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SIBLINGS

Contagion of Anxiety Symptoms Among Adolescent Siblings: A Twin Study

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Abstract

This study examined whether social contagion of anxiety symptoms is present between siblings during early adolescence and whether this process is moderated by sex, relationship quality, and genetic relatedness. Based on 658 Monozygotic and Dizygotic twins (338 females) assessed in grades six and seven, anxiety symptoms and sibling relationship quality were measured with self-report questionnaires. The predictive association of the co-twin's level of anxiety with adolescents' own anxiety was only observed among girls in same-sex twin dyads (monozygotic and dizygotic) and was higher for those who perceived a higher level of relationship quality with their co-twin. Raising awareness of a possible sibling contagion of anxiety may be useful for preventing the development of anxiety symptoms in youth.

Keywords: siblings, anxiety, social contagion, relationship quality, twins

Contagion of Anxiety Symptoms Among Adolescent Siblings: A Twin Study

There is no doubt that parents and friends influence the behavior and attitudes of children (Pomery et al., 2005). Siblings also have the potential to exert a great influence on each other. During infancy and early childhood, children spend more time with their brothers and sisters than with their parents and friends. Moreover, sibling relationships are much more stable than peer relationships (DeRosier, Kupersmidt, & Patterson, 1994). Several studies have provided support for the influence of siblings on child behavior, but their focus has been exclusively on the contagion of externalizing behavior problems, mostly regarding deviant behavior and alcohol and tobacco use (e.g., Fagan & Najman, 2003; McHale, Bissell, & Kim, 2009; Pomery, et al., 2005; Rende, Slomkowski, McCaffery, Lloyd-Richardson, & Niaura, 2005; Slomkowski, Rende, Conger, Simons, & Conger, 2001; Slomkowski, Rende, Novak, Lloyd-Richardson, & Niaura, 2005; Stormshak, Comeau, & Shepard, 2004). For instance, a study by Stormshak, Comeau and Shepard (2004) found that peers' as well as siblings' deviant behaviors increased the risk of alcohol and tobacco use over time. However, when both peers' deviance and siblings' deviance were included in the model, siblings' deviance was the stronger predictor of increased substance use over time. Other studies found similar patterns suggesting that siblings influence on substance use may be stronger than parents' and peers' influence (e.g., Pomery, et al., 2005). Importantly, genetically informative studies based on a combined twin- and non-twin sibling design suggest that the association between siblings' externalizing problems is not only due to genetic similarity between siblings, but that it is indeed also reflective of a social process (e.g., Rende, et al., 2005; Slomkowski, et al., 2005). Thus, Slomkowski et al. (2005) found an association between siblings' tobacco use even when controlling for shared genetic influences and this association remained significant even when the tobacco use of parents and friends was

taken into account. Such social contagion of externalizing behaviors could occur through social learning mechanisms such as modeling and reinforcement (Dishion & Tipsord, 2011). More specifically, Dishion and colleagues (e.g., 1995; 1996) proposed the concept of *deviancy training* to explain this phenomenon. Based on social learning principles, deviancy training is a form of mutual influence that occurs between two persons through social interaction in which deviant behaviors and attitudes are modeled and positively reinforced (Dishion & Tipsord, 2011).

To our knowledge, no study has focused specifically on the contagion of internalizing problems among siblings. However, there is empirical evidence for the emotional contagion of anxiogenic or depressiogenic thoughts and feelings between friends (e.g., Prinstein, 2007; Schwartz-Mette & Rose, 2012; Serra Poirier et al., 2015). Given the characteristics of sibling relationships, including closeness and intimacy shared between brothers and sisters, contagion of internalizing problems should also be evident. Similar to what has been proposed for emotional contagion between friends, social learning mechanisms such as modeling and reinforcement (Prinstein, 2007) could explain such a possible emotional contagion between siblings. More specifically, it has been suggested that co-rumination (i.e., excessive and repeated discussion of troubles and worrisome incidences as well as mutual reinforcement of negative thoughts and dwelling on negative events or expectation of negative outcomes) is one of the principal mechanisms of peer contagion of negative emotions (Rose, Carlson, & Waller, 2007; Schwartz-Mette & Rose, 2012). 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, & Keysers, 2009; Hatfield & Rapson, 2000). However, empirical evidence for an emotional contagion of internalizing problems between siblings is still lacking.

