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Aggression Can be Contagious: Longitudinal Associations between Proactive Aggression and Reactive Aggression Among Young Twins

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Abstract

The present study examined sibling influence over reactive and proactive aggression in a sample of 452 same-sex twins (113 male dyads, 113 female dyads). Between and within siblings influence processes were examined as a function of relative levels of parental coercion and hostility to test the hypothesis that aggression contagion between twins occurs only among dyads who experience parental coerciveness. Teacher reports of reactive and proactive aggression were collected for each twin in kindergarten (M = 6.04 years; SD = 0.27) and in first grade (M = 7.08 years; SD = 0.27). Families were divided into relatively low, average, and relatively high parental coercion-hostility groups on the basis of maternal reports collected when the children were 5 years old. In families with relatively high levels of parental coercion-hostility, there was evidence of between-sibling influence, such that one twin's reactive aggression at age 6 predicted increases in the other twin's reactive aggression from ages 6 to 7, and one twin's proactive aggression at age 6 predicted increases in the other twin's proactive aggression from ages 6 to 7. There was also evidence of within-sibling influence such that a child's level of reactive aggression at age 6 predicted increases in the same child's proactive aggression at age 7, regardless of parental coercion-hostility. The

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findings provide new information about the etiology of reactive and proactive aggression and individual differences in their developmental interplay.

Keywords

Twins; Sibling influence; Reactive aggression; Proactive aggression; Actor-partner Interdependence Model

To understand the origins of aggression, we must distinguish between the different functions of aggression (Dodge, 1991; Vitaro, Brendgen, & Barker, 2006). Proactive aggression represents goal oriented and planned aggression that is driven by rewards or dominance goals. Reactive aggression represents impulsive aggression that occurs in response to a perceived threat or provocation, with origins in the frustration-aggression mechanism. Although correlated, proactive aggression and reactive aggression are conceptually and empirically distinct, following divergent developmental courses and predicting distinct social and behavioral outcomes (Card & Little, 2006; Poulin & Boivin, 2000b; Vitaro & Brendgen, 2012). Each appears to have origins in different environmental risk factors. Proactive aggression is fostered by modeling and reinforcement, whereas reactive aggression is tied to the experience of maltreatment and chaotic family life (Vitaro & Brendgen, 2012).

The Role of Siblings in the Development of Proactive and Reactive Aggression

Studies examining social environmental risk factors of proactive and reactive aggression have typically focused on parents and peers. Less is known about the role of siblings, despite the high prevalence of sibling and twin aggression in some families (Fortuna, Goldner, & Knafo, 2010). It does appear that cross-sibling influence may have been understated (Hicks, Foster, Iacono, & McGue, 2013). Having an aggressive or antisocial twin predicts later delinquent behavior and conduct problems (e.g. Jaffee et al., 2005; Natsuaki, Ge, Reiss, & Neiderhiser, 2009). Similarly, elevated aggression in one non-twin sibling has been found to predict subsequent increases in the other sibling's aggression and behavior problems over a three year period (Slomkowski, Rende, Conger, Simons, & Conger, 2001; Williams, Conger, & Blozis, 2007). It is worth noting, however, that most previous studies make no distinction between reactive and proactive aggression. One cross-sectional study found that adolescents are more likely to engage in reactive rather than proactive aggression with their closest-age sibling, but the potential consequence of this aggressive behavior remain unknown (Tucker et al., 2013). As such, it is unclear whether the contagion of aggressive behavior between siblings is limited to proactive aggression, as has been found among friends (Lamarche et al., 2007; Poulin & Boivin, 2000a), or whether contagion effects also extend to reactive aggression.

To address this issue, the first goal of the present study was to examine whether one twin's proactive aggression predicted changes in the other twin's proactive aggression, and whether one twin's reactive aggression predicted changes in the other twin's reactive aggression.

