A Monozygotic Twin Difference Study of Friends’ Aggression and Children’s Adjustment Problems

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This study used the monozygotic (MZ) twin difference method to examine whether differences in friends’ aggression increased the differences in MZ twins’ aggression and depressive symptoms from kindergarten to Grade 1 and whether perceived victimization by the friend played a mediating role in this context. Participants were 223 MZ twin pairs. Results showed that differences in kindergarten friends’ aggression significantly predicted an increased difference in MZ twins’ aggression from kindergarten (mean age = 6.7 years) to Grade 1 (mean age = 7.5 years) for both boys and girls. Differences in perceived victimization by the friend mediated this association, albeit only in boys. Differences in perceived victimization by the friend also predicted an increase in MZ twins’ differences in depressive symptoms. These results support the importance of friendship experiences during early childhood.

Childhood aggression represents a well-researched risk factor for a variety of later negative outcomes such as interpersonal violence, serious delinquency, and dropping out of school (Farrington, 1991). Similarly, childhood depressive symptoms are a risk factor for later adjustment problems, including major depression and school difficulties (Birmaher et al., 1996). Although quantitative genetic studies show that childhood aggression and depressive symptoms are partly under genetic influences, genetic factors usually do not account for more than 50% of the respective variances (DiLalla, 2002; Rice, Harold, & Thapar, 2002). The remaining unexplained variance in both childhood aggression and depressive symptoms seems mostly attributable to environmental factors that are nonshared, rather than shared between children growing up in the same family (Happonen et al., 2002; Rhee & Waldman, 2002).

The Monozygotic (MZ) Twins Difference Method

Peer experiences such as exposure to aggressive friends have been emphasized as a potential unique nonshared environmental factor that may play an important role in explaining children’s psychosocial development (Harris, 1998; Plomin, Asbury, & Dunn, 2001). Indeed, studies that use one child per family provide ample evidence that aggressive friends are linked to an increase in children’s own aggressive behavior even after accounting for peer-related confounders such as peer rejection (Snyder et al., 2005). There is also evidence linking friends’
aggression to an increase in children’s depressive symptoms (Fergusson, Wanner, Vitaro, Horwood, & Swain-Campbell, 2003; Mrug, Hoza, & Bukowski, 2004). This evidence, however, is based on correlational studies that do not take into account conounding gene–environment processes such as gene–environment correlations (Plomin, DeFries, & Loehlin, 1977; Rutter, Pickles, Murray, & Eaves, 2001). The notion of gene–environment correlation rests on the possibility that a person’s genotype may influence that person’s exposure to environmental risks such as aggressive friends, making these environmental risks to some degree genetically mediated. Three types of gene–environment correlations (rGE) have been described (Plomin et al., 1977): Passive rGE (individuals receive both genetic and environmental risk factors from their parents), active rGE (individuals seek out environments consistent with their genetic predispositions), and evocative rGE (individuals’ genetically influenced behavior elicits reactions from their environment). There is empirical evidence showing that exposure to deviant friends and children’s adjustment problems may indeed have resulted from gene–environment correlations (Button et al., 2007; Rowe & Osgood, 1984). Specifically, this evidence shows that the same genetic risk factors that predispose individuals to being aggressive or delinquent also increase their propensity to affiliate with similarly aggressive or delinquent peers. This genetic correlation between own behavioral characteristics and friends’ behavioral characteristics may well be underway already during the preschool years when aggressive children tend to affiliate with similarly aggressive friends (Boivin, Vitaro, & Poulin, 2005). This propensity to affiliate with behaviorally similar friends could have resulted from an active rGE (aggressive children tend to select aggressive friends) or from an evocative rGE (aggressive children are selected by aggressive friends). Hence, the “effects” attributed to friends’ aggression in past studies may have been, at least partially, genetically mediated (i.e., spurious).

The MZ twin difference method offers a powerful tool to study nonshared environmental factors such as exposure to aggressive friends independently of genetic and gene–environment effects, as well as independently of shared environmental factors (Moffitt & Caspi, 2007; Pike, Reiss, Hetherington, & Plomin, 1996; Rutter et al., 2001). With this method, MZ twin differences in peer experiences can be related to MZ twin differences in behavior. Because MZ twins do not differ genetically and share the same family environment, associations between differences in their peer experiences and differences in their behavior necessarily reflect the net contribution of peer experiences (such as friends’ aggression) as a unique, nonshared environmental influence on behavior.

Therefore, in this study, we employed the MZ twin difference method to examine whether differential experiences with aggressive friends in kindergarten predicted an increase in MZ twins’ differentiation in aggression and depressive symptoms from kindergarten to Grade 1. We used two reporting sources for each of the main independent and dependent variables to reduce measurement error. In addition, to avoid spurious effects, we controlled for correlated non shared factors that might have produced differences in friends’ aggression as well as initial differences in twins’ aggressive behavior and depressive symptoms. Specifically, we controlled for twin differences in parental treatment (i.e., parent coercion) and difficult social experiences at the group level (i.e., peer rejection), because these variables have been found to predict affiliation with deviant peers, aggressive behaviors, and depressive symptoms (Brendgen, Vitaro, & Bukowski, 1998; Caspi et al., 2004; Ladd & Kochenderfer-Ladd, 2002; Snyder et al., 2003). Finally, for each of our two outcomes (i.e., differences in twins’ aggressive behavior and depressive symptoms in Grade 1), we controlled for baseline (i.e., kindergarten) levels of both outcomes, because these problems may co-occur and influence each other over time. Hence, the first objective of this study was to test the role of aggressive friends in the development or maintenance of aggressive and depressive behavior in young children using a stringent procedure that controls gene–environment correlations and shared influences. The second objective of our study was to examine an as yet rarely examined process through which friends’ aggression could contribute simultaneously to the aggravation of children’s aggressive behaviors and of their depressive symptoms, namely victimization by the friend.

