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Gene-Environment Correlation Linking Aggression and Peer Victimization: Do Classroom Behavioral Norms Matter?

Mara Brendgen[1,2]

Alain Girard [2]

Frank Vitaro [2,3]

Ginette Dionne [4]

Michel Boivin [4]

[1]Department of Psychology, University of Quebec at Montreal, Montréal, Canada; [2]Ste-Justine Hospital Research Center, Montreal, Quebec, Canada; [3]School of Psycho-Education, University of Montreal, Montreal, Canada; [5]Department of Psychology, Laval University, Quebec City, Canada;

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

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Abstract

Using a genetically informed design based on 197 Monozygotic and Dizygotic twin pairs assessed in grade 4, this study examined 1) whether, in line with a gene-environment correlation (rGE), a genetic disposition for physical aggression or relational aggression puts children at risk of being victimized by their classmates, and 2) whether this rGE is moderated by classroom injunctive norm salience in regard to physical or relational aggression. Physical aggression and relational aggression, as well as injunctive classroom norm salience in regard to these behaviors, were measured via peer nominations. Peer victimization was measured via self-reports. Multi-Level Mixed modeling revealed that children with a genetic disposition for either aggressive behavior are at higher risk of being victimized by their peers only when classroom norms are unfavourable toward such behaviors. However, when classroom injunctive norms favor aggressive behaviors, a genetic disposition for physical or relational aggression may actually protect children against peer victimization. These results lend further support to the notion that bullying interventions must include the larger peer context instead of a sole focus on victims and bullies.

Keywords: Gene-environment correlation, physical aggression, relational aggression, peer victimization, injunctive classroom norms

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Peer victimization carries considerable risks for the victims' psychosocial development. Apart from school related difficulties and impaired physical health, victims have been found to suffer from increases in externalizing problems such aggression as well as internalizing problems such as anxiety and depression (Reijntjes, Kamphuis, Prinzie, & Telch, 2010). However, pre-existing behavior problems can also put children at risk of becoming victimized by peers (Reijntjes et al., 2010). While children who exhibit internalizing symptoms may be seen as "easy targets", it is externalizing behavior – particularly aggression – that has been consistently identified as one of the most important predictors of peer victimization (Reijntjes et al., 2011). Aggressive children may become victimized because their behavior is likely to irritate and provoke potential bullies, who may then feel that their harassment behavior is justified. Most studies that examined aggression as a risk factor of peer victimization have focused on physical aggression or a combined measure of verbal and physical aggression (Barker et al., 2008; Schwartz, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999). However, physical aggression tends to decline over the course of early and middle childhood, whereas relational aggression such as spreading malicious rumours or secrets, friendship withdrawal threats, or attempts to exclude others from the group increase with age (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; Vaillancourt, Miller, Fagbemi, Côté, & Tremblay, 2007). It is thus important to consider how these forms of aggression are related to peer victimization.

Few studies have examined the predictive association between relational aggression and peer victimization, with somewhat inconsistent findings. For instance, based on unlimited peer nominations of aggression and victimization in Columbian fifth and sixth graders, Velasquez and

colleagues (Velásquez, Santo, Saldarriaga, López, & Bukowski, 2010) found that high levels of both physical aggression and relational aggression were uniquely associated with concomitant high levels of generalized peer victimization (being treated badly, being called bad names). Different results were reported based on teacher reports of aggression and victimization in a longitudinal study of Japanese fourth and fifth graders (Kawabata, Crick, & Hamaguchi, 2010). Here, relational aggression was related to increased relational peer victimization 6 months later, but physical aggression tended to be related to decreases in relational peer victimization and none of the aggressive behaviors were related to change in physical peer victimization. Still other findings emerged from a study using observed aggression and teacher rated victimization among American preschoolers (Ostrov, 2008). Controlling for the respective other type of victimization, both physical and relational aggression predicted increased relational peer victimization six months later and none of the aggressive behaviors were related to change in physical peer victimization.

Methodological differences between the studies (i.e., differing sample ages and reporting sources or the use of cross-sectional versus longitudinal designs) may partly explain these diverging findings. However, it is also likely that the association of physical or relational aggression with peer victimization varies according to the behavioral norms that prevail in the peer group. Inconsistent findings may thus also have been partly due to cross-cultural differences in classroom norms between Colombia, Japan, and the U.S. As noted by Salmivalli and Voeten (2004), school classes represent one of the most salient peer group contexts during childhood and are therefore especially important for understanding how behavioral norms may affect children's risk of peer victimization. Two types of norms have been discussed that may influence behavior: descriptive norms and injunctive norms. According to Cialdini, Kallgren, and Reno (1991),

descriptive norms describe what most people do and are typically operationalized based on the prevalence of a behavior. In contrast, injunctive norms characterize what individuals are expected to do - irrespective of actual behavioral prevalence - and are operationalized based on the level of approval or disapproval of a behavior. Another important aspect refers to norm salience (i.e., the degree to which norms are made explicit to the group members). Norm salience can be made explicit through information (for descriptive norms) or through rewards, sanctions or the social standing of the individuals engaging in the behavior (for injunctive norms).

There is considerable variation between classrooms with respect to both the general prevalence of physical aggression and relational aggression and the level of acceptability of such behaviors (Henry et al., 2000; Mercer, McMillen, & DeRosier, 2009; Salmivalli & Voeten, 2004; Werner & Hill, 2010). Moreover, several studies found greater increases in both physical and relational aggression among children when descriptive or injunctive classroom norms favoured such behavior (Henry et al., 2000; Mercer et al., 2009; Werner & Hill, 2010). The norms–behavior association seems to be specific to the form of aggression, with relational aggression norms – but not physical aggression norms – predicting relational aggression, although the reverse prediction was not tested (Werner & Hill, 2010). While most studies investigated either descriptive or injunctive norms, evidence from one study examining the relative roles of descriptive versus injunctive norms revealed that it is not so much the descriptive norm of the classroom (i.e., the mean level of aggression in the classroom) that predicts aggressive behavior (Henry et al., 2000). Rather, aggressive behavior increases most in classrooms where the injunctive norm - particularly injunctive norm salience (defined as the classroom-specific correlation between aggressive behavior and peer social preference) – is favourable towards aggressive behavior.

In contrast to the investigation of main effects of norms on aggression, research investigating the moderating effect of group norms on the association between aggression and peer difficulties is rare. Examining play groups of first and third grade boys, Boivin and colleagues (Boivin, Dodge, & Coie, 1995) found that (reactive) generalized aggression was only associated with more peer rejection in groups where such behaviour was non-normative (based on descriptive norms). In contrast, no association between aggression and peer rejection was found in groups where such behaviour was highly normative. Only one study has specifically examined whether peer group norms moderate the association between physical and relational aggression, on the one hand, and peer victimization, on the other hand. Using self-report data from a sample of Columbian fifth and sixth graders, Velásquez and colleagues (Velásquez et al., 2010) found that both physical and relational aggression were significantly associated with higher levels of concurrent peer victimization. However, these associations were moderated by the peer groups' descriptive norms of physical and relational aggression. Specifically, the association between relational aggression and victimization was weaker when that type of aggression was normative in the peer group (i.e., in groups with high levels of relational aggression) than when it was non-normative (i.e., in groups with low levels of relational aggression). The same pattern was found for physical aggression. The directionality of effects between victimization and aggression could not be ascertained in that study, however. Moreover, it is unclear whether a similar moderating effect can be found for injunctive norms of aggressive behavior.

