genetic risk for depressive symptoms, were z-standardized prior to analysis.

In Model 1, main effects of parents' marital satisfaction, family income, mother's level of education, the child's sex, pubertal status, genetic risk for depressive symptoms, and of the four relationship variables (i.e., support in the mother-child relationship, support in the father-child

Predictive Links between the Parent-Adolescent Relationship Quality and Depression 15 relationship, conflict in the mother-child relationship, and conflict in the father-child relationship) were assessed. Depressive symptoms in grade 8 were also included as an independent variable in model 1, so that the prediction of longitudinal change in depressive symptoms from grade 8 to grade 9 could be assessed.

Model 2 comprised four sub-models - one for each of the four parent-child relationship quality indicators - to assess interaction effects between adolescents' sex, their genetic vulnerability to depressive symptoms and the parent-child relationship quality indicators. In each sub-model, three double interactions and one triple interaction were added to the other predictors already in the model. Specifically, in Model 2a we added "support from the mother x sex", "support from the mother x genetic risk for depressive symptoms", "sex x genetic risk for depressive symptoms", "support from the mother x sex x genetic risk for depressive symptoms". In Model 2b we added "support from the father x sex", "support from the father x genetic risk for depressive symptoms", "sex x genetic risk for depressive symptoms", "support from the father x sex x genetic risk for depressive symptoms". In Model 2c we added "conflict with the mother x sex", "conflict with the mother x genetic risk for depressive symptoms", "sex x genetic risk for depressive symptoms", "conflict with the mother x sex x genetic risk for depressive symptoms". In Model 2d we added "conflict with the father x sex", "conflict with the father x genetic risk for depressive symptoms", "sex x genetic risk for depressive symptoms", "conflict with the father x sex x genetic risk for depressive symptoms".

Main Analysis: Results

Results from Model 1 showed that higher levels of depressive symptoms in grade 8 and a higher genetic risk for depression were significantly linked to depressive symptoms in grade 9 ($\beta = .49$, $SE = .06$, $p < .001$, and $\beta = .11$, $SE = .05$, $p < .05$, respectively). Girls also showed higher levels of depression than boys, albeit only with a statistical trend ($\beta = .13$, $SE = .08$, $p = .09$). Moreover, both a lack of support and a high level of conflict in the relationship with the father were associated with more depressive symptoms ($\beta = -.17$, $SE = .08$, $p < .05$, and $\beta = .12$, $SE = .06$, $p < .05$, respectively).

In Model 2a, a significant interaction between support in the mother-child relationship and adolescents' genetic risk for depressive symptoms ($\beta = .16$, $SE = .04$, $p < .001$) was found. This interaction significantly varied by adolescents' sex, however ($\beta = -.13$, $SE = .06$, $p < .05$). Probing of this triple interaction (see Figure 1) showed that a high level of support from the mother predicted boys' – but not girls' – increased depressive symptoms a year later, albeit only in boys who were at very high ($\beta = .40$, $SE = .13$, $p < .01$) or high ($\beta = .25$, $SE = .10$, $p < .05$) genetic risk for depressive symptoms. In contrast, the level of support from the mother was unrelated to depressive symptoms in boys at low ($\beta = .09$, $SE = .08$, $p = .24$) or very low ($\beta = -.06$, $SE = .08$, $p = .46$) genetic risk for developing such problems.

No significant interactions were found in Model 2b (i.e., involving conflict in the mother-adolescent relationship) or Model 2c (i.e., involving support in the father-child relationship). However, in Model 2d, a significant interaction was found between conflict in the father-child relationship and adolescents' genetic risk for depressive symptoms ($\beta = .14$, $SE = .05$, $p < .01$). Probing of this interaction (see Figure 2) revealed that the predictive effect of conflict with the father on adolescents' depressive symptoms a year later was fairly strong when they were at very high genetic risk for developing depressive symptoms ($\beta = .43$, $SE = .10$, $p < .001$), but became progressively weaker as genetic risk decreased ($\beta = .30$, $SE = .09$, $p < .01$, for high genetic risk, and $\beta = .17$, $SE = .08$, $p < .05$, for low genetic risk). Indeed, conflict with the father was unrelated to depressive symptoms when adolescents were at very low ($\beta = .04$, $SE = .08$, $p = .62$) genetic risk for such problems.

Discussion

The present study aimed to examine the unique roles of support and conflict in the relationship with the mother and the father in predicting changes in adolescents' depressive symptoms over a one-year period. We also investigated whether these associations varied according to either the offspring's or the parent's sex, or adolescents' genetic vulnerability to depressive symptoms.

As expected, and in accordance with previous studies (Stice et al., 2004; Sheeber et al., 2007), the relationship quality with both parents was related to adolescents' depressive symptoms one year later.