The Role of Relationship Quality

Some studies suggest that social contagion between siblings may vary depending on the quality of their relationship (Slomkowski et al. 2001; 2005). Relationship quality is generally divided into two components: positive aspects such as warmth and support and negative aspects such as conflict and coercion. Notably, the correlation between these two components has been shown to be relatively weak and not always significant (e.g., Berndt, 2004). Moreover, some findings suggest that each component has a unique impact on psychological adjustment (for a review, see Vitaro, Boivin, & Bukowski, 2011). It may therefore be useful to assess the effects of positive and negative aspects of the relationship quality separately. To date, most empirical evidence suggests that the positive aspects of the relationship quality moderate the extent of social contagion between siblings. According to social learning theory, individuals are more likely to be influenced by models who are warm, high in status, and similar to themselves (McHale, et al., 2009). Thus, a study by McHale, Bissell and Kim (2009) found that similarity in regard to risky orientations toward sexuality was stronger between siblings with close relationships. Similarly, a study by Slomkowski and colleagues (2005) revealed that the “contagion effect” of tobacco use between siblings was stronger when they perceived a high level of social connectedness in their relationship. In another study, however, Slomkowski and colleagues (2001) found that the degree of warmth and support as well as the degree of coercion and hostility in their relationship moderate the similarity between siblings with respect to delinquent behavior. This moderating effect further varied by gender. Specifically, the delinquent behavior of an older sister had a stronger predictive effect on the delinquent behavior of a younger sister when their relationship was marked by a high degree of hostility and coercion and by a low degree of support and warmth. Conversely, the social contagion of delinquent behaviors

between brothers was stronger not only when the relationship was marked by high levels of hostility and coercion but also when it was characterized by high levels of warmth and support. The authors proposed that, while more positive sibling relationship may contribute to reinforce delinquent behaviors later in development as siblings become “partners in crime”, hostility and coercive interactions between siblings may play a role in the «training» for delinquency at earlier stages. Slomkowski and colleagues (2001) suggest that brothers and sisters may differ in their “rate” of progression through this hypothetical pathway, with females progressing through those steps at a slower pace than males.

No study so far has examined social contagion of internalizing problems between siblings or the potential moderating role of relationship quality in this context. However, two studies have examined this question with respect to friends and found social contagion to be stronger in the context of lower friendship quality (Prinstein, 2007; Serra Poirier, et al., 2015). Whereas Prinstein (2007) found this association only among teenage boys (i.e., stronger contagion of depressive symptoms when the positive aspects of the relationship quality were perceived as low), Serra Poirier and colleagues (2015) found this association to be true for both male and female children (i.e., stronger contagion of anxiety symptoms when the negative aspects of the relationship quality were perceived as high). It has been suggested that excessive reassurance-seeking, which is especially prevalent among depressed and anxious individuals (Cogle et al., 2012; Parrish & Radomsky, 2010), may not only increase negative emotions in interaction partners but also negatively impact relationship quality, which in turn may lead to further internalizing problems (Heerey & Kring, 2007). The cumulative stress of being exposed to a close friend’s internalizing symptoms in addition to the stress associated with the deterioration of the friendship quality could thus lead to an increased contagion effect of negative emotions.

However, co-rumination, the principal mechanism likely to account for the social contagion of negative emotions based on positive reinforcement, has been found to be stronger in closer friendship relations (e.g., Rose, et al., 2007). Whether social contagion between siblings in regard to internalizing problems is moderated by the quality of the siblings' relationship and - if so - whether positive or negative relationship features are involved, still remains to be seen.