Patterson (1986) argued that negative exchanges among siblings provide a powerful training ground for aggression because siblings serve as both models and reinforcement agents. Previous findings from studies of friends (Lamarche et al., 2007; Poulin & Boivin, 2000a), suggest that modeling and social learning principles that underlie the contagion of proactive aggression should encourage higher levels of twin proactive aggression (Vitaro & Brendgen, 2005). The spread of reactive aggression, in contrast, is thought to be governed by negative reinforcement behavior outlined in coercion theory (Patterson, 1982). As a consequence, it is not clear if contagion applies equally to the spread of proactive aggression between friends as it does to that between twins. Previous studies have not found evidence of reactive aggression contagion between friends, despite the fact that friends, like twins, tend to engage in more reactive than proactive aggression (Brendgen, Vitaro, Boivin, Dionne, & Pérusse, 2006; Fossati, Borroni, Eisenberg, & Maffei, 2010). Twin relationships, however, are fundamentally different from those of friends, and for this reason we do not rule out the possibility of twin reactive aggression contagion. Friendships are voluntary relationships. As such, participants are free to terminate affiliations that are plagued by conflict (Laursen & Pursell, 2009), thus precluding the detection of contagion effects of reactive aggression over the typical one-year span of longitudinal studies. In contrast, twins do not have the liberty of ending conflict-prone relationships, leaving open the possibility of a mutual escalation of reactive aggression. Thus, contrary to the social learning processes believed to underlie the socialization of proactive aggression (which are common among friends and siblings), the socialization of reactive aggression should instead resemble the negative reinforcement processes described in coercion theory (which may be limited to involuntary, obligatory relationships: Patterson, 1982; Boivin & Vitaro, 1995). However, negative reinforcement is likely to be intermittent. Reactively aggressive responses may only be occasionally successful in avoiding a twin's threats or insults. If successful, reactive aggression is reinforced, if unsuccessful, emotional reactivity may still fuel such aggression.

Cross-over effects from one twin's proactive aggression to the other twin's reactive aggression are also possible. Proactive aggression is strongly associated with bullying, and has often been likened to bullying behavior (Prinstein & Cillessen, 2003). Proactive aggression and bullying frequently co-occur, because bullies view aggression as an effective means to dominate and get what they want from their victims (Camodeca, Goossens, Meerum Terwogt, & Schuengel, 2002; Fontaine, 2007; Poulin & Boivin, 2000b). Evidence suggests that a bully-victim dynamic is present in a number of sibling relationships during childhood (Tucker, Finkelhor, Shattuck, & Turner, 2013). In an effort to avoid being dominated and victimized, many victims of bullying show increased levels of reactive aggression, as predicted by coercion theory (Dodge et al., 2003; Poulin & Boivin, 2000b). An escalation of reactive aggression, however, is often an ineffective means of defense against bullying and can sometimes backfire by elevating the number of attacks directed at the victim (Lamarche et al., 2007; Poulin & Boivin, 2000a), which, in turn, may increase reactive aggressive responses. Thus, reactive aggression on the part of one twin may thus lead to an increase in proactive aggression on the part of the other twin.

Exploring the over-time associations between proactive and reactive aggression in twin samples holds several advantages over research with non-twin sibling samples. First, egalitarianism and reciprocity in the relationship is likely to be higher than in non-twin

siblings and equivalent to that in most friendships (Buhrmester, 1992). Second, twin siblings are at the same level of development. As a consequence, there is no need to control for age differences or birth order. Third, twins receive more similar treatment from parents than do non-twin siblings (Rowe, 1983), which provides the investigator greater control over parent child-rearing practices. Finally, because monozygotic and dizygotic twin siblings differ in terms of genetic relatedness, the genetic and environmental factors underlying aggressive influence can be explored.

The second goal of this study was to examine whether parental expressions of coercion and hostility moderate over time associations between one twin's reactive or proactive aggression and changes in the other twin's reactive or proactive aggression. Sibling effects on proactive and reactive aggression may be more likely in a family environment that is conducive to the expression of aggression between siblings. For example, when parents resort to hostile and coercive tactics to control oppositional behavior in children, proactively aggressive children may be more likely to emulate proactively aggressive behavior to control and subdue sibling reactivity (Compton, Snyder, Schrepferman, Bank, & Shortt, 2003). For their part, reactively aggressive children may become even more vigilant about threats and punishment if they are periodically exposed to parental hostility and coercion (Dodge, Pettit, Bates, & Valente, 1995). The result may be to increasingly respond with reactive aggression when provoked by a proactively aggressive sibling.

The Actor-Partner Interdependence Model

To address these two objectives, the present study employed a sample of same sex twins who were raised together. Sibling relationships are both influential and interdependent, which means that behavioral data obtained from both siblings are not independent. Traditional parametric analytic techniques are inappropriate under these circumstances, because correlated partner reports violate assumptions of statistical independence, biasing error estimates and compromising significance tests (Kenny, 1995). The Actor-Partner Interdependence Model (APIM) was designed to overcome these obstacles (Kenny, Kashy, & Cook, 2006), partitioning variance shared across partners on the same variables from variance that uniquely describes within- and between partner associations. Modifications for longitudinal data specifically address over time influence between members of a dyad (Laursen, Popp, Burk, Kerr, & Stattin, 2008). A longitudinal APIM is akin to a residual change model in that autoregressive effects describe the stability of a variable (Popp, Laursen, Kerr, Stattin, & Burk, 2008). By controlling for this stability, the residual change in aggression scores can be predicted. In the present study, longitudinal APIM analyses were used to determine the extent to which one twin's reactive and proactive aggression predicts changes in the other twin's reactive and proactive aggression, controlling for within-twin stability of proactive and reactive aggression and for within-twin cross-lagged effects between reactive and proactive aggression over time. Concurrent correlations between reactive and proactive aggression within- and between-twins make possible the measurement of change in influence analyses. Multiple group models were specified to examine whether longitudinal associations differed for those in families with relatively low, average, and relatively high levels of parental coercion-hostility.

