

Links between friends' physical aggression and adolescents' physical aggression:

What happens if gene-environment correlations are controlled?

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Abstract

Exposure to deviant friends has been found to be a powerful source of influence on children's and adolescents' aggressive behavior. However, the contribution of deviant friends may have been overestimated because of a possible non-accounted gene-environment correlation (rGE). In this study, we used a cross-lagged design to test whether friends' physical aggression at age 10 predicts an increase in participants' physical aggression from age 10 to age 13 years. Participants were 201 pairs of monozygotic twins who are part of the Quebec Longitudinal Twin Study. We performed two sets of analyses. In the first set of analyses, using twins as singletons, we found that teacher-rated friends' physical aggression predicted an increase in each twin's self-reported physical aggression from age 10 to age 13, above and beyond auto-regressive and concurrent links. Second, we used within-pair differences in regard to friends' physical aggression to predict an increase in within-pair differences in physical aggression, thus accounting for family-wide influences, including a likely rGE at age 10. No significant association was found, however. These results suggest that part of the influence attributed to friends in past studies may have been due to common underlying genetic effects on both physical aggression and association with physically aggressive friends.

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It is well established that high physical aggression during childhood predicts a host of adjustment problems in adolescence and beyond (Patterson, Capaldi, & Bank, 1991). There is also evidence to show that affiliation with physically aggressive friends contributes to this process, partly by amplifying early physical aggression through coercion or through deviancy training (Dishion, Andrews, & Crosby, 1995; Snyder et al., 2005; Vitaro, Pedersen, & Brendgen, 2007). This evidence is in line with behavioral genetic studies showing that an important portion of variance with respect to physical aggression is influenced by non-shared environmental factors (i.e., factors that are not shared among siblings and that make siblings, including twins, different from each other) (Burt, McGue, & Iacono, 2009). It has been suggested that friends are among the most important non-shared environmental influences in children's and adolescents' lives (Harris, 1998). At the same time, there is a growing literature suggesting that an individual's exposure to environmental factors, including friends, may be influenced by this individual's genotype (Scarr & McCartney, 1983; Vitaro, Brendgen, & Lacourse, 2015). This is commonly referred to as a genotype-environment correlation (rGE). Hence, physically aggressive adolescents can select (i.e., according to an active rGE) or be selected by (i.e., according to an evocative rGE) physically aggressive friends because of their own characteristics. In consequence, the contribution of friends' physical aggression towards changes in adolescents' physical aggression may not reflect a true environmental influence but instead reflect a genetically determined effect of the individual on his or her environment. These different possibilities are difficult to disentangle in studies using only one child per family. Using a genetically informed design based on twins, the goal of this study was to examine the

contribution of friends' physical aggression on adolescents' own physical aggression in two ways: while controlling for possible rGE and while not controlling for possible rGE.

Two Theoretical Perspectives

The perspectives above are reminiscent of the debate between the *Incidental* (i.e., *Selection*) and the *Social Influence* models in regard to peer influence (Vitaro, Tremblay, & Bukowski, 2001). According to the proponents of the Incidental model, the (predictive) association between friends' physical aggression and increases in participants' physical aggression does not necessarily indicate a causal influence of one on the other, but is instead explained by one or more other underlying factors. That is, the same factors that lead to a child's or an adolescent's aggressive behavior also contribute to their affiliation of aggressive friends (Gottfredson & Hirschi, 1990). These factors can be either genetic or environmental (Beaver, Ratchford, & Ferguson, 2009). An alternative perspective proposes that friends' physical aggression truly contributes to the development of aggressive behavior in youth even when possible selection processes and other risk factors are controlled. This explanation is compatible with a *Social Influence* model (Akers, 2009; Elliott, Huizinga, & Ageton, 1985). This debate has persisted over several decades and rests mainly on studies that used samples of singletons. Consequently none of them was able to evaluate and control for possible rGE.

In support of the Incidental model, there is evidence from behavioral genetic studies that friends' physical aggression is partially and increasingly under genetic control, from middle childhood to late adolescence. Specifically, Kendler and his colleagues (Kendler, Jacobson, Myers, & Eaves, 2008; Kendler, Jacobson, Gardner, Gillespie, Aggen, & Prescott, 2007) found that genetic effects on friends' aggressive and general antisocial behavior (measured as the proportion of respondents' friends who engaged in specific aggressive or antisocial behaviors)