Victimization by the Friend as Mediating Mechanism

Previous research showed that aggressive friends foster aggressive behaviors because they serve as models and training agents. These processes, known as deviancy training, are based on positive or neutral interactions between friends that consist mainly of prompting and positive reinforcement of deviant behaviors and extinction of conventional behaviors (Dishion, Patterson, & Griesler, 1994; Snyder et al., 2005). However, aggressive children
do not only interact in a positive manner with their friends but also act aggressively toward their friends (Deptula & Cohen, 2004; Dishion, Andrews, & Crosby, 1995). Behaviors such as commands, criticisms, threats, or hitting from an aggressive friend may trigger similar responses in a child. These responses may become more frequent because they may be negatively reinforced by occasional capitulations by the aggressive friend (Snyder, Schrepferman, Stoolmiller, & Brooker, 2007), set the norm for interpersonal relationships (Bukowski, Velasquez, & Brendgen, 2008), or foster hostile intents and retaliation against the friend (Schwartz, Dodge, et al., 1998). Victimization by the friend, which can be considered a special type of peer victimization, has indeed been related to concurrent externalizing behavior problems in middle childhood (Crick & Nelson, 2002). Victimization by the friend could thus mediate, at least in part, the link between friend’s aggression and child aggression. Victimization by a friend could also account for the possible link between friends’ aggression and children’s depressive symptoms. In fact, there is empirical evidence linking victimization by the friend to concurrent internalizing behavior problems in middle childhood (Crick & Nelson, 2002). Other studies have also found a relation between abrasive interactions and conflict among friends and depressive symptoms, especially in girls (Oldenburg & Kerns, 1997). The possible mediating role of victimization by a friend with respect to the link between friends’ aggression and children’s depressive symptoms has never been examined, however.

Hence, the second objective of this study was to examine whether twins’ differences in the degree of victimization by their friends could account for the possible links between differences in their friends’ aggression and increased differences in their own aggressive behavior and depressive symptoms. As already mentioned, examination of interpersonal mechanisms such as victimization by the friends would complement our current knowledge about processes which could account for the links between friends’ aggression and changes in children’s own aggression. It could also help account for the as yet unexplained links between friends’ aggression and children’s depressive symptoms.

A third, related goal of this study was to test whether the pattern of results applied equally to male and female twin pairs. Previous research findings suggest that boys and girls react differently when exposed to friends’ aggression, whether expressed toward other children (Hanish, Martin, Fabes, Leonard, & Herzog, 2005) or toward themselves (Oldenburg & Kerns, 1997). Boys tend to adopt their friends’ aggressive behaviors more readily than girls. In turn, girls tend to become more depressed than boys when victimized by their friends.

Method

Participants

The 223 MZ twin pairs (117 female pairs) who participated in this study were part of an ongoing longitudinal study (the Quebec Newborn Twin Study [QNTS]) of a population-based sample of twins from the greater Montreal area in the Province of Quebec, Canada, who were recruited at birth between November 1995 and July 1998 (N = 648 twin pairs; 254 MZ twin pairs). For same-sex twin pairs, zygosity was assessed at 18 months based on physical resemblance via the Zygosity Questionnaire for Young Twins (Goldsmith, 1991). For a subsample of these same-sex twin pairs (n = 123), DNA was collected to test for 10 highly polymorphous genetic markers. The comparison of zygosity based on the similarity of these genetic markers with zygosity based on physical resemblance revealed a 94% correspondence rate, which is similar to rates obtained in older twin samples (Forget-Dubois et al., 2003). Eighty-four 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 compared to those of a sample of single births that is representative of the large urban centers in the province of Quebec (Jette, Desrosiers, & Tremblay, 1998) when the children were 5 months of age. The results showed that 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 first born 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 of 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 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\% (42\%) had an annual total income between CAN$30,000 and CAN$59,999, and 27\% (29\%) had an annual total income of more than CAN$60,000. These results indicate extremely similar sociodemographic profiles in the twin sample and the representative sample of single births.

The sample was followed longitudinally at 5, 18, 30, 48, and 60 months focusing on a variety of child-related and family related characteristics. Two additional waves of data collection were completed at 72 and 84 months of age to assess children's social adaptation in kindergarten and Grade 1. This article describes findings from these last two data collections, although data from previous waves were used for the control variables. The average age at assessment was 72.7 months (SD = 3.6) in kindergarten (T1) and 84.5 months (SD = 3.5) in Grade 1 (T2). To be included in this study, children needed to have valid data on at least two measures in kindergarten and two measures in Grade 1. One hundred fifty pairs had valid data on all the study measures, including control variables. Of the remaining participants (n = 73), 42 had missing on either teacher- or peer-rated twins' aggression or depressive symptoms, 34 had missing on either teacher- or peer-rated friends' aggression, 16 had missing on perceived victimization by the friend (see description of the measures next). Participants with these occasional missing data were included in the analyses using the full information maximum likelihood method (Arbuckle & Wothke, 1999). In consequence, attrition in this study was 12.2\% (254 MZ pairs in the original sample – 223 participating MZ pairs in this study = 31 MZ pairs lost from the study). MZ twins remaining in the study at 72 and 84 months of age did not differ from those lost in regard to parent-rated temperament at 5 months of age. The lost twin families also did not differ from the remaining twin families in regard to any of the sociodemographic measures mentioned previously except that fathers in the remaining study sample had a slightly higher level of education than fathers of the twins who were lost from the study.