The Role of Genetic Relatedness

Most studies on the role of the sibling relationship quality for children's adjustment were conducted with children issued from single births, examining older and younger siblings with varying age differences. It is likely, however, that the effect of relationship quality is even more pronounced among twins (Bekkhuis, Staton, Borge, & Thorpe, 2011). The relationship between twins begins at conception and they tend to spend a lot more time together than non-twin siblings (Thorpe & Danby, 2006). Moreover, because twins are the same age, their relationship is more egalitarian than the relationship between older and younger siblings, and thus more similar to friendships (e.g., Ladd, 1983; Lamarche et al., 2006). As a consequence, the interactions between twin siblings are likely to be more reciprocal, as would be found in typical peer interactions, than those between singleton siblings (Nozaki, Fujisawa, Ando, & Hasegawa, 2012). The degree of genetic relatedness between twins (i.e., monozygotic (MZ) versus same-sex dizygotic (sDZ) versus mixed-sex dizygotic (mDZ) twins) may further influence their feelings and behavior towards each other. Thus, the relationship of monozygotic twins is typically characterized by more closeness and emotional dependence than that of same-sex dizygotic twins (Bekkhuis, et al., 2011; Fortuna, Goldner, & Knafo, 2010). In turn, a study by Thorpe and Gardner (2006) found that same-sex (MZ and sDZ) twins seem to be closer and more interdependent than mDZ twins, as the former tend to spend more time with their co-twin and to share more friends than the

latter. Other studies also showed that same-sex sibling dyads (especially sister-sister dyads) experience more closeness (Buist, Deković, & Prinzie, 2013; but see Fortuna, et al, 2010, and Penninkilampi-Kerola, Moilanen & Kaprio, 2005 for contradictory results). Since sibling influence may be stronger in relationships where siblings are more interdependent and spend more time together, modeling and imitation processes may thus be more evident in same-sex sibling dyads as compared to mixed-sex dyads. In line with this notion, some studies examining siblings' mutual influence on externalizing behaviors have shown greater similarity between same-sex dyads (Fagan & Najman, 2003; McHale, et al., 2009), but it is unclear whether a similar pattern can be found in regard to the contagion of internalizing problems. The degree of genetic relatedness was therefore considered as a potential moderator in the contagion of internalizing problems between siblings.

The Present Study

The main objective of the present study was to examine whether, controlling for previous anxiety in childhood (i.e., in grade six), the level of concomitant anxiety of the co-twin is related to increased anxiety of the target twin during early adolescence (i.e., in grade seven) and whether this association is moderated by the siblings' positive or negative relationship quality and-or their degree of genetic relatedness (i.e., monozygotic twins, same-sex dizygotic twins or mixed-sex dizygotic twins). Based on the previously mentioned findings on the social contagion of externalizing problems between siblings and the emotional contagion observed between friends, it was expected that, controlling for previous anxiety symptoms, youth with a co-twin presenting with higher levels of anxiety symptoms would exhibit more anxiety symptoms themselves than youth with a less anxious co-twin. In regard to the moderating role of the relationship quality, it was difficult to propose clear hypotheses given the conflicting results reported in the literature.

As such, a high level of relationship quality may accentuate the social contagion of anxiety symptoms between siblings through positive reinforcement mechanisms such as co-rumination, but the reverse was also possible based on a cumulative effect of stressors. The contagion effect of anxiety symptoms may also be more pronounced in twin pairs with higher levels of genetic relatedness, especially in monozygotic twins, since they generally tend to spend more time together and maintain a more interdependent relationship than dizygotic twins (mixed sex and same sex). Potential moderating effects of child sex were also examined. In light of findings that girls exhibit more anxious symptoms (Rose, et al., 2007) and that the relationship between female twins is marked by greater dependence (Lemery & Goldsmith, 2001; Penninkilampi-Kerola et al., 2005), the contagion of anxiety symptoms was expected to be stronger in female than in male twin pairs. A moderating effect favoring girls could also be expected based on findings by Schwartz-Mette and colleagues (2012), who found social contagion of anxiety only among female friends but not male friends.

Any examination of the unique role of sibling characteristics on child adjustment also needs to consider the role of family risk factors. In addition to negative life events such as parental divorce or poverty (Nugent, Tyrka, Carpenter, & Price, 2011), parental marital dissatisfaction (Bögels & Brechman-Toussaint, 2006), and parental psychopathology (anxiety - depression) (Bayer, et al., 2006) have been identified as family risk factors for the development of anxiety in the offspring. Thus, a review by Bögels and Brechman-Toussaint (2006) indicated that parental conflict can disrupt parental bonds with their children and serves as a general stressor to a child's environment, leading to the development of anxiety symptoms. Moreover, the risk of developing an anxiety disorder is three to five times higher when parents are themselves anxious (for review, see Klein & Pine, 2002). Parental anxiety may lead to increased

anxiety in their offspring through various mechanisms such as genetic transmission (Eley & Lau, 2005), modeling and reinforcement of poor coping strategies and problem-solving (Wood, McLeod, Sigman, Hwang, & Chu, 2003) or through maladaptive parenting such as overprotection or low warmth and involvement (e.g., Bayer, Sanson, & Hemphill, 2006). Parental psychopathology (i.e. anxiety and depression) can also directly affect children by exposing them to emotional distress and exposure to parent distress can be dysregulating (Bayer, et al., 2006). We therefore controlled for these family risk factors in all analyses.