The Usefulness of a Genetically Informed Design

Most studies examining personal or environmental risk factors of peer victimization are based on a correlational design using one child per family. Such designs, however, cannot

provide a completely valid test of whether, for example, pre-existing aggression causes children to become victimized by their peers and whether classroom behavioral norms moderate this association. This limitation is true even for transactional longitudinal studies, which are typically considered the most stringent type of longitudinal correlational design for testing the directionality of association between two variables (Boivin, Petitclerc, Feng, & Barker, 2010). One alternative is the use of a genetically informed design, such as a behavioral genetic study based on twins. As argued by Moffit (2005), by disentangling genetic from non-genetic sources of inter-individual variance, behavioral genetic studies can provide a more comprehensive test of transactional processes between individual, potentially heritable characteristics and environmental experiences than correlational studies using singleton samples. She maintains that, although such designs cannot provide conclusive proof of causation, they offer notable advantages for testing developmental hypotheses concerning child effects (rGE) or environmental moderation effects (GxE). In the present study, such an analysis allows assessing whether heritable factors associated with aggressive behavior contribute to the risk of peer victimization and whether the effect of such a gene-environment correlation (rGE) varies depending on the behavioral norms in the child's peer context with respect to aggression.

To date, barely a handful of twin-based studies have examined potential rGE linking aggression and peer victimization. In the first published study (Ball et al., 2008) participants' aggressive behavior (i.e., being mean, threatening, teasing) and peer victimization (i.e., being the target of verbal, relational, or physical bullying) were evaluated by mothers and teachers at age 10. Genetic factors explained almost three quarters of the variance of peer victimization and a significant if modest part (i.e., 14%) of these genetic influences were those that also underlie aggressive behavior. Similar results were obtained with data from the present study

sample, based on children's self-reported peer victimization and peer nominated (combined verbal and physical) aggression at age 10, and using an ordinal index of genetic risk for aggression (Brendgen et al., 2011). Specifically, an elevated genetic risk for aggressive behavior was associated with a higher level of victimization by the peer group. These findings provide evidence for an "evocative" process whereby characteristics inherent in the child – in this case aggression – elicit or provoke negative treatment by the peer environment. However, these genetically informed studies did not distinguish between physical and relational forms of aggression as risk factors of peer victimization. It is also unclear whether peer norms moderate the rGE linking physical or relational aggression to peer victimization.

The Present Study

Using a classical twin design, the main goal of the present study was to examine 1) whether a genetic disposition for physical aggression or relational aggression, respectively, puts children at risk of being victimized by their classmates (rGE), and 2) whether this rGE is moderated by classroom injunctive norm salience in regard to physical or relational aggression, respectively. Based on the extant evidence reviewed above, we expected that a genetic disposition for either physical or relational aggression would be indirectly related to a higher level of peer victimization, via children's actual physically or relationally aggressive behaviour as intervening process, and that this indirect pathway would be moderated by classroom injunctive norm salience. Specifically, a genetic disposition for physical or relational aggression should be more strongly related to actual behavior when classroom norms favour aggressive behavior. In turn, however, aggressive behavior should be less strongly related to peer victimization when classroom norms favour aggression. We also tested whether the expected pattern of results differs between girls and boys. Physical aggression is more prevalent among

boys, whereas the opposite pattern has been found – albeit not always consistently - for girls (Card, Stucky, Sawalani, & Little, 2008). However, previous studies did not test or did not find any sex moderation in regard to the effect of norms on either type of aggression (Henry et al., 2000; Salmivalli & Voeten, 2004; Werner & Hill, 2010). No or inconsistent gender differences were also reported for the association of physical or relational aggression with peer victimization (Velásquez et al., 2010). Therefore, no hypotheses could be made regarding sex differences in the pattern of associations.

Methods

Sample

The 197 twin pairs (MZ males = 60, MZ females = 50, DZ males = 42, DZ females = 45) participating in this study were part of a population-based sample of 464 MZ and same-sex DZ twin pairs from the greater Montreal area who were recruited at birth between November 1995 and July 1998 (Boivin et al., 2010). 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), a DNA sample was evaluated with respect to 8-10 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. Supplemented with chorionicity data, the accuracy rate climbed to 96%, which is similar to rates obtained in older twin samples (Forget-Dubois et al., 2003). Eighty-seven percent of the families were of European descent, 3% were of African descent, 3% were of Asian descent, and 1% were Native North Americans. The remaining families did not provide ethnicity information. The demographic characteristics of the twin families were extremely similar to those of a representative sample of families with a 5-month old infant from a

population-based birth-cohort study initiated in 1998 by the Quebec Ministry of Health and Social Services (Jetté & Des Groseilliers, 2000), Ninety-five percent of parents lived together; 44% of twins were the first born children; 66% of mothers and 60% of fathers were between 25 and 34 years old; 17% of mothers and 14% of fathers had not finished high school; 28% of mothers and 27% of fathers held a university degree; 83% of the parents held an employment; 10% of the families received social welfare or unemployment insurance; 30% of the families had an annual income of less than $30,000.

The sample was followed longitudinally at 5, 18, 30, 48, and 60 months focusing on a variety of child-related and family-related characteristics. New data collections were completed when the children were in kindergarten, grade one, and grades three and four. The present paper describes findings from the grade four data collection (mean age = 10.04 years, *SD* = .26). Attrition in the sample was around 6% per year, such that 307 twin pairs participated in grade four. In the majority of twin pairs (i.e., 197 or 64.2%), the two twins did not attend the same classroom. For statistical analyses with twin samples, the same environmental variable (e.g., classroom norms) needs to be measured consistently either at the level of the individual twin (i.e., when the two twins of a pair were in different classrooms) or at the level of the pair (i.e., when the two twins of a pair were in the same classroom). Because in most cases the two twins of a pair were in different classrooms, only these pairs were included in the present study. No twin child from one pair went to the same class as any other twin child from another pair. The twin pairs in the final study sample did not differ from those who were lost through attrition in regard to family status, parental education or parents' age, although family revenue was higher in the remaining study sample. Moreover, a comparison in regard to mother-rated aggressive

behavior at ages 18 to 48 months revealed no differences between those included in the present study and those excluded.

Active written consent from the parents of the twins and of the twins' classmates was obtained. Data collection took place in the spring to ensure that the children knew each other. The instruments were approved by the Institutional Review Board and the school board administrators.