Measures and Procedure

All instruments were administered either in English (21\%) or in French (79\%), depending on the language spoken by the participants. 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 in the questionnaire. Prior to data collection, active written consent from the parents of all the children in the classroom was obtained. Data collection took place in the spring of the school year to ensure that the teachers had become familiar with the children and that the children had become familiar with each other. The instruments were approved by the University of Montreal’s Institutional Review Board and the school board administrators. Different informants were involved in the data collection: Parents provided information about control variables (i.e., family income and parent coercion), peers were used to assess peer rejection, twins provided data about victimization by their friends, and teachers and peers rated the twins' and their friends' behaviors at T1 and at T2.

In 70\% of the cases, the two members of a twin pair were in different classrooms at T1, and in 73\% of the cases, the two members of a pair were in different classrooms at T2. A series of t tests revealed no differences between twins in the same classroom and twins in different classrooms with respect to difference scores on any of the variables used in this study.

Twins' aggression and depressive symptoms. At T1 and T2, teachers rated twins’ aggressive behaviors over the past 6 months using seven items from the Social Behavior Questionnaire (SBQ; Tremblay, Vitaro, Gagnon, Piché, & Royer, 1992). The list of seven items included the same three items as for friend’s aggression (described later), plus the following: “Gets into fights,” “Hits, bites, kicks others,” “Fights back when provoked by another child,” and “Says mean things behind someone’s back.” Similarly, the twins’ depressive symptoms over the past 6 months were rated by teachers using the following four items from the Emotional Disorders Scale of the Ontario Child Health Study (Offord, Boyle, & Racine, 1989): “Seems unhappy or sad,” “Is not as happy as other children,” “Lacks energy, seems tired,” and “Has difficulties enjoying him or herself.” Ratings for each item ranged from 0 (does not apply), to 1 (applies sometimes) and 2 (applies often). For each child, individual item scores were added to compute scale scores. Internal consistency for both scales was acceptable: Cronbach’s alphas for aggression = .87 at T1 and .89 at T2; Cronbach’s alphas for depressive symptoms = .76 at T1 and .76 at T2.

At T1 and T2, peers (i.e., classmates) also rated twins’ aggressive behaviors and depressive
were summed and the class, the nominations received for each item confidentiality of their responses. For each child in the procedure, the children were reminded to maintain pant understood the instructions. Throughout the loud, while the other made sure that each partici-

One research assistant read the instructions out

 nominated in reference to each behavior descriptor. Two other behavior descriptors referred to depressive symptoms: “Looks sad” and “Unhappy.” Two classmates could be nominated in reference to each behavior descriptor. One research assistant read the instructions out loud, while the other made sure that each participant understood the instructions. Throughout the procedure, the children were reminded to maintain confidentiality of their responses. For each child in the class, the nominations received for each item were summed and z-standardized within the classroom to control for variations in classroom size, yielding a score for each twin as well as for each of the other participating children in their class. Next, for each child in the class, the respective individual item scores were again summed up to yield a global peer-rated aggression and a peer-rated global depressive symptoms score, which were again z-standardized within the classroom. The correlations between teacher and peer-rated twins’ aggression and depressive symptoms scores were, respectively, \( r = .61 \) and \( r = .35 \) at T1, and \( r = .68 \) and \( r = .36 \) at T2. To maximize measurement reliability, we therefore created composite scores for the target twin’s aggression and depressive symptoms by standardizing and averaging teacher and peer ratings.

**Friends’ aggression.** At T1, each twin was asked to nominate up to three best friends in the classroom. Limiting friendship nominations to the classroom probably did not overly restrict selection of friends because the vast majority of elementary school children select a best friend among their classmates even when given the opportunity to nominate a friend outside the classroom (Kupersmidt, Burchinal, & Patterson, 1995; Parker & Asher, 1993). Twins who were in the same classroom were not allowed to nominate their cotwin as a friend. On average, children had nominated 2.94 friends at T1 and 2.95 friends at T2. The number of friends did not differ for girls and boys, at both times of measurement. However, only one friendship nomination was used because the putative mediator (perceived victimization by the friends) was assessed for one friend only. For the majority of twins (i.e., 72%), the first nominated friend was considered. However, when the first nominated friend was not available (either because parents did not give permission to participate, because the friend was not at school on the day of the assessment, or because both twins in the same classroom had selected the same best friend), the second (18%) or the third (10%) nominated friend was used. Overall, 58.4% of the friendships were reciprocated. A preliminary analysis using individual scores showed that friendship reciprocity did not interact with T1 friends’ aggression in predicting T2 twins’ aggression or depressive symptoms.

Teachers scored each friend’s aggression by rating how likely the friend was in the last 6 months to “Have physically attacked others,” “Dominated others,” and “Scared others to get what he or she wanted” on a 3-point scale (0 = never, 1 = sometimes, 2 = often). Cronbach’s alphas were .85 (T1) and .87 (T2) for the aggression scores of the nominated friends. Because peer-rated aggression scores were available for all children in a given twin’s class, including the friends each twin had nominated, peer-rated aggression could also be computed for the friends’ behavior. The correlation between teacher-rated and peer-rated friends’ aggression was relatively high \( (r = .51) \). Consequently, to reduce measurement error, we created a composite score for friends’ aggression by standardizing and averaging teacher and peer ratings.