Method

Sample

The 658 adolescents (320 males, 338 females) participating in this study were part of 239 MZ and DZ twin pairs from a population-based sample of 662 twin pairs from greater Montreal, Canada, who were recruited at birth between November 1995 and July 1998. For same-sex twin pairs, 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, zygosity was determined based on physical resemblance questionnaires at age 18 months and again at age nine years (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 and grades one, three, four, six, seven, eight and nine. The present paper describes longitudinal findings from the grade six and grade seven data collections (mean age in grade six = 12.10 years, $SD = 0.34$ and in grade seven = 13.06 years, $SD = 0.37$). Participants included in the present study were those for whom data were available for mothers' level of anxiety symptoms as well as for children's anxiety and relationship quality in grade seven ($n = 329$ twin pairs ; $MZ = 131$, $sDZ = 101$, $mDZ = 97$); see description of measures below). For each twin pair, one of the twins was randomly assigned as the target twin and the other was assigned as the co-twin for the purpose of analyses. The participants in the final study sample did not differ from those excluded in regard to parents' level of anxiety symptoms. However, the participants in the final study sample were more likely to live with both their parents and to come from family with higher revenue and higher level of parental education.

Measures

Anxiety symptoms. In grades six and seven, anxiety symptoms of each twin child were assessed via self-reports using seven items selected from the Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1985), which focused on worry and

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 four 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 seven item scores (grade six: Cronbach’s alpha = .81, $M = 1.64$, $SD = 0.44$, min = 1, max = 4, skewness = 1.39, kurtosis = 2.26) grade seven: Cronbach’s alpha = .81, $M = 1.61$, $SD = 0.51$, min = 1, max = 3.71, skewness = 1.23, kurtosis = 1.81).

Perceived relationship quality with the co-twin. In grade seven, the perceived relationship quality with the co-twin was evaluated based on items from the *Network of Relationships Inventory (NRI)* (Furman & Buhrmester, 1985, 1992). Six items focussed on positive features (e.g., “Do you feel loved and appreciated by your twin?”; “When things go wrong, can you count on your twin to provide you comfort?”; “Does your twin treat you as a competent person in different domains?”) and four items focused on negative features (e.g., “Do you get angry at your twin?”; “Are you annoyed or upset by the behavior of your twin?”; “Do you fight with your twin?”). Each item was rated on a five-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 = .90, $M = 3.11$, $SD = 1.10$, min = 1, max = 5, skewness = 0.01, kurtosis = -1.02, and Negative features scale: Cronbach’s alpha = .86, $M = 2.83$, $SD = 0.97$, min = 1, max = 5, skewness = 0.44, kurtosis = -0.55).

Family stressors. In grade six, a composite family stressors index was created based on mother reports on: 1) family status (twins living with both biological parents or not), 2) marital

satisfaction, based on eight items from the Dyadic Adjustment Scale (1976) (with the present sample, internal consistency was 0.88), 3) mother depression and, 4) mother anxiety. The co-occurrence of these factors has been found to predict anxiety in offspring (Bayer, et al., 2006; Bögels & Brechman-Toussaint, 2006; Nugent, et al., 2011). A score of 0 was attributed to family status if the child was living with both natural parents and a score of 1 was attributed to all other cases. Marital dissatisfaction was scored 1 when the individual scores were in the lower quartile of the respective variable distribution. A score of 0 was given to scores above the first quartile of the distributions. A score of 0 was attributed to mother depression if the mother did not report any depressive episode over the past nine years and a score of 1 was attributed to all other cases. Mother's anxiety was assessed using the following question: "I consider myself to be anxious or easily troubled", rated on a seven-point Likert type scale ranging from 1 'strongly disagree' to 7 'strongly agree'. A score of 1 was given if the mother endorsed a response of 6 or 7 ('agree' or 'strongly agree') and a score of 0 was attributed to mother's anxiety for all other cases (i.e., responses between 1 and 5). A total family stressors index was then computed by summing the individual stressors, with a high value indicating a high level of co-occurring family stressors ($M = 1.20$, $SD = 1.00$, $\min = 0$, $\max = 4$).