Measures

Physical and relational aggression. Peer nominations in each twin's classroom were used to assess the physical and relational aggression of each twin as well as of each of his or her respective classmates. Participation rate per class - based on active parental consent for each child - varied between 73% and 80%. A roster with the names of all children in a class with parental consent to participate was handed out to all participating children in the classroom. The children were then asked to nominate up to three classmates who best fit a specific behavioral descriptor. Two descriptors were used for *physical aggression* ("those who most often push and hit other children; those who fight most often with other children") and two others for *relational aggression* ("those who most often say to their friends mean things about other children; those who most often ask their friends not to play with the other children"). For each descriptor, the total number of received nominations was calculated for each child in the class and *z*-standardized within classroom to account for differences in classroom size. The *z*-standardized individual item scores were then averaged for each child and again z-standardized within classroom (r = .90 between the two physical aggression items and r = .61 for the two relational aggression items). Physical and relational aggression were positively correlated, r = .60, $p <$ .001. To account for this overlap, linear regressions were performed, using Hubert-White

Sandwich estimators to correct for data interdependence in the twin sample, to regress one type of aggression on the other. The residual Physical Aggression and Relational Aggression variables were used in all subsequent analyses and all results refer to the residual variables.

Classroom norms of physical and relational aggression. As in the study of Henry and colleagues (Henry et al., 2000), norm salience was operationalized as the extent to which each classroom made injunctive norms salient by virtue of higher peer rejection and lower peer popularity for aggressive children. During the sociometric procedure participants indicated the names of three classmates they most liked to play with (positive nominations) and three children they least liked to play with (negative nominations). The total number of received positive nominations was calculated for each participant and z-standardized within classroom to create a total Liked-Most-score (Coie, Dodge, & Coppotelli, 1982). Similarly, the total number of received negative nominations was calculated for each participant and z-standardized within classroom to create a total Liked-Least-score. The Liked-Most-score was subtracted from the Liked-Least-score to calculate a Peer Social Preference scale, which was again z-standardized within classroom. High levels on this scale indicate acceptance and low levels indicate rejection. Following Henry and colleagues (Henry et al., 2000), the level of *Injunctive norm salience for physical aggression* within a given classroom was indicated by the classroom-specific correlation coefficient between Peer Social Preference and (residual) Physical Aggression. Similarly, the level of *Injunctive norm salience for relational aggression* within a given classroom was indicated by the classroom-specific correlation coefficient between Peer Social Preference and (residual) Relational Aggression. Similar to the Henry et al. study, the average correlation showed that aggressive children were moderately rejected by peers (mean *r* across classrooms = -.35 for injunctive norm salience regarding physical aggression and mean *r* = -.33 for injunctive norm salience regarding

relational aggression), but there was considerable variability across classrooms (*rs* ranging from -.93 to .30 for physical aggression and from -.94 to .50 for relational aggression). Because only twins who were in a different classroom than their co-twin were included in the analyses, classroom norms were a 'child-level' variable like all other measured variables.

Peer Victimization of each twin was obtained via self-reports on items inspired by the Social Experiences Questionnaire (Crick & Bigbee, 1998). Based on the highest factor loadings reported by Crick and Bigbee (1998), we used four out of the five items from the Relational Victimization subscale and three out of the four items from the Overt Victimization subscale of the SEQ. We adapted some of the wording slightly to facilitate comprehension in our sample (e.g.,"During this school year, how many times has a child at your school…. called you names or said mean things to you?,… said mean things about you to other children? …., stopped you from playing with his or her group when you wanted to play?, …. pushed, hit or kicked you?". We also added a fourth overt victimization item to measure taxing: "…force you to give him or her something that belonged to you?"). Responses were given on a three-point scale from 0 (*never*) to 2 (*often*). Like the original SEQ subscales, overt and relational victimization were highly correlated ($r = .68$, $p < .001$) and item scores were therefore summed to a global peer victimization score (Alpha = .80, *Mean* = 5.4 *SD* = 3.4).

Analyses

SEM-Based Univariate ACE Analyses. As explained by Neale (2009), by comparing within-pair correlations for MZ twins (who are genetically identical) and same-sex DZ twins (who on average share only half of their genes), sources of variability of a measured variable (phenotype) can be estimated in terms of latent additive genetic effects (A), latent shared environmental effects (C), and latent nonshared environmental effects (E). Using the Mplus

software version 6.11, univariate Structural Equation Models (SEM) were fitted to the data to estimate the relative contribution of genetic, shared environmental and nonshared environmental factors to each variable. In SEM-based ACE models, within-twin pair correlations of the latent additive genetic factors (A) are fixed to 1.0 for MZ twins and to 0.5 for DZ twins. Within-pair correlations of the latent shared environmental factors (C) are fixed to 1.0 for both MZ and DZ twins. Within-pair correlations of the latent nonshared environmental factors (E) are fixed to 0.0 for both MZ and DZ twins. The squared path coefficients between the latent factors and the observed measures (i.e., parameters a^2, c^2, and e^2) represent partitions of variance of each phenotype, with measurement error included in e^2. Low and nonsignificant Log-Likelihood (LL) and χ^2 values and Root Mean Squared Error Approximation (RMSEA) values below .08 indicate good model fit.

Multi-Level Mixed-Effects Models. If the univariate genetic analyses show that not only children's physical aggression and relational aggression but also their level of victimization has some genetic basis, a possible gene-environment correlation (rGE) linking aggressive behavior to peer victimization can be tested. More specifically, it can be tested whether, via actual aggressive behaviour as intervening variable, a genetic disposition for physical aggression or relational aggression, respectively, puts children at risk of being victimized by their classmates. To this end, the factor scores of the latent genetic factors A and C derived from the previous SEM-based univariate ACE models can be saved in Mplus and then used as predictors in the subsequent Multi-Level Mixed-Effects models predicting to peer victimization (McArdle & Prescott, 2005; Rabe-Hesketh, Skrondal, & Gjessing, 2008). Because twins are clustered within a family (pair) and thus form a natural two-level hierarchy, ACE modeling using multi-level mixed effects

models treats the response of each twin as a different unit (level 1) nested within a pair (level 2). The specification of the ACE model can thus be written as:

$$Y_{fi} = \mu + w_f^{AC} A_f^C + w_{f1}^{AU} A_{f1}^U + w_{f2}^{AU} A_{f2}^U + S_f + E_{fi} .$$

where Y_{fi} is the observed phenotype of the *i*th individual in the *f*th family, and μ is a fixed effect representing the phenotypic mean. The random effects S_f and E_{fi} represent the shared environmental component and the nonshared environmental component, respectively, of the phenotype, such that $Var(S_f) = c^2$ and $Var(E_{fi}) = e^2$. The additive genetic effect is separated into two random effects: (1) A_f^C is common for twins of the same pair and (2) A_{f1}^U is unique to the individual, with $(w_f^{AC})^2 Var(A_f^C) + (w_{f1}^{AU})^2 Var(A_{f1}^U) + (w_{f2}^{AU})^2 Var(A_{f2}^U) = a^2$.