**Putative mediator: Perceived victimization by the friend.** At T1, a research assistant individually administered a modified version of the Friendship Features Interview for Young Children (FFIYC; Ladd, Kochenderfer, & Coleman, 1996) to each twin in reference to his or her friend. For the purpose of this study, only the three negative items of the modified version of the FFIYC were used. These three negative items tapped perceived conflict among friends and coercive behaviors initiated by the friend: Since the beginning of the school year, “How often did you get into a fight with (friend’s name)?” “How often did (friend’s name) tell you he or she did not want to be your friend anymore?” and “How often did (friend’s name) say mean things to you?” Each item could be rated 0 (never), 1 (one or two times), 2 (often), or 3 (very often). Cronbach’s alpha for this perceived victimization-by-the-friend scale was .71. For this measure, we followed Berndt and McCandless’s (2009) advice and focused on the twin’s perspective because our goal was to see whether the friend’s behavior...
toward the child mediated the possible links between the friend’s aggression and the child’s behavioral and emotional functioning.

**Peer-related control variable: Twins’ peer rejection by classmates.** At T1, the twins’ level of rejection by the peer group was assessed through peer nominations. Specifically, all children in the class were asked to circle the photos of three classmates they least liked to play with (negative nominations). The total number of received negative nominations was calculated for each participant and z-standardized within classroom to create a total rejection score. Only negative nominations were used to index peer rejection instead of the more common social preference score, which includes both positive and negative nominations (Coe, Dodge, & Coppotelli, 1982), because negative nominations have been found to specifically predict physical aggression (Parkhurst & Asher, 1992) and affiliation with aggressive friends (Brendgen, Bowen, Rondeau, & Vitaro, 1999).

**Other control variables: Family income and parental coercion.** Mothers provided information on family income and their parenting practices with respect to each twin when the children were 48 and 60 months old (T-1). Mothers rated their parenting behaviors using the Parental Cognitions and Conduct toward the Infant Scale (PACOTIS; Boivin, Pérusse et al., 2005). The PACOTIS is a 23-item scale assessing mothers’ perceptions about their self-efficacy and their parental impact with regard to their child’s behavior as well as their tendency to act in a hostile-coercive or overprotective manner toward their child. Only the hostile-coercive parenting scale was used in this study. The six items on this scale are: “How often do you get angry with the child?” “Yell at the child?” “Inflict physical punishment?” “Say bad things to the child?” “Hit the child when he or she misbehaves?” and “Shake the child?” Each item could be scored on a 6-point scale, with higher scores indicating more hostility-coercion. Cronbach’s alphas were .76 at 48 months and .79 at 60 months. Given the relatively high correlation between the 48- and the 60-month ratings ($r = .62$), a total score was calculated across the two data points. An average score over the two data points was also used for family income.

**Results**

**Preliminary Analyses: Individual Scores**

Before conducting the main analyses based on difference scores, we used each twin’s individual scores to examine the distributional properties of the measures and to see whether the bivariate links between study variables were in the expected direction. The distributional properties of all the study variables, as well as means and standard deviations are presented in Table 1. Kurtosis and skewness were within acceptable range. Table 2 presents the bivariate correlations among study variables based on individual scores. As the individual child served as the unit of analysis for these correlations, non-independence of the data for each pair of twins was accounted for through the use of intraclass correlations.

The correlation pattern illustrated in Table 2 reveals no collinearity problem. It also demonstrates the validity of the pattern of results. First, twins’ aggression and depressive symptoms scores were moderately stable from T1 to T2 although different teachers and partly different peers served as raters from one time to the next. Second, peer rejection was positively correlated with twins’

<table>
<thead>
<tr>
<th>Measure</th>
<th>M (SD)</th>
<th>Skewness (SE)</th>
<th>Kurtosis (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-1 family income</td>
<td>55,087.72 (22,595.3)</td>
<td>-0.47 (0.132)</td>
<td>-1.06 (0.26)</td>
</tr>
<tr>
<td>T-1 parent coercion</td>
<td>13.20 (2.87)</td>
<td>0.47 (0.12)</td>
<td>0.68 (0.23)</td>
</tr>
<tr>
<td>T1 peer rejectiona</td>
<td>-0.29 (0.88)</td>
<td>1.27 (0.14)</td>
<td>1.26 (0.27)</td>
</tr>
<tr>
<td>T1 friends’ aggressionb</td>
<td>-0.01 (0.86)</td>
<td>1.79 (0.14)</td>
<td>3.24 (0.28)</td>
</tr>
<tr>
<td>T1 victimization by the friend</td>
<td>1.04 (1.45)</td>
<td>1.67 (0.14)</td>
<td>2.45 (0.27)</td>
</tr>
<tr>
<td>T1 twins’ aggressionb</td>
<td>0.00 (0.90)</td>
<td>1.87 (0.14)</td>
<td>3.09 (0.27)</td>
</tr>
<tr>
<td>T2 twins’ aggressionb</td>
<td>-0.11 (0.93)</td>
<td>1.90 (0.13)</td>
<td>2.96 (0.26)</td>
</tr>
<tr>
<td>T1 twins’ depressive symptomsb</td>
<td>0.14 (0.78)</td>
<td>0.69 (0.14)</td>
<td>0.26 (0.27)</td>
</tr>
<tr>
<td>T2 twins’ depressive symptomsb</td>
<td>0.01 (0.86)</td>
<td>0.95 (0.13)</td>
<td>0.78 (0.26)</td>
</tr>
</tbody>
</table>

Note. T1 = kindergarten; T2 = Grade 1; T-1 = 48 and 60 months.

aScores standardized within the classroom. bAverage standardized score across teacher and peer ratings.
aggression and depressive symptoms. Finally, friends' aggression was positively related to twins' aggression at both T1 and T2 and to twins' depressive symptoms at T2 but not at T1.