Procedure

All instruments were administered in either English or French, depending on the language spoken by the families. 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 as well children's verbal assent 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 children's developmental adjustment, were approved by the Institutional Review Board of the University of Quebec at Montreal.

Results

Preliminary Analyses

Table 1 presents the bivariate correlations among the measures for the final study sample ($n = 329$). As shown, the target twin's levels of anxiety symptoms in grades six and seven were positively correlated with his or her co-twin's level of anxiety symptoms. The target twin's previous level of anxiety symptoms in grade six was also strongly and positively correlated with his or her own anxiety symptoms in grade seven. Target twin's level of anxiety symptoms in grade seven was also associated with sex, with girls being more anxious than boys. The level of perceived positive features in the sibling relationship was also associated with sex, with girls perceiving a higher level of positive features in their relationship with their co-twin than boys. Both the target twin's and the co-twin's levels of anxiety symptoms were associated with more negative (but not fewer positive) features of the sibling relationship as perceived by the target twin. Finally, family stressors were positively correlated with anxiety symptoms in both the target twin's and the co-twin as well as with the perceived level of negative features of the sibling relationship.

Main Analyses

In the first set of analyses, we examined whether, while controlling for previous anxiety (in grade six), the level of anxiety of the co-twin (in grade seven) is related to increased anxiety of the target twin during early adolescence (i.e. in grade seven) and whether this association is moderated by the twins' relationship quality (positive and negative features). This analysis was

performed using Hierarchical Multiple Regression with SPSS 20.0. To control for data interdependency due to twinning, we used the twin dyad as the level of analysis; for each twin pair, one of the twins was randomly assigned as the target twin and the other was assigned as the co-twin. Multiple imputations (number of imputations = 20) in SPSS were used to handle missing data (less than 1% of data points). To facilitate interpretation of effects, variables were z-standardized prior to analyses. On the first model step (Model 1), main effects of sex, twins' genetic relatedness (MZ, sDZ, mDZ) and family stressors were included in the model. Because genetic relatedness was a categorical variable with three levels, two dummy-coded variables were created with 'MZ' as the reference group. On a second step (Model 2) the target twin's previous level of anxiety symptoms in grade six, the co-twin's level of anxiety, and the siblings' relationship quality (positive and negative features) were included in the model. Potential moderating effects of positive and negative features of the relationship quality (Models 3a and 3b, respectively), genetic relatedness (Model 4) and child sex (Model 5) were tested in subsequent, alternate model steps. Significant interactions were probed following recommendations by Holmbeck (2001) for dichotomous and continuous moderator variables, the results from these analyses are presented in Table 2.

As can be seen in the upper part of Table 2, the results from Model 1 showed that girls exhibited higher level of anxiety than boys, $b = 0.31, p \leq 0.01$. Same-sex DZ were less anxious than MZs $b = -0.31, p \leq 0.01$. However, MZs and mixed-sex DZs did not differ in anxiety levels, $b = 0.12, ns$. Adolescents with a higher level of family stressors were more likely to present higher level of anxiety symptoms, $b = 0.18, p \leq 0.001$. The results from Model 2 showed that adolescents with a higher level of anxiety in grade six also presented a higher level of anxiety in grade seven, $b = 0.44, p \leq 0.001$. Results also showed that a higher level of negative features in

the sibling relationship was related to increased anxiety symptoms, $b = 0.16$, $p \leq 0.001$, whereas the extent of positive relationship features with the sibling was unrelated to adolescents' anxiety symptoms, $b = 0.003$, *ns*. Furthermore, a higher level of anxiety symptoms in the co-twin was also related to an increased level of anxiety symptoms in the target twin, $b = 0.14$, $p \leq 0.01$.