However, only a lack of support in the relationship with the father was predictive of both girls' and boys' depressive symptoms, regardless of their genetic vulnerability for internalizing problems. By the same token, this finding indicates that a high level of support from the father seems to help protect adolescents of both sexes from internalizing problems. This unique and extensive protective role of paternal support on adolescents' adjustment may be due to the specific form of support provided by fathers. According to Desjardins & Leadbeater (2011), fathers may provide support to their offspring that is oriented toward active coping strategies and problem solving, which may foster adolescents' sense of competency and autonomy and protect them from developing internalized difficulties. Conflict with the father also predicted an increase of depressive symptoms and this association became stronger with increasing genetic vulnerability for depressive symptoms. Excessive father-adolescent conflict in the present study may at least in part result from overly strict paternal discipline, as fathers are more likely than mothers to use harsh discipline behavior, such as yelling (Starrels, 1994). Wilkinson (2013) found that overly strict discipline triggered depressive symptoms only in adolescents with a higher genetic vulnerability for depressive symptoms. For this reason, conflict with the father may only be detrimental to adolescents' well-being when they are more sensitive to an adverse family environment due to genetic vulnerabilities, whereas adolescents not genetically at risk may be more resilient to its damaging effects. Future studies should test the role of paternal strict discipline in this context.

Regarding the relationship with the mother, results revealed that high levels of support from the mother was related to an increase in boys' - but not girls' - depressive symptoms, but only when they were at high genetic risk of developing internalizing problems. Although seemingly counterintuitive at first, this finding suggests that excessive parental support may in some cases become detrimental to adolescents' adjustment. Very high levels of parental support might indicate parental overprotection, which Levy (1970) characterized as a high degree of physical and social contact with the child, inordinate concern over the child, and prevention of independent behavior. Especially in adolescence, when the development of autonomy is an important developmental task (Koepke & Denissen, 2012), excessive

parental support may thus hamper adolescents' self-confidence and induce a sense of learned helplessness (Bowlby, 1977; Kraaij et al., 2003), thus fostering the development of depressive symptoms. In line with this notion, maternal overprotection has been found to uniquely contribute to adolescents' depressive symptoms, above and beyond the contribution of low maternal care (Martin, Bergen, Roeger & Allison, 2004). As suggested by Desjardins & Leadbeater (2011), overly supportive mothers may engage in co-rumination (i.e., the extensive discussion of problems) with her adolescent offspring. Especially frequent in very close relationships (Rose, 2002), co-rumination has been linked to poorer emotional adjustment such as depressive symptoms (Rose, Carlson & Waller, 2007).

Excessive maternal support only predicted depressive symptoms in genetically vulnerable youth, however, and only in boys. This result indicates a diathesis-stress process of GxE, whereby very high maternal support acts as a trigger in the development of depressive symptoms in genetically vulnerable boys. Interestingly, a study by Riggins-Caspers and Cadoret (2003) also found that excessive maternal support increased the risk of psychopathology – albeit in this case related to externalizing problems – especially in genetically vulnerable youth. The finding that a very high level of maternal support only predicted increased depressive symptoms in boys is in line with studies showing that excessive maternal support specifically impedes boys' – but not girls' – socio-emotional adjustment (e.g., Guimond & al., 2012; van der Bruggen, Bögels and van Zeilst, 2010). This sex-specific effect may be explained by gender role norms dictating that a lack of autonomy and low self-confidence is less socially acceptable for boys than for girls, which places them at a particularly high risk of rejection and sometimes even victimization by peers (Bowker, Markovic, Cogswell & Raja, 2012; Pollack, 2006). Not surprisingly, several studies have shown that overprotected boys are at increased risk of being victimized by their peers (Ladd & Ladd, 1998; Olweus, 1993). Moreover, peer victimization has been shown to mediate the link between very high levels of maternal support and increased depressive symptoms (Desjardins & Leadbeater, 2011). Although peer victimization was not assessed in the present study, our findings suggest that this potential mediating effect may be particularly true for genetically vulnerable boys.

Furthermore, since we did not measure maternal overprotection specifically, but rather perceived maternal support, it should be noted that our interpretation necessarily remains speculative, and further studies are needed to corroborate this hypothesis.

Regarding sex moderation effects, our results did not support our expectation that links between parent-adolescent relationship quality and depressive symptoms would generally be stronger for girls or for same-sex parent-adolescent dyads. Nevertheless, our findings corroborate the importance of distinguishing between the relationship with the mother and the relationship with the father when assessing adolescents' adjustment. In particular, it is worth noting that a high level of conflict in the relationship with the father was related to an increase of adolescents' depressive symptoms, whereas conflict with the mother played no role in this regard. This latter finding is similar to those from other studies, which showed that conflict with the mother is much less related to adolescent depression than conflict with the father. A possible explanation may lie in the nature of conflicts between adolescents and their parents. For instance, a study by Smetana (1989) showed that adolescents seem to quarrel more often with their mother regarding house rules, such as bedtime, whereas conflicts with fathers revolve more frequently around adolescents' personal behavior. The content of father-adolescent conflicts might thus have more direct implications for adolescents' self-perceptions - and hence constitute a greater risk factor for the development of depressive symptoms - than conflict with the mother. Overall, these findings not only suggest that maternal and paternal behaviors may distinctly affect adolescents' adjustment, but they also emphasize the importance of considering fathers in the study of adolescents' well-being. Indeed, whereas only maternal support was associated with adolescents' depressive symptoms - and only for boys -, both support and conflict within the father-adolescent relationship were linked to the development of boys' and girls' depressive symptoms. These findings suggest that fathers might play an even more extensive and generalized role than the mother-adolescent relationship in their offspring's well-being once youngsters reach adolescence. The present results thus reinforce the need for implicating fathers in the prevention and treatment of adolescent depression.