Table 3 shows the within-pair correlations with respect to the study variables. As can be seen, MZ twins were similar but not identical with respect to aggression \((r = .72 \text{ at T1 and } r = .69 \text{ at T2})\) and depressive symptoms \((r = .35 \text{ at T1 and } r = .59 \text{ at T2})\). MZ twins were also similar in regard to parent coercion \((r = .81)\) and, albeit to a lesser extent, in regard to peer rejection \((r = .38)\) and friends' aggression \((r = .31)\). However, MZ twins showed no notable similarity with respect to the degree of perceived victimization by the friends \((r = .03)\). According to our hypotheses, differences in friends' aggression and perceived victimization by the friends should predict differences in the twins' aggression and depressive symptoms at T2, even after accounting for differences in T1 aggression and depressive symptoms, as well as for differences in T1 peer rejection and parent coercion and for family income.

**Preliminary Analyses: Difference Scores**

Following the strategy most commonly used in MZ difference studies (Moffitt & Caspi, 2007; Pike et al., 1996), twin difference scores were first derived by simply subtracting Twin 2's scores from Twin 1's scores, with rank order between twins in a pair determined at random. As such, a high positive value on a given difference score meant that Twin 1 had a much higher value on that variable than his or her cotwin, whereas a high negative value on that difference score meant that Twin 1 had a much lower value on that variable than his or her cotwin. Table 4 presents distributional properties of the difference scores for the whole sample. As can be seen, skewness and kurtosis were in the acceptable range for all difference scores. Table 4 also includes difference scores for male and female twin pairs separately. A series of \(t\) tests revealed no sex mean differences for any of the difference scores. Moreover, Levene's test showed that the variances of the difference scores did not significantly differ between the two sex groups, with the exception of the variance of the T2 twins' aggression difference score, which showed more variability in male than in female MZ pairs.

The next step was to examine the bivariate correlations between MZ twin difference scores in peer experiences, control variables, and aggression and depressive symptoms. As can be seen in Table 5, MZ twin differences in both aggression
and depressive symptoms were stable from T1 to T2, although much less so than the individual scores shown in Table 2. Differences in friends’ aggression at T1 were positively correlated with differences in twins’ aggression at T2. In contrast, differences in friends’ aggression at T1 were not correlated with differences in twins’ depressive symptoms at T2. Table 4 also shows that differences in perceived victimization by the friend at T1 were correlated with differences in friends’ aggression at T1. The positive sign of the correlation indicates that the twin who had a more aggressive friend than his or her cotwin also experienced more victimization in his or her friendship than the cotwin. Finally, differences in perceived victimization by the friend at T1 were correlated with differences in twins’ aggression at T2.

Main Analyses

According to Baron and Kenny (1986), the following criteria need to be met to support a mediation hypothesis. First, the predictor must predict the outcome when the mediator is not included in the model; second, the predictor must predict the putative mediator; third, the putative mediator must predict the criterion; and fourth, the strength of association between the predictor variable and
the criterion must be reduced once the putative mediator is included in the model equation. A formal test of this reduction requires a significant indirect effect from the main predictor via the mediator to the outcome (Holmbeck, 2002). This indirect effect is usually tested via the Sobel test (Sobel, 1982). To test these assumptions, we conducted two sets of path analyses with the Mplus version 5.1 software package (Muthén & Muthén, 2004): one with differences in T2 twins’ aggression as the outcome and the other with differences in T2 twins’ depressive symptoms as the outcome. In each of the two sets of analyses, we first tested a direct effects model that included all direct effects from the control variables (i.e., family income, differences in parent coercion, differences in T1 peer rejection, differences in T1 twins’ aggression, and differences in T1 twins’ depressive symptoms) and from the main predictor of interest (differences in T1 friends’ aggression) on the outcome. In addition, all predictors were allowed to covary. Next, a mediational model was tested that—in addition to all parameters from the previous model—also included: (a) paths from all control variables and from the predictor of interest (differences in T1 friends’ aggression) to the putative mediator (differences in T1 perceived victimization by the friend) and (b) a path from the putative mediator to the outcome (differences in T2 twins’ aggression or differences in T2 twins’ depressive symptoms, respectively).

Both the direct effects model and the mediation model were first specified with all parameters constrained to be equal across sex to maximize degrees of freedom and hence statistical power for model testing (Kline, 2005). Model fit was assessed using the chi-square statistic as well as the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). According to Kline (2005), CFI values of .90 or higher, RMSEA values of .05 or lower, and SRMR values of .10 or lower indicate good model fit. If deemed necessary based on the model fit indices and based on modification indices and residual statistics, cross-sex equality constrains were released on specific parameters to improve model fit. Table 6 presents the results of the different models from each set of path analysis.