The weights (*w*) are fixed at values that indicate the proportion of genetic similarity between the two twins. Since MZ twins are genetically identical, there are only common genetic effects in these twin pairs, such that $w_f^{AC} = 1$ and $w_{f1}^{AU} = 0$. In contrast, DZ twins share on average 50% of their genes, such that $w_f^{AC} = \sqrt{.5}$, $w_{f1}^{AU} = \sqrt{.5}$ and $w_{f2}^{AU} = 0$ (or $w_{f1}^{AU} = 0$ and $w_{f2}^{AU} = \sqrt{.5}$). One advantage of mixed models is that they can easily accommodate main effects and interaction effects of multiple measured predictor variables and allow examining successively more complex models in the same way as standard hierarchical regression.

Multilevel Mixed models were estimated using SPSS version 20. Two series of consecutive models of increasing complexity were estimated. The first series tested associations between physical aggression and peer victimization and the second series tested associations between relational aggression and peer victimization. Before including any predictor variables, the basic ACE model of the main outcome (peer victimization) was estimated, i.e., without including any measured predictors. Because the C parameter for peer victimization was

estimated to be zero both in the SEM-based ACE models and in the Multilevel ACE models, a more parsimonious model (AE) was used as the baseline model for subsequent model tests. Next, child-level measured predictors (i.e., child sex, genetic risk for physical or relational aggression, actual physical or relational aggression, injunctive norms for physical or relational aggression, and interactions between these variables) were entered as fixed (level 1) effects. To facilitate interpretability of effects and reduce multicollinearity, all predictor variables except sex were centered via z-standardization prior to creating interaction terms. Each subsequent model was compared to the preceding one to evaluate whether the inclusion of additional predictors provided a better fit to the data. Nested models were compared using the Aikaike Information criterion (AIC) and the Bayesian Information criterion (BIC) as well as a Likelihood ratio test, which is comparable to a chi-square difference test. Sex moderation of main and interaction effects was tested in all models, but none was found. For the sake of parsimony, these analyses are not presented here.

Results

Preliminary Correlation Analyses

The MZ and DZ intra-pair correlations and the bivariate correlations of the study variables, derived from a multivariate within twin-pair correlation matrix, are presented in Table 1. As can be seen, MZ twins were more similar than DZ twins in regard to peer victimization, physical and relational aggression, but no intrapair similarity was observed for injunctive classroom norms for either MZ or DZ twins. Girls were less often victimized than boys (r = -.24, p < .001), and the former were also less physically aggressive but more relationally aggressive than the latter (r = -.50, p < .001 for physical aggression and r = .22, p < .001 for relational aggression). Higher levels of either type of aggression were associated with higher levels of peer victimization (r =

.23, $p < .001$ for physical aggression and $r = .10$, $p = .05$ for relational aggression). In contrast, aggression norms were not correlated with either of the respective aggressive behaviors or with peer victimization.

Univariate Genetic Analyses

The univariate SEM-based ACE analyses (see Table 2) showed that genetic factors explained 45% and nonshared environmental factors explained 55% of the variance of peer victimization, whereas the contribution of shared environmental factors was estimated to be zero. A similar pattern was found for relational aggression, with genetic factors explaining 31% and nonshared environmental factors explaining 69% of the variance, with the contribution of shared environmental factors estimated to be zero. For physical aggression, genetic factors explained 25% of the variance, shared environmental factors explained 23% and nonshared environmental factors explained the remaining variance. Aggression norms represented nonshared environmental influences unique to each child.

Multi-Level Mixed-Effects Model: Physical Aggression and Peer Victimization

The first series of mixed models examined whether genetic risk for physical aggression – via actual physical aggression as intervening variable – would predict peer victimization and whether this indirect association would be moderated by classroom injunctive norm salience for physical aggression. To this end, we first tested the association of the main predictor (genetic risk for physical aggression) and of the intervening variable (actual physical aggression) with peer victimization as well as potential moderating effects of classroom injunctive norm salience for physical aggression in this context (see Table 3). Because the SEM-based univariate ACE models had shown a significant shared environmental contribution to physical aggression, shared

environmental risk for physical aggression was also included as a control variable in the regression analysis.

The results from the first model step showed that girls were less victimized than boys, b = -.26, p = .06, but neither genetic nor shared environmental risk for physical aggression had a significant main effect on peer victimization. Actual physical aggression (entered on step 2) or injunctive norm salience for physical aggression (entered on step 3) also had no significant main effects. Moreover, neither genetic nor shared environmental risk for physical aggression interacted with injunctive norm salience in predicting peer victimization (step 4). However, the effect of actual physical behavior on peer victimization was moderated by injunctive norm salience for physical aggression, b = -.22, p = .05. To probe this interaction, the effect of actual physical behavior on peer victimization was examined at different levels of the moderator. This was achieved through rescaling of the moderator and repeating the Mixed Model regression analyses using the rescaled moderator values (for details, see Holmbeck, 2002). Because injunctive classroom norms were on a continuous z-standardized scale, values representing moderate (±1SD) and extreme (±2SD) levels of the moderator were used for that purpose. The results revealed revealed that higher levels of physical aggression were related to more peer victimization when injunctive norms were moderately (-1 SD) and highly (-2 SD) unfavourable towards physical aggression, (b = .13, p = .32; b = .34, p = .11, respectively), although none of the estimates reached statistical significance. In contrast, higher levels of physical aggression were related to more peer victimization when injunctive norms were moderately (+1SD) and highly (+2 SD) favourable towards physical aggression (b = -.29, p = .10; b = -.51, p = .05, respectively).

We also tested whether the effect of the main predictor (genetic risk for physical aggression) on the intervening variable (actual physical aggression) would be moderated by classroom injunctive norm salience for physical aggression. This test was done while controlling for a possible interaction between shared environmental risk for physical aggression and injunctive norm salience for physical aggression. Results showed a significant interaction between genetic risk for physical aggression and injunctive norms for physical aggression, b = .15, p = .05. Probing of this interaction using the same rationale as described above revealed a somewhat stronger relation between genetic risk for physical aggression and actual physical aggression when injunctive norms were moderately (+1SD) and highly (+2 SD) favourable towards physical aggression (b = 1.26, $p < .001$; b = 1.41, $p < .001$, respectively) than when injunctive norms were moderately (-1 SD) or highly (-2 SD) unfavourable towards physical aggression (b = .96, $p < .001$; b = .81, $p < .001$, respectively).