One added value of the longitudinal APIM was to make possible the examination of over-time influence between reactive and proactive aggression within each twin. According to a model advanced by Vitaro and Brendgen (2005), reactive aggression, which may be expressed in children as young as a few months of age, may occasionally eliminate the source of the frustration, negatively reinforcing the reactively aggressive response. In time, the success of aggression as a coping response may give the child reason to suspect that aggression may be similarly successful when deployed strategically, as a means to an end. Consistent with this model, a child's level of reactive aggression should predict his or her later use of proactive aggression. The same may not be true for over-time associations between proactive aggression and reactive aggression because, if unsuccessful, proactive aggression leads to disappointment or replanning but not vindication or frustration, which are the necessary ingredients for reactive aggression.

Method

Participants

Participants consisted of 452 same-sex twins (113 male dyads, 113 female dyads) drawn from an ongoing longitudinal study (Quebec Newborn Twin Study) of a population-based sample of twins from the greater Montreal area who were recruited at birth between November 1995 and July 1998 (Boivin et al., 2013). Participants were limited to dyads in which both siblings experienced similar levels of parental treatment. The sample consisted of 137 monozygotic and 89 same-sex dizygotic twin pairs enrolled in kindergarten (M_{age} = 6.04, *SD* = .27 years) at the outset. Zygosity was assessed at the age of 18 months on the basis of physical resemblance (Goldsmith, 1991). For a subsample of twin pairs, a DNA sample was evaluated with respect to 8–10 highly polymorphous genetic markers. Zygosity comparisons revealed a 94% correspondence rate, which is similar to rates obtained in older twin samples (Forget-Dubois et al., 2003).

Demographic characteristics of the twin families at 5 months were comparable to those of a sample of single births representative of urban centers in the province of Quebec. Eighty-seven percent of the families were of European descent, 3% were of African descent, 3% were of Asian descent, 1% were Native North Americans and the remainder did not specify ethnicity. At the study's outset, 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 parents were employed; and 10% of the families received social welfare or unemployment insurance. When twins were 48 months old, 24% of twin pairs had no other siblings, 29% reported 1 sibling, 31% reported 2 siblings, 14% reported 3 siblings, and 2% reported 4 siblings.

Written consent was obtained from parents. Institutional Review Board approval for data collection was provided by the University of Quebec in Montreal and Laval University.

Measures

Instruments were administered in either English (21%) or French (79%), depending on the language spoken by the teachers and parents. Back-translation procedures were employed and bilingual translators verified the semantic similarity between the back-translated items and the original items in the questionnaire.

Reactive and Proactive Aggression—Teachers provided an assessment of each twin's *reactive aggression* and *proactive aggression* in the spring of kindergarten (age 6) and the spring of first grade (age 7). Over 70% of the twins did not attend the same classroom in kindergarten and 77% did not attend the same classroom in first grade. Three reactive aggression items and three proactive aggression items were drawn from a well-established measure of aggression (Dodge & Coie, 1987). To this we added a fourth reactive aggression item: "Reacts in an aggressive manner when contradicted." (Vitaro, Barker, Boivin, Brendgen, & Tremblay, 2006). Items were rated on a scale from 0 (*never*) to 2 (*often*). Internal consistency was good for reactive aggression at age 6 (α = .89) and age 7 (α = .89), and adequate for proactive aggression at age 6 (α = .72) and age 7 (α = .73).

Parental Hostile-reactive Behavior—When children were 5 years old, mothers completed a 6-item scale adapted from the Parental Cognitions and Conduct toward the Infant Scale (Boivin et al., 2005) measuring the frequency of hostile and coercive parenting directed towards each twin sibling (e.g. How often do you get angry with the child?). Each item was scored on a scale ranging from 1 (low) to 7 (high). Internal reliability was adequate (α = .76). Within our sample, this measure was stable between 30 and 60 months of age (r = .42, $p < .001$). A similar level of stability is often found among earlier ages (Forget-Dubois et al., 2007; Pierce et al., 2010). Each twin was categorized into one of the three groups according to his or her parental coercion-hostility score: relatively low (0.5 *SD* below the mean), average (between 0.5 *SD* below the mean and 0.5 *SD* above the mean), and relatively high (0.5 *SD* above the mean). Twin pairs were classified into groups on the basis of parental coercion-hostility: both twins relatively low (n = 71 twin pairs; M = 1.62; SD = .21; *Range* =1.00–1.96), both twins average (n = 88 twin pairs; M = 2.19; SD = .15; *Range* = 1.99–2.48), and both twins relatively high (n = 67 twin pairs; M = 2.92; SD = .33; *Range* = 2.51–4.00). In addition, there were 50 twin pairs in which one twin was relatively low in parental coercion-hostility and the other average; 62 twin pairs in which one twin was relatively high in parental coercion-hostility and the other average; and 10 twin pairs in which one twin was relatively high in parental coercion-hostility and the other was relatively low.