### Analyses predicting differences in T2 twins’ aggression

#### Models predicting to Δ T2 twins’ aggression

<table>
<thead>
<tr>
<th>Models predicting to Δ T2 twins’ aggression</th>
<th>CFI</th>
<th>RMSEA</th>
<th>SRMR</th>
<th>χ² (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggression Model 1 Direct effects model (i.e., excluding the putative mediator), with cross-sex equality constraints on all parameters</td>
<td>1.00</td>
<td>.00</td>
<td>.03</td>
<td>6.66 (7)</td>
<td>.47</td>
</tr>
<tr>
<td>Aggression Model 2 Mediational model (i.e., including the putative mediator), with cross-sex equality constraints on all parameters</td>
<td>.75</td>
<td>.07</td>
<td>.06</td>
<td>24.12 (16)</td>
<td>.09</td>
</tr>
<tr>
<td>Aggression Model 2a Mediational model (i.e., including the putative mediator), with the path from the putative mediator to the outcome freely estimated across sex</td>
<td>.97</td>
<td>.03</td>
<td>.05</td>
<td>16.10 (15)</td>
<td>.38</td>
</tr>
</tbody>
</table>

Note. N = 223. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square error; χ²-difference test; df = degrees of freedom. All models are based on partial covariance matrices, controlling for family income.

*In models predicting to aggression the variance of Δ T2 twins’ aggression was allowed to vary between girls and boys.

### Analyses predicting differences in T2 twins’ depressive symptoms

<table>
<thead>
<tr>
<th>Models predicting to Δ T2 twins’ depressive symptoms</th>
<th>CFI</th>
<th>RMSEA</th>
<th>SRMR</th>
<th>χ² (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depressive Symptoms Model 1 Direct effects model (i.e., excluding the putative mediator), with cross-sex equality constraints on all parameters</td>
<td>1.00</td>
<td>.00</td>
<td>.03</td>
<td>3.13 (8)</td>
<td>.93</td>
</tr>
<tr>
<td>Depressive Symptoms Model 2 Mediational model (i.e., including the putative mediator), with cross-sex equality constraints on all parameters</td>
<td>1.00</td>
<td>.00</td>
<td>.05</td>
<td>13.02 (17)</td>
<td>.74</td>
</tr>
</tbody>
</table>

Table 6
Path Analysis Testing the Direct and Mediational Models With Δ T2 Twins’ Physical Aggression and Δ T2 Twins’ Depressive Symptoms as the Dependent Variables
variance of the T2 twins’ aggression difference score, which had shown a significant sex difference in the preliminary analyses. Modification indices and residual statistics did not indicate that freeing up any other cross-sex equality constraints would further improve model fit. Inspection of the parameter estimates from Aggression Model 1 showed that within-twin pair differences in T1 friends’ aggression significantly predicted differences in T2 twins’ aggression ($\beta = .23$, $SE = 0.10$, $p < .05$), above and beyond differences in control variables, T1 differences in twins’ depressive symptoms, and T1 differences in twins’ aggression (which was the only other significant predictor in the model, $\beta = .25$, $SE = 0.07$, $p < .001$).

In contrast to the direct effects model, the results from the mediational model (Aggression Model 2 in Table 6), where all parameters (except the variance of the T2 twins’ aggression difference score) were constrained to be equal across sex groups, showed inadequate model fit, $\chi^2(16) = 24.12$, $p = .09$. Modification indices and residual statistics indicated that model fit could be significantly improved by freeing the path from the putative mediator (differences in T1 perceived victimization by the friend) to the dependent variable (differences in T2 twins’ aggression). After freeing this parameter (Aggression Model 2a in Table 6), a significant improvement in fit was observed, $\Delta \chi^2(1) = 8.02$, $p < .001$. Inspection of the parameter estimates from Aggression Model 2a showed that differences in T1 friends’ aggression (i.e., the predictor of interest) significantly predicted the putative mediator, that is, differences in T1 perceived victimization by the friend ($\beta = .54$, $SE = 0.16$, $p < .001$, in both sex groups). In turn, differences in T1 perceived victimization by the friend significantly predicted differences in T2 twins’ aggression (our first outcome), but only for boys ($\beta = .15$, $SE = 0.06$, $p < .05$). In girls, differences in T1 perceived victimization by the friend were not related to differences in T2 twins’ aggression ($\beta = -.04$, $SE = 0.03$, $p = .18$). To test whether differences in T1 friends’ aggression had a significant indirect effect on differences in T2 male twins’ aggression through their effect on differences in T1 perceived victimization by the friend, indirect paths were estimated using the method described by Sobel (1982). The results showed that the indirect path was indeed significant for boys ($\beta = .08$, $SE = 0.03$, $p < .05$) but not for girls ($\beta = -.02$, $SE = 0.02$, $p = .21$). For both boys and girls, there was also a remaining direct effect from differences in T1 friends’ aggression on differences in T2 twins’ aggression ($\beta = .16$, $SE = 0.07$, $p < .05$) after accounting for the effects of differences in T1 twins’ aggression and depressive symptoms, the putative mediator, and other control variables. As for the control variables, no significant links were found except for differences in T1 peer rejection predicting differences in T1 perceived victimization by the friend ($\beta = .43$, $SE = 0.16$, $p < .01$) and differences in T1 twins’ aggression predicting differences in T2 twins’ aggression ($\beta = .29$, $SE = 0.08$, $p < .001$). These pathways are illustrated in Figure 1.