Finally, we examined the indirect effect of genetic risk for physical aggression on peer victimization via actual physical aggression as the intervening variable. Indirect effects were estimated using the classical product of coefficients approach (Hayes, 2009; Mathieu & Taylor, 2006), i.e., the multiplicative term of a (the effect of genetic risk on physical aggression) and b (the effect of physical aggression on victimization). Because the previous results had shown that both coefficients constituting the multiplicative term were moderated by classroom injunctive norms, we followed the recommendation by Hayes (2009) and estimated the indirect effect conditional on different levels of the moderator (i.e., classroom norms). The coefficients constituting the multiplicative term $a*b$ at different levels of the moderator (i.e., at ±1SD and ±2SD of injunctive classroom norms) were derived from the previously described interaction probes. The results showed an increasingly negative indirect effect of genetic risk for physical

aggression on peer victimization via actual physical aggression when injunctive norms were moderately (+1 SD) and highly (+2 SD) favourable towards physical aggression (b = -.38, p = .10; b = -.73, p = .07, respectively). In contrast, there was an increasingly positive indirect effect of genetic risk for physical aggression on peer victimization via actual physical aggression when injunctive norms were moderately (-1 SD) and highly (-2 SD) unfavourable towards physical aggression, (b = .13, p = .32; b = .28, p = .13, respectively), although none of the estimates reached statistical significance. Notably, for an indirect effects model, the product $a*b$ has a straightforward interpretation as the amount by which peer victimization is expected to increase indirectly through actual aggression per unit change in genetic risk for aggression (Preacher & Kelley, 2011). Because all variables involved in the indirect effect were z-standardized, indirect effect coefficients can thus be interpreted as standardized effect sizes. A graphical illustration of the moderated indirect effect is shown in the upper half of Figure 1.

Multi-Level Mixed-Effects Model: Relational Aggression and Peer Victimization

The second series of mixed models examined whether genetic risk for relational aggression – via actual relational aggression as the intervening variable – would predict peer victimization and whether this indirect association would be moderated by classroom injunctive norm salience for relational aggression. To this end, we first tested the association of the main predictor (genetic risk for relational aggression) and of the intervening variable (actual relational aggression) with peer victimization as well as potential moderating effects of classroom injunctive norm salience for relational aggression in this context (see Table 4). Contrary to physical aggression, the univariate SEM-based ACE models had shown no shared environmental contribution to relational aggression and therefore no shared environmental risk for relational aggression could be included in the regression analysis. The results from the first model step

showed that girls were less victimized than boys, b = -.57, p <.001, and that children with a higher genetic risk for relational aggression were more victimized than children with a lower genetic risk, b = .17, p < .001. Neither actual relational aggression nor injunctive norm salience for relational aggression (entered on steps 2 and 3, respectively) had a significant main effect on peer victimization. However, results from step 4 showed that the effect of actual relational aggression on peer victimization was moderated by injunctive norm salience for relational aggression, b = -.25, p = .02. Probing of this interaction revealed that, similar to what was found for physical aggression, higher levels of actual relational aggression were related to higher levels of peer victimization when injunctive norms were moderately (-1 SD) and highly (-2 SD) unfavourable towards relational aggression (b = .33, p = .01; b = .58, p = .01, respectively). In contrast, higher levels of actual relational aggression were related to lower levels of peer victimization when injunctive norms were moderately (+1 SD) and highly (+2 SD) favourable towards relational aggression, (b = -.16, p = .21; b = -.41, p = .06, respectively), although none of the estimates reached statistical significance.

We also examined whether the effect of the main predictor (genetic risk for relational aggression) on the intervening variable (actual relational aggression) would be moderated by classroom injunctive norm salience for relational aggression. Results showed a main effect of genetic risk for relational aggression, b = .86, p < .001, but no moderation by injunctive norms for relational aggression, b = .02, p = .47. Because the coefficient associated with the interaction effect between injunctive norms and generic risk was close to zero, this finding is unlikely to merely result from low statistical power.

Finally, we examined the indirect effect of genetic risk for relational aggression on peer victimization –via actual relational aggression as the intervening variable – at ±1SD and ±2SD of

injunctive classroom norms for relational aggression. The indirect effects were calculated based on the multiplicative term of *a* (the effect of genetic risk for relational aggression on actual relational aggression) and *b* (the effect of genetic risk for relational aggression on peer victimization). Because the previous results had shown that one of the coefficients constituting the multiplicative term (i.e., the effect of genetic risk for relational aggression on peer victimization) was moderated by classroom injunctive norms, we estimated the indirect effect conditional on different levels of the moderator (i.e., classroom norms). To this end, coefficient *a* was derived from the previously described mixed model regression of relational aggression on genetic risk for relational aggression. Coefficient *b* was derived from the previously described interaction probes of the effect of relational aggression on peer victimization at ±1SD and ±2SD of injunctive classroom norms. The results showed an increasingly negative indirect effect of genetic risk for relational aggression on peer victimization via actual relational aggression when injunctive norms were moderately (+1 SD) and highly (+2 SD) favourable towards relational aggression, (b = -.14, p = .21; b = -.35, p = .06, respectively), although none of the estimates reached statistical significance. In contrast, there was an increasingly positive indirect effect of genetic risk for relational aggression on peer victimization via actual relational aggression when injunctive norms were moderately (-1 SD) and highly (-2 SD) unfavourable towards relational aggression (b = .29, p = .01; b = .50, p = .01, respectively). A graphical illustration of the moderated indirect effect is shown in the lower half of Figure 1.

Discussion

The present study examined 1) whether, in line with a gene-environment correlation (rGE), a genetic disposition for physical aggression or relational aggression puts children at risk of being victimized by classmates, and 2) whether this rGE is moderated by classroom injunctive

norm salience regarding physical or relational aggression. As expected, children with a stronger genetic disposition for either type of aggression were more likely to behave aggressively and – at least in the case of physical aggression – even more so when classroom injunctive norms favoured such behavior. Indeed, similar to previous findings (Henry et al., 2000), classrooms varied considerably in terms of the acceptability of physical and relational aggression. Although on average such behaviors were met with disapproval and rejection, some classrooms conferred a very high social status to aggressive children. This is in line with findings that especially in older children aggressive behavior is sometimes admired and may be successfully used to gain or maintain a central position in the peer group (Cillessen & Mayeux, 2004). Our result that a genetic disposition for physical aggression was more likely to be expressed when such behavior was socially rewarded concords with findings from non-genetically informed research showing increased (general) aggression when injunctive classroom norms favour such behavior (Henry et al., 2000). We did not find a similar moderating effect of injunctive norms in regard to the expression of genetic risk for relational aggression, however, which was expressed even when injunctive norms were unfavourable. For most children, physical aggression peaks in toddlerhood and shows a steady decline thereafter, whereas relational aggression tends to increase over the course of early and middle childhood (Côté et al., 2006; Vaillancourt et al., 2007). Moreover, physical aggression usually entails negative sanctions especially from adults and has been shown to be the strongest predictor of severe verbal reprimands from teachers (Brendgen, Wanner, & Vitaro, 2006). Children with a genetic disposition for physical aggression may thus be more likely to express this trait when they are certain to reap some social benefits such as a high status in the peer group. In contrast, relational aggression involves circuitous behaviors such as the spreading of vicious rumours about the victim that often make it difficult to

identify and punish the initiator. Adults also intervene less often against children's relational aggression (Werner, Senich, & Przepyszny, 2006). Children with a genetic disposition for relational aggression may thus more readily use this behavior for social gains irrespective of the social norms in their peer group.