Strengths, Limitations and Conclusion

The present study is the first to assess the unique roles of support and conflict in the relationship with the mother and with the father in predicting adolescents' depressive symptoms within a genetically informed perspective. The inclusion of adolescents' genetic vulnerability for depressive symptoms allowed us to control for genetic effects on depressive symptoms and hence obtain a clearer assessment of potential environmental influences than can be obtained with non-genetically informed designs (Hicks et al., 2009; Lau & Eley, 2008). The use of a genetically informed design also enabled us to test theoretical models of GxE concordant with a diathesis-stress process (Zuckerman, 1999). Another strength of our study is its longitudinal perspective, which allowed us to specifically test the predictive link between relationship quality with the parents and changes in adolescents' depressive symptoms.

Our study also presents several limitations. First, despite using a genetically informed design, we did not measure the effect of specific genes. Instead, an ordinal scale of genetic risk was computed to represent an overall genetic risk as an "observed" variable in the analysis. While this measure has been used in several previous studies to test the presence of gene-environment interactions (Brendgen et al., 2013; Guimond & al., 2014, Jaffee et al., 2005), it can only provide a relatively rough approximation of genetic risk. Second, the sole use of adolescents' self-reports may have increased the risk of inflated associations due to shared source variance. Indeed, depressed adolescents may overestimate the level of conflict in the relationship with their parents and minimize their parents' supportive behaviors (Ehrmantrout, Allen, Leve, Davis, & Sheeber, 2011). Some scholars suggest, however, that adolescents' subjective perceptions of their environmental experiences are the most important predictor of their emotional well-being (Gottlieb, 1985, Shoval & al., 2013). Adolescents' self-reports also reduce the risk of bias that can occur when using parental reports in a twin design, as parents tend to show inflated evaluations of monozygotic twins' similarity while exaggerating differences between dizygotic twins (Saudino, Cherny, & Plomin, 2000). The use of multiple reporting sources may help reduce such potential biases in future studies.

Finally, the present study employed a unidirectional approach to the link between parent-adolescent relationship quality and depression symptoms. However, depressive symptoms may also increase the risk of experiencing problems in interpersonal relationships (Coyne, 1976). According to this view, adolescents with a genetic vulnerability to depressive symptoms may express aversive behaviors related to this predisposition, such as irritability, negativity and insecurity. This may, in turn, induce either negative affect or elicit excessively supportive behavior in those they interact with, thus promoting a further increase of depressive symptoms. While the longitudinal perspective of the present study enabled us to identify one direction of the link between parent-adolescent relationship quality and depressive symptoms, future studies should examine whether the inverse direction is also at play. Furthermore, future genetically informed studies may want to also include information on the potential environmental effect of mothers' and fathers' depression on adolescent depression, beyond the transmission of genetic vulnerabilities, and examine to what extent the parent-child relationship mediates this effect. Indeed, according to a recent meta-analysis by Wilson and Durbin (2010), the parent-child relationship could mediate the transmission of depressive symptoms from parents to their offspring. Studies using a "Children-of-twins" design, which evaluates the characteristics of twins who are parents along with the characteristics of their offspring, will be ideally suited to address this question (D'Onofrio et al, 2003).

Despite these limitations, the present study contributes to our understanding of the unique roles of the relationship quality with the mother and with the father in the development of depressive symptoms during adolescence. Our findings emphasize the importance of systemic, family-based interventions that include both parents to prevent adolescents from developing depressive symptoms. By improving parental knowledge about their unique role in the development of adolescents' depressive symptoms, prevention programs may help foster parents' adaptive responses related to their child's needs. Indeed, while parent-child relationships may contribute to an increase of depressive symptoms, they also have the power to reverse this trend.

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.
- Avenevoli, S., Knight, E., Kessler, R. C., & Merikangas, K. R. (2008). Epidemiology of depression in children and adolescents. In J.R.Z. Abela & B.L. Hankin (Eds.), *Handbook of depression in children and adolescents*, (pp. 6-32). Guilford Press.
- Bowker, J. C., Markovic, A., Cogswell, A., & Raja, R. (2012). Moderating effects of aggression on the associations between social withdrawal subtypes and peer difficulties during early adolescence. *Journal of youth and adolescence*, 41(8), 995-1007. doi : [2048/10.1007/s10964011-9712-0](https://doi.org/10.1007/s10964011-9712-0)
- Bowlby, J. (1977). The making and breaking of affectional bonds. II. Some principles of psychotherapy. The fiftieth Maudsley Lecture. *The British Journal of Psychiatry*, 130(5), 421-431. doi : [10.1192/bjp.130.5.421](https://doi.org/10.1192/bjp.130.5.421)
- Branje, S. J., Hale III, W. W., Frijns, T., & Meeus, W. H. (2010). Longitudinal associations between perceived parent-child relationship quality and depressive symptoms in adolescence. *Journal of Abnormal Child Psychology*, 38(6), 751-763. doi: [10.1007/s10802-010-9401-6](https://doi.org/10.1007/s10802-010-9401-6)
- Brendgen, M., 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 (2), 277-289. doi: [10.1017/S0954579412001058](https://doi.org/10.1017/S0954579412001058)
- Conger, R. D., Conger, K. J., & Martin, M. J. (2010). Socioeconomic status, family processes, and individual development. *Journal of Marriage and Family*, 72(3), 685-704. doi: [10.1111/j.1741-3737.2010.00725.x](https://doi.org/10.1111/j.1741-3737.2010.00725.x)
- Coyne, J.C. (1976). Toward an interactional description of depression. *Psychiatry: Journal for the Study of Interpersonal Processes*, 39 (1), 28-40.