Reactive and proactive aggression data were collected when the twins were 6 years-old at T_1 and 7 years-old at T_2. At this early age, coercive conflicts between siblings are common and malleable (Kim, McHale, Osgood, & Crouter, 2006). Because measures that could reliably and validly distinguish forms and functions of aggression in young children became available only after the data used in this study were collected (Ostrov & Crick, 2007), our measures of aggression do not distinguish physical from relational aggression. Our measure of parent coercion-hostility was taken from the preceding measurement wave, when the twins were 5 years old, which was the last time it was assessed.

Plan of Analysis

The final sample of 452 same-sex twins (226 twin pairs) was selected from a larger initial sample of participants. At the commencement of the Quebec Newborn Twin Study, data was obtained from a total of 662 5-month-old twin pairs. Of this sample, aggression data concerning 485 twin pairs (73.3%) were collected when twins were 6 years old. Next, tests of distinguishability (Kenny, Kashy, & Cook, 2006) were used to determine what portion of this sample should be included in the indistinguishable APIM. These tests indicated that the 137 (28.2%) other-sex twin pairs could be distinguished on the basis of reactive aggression, $\Delta\chi^2(6) = 43.48$, $p < .05$, and proactive aggression, $\Delta\chi^2(6) = 12.51$, $p = .05$. Furthermore, tests revealed that 122 same-sex twin pairs whose parents differed on coercion-hostility could be distinguished by proactive aggression, $\Delta\chi^2(6) = 14.00$, $p < .05$. The remaining 226 same-sex twin pairs (452 same-sex twins) whose parents described similar levels of coercion-hostility for both siblings could not be distinguished by reactive aggression or proactive aggression. Therefore, analyses were limited to this portion of the sample. There were no greater than chance differences between those whose mothers reported the same levels of coercion-hostility toward each twin and those whose mothers reported different levels of coercion-hostility on zygosity, parent-rated temperament, sociodemographic measures, or study variables. Neither were there greater than chance differences between same-sex twins included in the study and other-sex twins excluded from the study.

An average of 16.9% (13.1%-21.0%) of the data were missing on reactive aggression, proactive aggression, and parental coercion-hostility. Little's MCAR test indicated data were missing completely at random, $\chi^2(79) = 89.55$, $p > .05$. Missing reports of parental coercion-hostility (17.4%) were imputed using an EM algorithm with 20 iterations. Full-Information Maximum Likelihood (FIML) estimation procedures were used to handle remaining missing data.

Longitudinal indistinguishable APIM analyses were conducted using Mplus v7.11 (Muthén & Muthén, 2012) with MLR estimation. Log transformations were performed on scores for reactive aggression and proactive aggression to correct for skew. Figure 1 depicts the fully saturated measurement model. Identical path labels reflect the interchangeable nature of partners in the indistinguishable dyad analyses (Olsen & Kenny, 2006). Within-dyad constraints were imposed on within-individual stability paths (actor paths *a* and *b*), within-individual influence paths (actor paths *c* and *d*), between-individual influence paths (partner paths *e*, *f*, *g*, and *h*), within-individual correlations (*w* and *x*), and between-individual correlations (*y* and *z*), as well as on the means (*m* and *n*) and variances (*v* and *u*) of proactive and reactive aggression at age 6, and the intercepts (*i* and *j*) and residuals (*r* and *s*) of aggression scores at age 7. Nonsignificant paths were trimmed from the fully saturated model.

Multiple group model comparisons tested the hypothesis that patterns of association would differ as a function of parental coercion-hostility. A progressive model fitting procedure was used in which constraints were added to the multiple-group model in a step-wise fashion. The initial model included no constraints; all paths in the model were freely estimated within groups. Next, scaled Satorra-Bentler chi-square difference tests were used to compare

the magnitude of each association across relatively low, average, and relatively high parental coercion-hostility groups. Associations that did not significantly differ ($p > .05$) across groups were constrained to be equal. Constraints were placed on stabilities, correlations, and influence paths in that order. Beta weights for constrained associations were averaged across coercion-hostility groups.

Additional multiple group analyses were conducted separately with sex, zygosity and household status as moderators. There were no statistically significant χ^2 differences, indicating that patterns of association did not differ between boys and girls, between monozygotic and dizygotic twins, and between children from households with two biological parents and households with one biological parent. In supplemental analyses, age and zygosity were separately entered into the model as control variables. The same pattern of statistically significant results emerged.