More central to the main goal of the present study, injunctive classroom norms determined whether the expression of a genetic disposition for physical or relational aggression puts children at risk of peer victimization. As expected, children with a genetic disposition for aggression were at increased risk of being victimized only when such behavior was sanctioned by the peer group. These results applied to both physical and relational aggression, but the indirect effect only reached statistical significance for the latter. Perhaps classmates are more hesitant to ridicule or provoke a physically aggressive child, even if they strongly disapprove of such behavior, for fear of eliciting violent revenge. Peers' avoidance of further physical harm may also explain, at least in part, why children with a genetic disposition for physical aggression were *less* likely to be victimized than others in classrooms where physical aggression was related to a high social status. High status children's aggressive behavior may be readily imitated by others (Dijkstra, Lindenberg, & Veenstra, 2008) and peers attempting to ridicule or otherwise provoke a physically aggressive child in such a social context may quickly end up in a highly physically vulnerable position themselves. Although less pronounced, a similar pattern was found for relational aggression. While their high social status may confer protection against victimization to a certain degree, relationally aggressive children might nevertheless appear to be somewhat easier targets for (potentially retaliatory) attacks than physically aggressive children. Still, in light of the overall similarity of results found for physical aggression and relational

aggression, these slight differences in effect size need to be interpreted with caution and are likely a matter of degree.

Overall, our findings are highly concordant with those reported by Velásquez and colleagues (Velásquez et al., 2010) with respect to the moderating effect of descriptive classroom norms on the association of physical and relational aggression, respectively, with concurrent peer victimization. Our results suggest that a similar, yet even more pronounced pattern emerges when considering injunctive norm salience. Indeed, Velasquez and colleagues found that a high prevalence of aggression in a class merely attenuates aggressive children's risk of being victimized, but our findings suggest that the expression of a genetic disposition for physical or relational aggression may actually convey protection against peer victimization in classrooms where such behavior is held in high esteem. The fact that these findings applied equally to girls and boys is consistent with other studies showing that behavior norms affect both genders similarly despite differences in the prevalence of the two forms of aggression (Henry et al., 2000; Salmivalli & Voeten, 2004; Velásquez et al., 2010; Werner & Hill, 2010).

Strengths, Limitations and Conclusion

The present study is the first to show that, while the expression of an inherent disposition for physical or relational aggression is fostered by norms that favour such behaviors, increased expression of either type of aggression may in turn lead to a reduced risk of peer victimization under these conditions. The present research thus extends and qualifies previous genetically informed studies showing that a genetic disposition for aggression puts children at risk of in turn being bullied by others (Ball et al., 2008; Brendgen et al., 2011). Apart from its genetically informed design, a major strength of the present study is that our measure of injunctive norm salience was based on the acceptability of each form of aggression based on its correlation with

social preference within a given class. Such data are rarely available in twin studies. A further asset is the use of different reporting sources for different variables (i.e., peer nominations, self-reports) to reduce shared source variance.

In addition to these strengths, the present study also has several limitations. One limitation concerns the cross-sectional nature of the data. Ideally, a short-term longitudinal design covering the same school year should be employed to examine the role of peer group norms in the link between genetic vulnerability for aggressive behavior and peer victimization. However, most twins of a pair were not in the same class and budget limitations did not allow us to make repeated assessments of the 504 participating classrooms. Moreover, the use of genetic risk for aggression as the main predictor of peer victimization allows a more conclusive interpretation of the direction of effects than correlational studies based on singleton designs (Moffitt, 2005). As previously mentioned, such gene-environment correlations reflect the child's effects on his or her environment (and not the reverse) insofar as heritable personal characteristics such as a disposition for physical or relational aggression may shape environmental experiences such as peer victimization. Another limitation relates to the fact that we could not compare the relative role of descriptive and injunctive norms as moderators of the rGE linking aggression with peer victimization. Peer nominations of aggression do not provide information about absolute levels of such behavior but no other sources of information were available for all the children in a given twin child's class. However, findings by Henry and colleagues suggest that children's behavior is influenced by the acceptability of a behavior (i.e., injunctive norms) rather than by the average level of that behavior (i.e., descriptive norms) in their class (Henry et al., 2000).

The sole use of self-reports of peer victimization constitutes another limitation of our study. Since injunctive classroom norms of aggressive behavior and actual aggressive behavior were necessarily based on peer nominations, the choice of self-reports for peer victimization was motivated by a concern to reduce mono-rater bias. However, like peer reports, self-reports of peer difficulties can be subject to perception bias (Gromann, Goossens, & Krabbendam, 2011; Hymel, Wagner, & Butler, 1990). If sufficient convergence between reporters can be achieved, future studies may consider using multiple reporters of peer victimization (i.e., peer and self-reports). In a related vein, the limited number of self-reported peer victimization items available made examinations of physical and relational subtypes of victimization unfeasible. While predictions to specific subtypes of victimization were beyond the scope of the present study, future research may examine whether the observed interaction between genetic dispositions and group norms are specific to certain subtypes of peer victimization. The use of a 3-point response scale for victimization, motivated by time constraints, may also have reduced variability to some extent and thus limited statistical power. A related, further limitation is the relatively small sample size, which was in part due to the fact that twin pairs where both members attended the same classroom had to be excluded from analyses to ensure consistency in classroom information as a child-level variable for the multi-level regression analyses. Although the final sample did not seem overly biased and sufficiently large to detect interaction effects, statistical power was sometimes too low to yield statistically significant coefficients when probing the significant interactions, although moderate to large effect sizes were observed. Future studies thus need to replicate the present findings with larger samples. Larger samples will also allow more stringent tests of potential sex differences in regard to the interactive effects between genetic risk and group norms. Replication is also important in order to examine the

generalizability of our findings. Because a) the sociodemographic characteristics of the twin sample were highly comparable to those of a sample of children from a population-based representative birth-cohort study in the province of Québec, and b) the twin families were distributed across all administrative districts surrounding and within the Greater Montreal area, we might expect that the sampled schools and classrooms are also largely representative of the population residing therein. Nevertheless, our findings may not generalize to other populations or settings, including other ethnic groups, other Canadian provinces or other countries. Similarly, our findings may not generalize to children with clinical levels of aggression or beyond the assessed age group.

Despite these limitations, this study offers new insights into the role of group norms in the link between peer victimization and child adjustment. While children with a genetic disposition for either aggressive behavior are at higher risk of being victimized by their peers in some social environments, the same characteristics may offer some protection against victimization in other social environments. Thus, our study lends further support to current perspectives on bullying intervention that include the larger peer context instead of a sole focus on victims and bullies (Rivers, Duncan, & Besag, 2007; Salmivalli, 2010). Intervention efforts that incorporate a "whole-school" approach may be most effective, as both a positive teacher-child relationship and teachers' prompt response to hearing about or witnessing aggression have been linked to injunctive norms that disfavour aggression in the peer group and to reduced aggression among students (Elsaesser, Gorman-Smith, & Henry, 2013). These efforts also need to include parents, as parental attitudes about and responses to aggression as well as parental involvement with their child moderate the effect of injunctive peer norms on aggressive behavior (Farrell, Henry, Mays, & Schoeny, 2011). Because our findings suggest that aggression is both

positively (through a high social status) and negatively (through protection against victimization) reinforced in groups that favour aggression, the involvement of all agents within a child's proximal social environment will be necessary to break the cycle of violence in such classroom contexts.