increased substantially and steadily across five age periods: 8-11, 12-14, 15-17, 18-21, and 22-25. Furthermore, some studies reported that the same genetic factors that predispose an individual to being aggressive also increase the risk of that individual's affiliating with aggressive friends, of the which questions the independent causal role of friends' physical aggression (Button, Corley, Rhee, Hewitt, Young, & Stallings, 2007) . The conclusion of these studies towards a non-causal role of aggressive friends is supported further by studies that explored the role of aggressive/deviant friends while controlling possible rGEs through the use of the MZ difference method. MZ twins share 100% of their genes and, when raised together, also the same family environment. As a result, the MZ difference method affords a unique opportunity to examine the role of non-shared environmental experiences that make the two twins of a pair different from each other, while controlling for genetic and family-wide influences. This is achieved by correlating differences in the measured environment (e.g., friends' physical aggression) with later differences in the measured behavior (e.g., participants' own physical aggression), while controlling for baseline differences in aggressive behavior (see Vitaro, Brendgen, & Arseneault, 2009, for a full description of the method). As a consequence, the MZ difference method allows testing the premise of the Social Influence model that friends' physical aggression predicts an increase in participants' physical aggression even when possible selection processes based on genetically influenced characteristics and other familial influences are controlled.

To date, three studies have used the MZ difference method with adolescent samples to address this issue. They found that within-pair differences in peers' aggressive or antisocial behavior were unrelated to increased within-pair differences in twins' aggressive or antisocial behavior, which stands in contrast to what would be expected according to the Social Influence

model (Beaver, 2008; Burt, McGue, & Iacono, 2009; Hou, Chen, Natsuaki, Li, Yang, Zhang, & Zhang, 2013). All three studies controlled for continuity in participants' aggressive or antisocial behavior over time through the use of a longitudinal design. In addition, two studies (Burt et al., 2009; Hou et al., 2013) also controlled for continuity in friends' antisocial behavior by adopting a cross-lagged design over two data points. However, all three studies used twins' perceptions of their friends' deviance. This may have confounded, at least partially, individuals' (partly genetically driven) characteristics and their friends' characteristics, consequently reducing the true non-shared environmental value of friends' aggressive or antisocial behavior. A fourth study that used friends' self-reports, but a modified version of the Defries-Fulker method to assess and control for possible rGE (instead of the MZ-difference method), also concluded that friends' deviance was not correlated with participants' deviance (Teneyck & Barnes, 2015). Despite methodological differences, all of the above mentioned studies support the Incidental model. However, all used samples of mid- to-late adolescents for whom rGEs may have culminated, as youngsters gain autonomy from parents and teachers. According to the Confluence model (Dishion, Patterson, & Griesler, 1994) age 10 represents the developmental turning point when youngsters progressively select –and are selected by– friends who share and positively reinforce their own values to the exclusion of others. However, no genetically informed study to date has examined whether friends' physical aggression predicts an increase in youngsters' physical aggression during this developmental period when they begin to start forming stable and well defined friendships.

The Present Study

The goal of the present study was to determine the contribution of MZ-twin differences in friends' physical aggression with respect to changes in MZ-twin differences in physical

aggression from age 10 to age 13. This was achieved using a cross-lagged design to control for stability of both the twins' own and their friends' physical aggression. Importantly, we relied on the friends themselves to report on their physical aggression. The same analyses were repeated using raw scores (not within twin difference scores) with each twin separately. This second set of analyses aimed to mimic past studies using singletons without any control for possible rGE. Finally, since physical aggression is more prevalent in males than in females, it was possible that the pattern of selection or socialization effects, if any, would be stronger in males than in females. Therefore, we also examined whether the same pattern of results applied to males and females.

Method

Sample

Participants of this study were drawn from a population-based sample of MZ and same-sex DZ twin pairs from the greater Montreal area recruited at birth between November 1995 and July 1998 (see Boivin et al., 2013). Zygosity was assessed by genetic marker analysis of 8-10 highly polymorphous genetic markers and twins were diagnosed as MZ when concordant for every genetic marker. When genetic material was insufficient or unavailable due to parental refusal (43% of cases), Zygosity was determined based on physical resemblance questionnaires at 18 months and again at age 9 (Spitz et al., 1996). The comparison of zygosity based on genotyping with zygosity based on physical resemblance in a subsample of 237 same-sex pairs revealed a 94% correspondence rate, which is extremely similar to rates obtained by other researchers (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% was Native North Americans. The remaining families did not provide ethnicity information. Demographic characteristics of the

twin families were comparable to those of a sample of single births representative of urban centers in the province of Quebec. At the time of their child(ren)'s birth, 95% of parents lived together; 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 child and family characteristics. New data collections were completed when the children were age 6, 7, 10, and 13. Only age 10 and age 13 data were used for the purpose of this study (mean age = 10.2 years, $SD = .42$; mean age = 13.1, $SD = .31$). Out of the initial 662 pairs (which also included opposite-sex DZ pairs), 351 twin pairs participated at age 10: 201 monozygotic (MZ) pairs (51% female) and 150 same-sex dizygotic (DZ) pairs (48% female). The twin pairs in the final study sample did not differ from those who were lost through attrition in regard to mother-rated aggressive behavior at ages 18 to 48 months, family status, parental education or parents' age, but family revenue was higher in the remaining study sample.