Results

Preliminary Analyses

Table 1 describes correlations between variables. All variables were positively correlated, concurrently and over time.

Separate 2 (age) X 2 (sex) repeated measures ANOVAs were conducted with reactive aggression and proactive aggression as the dependent variables. To avoid statistical bias arising from non-independence, one member of each dyad was randomly selected for inclusion in these analyses. A total of 20 imputed datasets were created using an EM algorithm with 25 iterations; ANOVAs were performed on each dataset. There was a significant effect of sex on reactive aggression, $F(1, 346) = 14.79$, *Range* = 10.78–19.00, $p < .001$, $\eta p_2 = .04$, *Range* = .03-.05, but not proactive aggression, $F(1, 346) = 0.34$, *Range* = .00-.95, $p = .56$, $\eta p_2 = .00$, *Range* =.001- .003. Males ($M = .43$, $SD = .48$) were more reactively aggressive than females ($M = .25$, $SD = .34$; $d = .31$; *Range* = .20-.42). There were neither main effects nor statistically significant interactions involving age.

Over-Time Associations Between Reactive Aggression and Proactive Aggression in Twin Pairs who Differed in Parental Coercion-Hostility

Figure 2 depicts the results of the final multiple group longitudinal APIM model, $\chi^2(31, N = 226) = 28.91$, $p = .57$, *CFI* = 1.00, *RMSEA* = .00. Compared to the fully saturated measurement model, fit for the final model did not significantly worsen when non-significant paths were omitted. Neither were there changes in model fit when multiple group constraints were added.

There was a statistically significant within-twin association between age 6 reactive aggression and age 7 proactive aggression (path *d;* β=.17 *CI*=.02-.32). Higher initial levels of an individual's reactive aggression predicted greater increases in his or her own proactive aggression over the course of a year. The within-twin association between age 6 proactive aggression and age 7 reactive aggression (path *c;* β=-.05 *CI*=-.18-.08) was non-significant and was trimmed from the model. Within twin influence paths were not moderated by parental coercion-hostility.

There were two statistically significant between-twin associations, each moderated by parental coercion-hostility. For relatively high coercion-hostility dyads only, there were statistically significant associations between age 6 reactive aggression and age 7 reactive aggression (path *g; β*=.27 *CI*=.11-.42), and between age 6 proactive aggression and age 7 proactive aggression (path *h; β*=.35 *CI*=.20-.51). In each case, higher initial levels of one twin's aggression predicted greater increases in the other twin's aggression over the course of a year. Scaled chi-square difference tests revealed that both associations were significantly stronger ($p < .05$) in the relatively high coercion-hostility group than in the relatively low and average coercion-hostility groups. The two remaining between-twin associations (paths *e β*=.05 *CI*=-.07-.16, and *f β*=-.01 *CI*=-.17-.15) did not reach conventional levels of statistical significance and were trimmed from the model.

Discussion

Our study is unique in that previous studies examining sibling influence in young children failed to distinguish between reactive and proactive aggression, so that it was unclear whether the contagion of aggressive behavior between siblings is limited to proactive aggression, as has been found among friends (Lamarche, Brendgen, Boivin, Vitaro, Dionne, & Pérusse, 2007; Poulin & Boivin, 2000a), or whether contagion effects also extend to reactive aggression as suggested by coercion theory (Patterson, 1984). We found contagion effects for both proactive and reactive aggression, such that twins of more proactively aggressive children become more proactively aggressive and twins of more reactively aggressive children become more reactively aggressive. Our study is also unique in that it explored longitudinal influence effects within twins over a year to determine whether reactive aggression is associated with later increases in proactive aggression as suggested by Vitaro and Brendgen (2005). We found that early reactive aggression predicted changes in proactive aggression, such that twins who are initially more reactively aggressive become more proactively aggressive over time. Finally, our study is unique in that it is the first to test the hypothesis that parental coercion moderates the over-time influence of reactive and proactive aggression between and within siblings. We found that contagion between twins in both reactive aggression and proactive aggression was moderated by parental coercion, such that only twins whose parents were relatively high in coercion-hostility exhibited contagion. First, higher levels of proactive aggression in one twin gave rise to greater increases in proactive aggression in the other twin. Interestingly, similar twin contagion effects were also found for reactive aggression. Second, reactive aggression manifested by each twin fed their tendency to use proactive aggression but not the other way around. Finally, and new to this study, is the finding that the strength of across-twin influence, but not within-twin influence, differs as a function of parental coercion-hostility. Specifically, aggression begets aggression for twins with parents relatively high on coercion-hostility but not for twins with parents who are relatively low or moderate on coercion-hostility. In sum, this study adds to our previous research examining the genetic and environmental effects of proactive and reactive aggression (Brendgen, Vitaro, Boivin, Dionne, & Pérusse, 2006) by explaining one of the mechanisms that underlie the environmental effects. Our results illustrate how twins influence one another on proactive and reactive aggression and under what circumstances.