- Desjardins, T. L., & Leadbeater, B. J. (2011). Relational victimization and depressive symptoms in adolescence: Moderating effects of mother, father, and peer emotional support. *Journal of Youth and Adolescence*, 40(5), 531-544. doi : [2048/10.1007/s10964-010-9562-1](https://doi.org/10.1007/s10964-010-9562-1)
- D'onofrio, B. M., Turkheimer, E. N., Eaves, L. J., Corey, L. A., Berg, K., Solaas, M. H., & Emery, R. E. (2003). The role of the children of twins design in elucidating causal relations between parent characteristics and child outcomes. *Journal of Child Psychology and Psychiatry*, 44(8), 1130-1144. doi: [10.1111/1469-7610.00196](https://doi.org/10.1111/1469-7610.00196)
- Ehrmantrout, N., Allen, N. B., Leve, C., Davis, B., & Sheeber, L. (2011). Adolescent recognition of parental affect: Influence of depressive symptoms. *Journal of Abnormal Psychology*, 120(3), 628. doi : [10.1037/a0022500](https://doi.org/10.1037/a0022500)
- Furman, W., & Buhrmester, D. (1985). Children's perceptions of the personal relationships in their social networks. *Developmental psychology*, 21(6), 1016. doi: [10.1037/00121649.21.6.1016](https://doi.org/10.1037/00121649.21.6.1016)
- Furman, W., & Buhrmester, D. (1992). Age and sex differences in perceptions of networks of personal relationships. *Child Development*, 63(1), 103-115. doi: [10.2307/1130905](https://doi.org/10.2307/1130905)
- Goldsmith, H. (1991). A zygosity questionnaire for young twins: A research note. *Behavior Genetics*, 21(3), 257-269. doi: [2048/10.1007/BF01065819](https://doi.org/10.1007/BF01065819)
- Gottlieb, B. H. (1985). Social support and the study of personal relationships. *Journal of Social and Personal Relationships*, 2(3), 351-375.
- Guimond, F. A., Brendgen, M., Vitaro, F., Forget-Dubois, N., Dionne, G., Tremblay, R. E., & Boivin, M. (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. doi : [10.1037/a0034354](https://doi.org/10.1037/a0034354)
- Guimond, F. A., Brendgen, M., Forget-Dubois, N., Dionne, G., Vitaro, F., Tremblay, R. E., & Boivin, M. (2012). Associations of mother's and father's parenting practices with children's observed social

reticence in a competitive situation: A monozygotic twin difference study. *Journal of abnormal child psychology*, 40(3), 391-402. doi : [10.1007/s10802-011-9573-8](https://doi.org/10.1007/s10802-011-9573-8)

Hicks, B.M., DiRago, A.C., Iacono, W.G., et McGue, M. (2009). Gene-environment interplay in internalizing disorders: consistent findings across six environmental risk factors. *Journal of Child Psychology and Psychiatry*, 50(10), 1309-1317. doi: [10.1111/j.14697610.2009.02100.x](https://doi.org/10.1111/j.14697610.2009.02100.x)

Jaccard, J., & Turrissi, R. (2003). *Interaction effects in multiple regression* (No. 72). Sage.

Jaffee, S. R., Caspi, A., Moffitt, T. E., Dodge, K. A., Rutter, M., Taylor, A., & Tully, L. A. (2005). Nature× nurture: Genetic vulnerabilities interact with physical maltreatment to promote conduct problems. *Development and Psychopathology*, 17(01), 67-84. doi:[10.1017/S0954579405050042](https://doi.org/10.1017/S0954579405050042)

Jenkins, S. R., Goodness, K., et Buhrmester, D. (2002). Gender differences in early adolescents' relationship qualities, self-efficacy, and depression symptoms. *The Journal of Early Adolescence*, 22(3), 277-309. doi:10.1177/02731602022003003

Johnson, W., Turkheimer, E., Gottesman, I. I., & Bouchard, T. J. (2009). Beyond heritability twin studies in behavioral research. *Current Directions in Psychological Science*, 18(4), 217-220. doi:[10.1111/j.1467-8721.2009.01639.x](https://doi.org/10.1111/j.1467-8721.2009.01639.x)

Koepke, S., & Denissen, J. J. (2012). Dynamics of identity development and separation–individuation in parent–child relationships during adolescence and emerging adulthood—A conceptual integration. *Developmental Review*, 32(1), 67-88. doi : [2048/10.1016/j.dr.2012.01.001](https://doi.org/2048/10.1016/j.dr.2012.01.001)

Kovacs, M. (1992). *Children's Depression Inventory (CDI) manual*. North Tonawanda, NY: Multi-Health Systems.