Results from Model 3a revealed a significant interaction between the co-twin's level of anxiety symptoms and the positive aspects of the sibling relationship ($b = 0.09$, $p \leq 0.05$). Probing of this interaction showed that the co-twin's level of anxiety symptoms was positively and significantly associated with higher levels of adolescents' own anxiety symptoms when the level of positive features in the siblings' relationship was perceived as high (i.e., 1 SD above the mean), $b = 0.25$, $p \leq 0.001$. In contrast, no association was observed when the level of positive features in the siblings' relationship was perceived as low ($b = 0.08$, *ns*). No interaction was found between the co-twin's level of anxiety symptoms and the negative aspects of the sibling relationship ($b = -0.04$, *ns*) (Model 3b).

Results from Model 4 revealed a significant interaction between the co-twin's level of anxiety and genetic relatedness, specifically for the contrast between MZ twin pairs and mixed-sex DZ twin pairs, $b = -0.22$, $p \leq 0.05$. Probing of this interaction showed that the predictive effect of the co-twin's level of anxiety symptoms on adolescents' own anxiety symptoms was observed in monozygotic twin pairs ($b = 0.24$, $p \leq 0.001$) but not in mixed-sex dizygotic twin pairs ($b = 0.03$, *ns*). The interaction between the co-twin's level of anxiety and genetic relatedness was not significant for the contrast between MZ twin pairs and same-sex DZ twin pairs ($b = -0.14$, *ns*). This indicates that the predictive effect of the co-twin's level of anxiety symptoms on adolescents' own anxiety symptoms did not differ between MZ twin pairs and same-sex DZ twin pairs.

Results from Model 5 revealed a significant interaction between sex and the co-twin's level of anxiety, $b = 0.21$, $p \leq 0.05$. Probing of this interaction showed that the predictive effect of the co-twin's level of anxiety symptoms on adolescents' own anxiety symptoms was observed among girls ($b = 0.21$, $p \leq 0.001$) but not among boys ($b = 0.04$, *ns*).

Discussion

The present study examined whether, controlling for previous anxiety in childhood (i.e., in grade six), the level of concomitant anxiety of the co-twin is related to increased anxiety of the target twin during early adolescence (i.e. in grade seven) and whether this association is moderated by 1) sex, 2) the degree of genetic relatedness (i.e., monozygotic twins, same-sex dizygotic twins or mixed-sex dizygotic twins) and 3) the siblings' positive or negative relationship quality.

Previous studies examining siblings' mutual influence have found evidence of a social contagion process for externalizing problems such as deviant behavior and alcohol and tobacco use (Rende, et al., 2005; Slomkowski, et al., 2001; Slomkowski, et al., 2005). Results of the present study also suggest the presence of a social contagion effect of internalizing problem (i.e. anxiety) between siblings, albeit only in girls. Thus, controlling for previous anxiety symptoms, adolescent girls with a co-twin presenting higher levels of anxiety symptoms were also more likely to exhibit higher levels of anxiety symptoms themselves. This is in line with results from the study of Schwartz-Mette and Rose (2012) who found evidence of social contagion of anxiety only among female friends but not male friends. The fact that adolescent girls tend to exhibit more anxiety symptoms than boys (e.g., Costello, Mustillo, Erkanli, Keeler, & Angold, 2003; Rose, et al., 2007), which was also observed in the present study, together with the fact that the relationship between female twins is marked by greater dependence (Lemery & Goldsmith,

2001; Penninkilampi-Kerola, Moilanen, & Kaprio, 2005), may explain why the contagion of anxiety symptoms between siblings is only present in girls. Moreover, the phenomenon was observed only in same-sex twin dyads (monozygotic and dizygotic). Given the relatively small sample size of the current study, we did not have sufficient statistical power to test for triple interactions to determine whether the social contagion of anxiety between siblings is present only among female same-sex twins dyad (MZ and sDZ). Future studies need to replicate the present findings with larger samples, which will allow testing for potential higher-order moderating effects of sex and genetic relatedness. However, results from other research suggest that girls in all zygosity groups tend to report a higher level of interdependence with their co-twin than boys (Lemery & Goldsmith, 2001; Penninkilampi-Kerola, et al., 2005), which may explain at least in part why social contagion of anxiety symptoms between siblings was stronger among female twins in our study. In a related vein, same-sex twin dyads have been found to spend more time together at school and to share more friends than mixed-sex dizygotic twins (Thorpe & Gardner, 2006), which is likely to increase the risk for social contagion between siblings. In line with this notion, a study by McHale and colleagues (2009) showed that social contagion of risky orientations toward sexuality was greater between siblings in same-sex dyads than between siblings in mixed-sex dyads. The findings from the present study suggest that this enhanced social contagion between same-sex siblings not only concern externalizing cognitions or behaviors but also internalizing problems such as anxiety.