Between twin influence

Children became more proactively aggressive over time if their twin was initially high in proactive aggression. Several hypotheses have been advanced to explain similar findings among friends. Modeling enjoys considerable currency, but so too do formulations in which aggression is reinforced by others who regard such behavior as a justifiable response to being pushed around (Dishion, Patterson, & Griesler, 1994). In contrast to previous findings for friends, however, our results suggest that aggression contagion between siblings also extends to reactive aggression. Unlike friendships, sibling relationships are not based on voluntary choice. Siblings are not free to end their relationship, even if it is characterized by a high level of mutual hostility. As Patterson (1984) predicted, repeated coercive exchanges between siblings can translate into a mutual contagion of reactive aggression over time.

Also worth noting is the fact that proactive aggression did not predict changes in siblings' reactive aggression, and reactive aggression did not predict changes in siblings' proactive aggression. The latter association was found to be significant in a study of peers (Lamarche et al., 2007). We can only speculate as to the reasons for these unexpected null findings. It may be that between sibling links from reactive to proactive aggression emerge in older age groups. It may be that effects are too small to detect in our complex path model, with little variance remaining in age 7 proactive aggression after partitioning out antecedent scores for the self and the sibling. It may be that the settings in which siblings interact discourage spillover between the two functions of aggression. Although the findings imply that twins tend not to engage in a bully-victim proactive-reactive aggression cycle, we are hesitant to unequivocally make this claim given evidence that non-twin siblings are more likely to bully and be bullied by one another over time (Skinner & Kowalski, 2013). However, same-aged siblings may share a more equitable balance of power than siblings who differ in age, which may help to limit the formation of such a cycle. The growing list of null findings strengthens conclusions that proactive aggression and reactive aggression are distinct behavioral patterns with unique behavioral origins.

Within twin influence

The within-twin results provided evidence of individual stability in proactive aggression and in reactive aggression, independent of maternal coercion-hostility. Yet even in the midst of considerable stability, there was evidence of change. Within-twin influence was found, such that a child's initial level of reactive aggression predicted changes in his or her own proactive aggression over time. Other researchers have found similar results (Salmivalli & Helteenvuori, 2007; Ojanen & Kiefer, 2013). The findings support a model advanced by Vitaro and Brendgen (2005), who argue that aggression expressed as a reaction to an undesirable stimulus may occasionally eliminate that stimulus, negatively reinforcing the response. In time, the success of aggression as a coping response may generalize to the use of aggression as a means to an end. Consistent with this model, there were no over time within twin associations from proactive aggression to reactive aggression.

Moderating role of parent coercion-hostility

Escalating between-twin aggression was restricted to siblings with parents who were above average in terms of coercion-hostility directed toward their children. Specifically, links from

proactive to proactive aggression and from reactive to reactive aggression were stronger when parents were relatively high on coercion-hostility than when they were not. Although absolute levels of coercion-hostility were not high, when parents did resort to hostile parenting practices, siblings were more likely to display contagion effects. This suggests that even moderate levels of parental coercion can encourage the transmission of aggressive behavior. Past research points to several interconnected mechanisms that may explain why. Parents who act coercively toward their children may also view the use of aggression, whether proactive and reactive, as normative and therefore tolerate its use to a greater extent than parents who do not. Parents with coercive tendencies provide a model that encourages hostility between siblings (Compton, Snyder, Schrepferman, Bank, & Shortt, 2003). Aggressive responses also escalate when parents and siblings fall into a negative reinforcement trap (Patterson, 1982; Patterson, Reid, & Dishion, 1992), whereby one family member withdraws demands and relents in the face of hostility, inadvertently rewarding the initial hostile behavior. Finally, instances of parental coercion and hostility may promote hostile attribution biases, wherein benign situations are interpreted as threatening, which can give rise to reactive aggression (Heidgerken, Hughes, Cavell, & Willson, 2004). If such biases persist, coercive relationships with mothers lead to increased aggression between peers (Mackinnon-Lewis et al., 1994). Our evidence suggests that similar mechanisms may underlay aggression between siblings.

It is worth noting that patterns of influence did not differ for monozygotic and dizygotic same-sex dyads. This result contrasts with past research showing that adult MZ twins influence each other more so than DZ twins with respect to antisocial behavior (Carey, 1992). The different results may be attributed to differences in age, measures of aggression, and the inclusion of opposite sex DZ twins. Of course, null effects must be interpreted with caution, but the findings suggest that neither genetic nor non-shared environmental factors are responsible for the results. Instead, our findings, like those reported elsewhere (e.g., Brendgen, et al., 2006) point toward the one thing that MZ and DZ twins have most in common: Shared family experiences. In that sense, our findings concord with those of other studies (Carey, 1992; Hicks et al., 2013).