Kraaij, V., Garnefski, N., de Wilde, E. J., Dijkstra, A., Gebhardt, W., Maes, S., & L. ter Doest (2003). Negative life events and depressive symptoms in late adolescence: Bonding and cognitive coping as vulnerability factors? *Journal of Youth and Adolescence*, 32(3), 185–193. doi: [10.1023/A:1022543419747](https://doi.org/10.1023/A:1022543419747)

- Ladd, G. W., & Ladd, B. K. (1998). Parenting behaviors and parent-child relationships: Correlates of peer victimization in kindergarten? *Developmental Psychology*, 34(6), 1450. doi : [2048/10.1037/0012-1649.34.6.1450](https://doi.org/10.1037/0012-1649.34.6.1450)
- Lau, J. Y. F., & Eley, T. C. (2008). New behavioral genetic approaches to depression in childhood and adolescence. In J. R. Z. Abela et B. L. Hankin (Eds.), *Handbook of depression in children and adolescents* (pp. 124–148). New York: Guilford Press.
- Laursen, B., & Mooney, K. S. (2008). Relationship network quality: Adolescent adjustment and perceptions of relationships with parents and friends. *American Journal of Orthopsychiatry*, 78(1), 47. doi : [10.1037/0002-9432.78.1.47](https://doi.org/10.1037/0002-9432.78.1.47)
- Levy, D. M. (1970) The concept of maternal overprotection. In E. J. Anthony & T. Benedek (Eds.), *Parenthood*. Little, Brown, and Company, Boston, MA, USA.
- Magnusson, P. K. E., Almqvist, C., Rahman, I., Ganna, A., Viktorin, A., Walum, H., ...Lichtenstein, P. (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:10.1017/thg.2012.104
- Martin, G., Bergen, H. A., Roeger, L., & Allison, S. (2004). Depression in young adolescents: investigations using 2 and 3 factor versions of the Parental Bonding Instrument. *The Journal of Nervous and Mental Disease*, 192(10), 650-657. doi : [10.1097/01.nmd.0000142028.10056.c6](https://doi.org/10.1097/01.nmd.0000142028.10056.c6)
- Nolen-Hoeksema, S. (2001). Gender differences in depression. *Current Directions in Psychological Science*, 10, 173–176. doi: [10.1111/1467-8721.00142](https://doi.org/10.1111/1467-8721.00142)
- Olweus, D. (1993). Victimization by peers: Antecedents and long-term outcomes. In K.H. Rubin & J.B. Asendorpf (Eds.). *Social withdrawal, inhibition, and shyness in childhood* (pp. 315 – 341). Hillsdale, NJ, US: Lawrence Erlbaum Associates.
- Petersen, A. C., Crockett, L., Richards, M. & Boxer, A. (1987). A self-report measure of pubertal status: Reliability, validity, and initial norms. *Journal of Youth and Adolescence* 17, 117 - 133. doi: [10.1007/BF01537962](https://doi.org/10.1007/BF01537962)

- Pollack, W. S. (2006). The "war" for boys: Hearing "real boys'" voices, healing their pain. *Professional Psychology: Research and Practice*, 37(2), 190. doi : [2048/10.1037/0735-7028.37.2.190](https://doi.org/10.1037/0735-7028.37.2.190)
- Riggins-Caspers, K., & Cadoret, R. J. (2003). Family process as mediator of biology x environment interaction. *Marriage & Family Review*, 33(2-3). doi : [2048/10.1300/J002v33n02_01](https://doi.org/10.1300/J002v33n02_01)
- Rose, A. J. (2002). Co-rumination in the friendships of girls and boys. *Child Development*, 73(6), 1830-1843. doi : [2048/10.1111/1467-8624.00509](https://doi.org/10.1111/1467-8624.00509)
- 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. doi : [2048/10.1037/0012-1649.43.4.1019](https://doi.org/10.1037/0012-1649.43.4.1019)
- Rudolph, K. D., & Clark, A. G. (2001). Conceptions of relationships in children with depressive and aggressive symptoms: Social-cognitive distortion or reality? *Journal of Abnormal Child Psychology*, 29(1), 41-56. doi: [10.1023/A:1005299429060](https://doi.org/10.1023/A:1005299429060)
- Rudolph, K. D., & Hammen, C. (1999). Age and gender as determinants of stress exposure, generation, and reactions in youngsters: A transactional perspective. *Child Development*, 70(3), 660-677. doi: [2048/10.1111/1467-8624.00048](https://doi.org/10.1111/1467-8624.00048)
- Rudolph, K. D., Hammen, C., Burge, D., Lindberg, N., Herzberg, D., & Daley, S. E. (2000). Toward an interpersonal life-stress model of depression: The developmental context of stress generation. *Development and Psychopathology*, 12(02), 215-234. doi: [10.1017/S0954579400002066](https://doi.org/10.1017/S0954579400002066)
- Rushton, J. L., Forcier, M., & Schectman, R. M. (2002). Epidemiology of depressive symptoms in the National Longitudinal Study of Adolescent Health. *Journal of the American Academy of Child & Adolescent Psychiatry*, 41(2), 199-205. doi : [10.1097/00004583-200202000-00014](https://doi.org/10.1097/00004583-200202000-00014)
- Saint-Laurent, L. (1990). Étude psychométrique de l'Inventaire de dépression pour enfants de Kovacs auprès d'un échantillon francophone. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, 22(4), 377. doi: [10.1037/h0078990](https://doi.org/10.1037/h0078990)