Table 1

Bivariate Correlations and Within-Pair Correlations of the Study Variables

	Bivariate Correlations					
	1	2	3	4	5	6
1. Peer Victimization	--					
2. Physical Aggression	0.23***	--				
3. Relational Aggression	.10***	-0.53***	--			
4. Physical Aggression Norm	-0.08	0.02	-0.04	--		
5. Relational Aggression Norm	.05	0.05	-0.04	-.26***	--	
6. Child Sex	-0.24***	-0.50***	0.22***	0.03	-0.01	--
	Within-pair Correlations					
MZ-twin pairs	.45***	.49***	.34***	-.04	-.21	--
DZ-twin pairs	.19	.35***	.09	.05	-.15	--

Note. Correlations are derived from a multivariate within twin-pair correlation matrix, * = $p < .05$, ** = $p < .01$, *** = $p < .001$; Child sex is coded such that 1 indicates girls and 0 indicates boys. Physical aggression and relational aggression refer to residual variables where the overlap with the respective other type of aggression is controlled. Similarly, physical aggression norm and relational aggression norm refer to residual variables where the overlap with the norm regarding the other type of aggression is controlled.

Table 2

Univariate Model Results from SEM-based ACE Modeling

	A	C	E	%A^2	%C^2	%E^2	RMSEA	LL	p
Peer Victimization	.66 (.53; .80)	.00 (-1.14; 1.14)	.74 (.64; .83)	45	0	55	.00	-501.985	.692
Physical Aggression	.50 (.04; .96)	.48 (.07; .89)	.72 (.62; .82)	25	23	52	.00	-499.71	.939
Relational Aggression	.56 (.40; .72)	.00 (-1.21; 1.21)	.83 (.72; .93)	31	0	69	.05	-510.75	.166
Physical Aggression Norm	.00 (-.96; .96)	.09 (-.78; .95)	.99 (.89; 1.10)	0	1	99	.08	-517.13	.024
Relational Aggression Norm	.00 (-.29; .29)	.00 (-.26; .26)	1 (.92; 1.07)	0	0	100	.03	-516.55	.018

Note. Physical aggression and relational aggression refer to residual variables where the overlap with the respective other type of aggression is controlled. Similarly, physical aggression norm and relational aggression norm refer to residual variables where the overlap with the norm regarding the other type of aggression is controlled.

Table 3

Multi-Level Mixed Model Results with Physical Aggression as a Predictor of Peer Victimization

Model Step	Effects	Estimate (se)	A^2 (se)	E^2 (se)	-2 Log-likelihood	AIC	BIC
Baseline (AE)			.44 (.09)	.55 (.07)	995.5	1001.5	1013.1
1			.32 (.09)	.58 (.08)	971.4	983.4	1006.8
	Child Sex	-.26 (.14)					
	Genetic Risk for Physical Aggression	.09 (.16)					
	Shared Environmental Risk for Physical Aggression	.11 (.17)					
2			.32 (.09)	.58 (.08)	971.1	985.1	1012.3
	Physical Aggression	-.06 (.10)					
3			.31 (.09)	.58 (.08)	969.8	985.7	1016.9
	Physical Aggression Norm	-.05 (.05)					
4			.31 (.09)	.57 (.08)	963.2	985.2	1027.9
	Genetic Risk X Phys. Agg. Norm	.05 (.24)					
	Shared Env. Risk X Phys. Agg. Norm	.08 (.20)					
	Physical Aggression X Phys. Agg. Norm	-.22* (.11)					

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Physical aggression refers to a residual variable where the overlap with relational aggression is controlled. Similarly, physical aggression norm refers to a residual variable where the overlap with the norm regarding relational aggression is controlled.

Table 4

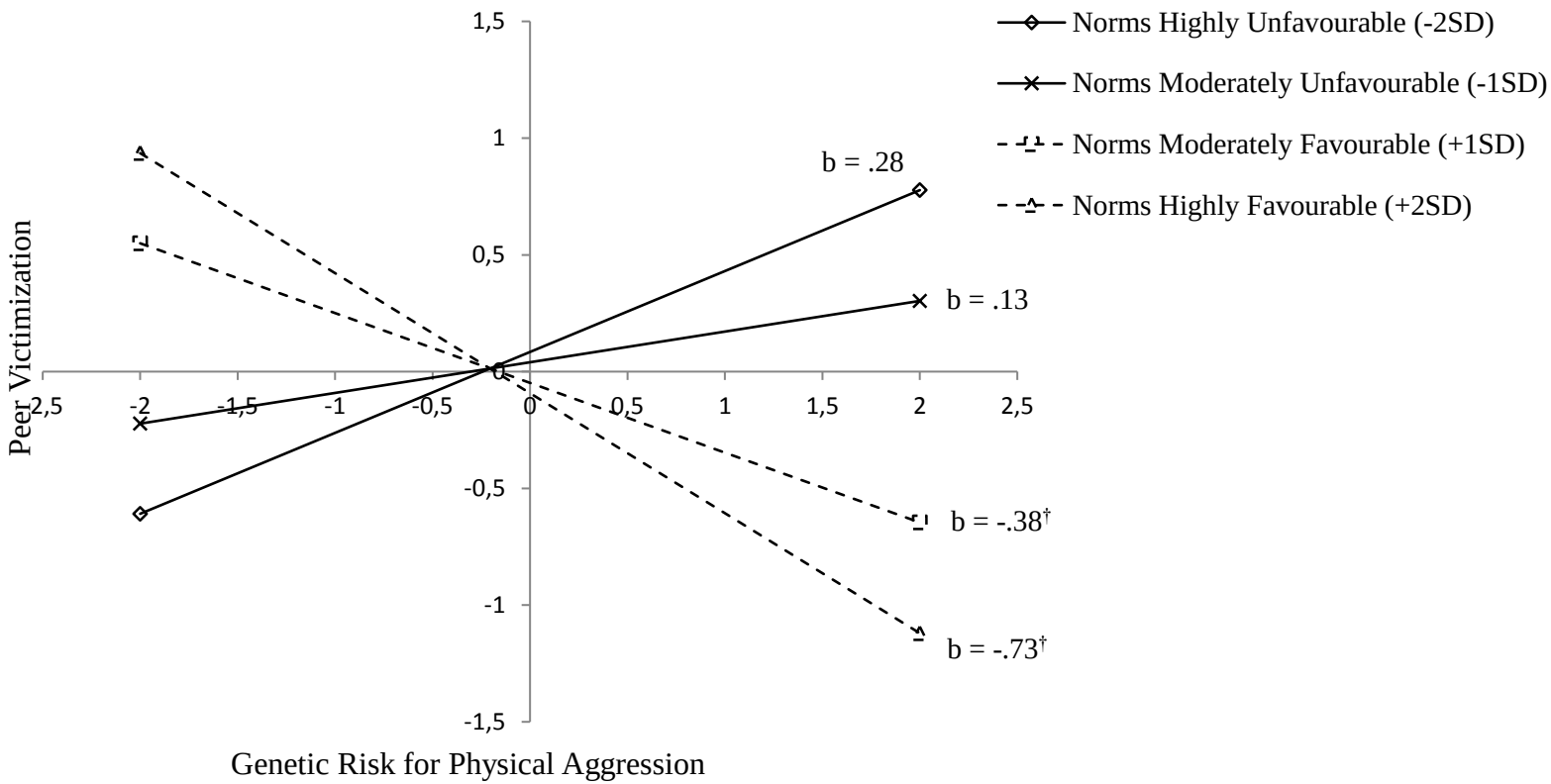
Multi-Level Mixed Model Results with Relational Aggression as a Predictor of Peer Victimization