There are many aspects of shared family life that may promote aggression. Although aggressive parents tend to raise aggressive children (Conger, Neppl, Kim, & Scaramella, 2003), hostile parenting practices may further encourage the development of aggressive behavior via interfamilial modeling. We find that parental coercion-hostility is one form of shared experience that sets the stage for sibling aggression. This is more than just an example of intergenerational transmission of aggression. Our correlations between parent coercion-hostility and dyad aggression were quite modest. Instead, a complicated interplay is at work, whereby parent behavior creates conditions for sibling aggression contagion. Given that genetic dissimilarity among dizygotic twins did not attenuate the influence paths, coercive family dynamics, not genetic predispositions that favor aggressive tendencies, are likely to be responsible for such associations. This conclusion, however, may be age specific. As children grow older, both nonshared environmental influences and genetic dispositions may become increasingly important in explaining interindividual differences in reactive or proactive aggression because children gain in autonomy and become exposed to extra-family experiences. Even so, heightened aggression early in life may have long-lasting

negative effects throughout childhood and adolescence, and sibling and parental coerciveness experienced at young ages can lead to antisocial behavior years later (Compton, Snyder, Schrepferman, Bank, & Shortt, 2003). As such, this study necessarily focused on the youngest available twins to investigate the process of sibling influence in aggression as early as possible in order to provide information needed for successful prevention and intervention efforts.

Limitations and Conclusion

Our study has some limitations. Parental coercion-hostility was measured a year before the first teacher reports of aggression were collected. Although our strategy ensured a temporal, if not causal, sequence between parental coercion-hostility and children's levels of reactive and proactive aggression at age 6 and although parental coercion-hostility tends to be quite stable in our study as in other studies (Forget-Dubois et al., 2007; Pierce et al., 2010; Roberts et al., 1984), it is possible that parental coercion-hostility may be elicited in response to earlier child aggression. Second, a small minority of families evinced differential sibling treatment in that some parents were more coercive with one member of the twin dyad than the other. Although not addressed in our study, differences in parental treatment have been linked to a divergence in twin behavior. Typically, the wider the difference in treatment the stronger the divergence in behavior (Asbury, Dunn, Pike, & Plomin, 2003). The MZ twin who experiences poorer parental treatment (e.g. low warmth; high negativity) than his or her sibling is more likely to develop antisocial behavior (Caspi, Moffitt, Morgan, Rutter, & Taylor, 2004). Although our analytic strategy mitigates these differences, the presence of differential treatment in those excluded from our analyses may undercut arguments that all families represent shared environments for twins. Third, data on aggression was not available at earlier ages. This constraint limited our ability to determine whether patterns of influence are present among younger twins. Fourth, although our study incorporates distinctions between reactive and proactive aggression, it does not make a distinction between forms of aggression, such as physical and relational aggression. Findings that the strength of the social contagion of proactive and reactive aggression may depend on the form of the aggressive acts suggest that a focus on a single form of aggression is likely to yield an incomplete picture of socialization processes (Prinstein & Cillessen, 2003; Ostrov, Murray-Close, Godleski, & Hart, 2013). Of course, greater specificity will come at a cost. It will not be easy to expand APIM analyses to examine functions (e.g., proactive and reactive aggression) within different forms (e.g., physical and relational aggression). A related limitation is that the target of children's reactive and proactive aggression remains unknown. There is evidence, however, showing that children who are aggressive, either reactively or proactively, towards peers behave in a consistent manner towards their siblings (Duncan, 1999). Finally, although some may question the degree to which findings from twins generalize to other populations, empirical evidence suggests that twin children do not differ from singletons with respect to externalizing behavior problems (e.g., Johnson, Krueger, Bouchard, & McGue, 2002; Pulkkinen, Vaalamo, Hietala, Kaprio, & Rose, 2003).

The results have important implications for our understanding of the etiology of proactive and reactive aggression. Although peers often shoulder much of the blame for elevated

instances of aggressive behavior, we found that parents may lay the groundwork for the contagion of aggressive behavior between siblings during early childhood, probably through a combination of modeling and negatively reinforcing coercive-hostile behavior. Under these circumstances, even moderate levels of sibling aggression can promote the growth of aggressive behavior. Because sibling aggression and conflict can create social and behavioral patterns that lead to later antisocial behavior and associations with deviant peers (Bank, Patterson, & Reid, 1996), it is important to identify and remedy coercive interactions among parents and children.