Results from the present study also indicated that a high level of negative features, such as conflict in the sibling relationship, was positively associated with adolescents' anxiety symptoms. This is in line with previous findings that a low relationship quality and a high level of conflict are related to poor emotional adjustment, including increased levels of anxiety

symptoms (Bekkhuis, et al., 2011; Richmond, Stocker, & Rienks, 2005; Stocker, Burwell, & Briggs, 2002). More importantly, although we did not find a moderating effect of perceived negative sibling relationship features on the predictive association between their co-twin's and adolescents' own anxiety symptoms, we did find a significant moderating effect of perceived positive friendship features. Specifically, the predictive link between their co-twin's anxiety symptoms and adolescents' own anxiety symptoms was stronger when the positive features of the relationship were perceived as high. Our findings are similar to those reported by Slomkowski and colleagues (2005) and by McHale and colleagues (2009), who found that the "contagion effect" of tobacco use and risky orientations toward sexuality between siblings was stronger when they perceived a higher level of social connectedness or closeness in their relationship. The results from the present study provide first evidence that a similar contagion of internalizing problems occurs between adolescent siblings (albeit only among girls in same-sex twin dyads) who have a very close relationship with each other.

Social learning theory suggests that, because individuals typically interact more frequently and willingly the better their relationship, modeling and reinforcement processes should also be stronger the higher the quality of the relationship (Berndt, 2004; Hatfield & Rapson, 2000). Research on co-rumination - which has been proposed as one of the principal mechanisms of peer contagion of negative emotion (Rose, et al., 2007) - tends to support this view. Specifically, co-rumination (i.e., modeling and positive reinforcement of negative thoughts and emotions by extensively discussing troubles and worrisome incidences with another person) has not only been linked to increased depressive and anxious symptoms but also to increased relationship quality (e.g., Rose, et al., 2007; Schwartz-Mette & Rose, 2012). It is thus possible that a very close relationship provides an especially fertile ground for continuing co-rumination, triggering a

vicious cycle of mutually reinforced negative emotions. In addition, some authors have suggested that co-rumination could foster “empathetic distress” (Smith & Rose, 2011), a process by which youngsters strongly empathize with the other person’s distress to the point of taking on the distress as their own (Schwartz-Mette & Rose, 2012). Because empathy toward a sibling seems to be stronger the better the relationship among siblings (Janus & Goldberg, 1995), increased empathetic distress may thus also account for our finding that contagion of anxiety was especially strong in close sibling relationships. Moreover, both co-rumination and empathetic distress appear to be more frequent among girls (e.g., Rose, et al., 2007; Schwartz-Mette & Rose, 2012; Smith & Rose, 2011), which may partly explain why a contagion process of anxiety symptoms was only found among the girls in our study.

Strengths, Limitations, and Conclusions

The present study is the first to examine the potential social contagion of anxiety symptoms between siblings. In doing so, we included a variety of potential moderators (sex, genetic relatedness, and siblings’ relationship quality) and also controlled for the potential effect of family stressors. An important additional strength of the study rests on the fact that our measure of anxiety symptoms and twins’ relationship quality were based on self-report rather than parental reports. This strategy reduced the risk of bias compared to parental reports, which are often used as informants of sibling relationship quality (e.g., Bekkhus, et al., 2011; Fortuna, et al., 2010) and which may inflate ratings of closeness between twins based on zygosity, as well as their similarity on anxiety symptoms (Saudino, Cherny, & Plomin, 2000). Using a twin sample also allowed us to examine the impact of genetic relatedness on the social contagion of anxiety.