**Analyses predicting differences in T2 twins’ depressive symptoms.** The results from the direct effects model where all parameters were constrained to be

![Figure 1](image-url)
equal across sex groups (Depressive Symptoms Model 1) revealed an adequate model fit, \( \chi^2(8) = 3.13, p = .93 \). Modification indices and residual statistics did not indicate that freeing up cross-sex equality constraints would further improve model fit, confirming that none of the parameters significantly differed between boys and girls. Yet, inspection of the parameter estimates from this model showed no significant direct link from differences in T1 friends’ aggression to differences in T2 twins’ depressive symptoms (\( \beta = -.12, SE = 0.08, p = .10 \)). This lack of direct effect from differences in T1 friends’ aggression meant that no real mediation involving differences in T1 perceived victimization by the friend was possible. Nevertheless, it was still possible that an indirect effect from differences in T1 friends’ aggression on differences in T2 twins’ depressive symptoms via differences in T1 perceived victimization by the friend would emerge. This indirect effect was tested in depressive symptoms Model 2 (Table 6), which included: (a) paths from all control variables and from differences in T1 friends’ aggression to differences in T1 perceived victimization by the friend, and (b) a path from differences in T1 perceived victimization by the friend to differences in T2 twins’ depressive symptoms. This model, where all parameters were constrained to be equal across sex groups, fit the data well, \( \chi^2(17) = 13.02, p = .74 \), indicating that no parameters significantly differed between male and female twin pairs. Inspection of the parameter estimates from depressive symptoms Model 2 showed that differences in T1 perceived victimization by the friend predicted differences in T2 twins’ depressive symptoms (\( \beta = .08, SE = 0.03, p < .05 \)), above and beyond differences in T1 differences in depressive symptoms (\( \beta = .13, SE = 0.07, p = .07 \)). In turn, differences in T1 perceived victimization by the friend were predicted by differences in T1 friends’ aggression (\( \beta = .54, SE = 0.16, p < .001 \)) and by differences in T1 peer rejection (\( \beta = .41, SE = 0.16, p < .05 \); see Figure 2). However, the indirect effect from differences in T1 friends’ aggression to differences in T2 twins’ depressive symptoms via differences in T1 perceived victimization by the friend only showed a statistical trend according to the Sobel test (\( \beta = .04, SE = 0.02, p = .07 \), for the indirect effect).

**Discussion**

The first goal of this study was to examine whether differences in friends’ aggression in kindergarten predicted an increased differentiation in MZ twins’ aggression and depressive symptoms from kindergarten to Grade 1. The second goal was to investigate whether differences in perceived victimization by each twin’s friend could account for these associations. The third and final goal was to test whether children’s sex played a moderating role in regard to these associations.

**Friends’ Aggression and Twins’ Aggression**

Differences in friends’ aggression in kindergarten predicted increased differences in twins’
aggression over a 1-year interval. This result was significant after controlling for potential confounders such as differences in parent coercion and peer rejection and after accounting for initial discordance in regard to aggression between MZ twins. Moreover, this result applied equally to male and female twin pairs. This finding adds empirical credence to the growing literature on aggressive friends as an important environmental factor that is related to the maintenance or the aggravation of aggression during the first years of schooling (Boivin et al., 2005). In fact, the presence of aggressive friends might help explain why some young aggressive children do not follow the typical decreasing aggression trajectory followed by the majority of their aggressive peers from age 3 through age 7 (Tremblay & Nagin, 2005). Despite these significant findings, the portion of variance in twins’ T2 difference scores predicted by friends’ T1 difference scores is small to moderate according to current standards. Small to moderate effect sizes ought to be expected in MZ difference studies, however, given that the resulting parameters are purged of any inflating family wide effects and possible gene–environment correlations (Moffitt & Caspi, 2007).

Differences in T1 perceived victimization by the friend partly mediated the link between T1 differences in friends’ aggression and T2 differences in twins’ aggression. In line with previous studies involving young children, this process was limited to boys (Crick & Nelson, 2002; Ladd et al., 1996). Boys’ friendships involve more direct victimization than girls’ friendships, as shown in a study by Crick and Nelson (2002) and as indicated by a moderate correlation between male sex and perceived victimization by the friend in our study. Hence, although friends’ aggression is a risk factor for both sex groups, perceived victimization by the friend seems to play a mediating role only for boys. What are the microsocial processes responsible for this mediating role? One line of explanation based on operant conditioning suggests that aggressive friends’ negative behaviors toward the child trigger, at least occasionally, aggressive responses from the child. The occasional resolution of these conflictual episodes in favor of the child can shape the use of aggression by the child through intermittent negative reinforcement (Snyder, Horsch, & Childs, 1997). Another line of explanation suggests that the repeated use of aggression as a mean, for the friend, to interact with the child and to resolve conflicts may serve to establish norms with respect to the use of aggression in interpersonal relationships. These norms, once established, may generalize to interactions with other children and possibly adults (Bukowski et al., 2008). Finally, it is possible that victimization by the friend fosters the attribution of hostile intents, first toward the friend and then toward peers in general. These hostile intent attributions might further justify the use of retaliatory aggressive acts against others (Crick & Nelson, 2002; Schwartz, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1998). Research that focuses on micro intrapersonal and interpersonal processes is needed to support these tentative lines of explanation. In any case, perceived victimization by the friend only explained part of the association between T1 differences in friends’ aggression and increased differences in twins’ aggression from T1 to T2, because the residual direct link between differences in T1 friends’ aggression and differences in T2 twins’ aggression remained significant after including the putative mediator. Partial mediation by victimization by the friend ought to be expected, however, since victimization by the friend would only mediate the part of the friend’s “influence” that would result from aggressive acts perpetrated against the child. Friends’ aggressive acts perpetrated outside the friendship may foster aggressive behavior in the child via deviancy training processes (i.e., through differential reinforcement, prompting, and modeling).