Measures

Twins' Physical Aggression. Teacher ratings were used to assess each twin's level of physical aggression at age 10. Teachers rated the twin's level of physical aggression using three items based on the Social Behavior Questionnaire ("gets into fights", "physically attacks others", and "hits, bites, or kicks others"; Tremblay, Vitaro, Gagnon, Piché, & Royer, 1992). The items were embedded in a larger questionnaire on child adjustment. Teacher-ratings of children's physical aggression have been shown to have good stability as well as good construct and

predictive validity based on concurrent and longitudinal links with related antisocial behaviors and peer difficulties (Willoughby, Kupersmidt, & Bryant, 2001). The teachers indicated to what extent each of the physical aggression items applied to the child using a 3-point scale (0 = never, 1 = sometimes, 2 = often). The respective individual item scores were summed up to yield a total physical aggression score. Means and standard deviations are presented in Table 1. Internal consistency of the total scale in the present sample was acceptable, with Cronbach's alpha = .87.

Each twin's physical aggression was measured using self-reports at age 13 years. The physical aggression scale included six items (ex., fighting, bullying). Each item was rated on a 4-point scale: 0 (*never*), 1 (*once or twice*), 2 (*often*) and 3 (*very often*) in reference to the last 12 months. Means and standard deviations are presented in Table 1. The items were part of the Self-Reported Delinquency Questionnaire for which LeBlanc and McDuff (1991) reported good temporal stability and satisfactory concurrent validity. Internal consistency in this study was also satisfactory (Cronbach alpha = .76). Physical aggression scores at both times were not normally distributed. In consequence, a square-root transformation was used to reduce skewness and kurtosis to acceptable levels (see Table 1).

Friends' Physical Aggression. Each twin was asked to nominate up to three friends in his-her classroom at age 10 and up to six friends at age 13. At age 13, however, friends were not limited to the classroom anymore. With parental approval, friends answered the same six physical aggression items as the twins at age 13. At age 10, the names of the three nominated friends were transposed onto the teacher questionnaire described previously, such that teachers did not only rate the twin child's own behavior but also that of each of the child's nominated friends. To minimize the teachers' work load, teachers were asked to rate each friend using only two items ("gets into fights", "physically attacks others"). The correlations between the two

items were .86, .96, and .99 for each nominated friend, respectively. The same 3-point response scale was used as described previously. For each target child, the friends' teacher-rated physical aggression scores were then averaged across the nominated friends. An average score across all participating friends' self-reported aggression was also computed at age 13. Means and standard deviations are presented in Table 1.

On average 1.97 nominated friends participated at age 10 and 2.17 nominated friends participated at age 13. Given that 70.1% of the twins were not in the same classroom at age 10, the overlap in friends' identity between the two twins of a pair was minimal, with virtually no pair nominating the same three friends. However, 17.8% of the pairs shared one or two friends. At age 13, the two twins of a given pair nominated the same friends in only 2.5% of all cases, whereas in 51.3% of cases the two twins of a given pair nominated no friend in common at all.

Procedure

All instruments were administered either in English (21%) or in French (79%), depending on the language spoken by the respondents. Instruments that were administered in French but were originally designed in English were 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. Data collection took place in the Spring of the school year, to ensure that the teachers and the children were well acquainted with each other. Active written consent from the twins' parents as well as from the parents of the twins' friends was obtained. All instruments were approved by the Institutional Review Board and the school board administrators.

Results

Preliminary analyses

The twin design makes it possible to assess the relative role of genetic factors and environmental factors associated with a given phenotype (Falconer, 1989). The examination of within-pair correlations for MZ twins and same-sex DZ twins can be used to roughly estimate the sources of variability of a given phenotype in terms of genetic and environmental factors. The relative strength of additive genetic factors on individual differences (a^2) is approximately twice the MZ and same-sex DZ correlation difference, $a^2 = 2(r_{MZ} - r_{DZ})$. The relative strength of shared environmental factors that affect twins within a pair in a similar way (c^2) can be estimated by subtracting the MZ correlation from twice the DZ correlation, $c^2 = 2r_{DZ} - r_{MZ}$. Non-shared environmental factors that uniquely affect each twin in a pair (e^2) are approximated by the extent to which the MZ correlation is less than 1, $e^2 = 1 - r_{MZ}$. Table 2 shows the within-pair correlations of twins' own physical aggression and friends' aggression at ages 10 and 13, separately for MZ twins and same-sex DZ twins. As can be seen, the MZ correlation for physical aggression at both the ages 10 and 13 is higher than the same-sex DZ correlation, suggesting an important contribution of genetic factors. Similarly, MZ twins were more highly similar with respect to their friends' physical aggression scores both at age 10 and at age 13 than same-sex DZ twins, suggesting the presence of genetic influences (and hence, the presence of rGE) in regard to their friends' physical aggression scores at both the ages. To confirm that genetic influences on the correlation between friends' aggression and participants' aggression are partly the same, we examined whether cross-twin, cross-friends correlations were larger in MZ twin pairs than in same-sex DZ twin pairs (Plomin, DeFries, Knopik, & Neiderheiser, 2013). This was achieved by a) correlating twin 1 friends' aggression with twin 2 own aggression, and twin 2 friends' aggression with twin 1 own aggression and b) imposing equality constraints across twins from the same pair. Results for age 10 indicate that the cross-twin, cross-friend correlation for MZ and

same-sex DZ pairs is .29 and .18, respectively. Cross-twin, cross-friend correlations for age 13 are .21 and .07 for MZ and DZ pairs, respectively.