- Saluja, G., Iachan, R., Scheidt, P.C., Overpeck MD., Sun W., et Giedd, JN. (2004). Prevalence of and risk factors for depressive symptoms among young adolescents. *Archives of Pediatrics et Adolescent Medicine*, 158 (8), 760-765.
- Santé Québec, Jetté, M., Desrosiers, H., et Tremblay, R. E. (1998). "In 2001 . . . I'll be 5 years old!" Survey of 5-month old infants. Preliminary report of the Longitudinal Study of Child Development in Québec. Québec: Bibliothèque Nationale du Québec.
- Saudino, K. J., Cherny, S. S., & Plomin, R. (2000). Parent ratings of temperament in twins: explaining the 'too low' DZ correlations. *Twin Research and Human Genetics*, 3(04), 224-233.
doi:10.1375/twin.3.4.224
- Shanahan, M. J., & Hofer, S. M. (2005). Social context in gene–environment interactions: Retrospect and prospect. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 60(Special Issue 1), 65-76. doi:[10.1093/geronb/60.Special_Issue_1.65](https://doi.org/10.1093/geronb/60.Special_Issue_1.65)
- Sheeber, L.B., Davis, B., Leve, C., Hops, H., & Tildesley, E.(2007). Adolescents' relationships with their mothers and fathers: Associations with depressive disorder and subdiagnostic symptomatology. *Journal of Abnormal Psychology*, 116(1), 144-154. doi: [10.1037/0021-843X.116.1.144](https://doi.org/10.1037/0021-843X.116.1.144)
- Sheeber, L., Hops, H., Alpert, A., Davis, B., & Andrews, J. (1997). Family support and conflict: Prospective relations to adolescent depression. *Journal of Abnormal Child Psychology*, 25(4), 333-344. doi: [10.1023/A:1025768504415](https://doi.org/10.1023/A:1025768504415)
- Shoval, G., Mansbach-Kleinfeld, I., Farbstein, I., Kanaaneh, R., Lubin, G., Apter, A., ... & Zalsman, G. (2013). Self versus maternal reports of emotional and behavioral difficulties in suicidal and non-suicidal adolescents: An Israeli nationwide survey. *European Psychiatry*, 28(4), 235-239.
doi : 2048/10.1016/j.eurpsy.2012.02.009
- Smetana, J. G. (1989). Adolescents' and parents' reasoning about actual family conflict. *Child Development*, 1052-1067.

- Smetana, J. G. (2002). Culture, autonomy, and personal jurisdiction in adolescent-parent relationships. *Advances in child development and behavior*, 29, 51-87.
- Smetana, J. G., Campione-Barr, N., & Metzger, A. (2006). Adolescent development in interpersonal and societal contexts. *Annu Rev. Psychol*, 57, 255-284. doi 10.1146/annurev.psych.57.102904.190124
- Smucker, M. R., Craighead, W. E., Craighead, L. W., & Green, B. J. (1986). Normative and reliability data for the Children's Depression Inventory. *Journal of Abnormal Child Psychology*, 14(1), 239. doi: [2048/10.1007/BF00917219](https://doi.org/10.1007/BF00917219)
- Spanier, G. B. (1976). Measuring Dyadic Adjustment: New Scales for Assessing the Quality of Marriage and Similar Dyads. *Journal of Marriage and Family*, 38(1), 15-28. doi: 10.2307/350547
- Spitz, E., Carlier, M., Vacher-Lavenu, M. C., Reed (1996). Long-term effect of prenatal heterogeneity among monozygotes. *Cahiers de Psychologie Cognitive*, 15(3), 283-308.
- Starrels, M. E. (1994). Gender differences in parent-child relations. *Journal of family Issues*, 15(1), 148-165. doi : [2048/10.1177/019251394015001007](https://doi.org/10.1177/019251394015001007)
- Stice, E., Ragan, J., & Randall, P. (2004). Prospective relations between social support and depression: Differential direction of effects for parent and peer support? *Journal of Abnormal Psychology*, 113(1), 155. doi: [10.1037/0021-843X.113.1.155](https://doi.org/10.1037/0021-843X.113.1.155)
- Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence. *The Lancet*, 379(9820), 1056-1067. doi: [10.1016/S01406736\(11\)60871-4](https://doi.org/10.1016/S01406736(11)60871-4)
- Vallerand, R. J. (1989). Vers une methodologie de validation transculturelle de questionnaires psychologiques: Implications pour la recherche en langue francaise [Toward a methodology for the transcultural validation of psychological questionnaires: Implications for research in the French language]. *Canadian Psychology*, 30, 662-680.
- van der Bruggen, C. O., Bögels, S. M., & van Zeilst, N. (2010). What influences parental controlling behaviour? The role of parent and child trait anxiety. *Cognition and Emotion*, 24(1), 141-149. doi : [2048/10.1080/02699930802618843](https://doi.org/10.1080/02699930802618843)

- Weiss, R. (1974). The provisions of social relationships. In Z. Rubin (Eds.), *Doing unto others* (p.17-26). Englewood Cliffs, NJ: Prentice-Hall,
- Wilkinson, P. O., Trzaskowski, M., Haworth, C., et Eley, T. C. (2013). The role of gene environment correlations and interactions in middle childhood depressive symptoms. *Development and Psychopathology*, 25(01), 93-104. doi:10.1017/S0954579412000922.
- Wilson, S., & Durbin, C. E. (2010). Effects of paternal depression on fathers' parenting behaviors: A meta-analytic review. *Clinical psychology review*, 30(2), 167-180. doi : 10.1016/j.cpr.2009.10.007
- Zahn-Waxler, C., Shirtcliff, E. A., & Marceau, K. (2008). Disorders of childhood and adolescence: Gender and psychopathology. *Annual Revue of Clinical Psychology*, 4, 275-303.
- Zuckerman, M. (1999). *Vulnerability to Psychopathology: A Biosocial Model*. Washington, DC: American Psychological Association.