Friends’ Aggression and Twins’ Depressive Symptoms

Differences in friends’ aggression at T1 did not predict differences in twins’ depressive symptoms at T2 after accounting for initial differences in depression at T1. These results are not in line with past studies that found a link between friends’ aggression and participants’ depressive symptoms (Fergusson et al., 2003; Mrug et al., 2004). A difference in the age of participants may partly explain these discrepant results. Past studies included adolescents, for many of whom depressive symptoms are on the rise, whereas the current study included young children. Differences in methodology could also account for the discrepant results: First, past studies used self-reports to assess depressive symptoms and depressive feelings whereas this study used teacher and peer reports, which may be less sensitive than self-reports to assess internalized outcomes. Second, past studies used one-child-per-family designs whereas this study used a discordant twin design. One-child-per-family studies tend to produce more liberal findings because they do not control for possible gene–environment correlations, which, as a consequence, become confounded.
with environmental effects such as friends’ aggression. As already mentioned, the results from discordant twin studies are purged of such possible gene–environment correlations.

Given the lack of association between differences in friends’ aggression and increased differences in twins’ depressive feelings, no mediation by differences in perceived victimization by the friend was possible. Nevertheless, we found that differences in perceived victimization by the friend in kindergarten independently contributed, although modestly, to increased differences in twins’ depressive symptoms. This result is in line with previous studies, which found a link between perceived victimization by the friend and concurrent internalizing problems (Crick & Nelson, 2002). Although modest, the link between differences in perceived victimization by the friend and increased differences in depressive symptoms is noteworthy given the use of different informants and the fact that depressive symptoms are not yet as prevalent in young children as they are in adolescents. This result supports the notion that victimization by a friend may be considered a special form of general peer victimization, which has been found to predict an increase in young children’s internalizing problems, including depressive symptoms (Arseneault et al., 2008; Leadbeater & Hoglund, 2009).

**Limitations and Conclusions**

This study has a number of positive features: (a) the use of two informants for the predictor and the outcome variables, thus reducing measurement error; (b) the use of different informants for the putative mediator, the predictor variables, and the outcome variables, thus reducing the risk of inflated links attributable to shared method variance; (c) strong internal validity through the control of a number of important possible confounders, thus reducing the risk of spurious links; (d) the use of a longitudinal perspective, thus clarifying the directionality of the links, and, finally; (e) the use of the discordant twin method, thus eliminating the risk of inflated linkages between environmental factors and children’s outcomes as a result of gene–environment correlations. An additional asset of this study was to examine the links between an environmental factor (i.e., differences in friends’ aggression) and two different behavioral outcomes (i.e., differences in twins’ aggression and depressive symptoms) as potentially mediated by the same interpersonal experience (i.e., differences in perceived victimization by the friend).

This study also has limitations that need to be considered when interpreting the results: (a) the use of paper-and-pencil measures only; (b) a focus on friends’ and twins’ direct aggressive behaviors, although twins’ measures included one indirect aggression item; (c) the use of the second or third best friend for one third of the participants; (d) a small sample size; and (e) limited external validity given the ethnic and age composition of the sample. An additional limitation comes from our empirically driven approach to model testing, especially with respect to the testing of possible sex differences, which might have been more sensitive to sample specific variability than a more theoretically driven approach.

Despite these limitations, this study adds unique information about the important and possibly causal role of friends’ aggression in maintaining and increasing children’s aggressive behaviors during the first years of schooling. Until recently, friends were thought to play no important role in the development of aggression in such young children. This study also helps uncover the role of victimization by friends as a possible mediator of the link between friends’ aggression and increases in children’s aggression, at least in boys. Hence, what members of a friendship dyad do to each other matters in regard to the evolution of their aggressive behaviors, possibly as much as what they do to others or what others do to them, but not in the same way for boys and girls. What friends do to each other during the first years of schooling is also predictively related to their emotional well-being (e.g., their depressive symptoms), independent of friends’ characteristics. The strength of these associations may further depend on children’s initial level of either aggression or depressive feelings, although it is not clear whether children with extreme levels of initial adjustment problems would be more or less vulnerable than others to the purported influence of aggressive friends (see Vitaro, Boivin, & Bukowski, 2009).

Before concluding, it is worth raising the question whether causality terms can be used when using the MZ twin difference method. Given that the children are MZ twins who presumably share the same genes and the same family environment, and given that we controlled for initial differences in aggression, depression, and associated family- and peer-related confounders, the plausibility of an affirmative answer to this question is higher than it would be solely based on longitudinal studies that use one child per family. However, the answer is not a definite yes, because not all nonshared
experiences that may be correlated with friends’ and twins’ behaviors can be accounted for. In other words, the MZ twins’ difference method remains correlational in nature although it allows the control of possible gene–environment correlations, shared experiences, and a number of nonshared experiences. Even after exerting all these controls, the findings from this study support the notion that friends’ aggression in kindergarten and perceived victimization by the friend are important environmental experiences that predict a significant portion of young children’s subsequent behavioral and emotional functioning.

References


A Twin Difference Study of Friends’ Aggression


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