Main Analyses with the MZ twin subsample

First, bivariate correlations between twins' own and their friends' physical aggression at ages 10 and 13 were examined using each individual twin's raw scores. As can be seen in table 3, each twin's aggression scores were moderately stable from age 10 to age 13, despite the use of different reporting sources. Second, their friends' aggression scores were also moderately stable. Third, twins' aggression scores at age 10 were concurrently correlated with their friends' aggression scores at age 10, whereas their aggression scores at age 13 were concurrently correlated with their friends' aggression scores at age 13. Fourth, friends' aggression scores at age 10 predicted twins' aggression scores at age 13, suggesting a possible socialization effect. However, no selection effect was apparent (i.e., twins' aggression scores at age 10 did not predict friends' aggression at age 13). Finally, boys scored significantly higher than girls with respect to their own and their friends' physically aggressive behavior at ages 10 and 13.

We also examined the same bivariate correlations using the MZ twin difference scores. Following the strategy most commonly used in MZ-differences studies (Moffitt & Caspi, 2007; Pike, Reiss, Hetherington, & Plomin, 1996), within-pair twin-difference scores were first derived by subtracting one twin's scores from his or her co-twin's score. Twin order in the subtraction equation (i.e., the decision of who was considered twin 1 and who was considered twin 2) was determined at random. However, once determined, the score of twin 2 was always subtracted from the corresponding score of twin 1 to create difference scores. As such, a high positive value on a given difference score meant that twin 1 had a higher value on that variable than his or her co-twin (i.e., twin 2). Conversely, a high negative value on a given difference score meant that

twin 1 had a lower value on that variable than his or her co-twin (i.e., twin 2). Table 1 presents the distributional properties as well as the bivariate correlations of the MZ-difference scores. As can be seen, MZ-twin differences in regard to their own aggression scores were stable from age 10 to age 13, such that the twin judged more aggressive by the teacher at age 10 also rated himself-herself as more aggressive at age 13 than his-her co-twin. MZ-twin difference scores in regard to their friends' aggression scores were also stable from age 10 to age 13, such that the twin who affiliated with more aggressive friends at age 10 also affiliated with more aggressive friends at age 13. However, no other correlation was significant when considering within-pair difference scores.

Next, for both the individual raw scores and the within-pair difference scores, model tests were performed with the Mplus Version 6 software package (Muthén & Muthén, 1998-2011). These analyses were conducted using Full Information Maximum Likelihood (FIML) estimation, which is the default in Mplus to account for occasional missing data (28% of data points in the present sample) when using maximum likelihood estimation for continuous variables. Model fit was assessed using the chi-square statistic, 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. Sex was included as a control variable in all the analyses. In addition, two-group models with equality constraints across sexes were estimated using nested model-chi-square difference tests to examine potential sex moderation of the pattern of associations. However, no sex moderation was found, suggesting that the same pattern of results applies to males and females. These models are not reported for parsimony.

To insure that the results were not affected by the log-transformation that was used to correct the non-normality of the variable distributions, we reran every analysis using count measures and Poisson distributions. All results, whether based on difference scores or on individual scores, remained unchanged in terms of significance.

Individual Scores. For each twin separately, we first tested a fully saturated cross-lagged model that included bi-directional links between twins' and friends' individual physical aggression scores at age 10 and twins' and friends' individual physical aggression scores at age 13. Stability coefficients for twins' and friends' individual aggression scores were included and within-time relationships among them were allowed to covary. The results are depicted in Figure 1 and in Table 4. As can be seen, twins' aggression and friends' aggression scores were stable from age 10 to age 13 for both twins. Concurrent links between each twin's aggression scores and their friends' aggression scores were also significant, albeit marginally at age 13. Finally, for each twin separately, friends' aggression score at age 10 predicted an increase in his-her aggression scores from age 10 to age 13, above and beyond stability coefficients and cross-sectional links. However, each twin's physical aggression scores at age 10 did not predict a change in their friends' aggression scores from age 10 to age 13.