Table 1

Bivariate Correlations of the Study Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Sex	---											
2. Puberty	-.15**	---										
3. Marital Satisfaction ^{nb}	.08	-.02	---									
4. Family Income ^{nb}	-.01	-.01	.18*	---								
5. Mother’s Education ^{nb}	-.08	.02	.09	.28**	---							
6. Depressive Symptoms Gr 8	.21***	-.01	-.14*	.01	.01	---						
7. Depressive Symptoms Gr 9	.18***	.02	-.09	-.03	.00	.62***	---					
8. Genetic Risk	.16**	-.08	-.08	.02	.01	.43***	.36***	---				
9. Support – Mother	.13**	-.08	.11*	.02	.00	-.30***	-.26***	-.15**	---			
10. Support – Father	.07	-.03	.04	.03	.02	-.25***	-.31***	-.19***	.75***	---		
11. Conflict – Mother	.08	.15**	-.11*	.02	.02	.37***	.28***	.19***	-.27***	-.11*	---	
12. Conflict – Father	.08	.08	.03	.05†	.01	.31***	.33***	.18***	-.09†	-.23***	.41***	---

Note. Bivariate correlations between all study variables are shown below the diagonal.

Sex is coded such that 0 indicates boys and 1 indicates girls.

*** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$; † $p \leq .10$.

^{nb} Bivariate associations between family-level variables and individual twin-level variables were examined with a multilevel regression.

Table 2

GEE Regressions Predicting Changes in Depressive Symptoms

Model	Predictors	Estimate	SE	<i>p</i>
1	Marital Satisfaction	-.01	.04	.78
	Family Income	-.02	.02	.27
	Mother's level of Education	.00	.01	.76
	Sex	.13	.08	.09
	Puberty	.03	.03	.39
	Genetic Risk	.11	.05	.04
	Depressive Symptoms in Grade 8	.49	.06	.00
	Support – Mother	.04	.07	.62
	Support – Father	-.17	.07	.02
	Conflict – Mother	.01	.05	.88
	Conflict – Father	.12	.06	.03
R ²		.45		
2a	Support Mother x Sex	.19	.13	.15
	Support Mother x Genetic Risk	.16	.04	.00
	Genetic Risk x Sex	-.10	.09	.30
	Support Mother x Genetic Risk x Sex	-.13	.06	.04
R ²		.45		
2b	Support Father x Sex	.14	.15	.34
	Support Father x Genetic Risk	.02	.07	.77

	Genetic Risk x Sex	-.04	.09	.70
	Support Father x Genetic Risk x Sex	-.09	.09	.32
R ²		.45		
2c	Conflict Mother x Sex	-.04	.13	.74
	Conflict Mother x Genetic Risk	-.06	.04	.20
	Genetic Risk x Sex	-.05	.10	.63
	Conflict Mother x Genetic Risk x Sex	.09	.06	.17
R ²		.45		
2d	Conflict Father x Sex	-.03	.15	.84
	Conflict Father x Genetic Risk	.14	.05	.00
	Genetic Risk x Sex	-.02	.09	.85
	Conflict Father x Genetic Risk x Sex	-.02	.06	.73
R ²		.46		

Note. GEE = Generalized Estimation Equation. SE = Standard error. All regression coefficient estimates and associated SEs are based on multiple imputations.