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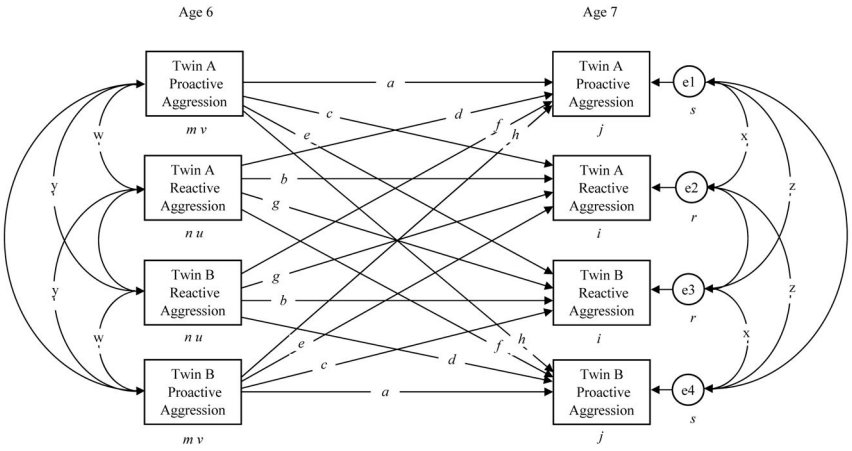

Figure 1.

Indistinguishable dyad Actor-Partner Interdependence Model: Measurement model of longitudinal associations between reactive and proactive aggression.

Note. The model includes stability paths (*a* and *b*), within-twin influence paths (*c* and *d*), between-twin influence paths (*e*, *f*, *g*, and *h*), within-twin correlations (*w* and *x*), and between-twin correlations (*y* and *z*).

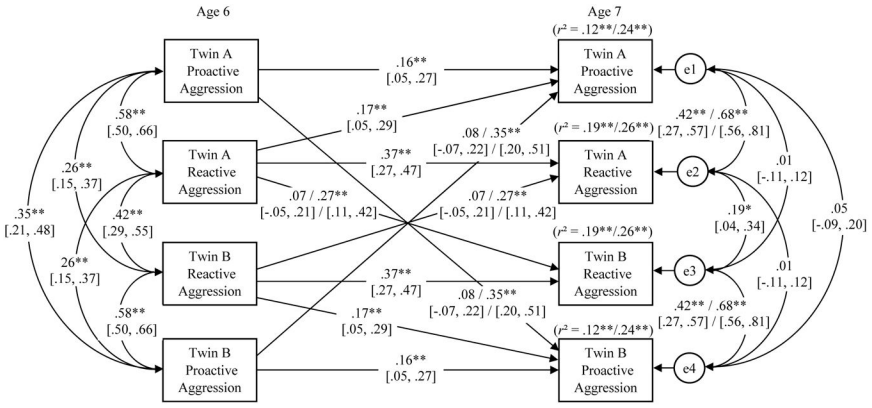

Figure 2.

Parental coercion-hostility moderates longitudinal associations between proactive aggression and reactive aggression.

Note. *N*=452 (226 twin pairs). For paths with one beta weight, results for twin pairs in the relatively low, moderate and high parental coercion-hostility groups were constrained to be equal. For paths with two beta weights, results for twin pairs in the relatively low and moderate parental coercion-hostility groups were constrained to be equal and are reported on the left of the slash; results for the relatively high parental coercion-hostility group are reported on the right of the slash. For each path, 95% confidence intervals are presented in brackets, *p<.05, **p<.01, two-tailed.

Table 1

Descriptive Statistics and Bivariate Correlations

Variable	1 [95% CI]	2 [95% CI]	3 [95% CI]	4 [95% CI]	*M* [95% CI]	*SD*	*Min*	*Max*
1. Parental Coercion-Hostility (age 5)	—				2.23 [2.17, 2.29]	0.57	1.00	4.00
2. Proactive Aggression (age 6)	.10 [−.01, .21]	—			0.23 [0.20, 0.27]	0.38	0.00	2.00
3. Reactive Aggression (age 6)	.11* [.01, .22]	.59** [.50, .68]	—		0.35 [0.30, 0.40]	0.50	0.00	2.00
4. Proactive Aggression (age 7)	.26** [.16, .37]	.31** [.18, .43]	.32** [.21, .42]	—	0.20 [0.16, 0.23]	0.35	0.00	2.00
5. Reactive Aggression (age 7)	.25** [.15, .36]	.22** [.11, .32]	.45** [.34, .56]	.60** [.52, .67]	0.33 [0.28, 0.38]	0.50	0.00	2.00

Note. N=452 (226 twin pairs). Reactive and proactive aggression were rated on a scale from 0 (*never*) to 2 (*often*). Parental coerciveness-hostility was rated on a scale from 1 (*low*) to 7 (*high*).

* $p<.05$

** $p<.01$, two-tailed.