Difference Scores. As we had done for individual scores, we first tested a fully saturated cross-lagged model that included bi-directional links between within-pair differences in twins' and friends' physical aggression at age 10 and within-pair differences in twins' and friends' physical aggression at age 13. Notably, we wanted to test whether within-pair differences in friends' aggression at age 10 predicted an increase in within-pair differences from age 10 to age 13. Therefore, stability coefficients for both within-pair differences in twins' aggression and

within-pair differences in friends' aggression were included and within-time relationships among them were allowed to covary.

As can be seen in Figure 2 and in Table 4, within-pair differences in twins' aggression and within-pair differences in friends' aggression scores were stable from age 10 to age 13. Hence, the twin who was more physically aggressive and who affiliated with more physically aggressive friends at age 10 tended to remain more aggressive and to affiliate with more aggressive friends at age 13 than his or her co-twin. However, in contrast to the results with individual scores, no concurrent links and no cross-lagged links between within-pair differences in friends' aggression and within-pair differences in twins' aggression were found.

Discussion

The goal of this study was to investigate whether within-pair differences in friends' physical aggression at age 10 predicted an increase in within-pair differences in MZ twins' physical aggression from age 10 to age 13 while accounting a) for concurrent and stability links through the use of a cross-lagged design and b) for genetic influences and shared environmental influences through the use of an MZ-twin difference design. Results showed that, for both males and females, friends' physical aggression did not predict an increase in twins' aggression while controlling for possible rGE through the MZ-twin difference design. However, when using the twins as singletons, a moderate effect of friends' physical aggression on changes in twins' physical aggression was found. These results are in line with other studies using the MZ-twin difference method, which also found no predictive effect of friends' antisocial behavior on participants' own antisocial behavior (Beaver, 2008; Burt et al., 2009; Hou et al., 2013). They are also in line with recent findings by Teneyck and Barnes (2015) showing that friends'

deviance is correlated with participants' deviance before, but not after, controlling for genetic factors.

However, our findings do not concord with results from several other studies that did not control for possible rGE. As in many studies using singletons, we found that friends' aggression was associated with an increase of children's aggression even after a three-year interval (see Bukowski, Castellanos, Vitaro, & Brendgen, 2015, for an overview). Had we not controlled for possible rGE, we would have concluded that these results are in line with the Social Influence model. However, this conclusion would have been incorrect, since no predictive effect of friends' aggression was found when using MZ difference scores (i.e., after controlling for genetic and shared environmental influences on children's own and their friends' physical aggression).

Our results are also not in line with previous results from our study sample at an earlier age, where we found a predictive effect of friends' aggression on an increase in children's own aggression while controlling for rGE through the use of the MZ-twin difference method (e.g., Vitaro et al., 2011). In that study, our participants were aged 6 years old, whereas participants in all the other twin studies were adolescents or pre-adolescents. As shown by Brendgen, Boivin et al. (2008) and by van Lier, Boivin et al. (2007), friends' aggression at ages 6 and 7 is not (yet) under genetic influence. In accordance with the Confluence model, the pattern of within-pair correlations in the present study suggests that this changes once children (i.e., the twins) reach age 10 and become more autonomous in selecting their friends based on their own personal characteristics. Thus, friends' aggression seems to influence children's aggression from age 6 to age 7, but not from age 10 to age 13, once rGE become apparent. The longer interval between the data points in the present study compared to the Vitaro et al. study (2011) cannot in itself fully explain these discrepant results, since significant associations were found in the present

study when using individual raw scores (i.e., when using the twins as singletons). Only after controlling for the common genetic influences shared by friends' aggression and children's aggression through the use of the MZ-twin difference method, did we obtain a non-significant effect of friends.

The finding of a genetic effect on friends' aggression at ages 10 and 13 – along with the finding that friends' influence disappears when controlling for such genetic influences – is in line with the Incidental model because it suggests an active or reactive rGE, which would involve some kind of selection process. Why, then, was no evidence of a selection effect found either when using the twins as singletons or when controlling for rGE through the MZ-twin difference method? In the present study, this lack of selection effect may have resulted from the use of a cross-lagged design spanning a three-year interval. Indeed, the presence of genetic effects on friends' aggression at both age 10 and age 13, suggests that selection of a friend based on behavioral similarity may be a rather immediate process but not necessarily indicate individuals' friendship affiliation a few years down the road. The lacking evidence of a selection effect in the present study may also be due to the fact that active selection is only starting by age 10 and not yet systematic as at later ages, as suggested by the Confluence model. Indeed, two other studies examined influence and selection effects in older adolescents with a cross-lagged design spanning a two- or a three-year interval while controlling for possible rGE through the use of the MZ-difference method (i.e., Burt et al., 2009; Hou et al., 2013). Participants in both studies were 14 years old on average at the beginning of the study. As in the present study, the authors did not find a socialization effect (i.e., that within-pair scores with respect to friends' antisocial behavior predicted an increase in within-pair scores with respect to participants' antisocial behavior). However, in both studies, they found a selection effect (i.e., that within-pair differences in

participants' antisocial behavior predicted an increase in within-pair scores with respect to friends' antisocial behavior). Together, the findings from these studies and from our own studies suggest that selection effects may increase over time whereas socialization effects may decrease. Importantly, it is possible that the period around age 10 operates as the turning plate for this process. With puberty and more autonomy from adults, early adolescents may be increasingly embedded into peer groups that are homogeneous with respect to behaviors and attitudes. As selection effects based on genetically influenced characteristics increase (Kendler et al., 2007; Kendler et al., 2008), socialization effects decrease.