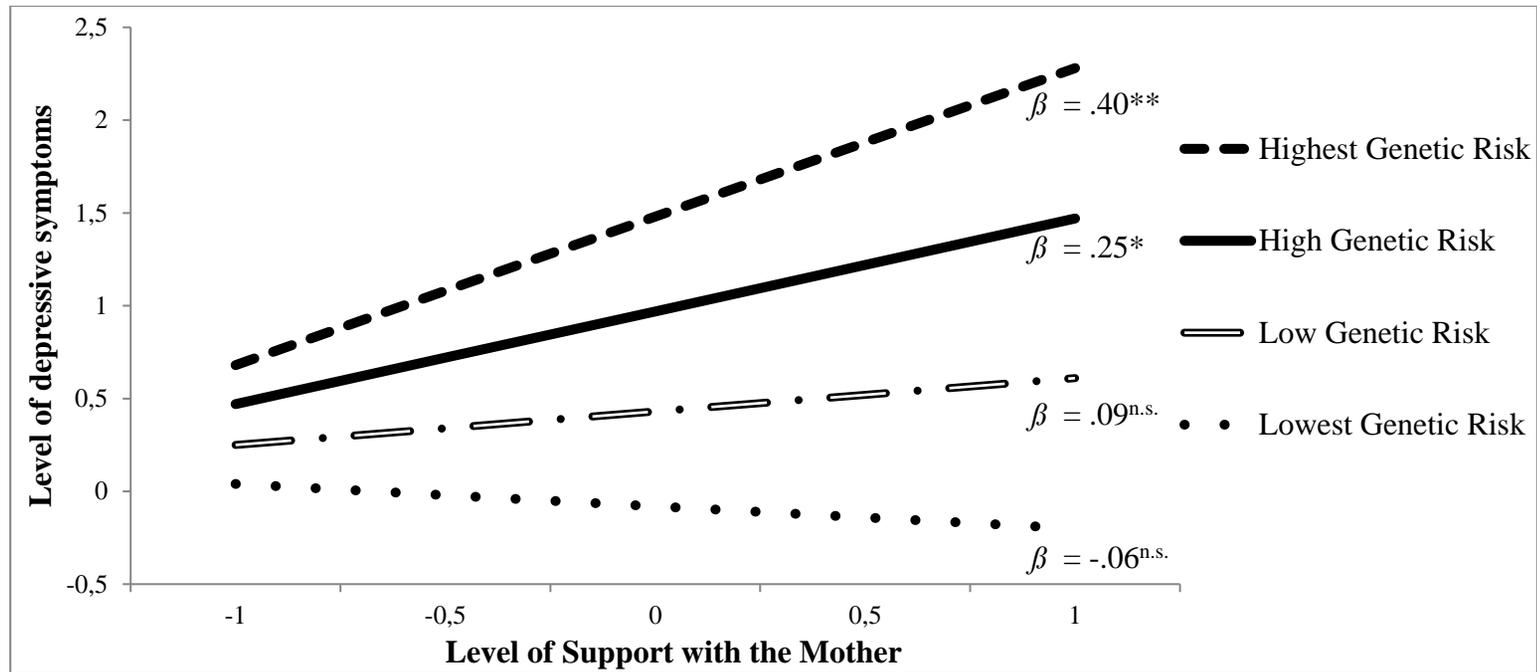


Figure 1. Links between support in the mother-adolescent relationship and boys' depressive symptoms, according to their genetic vulnerability for depressive symptoms.

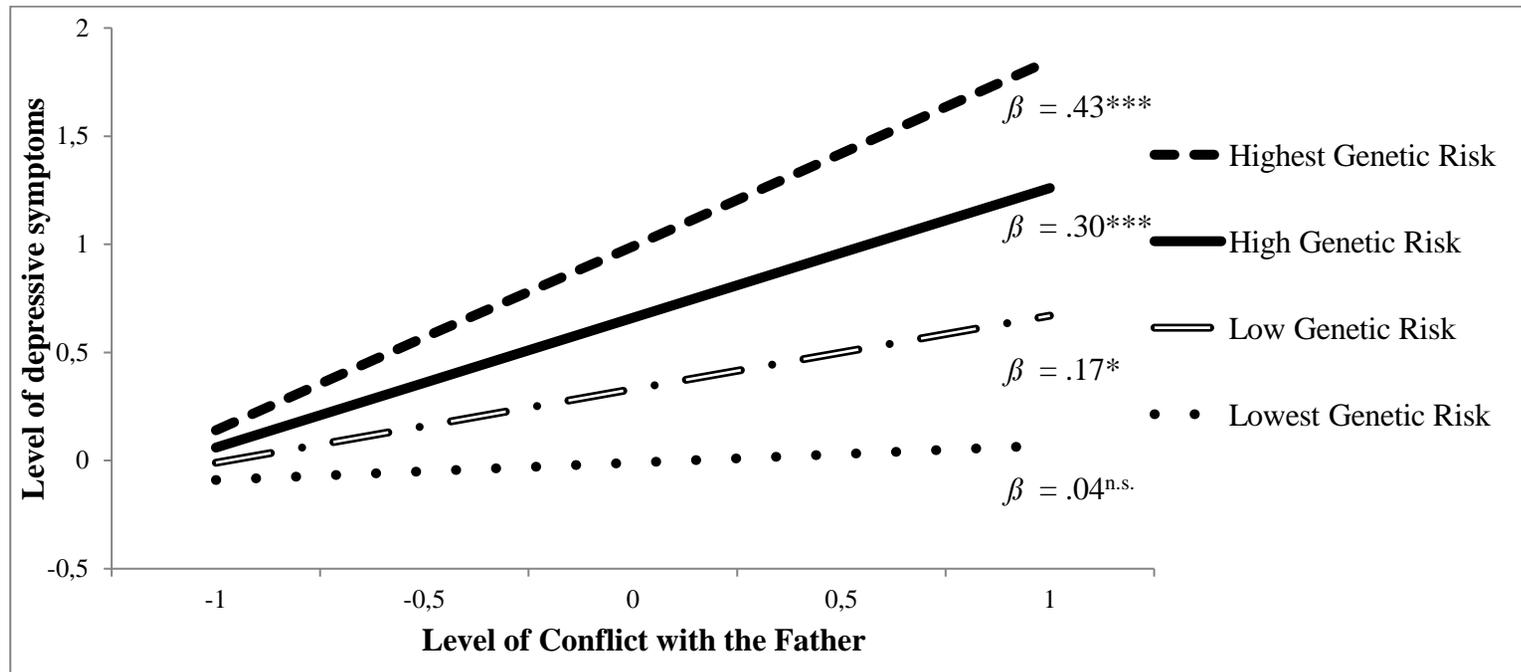


Figure 2. Links between conflict in the father-adolescent relationship and adolescents' depressive symptoms, according to their genetic vulnerability for depressive symptoms.