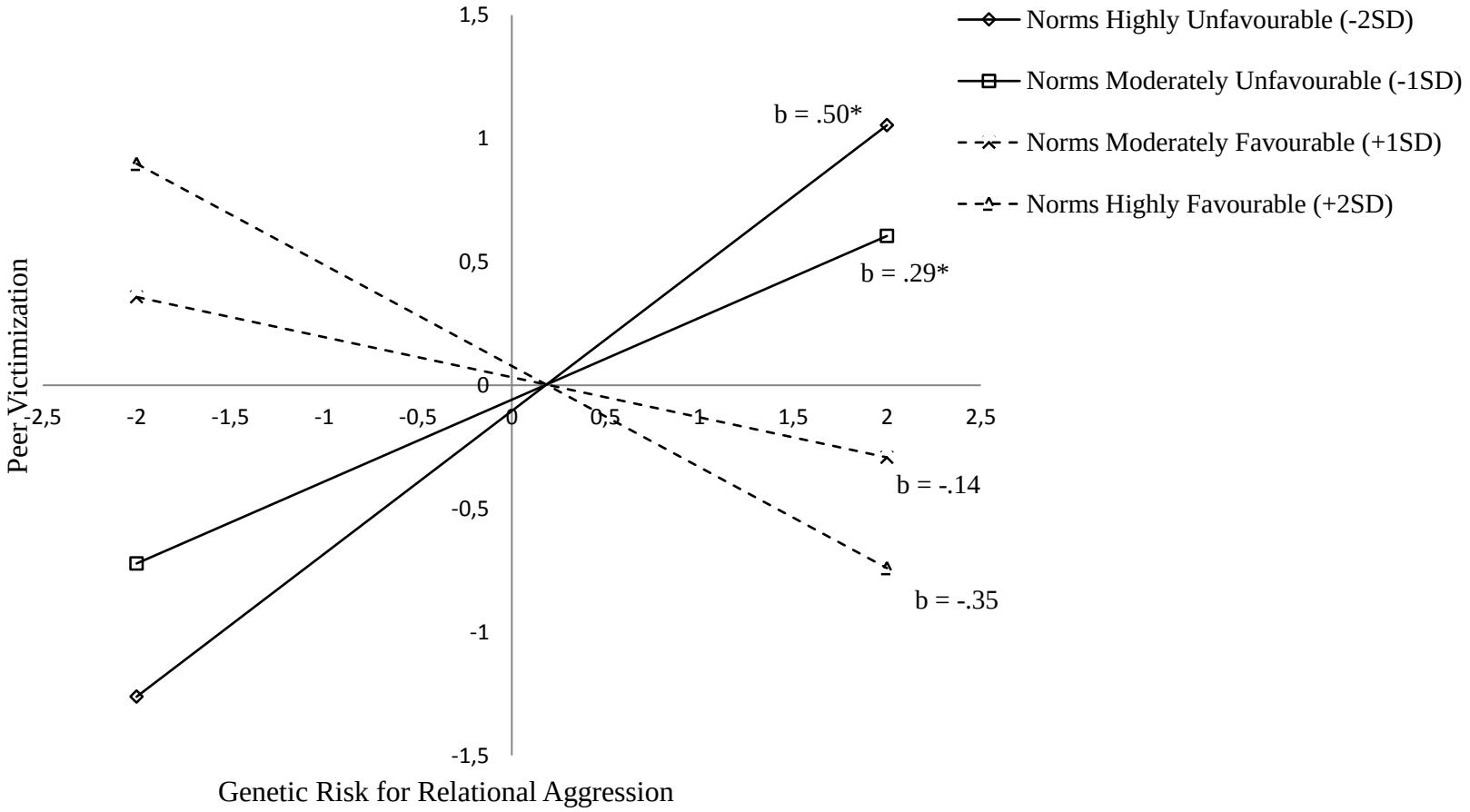
Model Step	Effects (se)	Estimate (se)	A^2 (se)	E^2 (se)	-2 Log-likelihood	AIC	BIC
Baseline (AE)			.44 (.09)	.54 (.07)	1004.0	1010.0	1021.7
1			.35 (.08)	.55 (.07)	977.9	987.9	1007.4
	Child Sex	-.57*** (.12)					
	Genetic Risk for Relational Aggression	.17*** (.06)					
2			.35 (.08)	.55 (.07)	977.3	989.3	1012.7
	Relational Aggression	.06 (.08)					
3			.34 (.08)	.55 (.07)	976.3	990.3	1017.6
	Relational Aggression Norm	.04 (.04)					
4			.32 (.08)	.55 (.07)	965.3	983.3	1018.4
	Genetic Risk X Rel. Agg. Norm	.11 (.10)					
	Relational Aggression X Rel. Agg. Norm	-.25* (.10)					

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. Relational aggression refers to a residual variable where the overlap with physical aggression is controlled. Similarly, relational aggression norm refers to a residual variable where the overlap with the norm regarding physical aggression is controlled.

Figure 1. Moderation by classroom injunctive norms of the indirect effect of genetic risk for physical aggression on peer victimization (via actual physical aggression). † $p < .10$

Figure 2. Moderation by classroom injunctive norms of the indirect effect of genetic risk for relational aggression on peer victimization (via actual relational aggression). † $p \leq .10$; * $p \leq .01$


Norms Highly Unfavourable (-2SD)
Norms Moderately Unfavourable (-1SD)
Norms Moderately Favourable (+1SD)
Norms Highly Favourable (+2SD)
b = .28
b = .13
b = -.38†
b = -.73†
Peer Victimization
Genetic Risk for Physical Aggression
1,5
1
0,5
0
-0,5
-1
-1,5
-2,5
-2
-1,5
-1
-0,5
0
0,5
1
1,5
2
2,5


Norms Highly Unfavourable (-2SD)
Norms Moderately Unfavourable (-1SD)
Norms Moderately Favourable (+1SD)
Norms Highly Favourable (+2SD)
b = .50*
b = .29*
b = -.14
b = -.35
Peer Victimization
Genetic Risk for Relational Aggression
1,5
1
0,5
0
-0,5
-1
-1,5
-2,5
-2
-1,5
-1
-0,5
0
0,5
1
1,5
2
2,5

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