Despite these strengths, our study also has several limitations. A first limitation concerns the cross-sectional nature of the study. Compared to the social contagion of behaviors, which can be observed over longer periods (e.g., one year or more) (McHale, et al., 2009; Slomkowski, et al., 2001), the contagion of emotions such as anxiety is likely to occur over the short-term (i.e., contagion via co-rumination related to current problems or empathetic distress following non-verbal signals such as facial expressions of distress). While the control for adolescents' previous level of anxiety symptoms in the present study provides some support for the notion that an emotional contagion may indeed take place between siblings, our findings cannot provide conclusive proof of causality. More research is therefore needed to examine whether the present results can be replicated over short-term longitudinal intervals. Another limitation is the relatively small sample size, which, while sufficient to detect significant two-way interactions, did not offer enough statistical power to test for three-way interactions. In regard to sample characteristics, generalization from twin to other sibling dyads may be limited. Most studies examining the social contagion of negative emotions have been conducted between friends. Because twins are the same age, their relationship is more egalitarian than the relationship between older and younger sibling and may thus be more similar to friendships than to relationships between siblings of different ages (Ladd, 1983; Lamarche, et al., 2006). Additional studies are thus necessary to test whether the present findings replicate in non-twin siblings. A final 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 emotional contagion between siblings in the development of anxiety.

Notwithstanding these limitations, our study provides important new insights into the role of siblings in the development of anxiety symptoms in adolescents. Therefore, raising awareness of a possible contagion of anxiety between siblings in the context of family-based prevention programs may be useful to impede the development of anxiety symptoms in youth. Family cognitive behavioral therapies for anxiety disorders in children and youth that incorporate parents in the therapeutic process, such as the program FRIENDS, have been shown to be effective (Shortt, Barrett, & Fox, 2001). Involving parents may reduce the risk of social contagion between siblings by changing certain aspects of the family environment that have been found to maintain anxiety symptoms in youth such as high parental control, parental anxiety, and parental reinforcement of avoidant coping strategies (Shortt, et al., 2001). However, results from the present study suggest that specifically including siblings in the intervention may be important as well.

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Table 1

Bivariate Correlations among Measures

Measures	1	2	3	4	5	6	7
1. Sex	—						
2. Family stressors	0.11	—					
3. Previous anxiety symptoms (grade 6)	0.10	0.27***	—				
4. Target twin anxiety symptoms (grade 7)	0.18**	0.20***	0.53***	—			
5. Co-twin's anxiety symptoms	0.06	0.14*	0.16**	0.24***	—		
6. Positive features of the siblings' relationship quality	0.20***	-0.05	-0.05	-0.08	-0.06	—	
7. Negative features of the siblings' relationship quality	0.01	0.23***	0.23***	0.29***	0.12*	-0.43***	—

Note. $n = 329$. Correlation based on the twin dyad. Sex is coded such that a higher level represents girls.

* $p \leq 0.05$, ** $p \leq .01$, *** $p \leq .001$.

Table 2

Multiple Regression Predicting Anxiety Symptoms in Grade 7

Model	Predictors	B	SE	p	R ²
1 a)	Sex	0.31	0.10	0.003	0.10
	Genetic relatedness				
	Dummy 1 (MZ and mDZ vs sDZ)	-0.31	0.12	0.010	
	Dummy 2 (MZ and sDZ vs mDZ)	0.12	0.13	0.340	
	Family stressors	0.18	0.05	0.001	
1 b)	Previous anxiety symptoms (grade 6)	0.44	0.05	0.000	0.35
	Positive features of the siblings' relationship quality	0.00	0.05	0.950	
	Negative features of the siblings' relationship quality	0.16	0.05	0.001	
	Co-twin's anxiety symptoms	0.14	0.05	0.002	
2 a)	Co-twin's anxiety X Positive features	0.09	0.04	0.040	0.36
2 b)	Co-twin's anxiety X Negative features	-0.04	0.04	0.330	0.36
3	Co-twin's anxiety X Dummy 1	-0.14	0.11	0.210	0.36
	Co-twin's anxiety X Dummy 2	-0.22	0.10	0.040	
4	Co-twin's anxiety X Sex	0.18	0.09	0.050	0.36

Note. $n = 329$. Analyses based on the twin dyad. Sex is coded such that a higher level represents girls. MZ = Monozygotic Twins; mDZ = mixed-sex Dizygotic Twins; sDZ = same-sex Dizygotic Twins. Regression coefficients and R² values are mean values across 20 imputations. SE (standard errors) were computed based on Rubin's rules (1987).