Does this Mean that Friends Play No Role after Age 10?

Although selection and not socialization might be the driving force behind the increasing homophily within friendship dyads and peer groups in aggression and related behaviors across adolescence, it does not mean that friends and peers play no role in the development of aggression. Instead of influencing adolescents' aggressive behavior through a direct main effect, it is possible that friends and peers operate as moderators of genetic liability during adolescence, supporting or sometimes mitigating the expression of genetic dispositions that may have been kept in check until then through adult control. Although this proposition has not been tested in this study, it has been tested elsewhere. Specifically, evidence from genetically-informed studies uniformly suggests that genetic influences on aggressive and delinquent behavior are indeed amplified when adolescents affiliate with deviant peers. These findings, which reflect what is termed a gene x environment interaction (GxE), are observed with adolescent samples even when controlling for rGE (Button et al., 2007). They are also observed with children. For example, van Lier et al. (2007) found that kindergartners were most likely to display high levels of aggression if they were at high genetic risk for such behavior and, at the same time, were

exposed to highly aggressive friends. A follow-up study conducted with data collected in grade one (Brendgen et al., 2008) revealed that this GxE may only hold for the link between children's and friends' physical aggression but not relational aggression, a more insidious type of aggression that includes social exclusion or malicious gossiping. Instead, affiliation with relationally aggressive friends seemed to foster relational aggression independently of genetic effects on this behavior. In sum, friends may exert a strong moderating role at all ages even if they do not play a direct role at some ages. This proposition is in line with the *Social interactional* model (also referred to as the Social enhancement model) (Vitaro et al., 2001). According to this perspective, deviant friends are not necessary for aggressive children to become aggressive, but aggression is more likely to be expressed or maintained for those individuals who affiliate with aggressive peers.

Of note, all of the observed associations were found to be the same for males and females, using either individual or within-pair difference scores. While this result should be interpreted with caution given the relative small sample size, it is nevertheless in line with other studies who also found no differences in males and females in regard to antisocial friends' influence or the selection of antisocial friends (see Bukowski et al., 2015, for an overview).

Strengths, Limitations and Conclusions

The present study was the first to use a cross-lagged MZ twin design to examine whether friends' aggression predicted changes in participants' aggression using both individual and difference scores. Friends' aggression scores were based on teacher ratings or friends' self-reports and overlap in friends among twins from a same pair was kept to a minimum. This allowed us to show that the findings and their related conclusions can vary dramatically depending on whether rGE is controlled or not. The present study to examine this issue is also

the first to do so during a critical moment in youngsters' development, i.e., early adolescence, when peers become increasingly important while social control from adults diminishes. Despite these strengths, the present study is not without limitations. First, the number of items to assess friends' aggression was limited. Aggregating friends' scores on two aggression items nevertheless created sufficient variance to produce significant results in the context of individual scores. Second, a different informant was used to assess friends' and participants' aggression at age 10 and at age 13, which was an asset in terms of reducing shared method variance for concurrent and longitudinal associations. At the same time, however, the use of different sources may have underestimated cross-lagged associations between individuals and their friends. Third, although sufficient to produce significant findings in the context of individual scores, the sample size and hence statistical power was limited with respect to the examination of the moderating role of sex. In consequence, the lack of sex differences observed in the present study should be interpreted with caution. Finally, this study examined a specific time frame, i.e., from age 10 to age 13, and included only Canadian children, which limits the generalizability of the present findings.

In spite of these limitations, this study contributes to a growing literature suggesting that an individual's exposure to (non-shared) environmental factors such as friends' aggression may be influenced by this individual's genotype. It also supports the notion put forth by some authors that the contribution of friends' physical aggression towards an increase in participants' physical aggression may have been partly or totally overestimated in past studies because of non-controlled rGE (Scarr & McCartney, 1983; Vitaro et al., 2015). These tentative and challenging suggestions need of course to be replicated before any definite conclusion can be drawn in this regard.

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Table 1

Means, Standard Deviation and Distributional Properties of Study Variables as Individual Scores (first line, N = 402) and Within-pair Difference Scores (second line, N = 201)

	Mean	Standard Deviation	Skewness	Kurtosis
Age 10 Twins' Physical Aggression (range: 0-6; 3 items: 0,1,2)	.25 (.26) -.02	.45 (.42) .33	1.91 (1.19) -.16	3.15 (-.14) 3.47
Age 10 Friends' Physical Aggression (range: 0-4; 2 items: 0,1,2)	.17 (.22) .00	.29 (.35) .30	1.85 (1.12) -.49	3.29 (-.37) 1.45
Age 13 Twins' Physical Aggression (range: 0-18; 6 items: 0,1,2,3)	.65 (.44) -.03	1.15 (.67) 1.14	2.12 (1.11) 1.13	4.65 (-.17) 8.24
Age 13 Friends' Physical Aggression (range: 0-18; 6 items: 0,1,2,3)	.65 (.59) .01	.75 (.55) .38	1.11 (.22) .80	.52 (-1.36) 4.62

Note: For individual scores, twins' scores from the same pair have been averaged; square root transformed scores are presented in parentheses.

Table 2

Within-pair Correlations for MZ and same-sex DZ pairs in reference to Twins' and Friends'

Physical Aggression

Within-pair Correlations		
	MZ	DZ
Age 10 Twins' Physical Aggression	.68 ***	.41 ***
Age 10 Friends' Physical Aggression	.41 ***	.28 **
Age 13 Twins' Physical Aggression	.54 ***	.35 **
Age 13 Friends' Physical Aggression	.80***	.66***

** = $p < .01$, *** = $p < .001$; N = 201 MZ pairs and N = 150 same-sex DZ pairs

Table 3

Bivariate Correlations among Individual (Raw) Scores, Adjusting for Non Independence and Averaging across Twins, (below the diagonal) and among Within-Pair Difference Scores (above the diagonal)

Variables	1	2	3	4
1- Age 10 Twins' Physical Aggression		-.09	.24 **	-.03
2- Age 10 Friends' Physical Aggression	.25 **		-.09	.27 *
3- Age 13 Twins' Physical Aggression	.46**	.27 **		.10
4- Age 13 Friends' Physical Aggression	.01	.19*	.18*	

Note. * = $p < .05$, ** = $p < .01$; $N = 201$

Table 4

Parameter Estimates and Confidence Intervals for Cross-lagged Models Illustrated in Figures 1 and 2

Model	Coefficients	Estimate	SE	95% Confidence Intervals
Cross-lagged Model–				
Individual scores- Twin 1	Age10 Twin's PA → Age 13 Twin's PA	.41	.08	(.26, .57)
	Age 10 Friends' PA → Age 13 Twin's PA	.18	.09	(.01, .35)
	Age 10 Twin's PA → Age 13 Friends' PA	.04	.12	(-.19, .27)
	Age 10 Friends' PA → Age 13 Friends' PA	.38	.10	(.18, .57)
Cross-lagged Model–				
Individual scores- Twin 2	Age10 Twin's PA → Age 13 Twin's PA	.45	.07	(.31, .58)
	Age 10 Friends' PA → Age 13 Twin's PA	.19	.08	(.04, .34)
	Age 10 Twin's PA → Age 13 Friends' PA	.00	.11	(-.22, .22)
	Age 10 Friends' PA → Age 13 Friends' PA	.13	.11	(-.10, .35)
Cross-lagged Model-				
Within-Pair Differences	Age10 Diff Twins' PA → Age 13 Diff Twins' PA	.24	.09	(.07, .41)
	Age 10 Diff Friends' PA → Age 13 Diff Twins' PA	-.06	.09	(-.24, .12)
	Age 10 Diff Twins' PA → Age 13 Diff Friends' PA	.00	.16	(-.32, .32)
	Age 10 Diff Friends' PA → Age 13 Diff Friends' PA	.31	.13	(.06, .56)

CFI =	.92/.86
RMSEA =	.13/.09
SRMR =	.05/.07

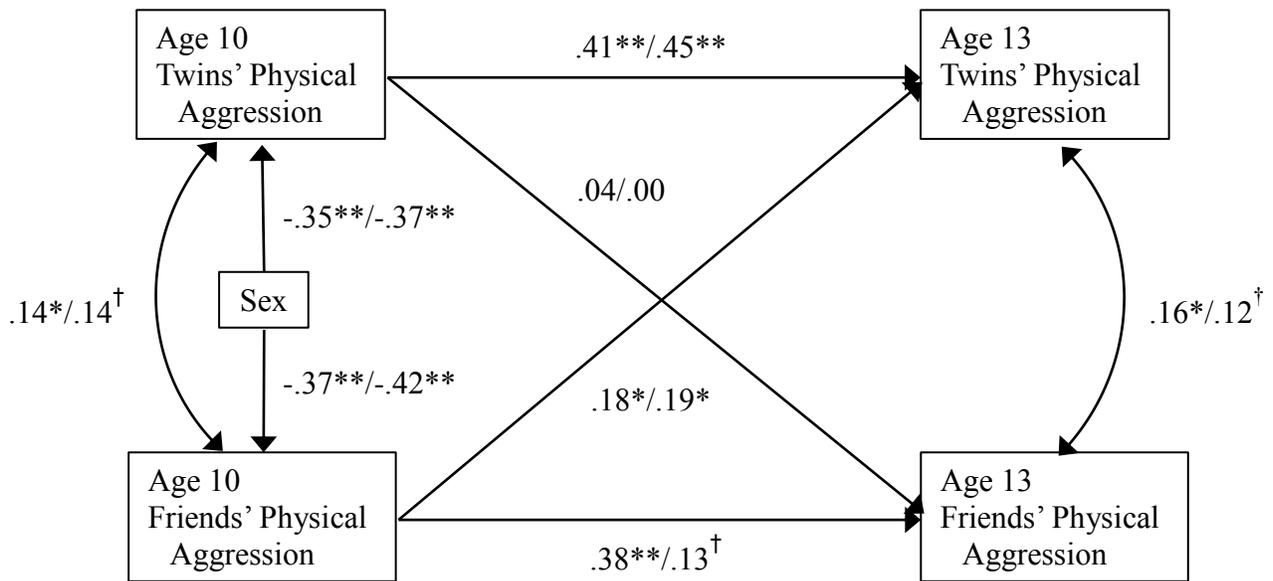


Figure 1. Results from the cross-lagged model using individual scores; the first parameter corresponds to twin 1 and the second to twin 2; z-standardized coefficients are reported

** : $p < .01$; * : $p < .05$; [†] : $p < .10$; $N = 201$

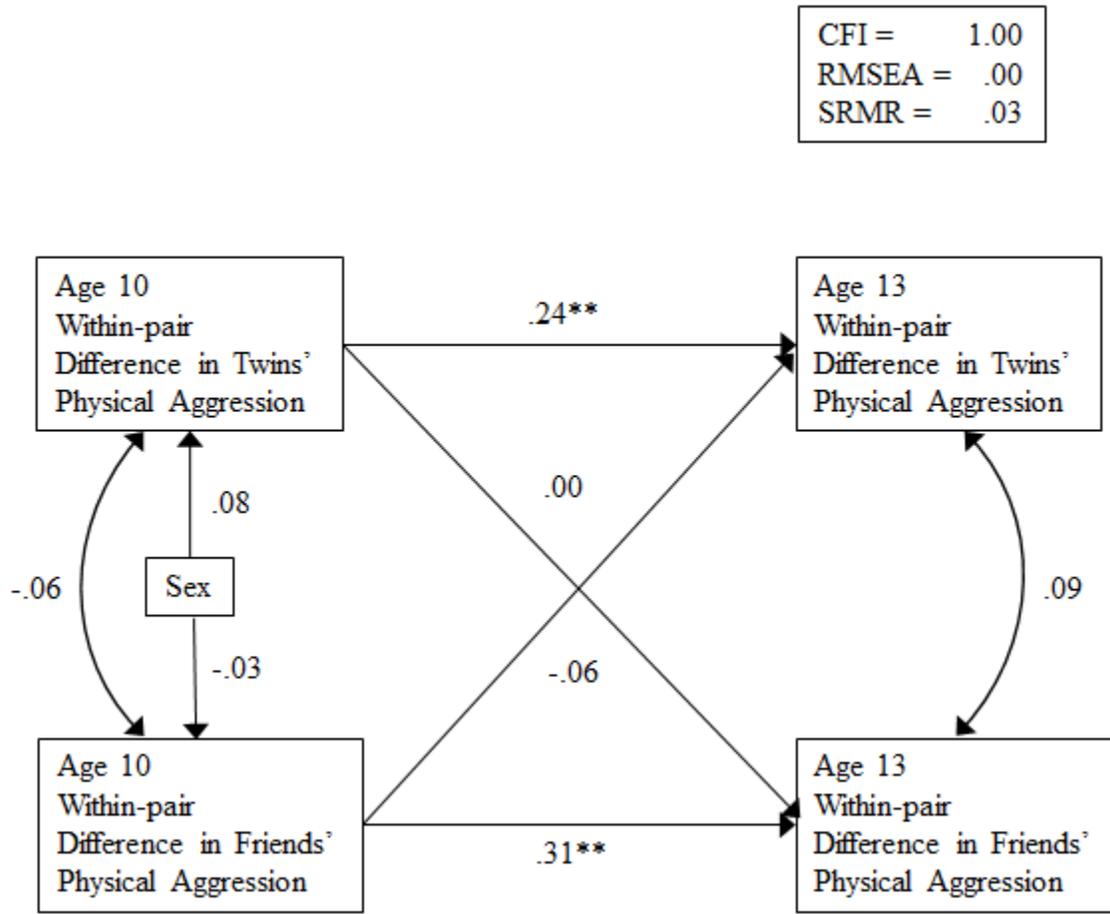


Figure 2. Results from the cross-lagged model using within-pair difference scores; z-standardized coefficients are reported

** : $p < .01$; * : $p < .05$; $N = 201$