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Social centrality and aggressive behavior in the elementary school: Gender segregation, social structure, and psychological factors

Andres Molano and
Universidad de los Andes

Stephanie M. Jones
Harvard University

Abstract

In this paper, we build on key findings in the sociological literature regarding different patterns of association between social centrality and overt aggressive behavior in the context of same-and-cross gender social interactions. We explore these associations in a population of urban elementary school students ($\widehat{Age} = 8.62$, $SD = 0.69$, $N = 848$), while addressing claims that the role of psychological factors is overstated in this literature. Our results indicate that, on average, social centrality is positively associated with aggressive behavior for boys, but negatively for girls. We also find a moderating effect indicating that the proportion of male peers with whom participants are reported to hang around, as well as their own gender play a role in the association between social centrality and aggression. These findings are discussed in the context of an ecological perspective on human development in which interactions among individuals, their social groups, and key environments are viewed as central to shaping developmental pathways.

Keywords

Social centrality; Aggressive behavior; urban elementary school students; Social Network Analysis; Tobit Multilevel Regression

Aggressive behavior among school age children is a risk factor for positive youth development (Shinn & Yoshikawa, 2008). According to the Indicators of School Crime and Safety, in the U.S. approximately 3% of students ages 12-18 report being victimized at school during the first 6 months of 2015 (Musu-Gillette et al., 2017). While much of the negative consequences of these acts are experienced directly by its victims, overtly aggressive children also suffer life adjustment difficulties. For example, from meta-analytic work, Card and Little (2006) report unique associations between the use of direct forms of aggression and internalizing and externalizing problems, peer rejection and victimization.

Direct aggression, broadly defined as a behavior intended to harm someone physically, by means of hitting, pushing, tripping, or verbally by name calling, taunting or threatening (Berkowitz, 1993), has received considerable attention in the literature. Developmental work has characterized this form of aggression as an important predictor of social adjustment (Jackson, Cappella & Watling-Neal, 2015) and youth development (Huesmann, Dubow & Boxer, 2009). From this perspective, the onset of direct aggression in the elementary years has been associated with an increase in the risk of violence and delinquency during adolescence (Broidy et al., 2003), slower growth in academic attainment, and increases in the incidence of anxiety and depression around age 30 (Masten et al. 2005; Moilanen, Shaw & Maxwell, 2010; Van Lier & Koot, 2010).

While much of this work focuses on individual predictors and consequences of aggressive behavior, highlighting key differences across gender lines (Archer, 2004), recent work recognizes the important role of structural and relational conditions in the development of direct aggression. From a sociological perspective, Faris and Felmlee (2014; 2011) emphasize how the social status that children attain within their social networks is positively related to aggressive behavior. The authors present evidence from a sample of middle schools in North Carolina, while questioning a frequent assumption in the psychological literature: *"...aggression is not primarily a maladjusted reaction from socially marginal or psychologically troubled adolescents. Rather, aggression is intrinsic to status but in a nonlinear fashion"* (pp. 67). While this conclusion is quite consistent with recent work exploring processes of social selection and influence in the development of aggression and other risky behaviors during childhood and adolescence (see Molano, Jones, Brown & Aber, 2013; Veenstra, Dijkstra, Steglich, & Van Zalk, 2013), it has been rarely supported by work evaluating the effect of structural processes alongside psychological factors.

In this paper, we address this gap in the literature by adopting a perspective consistent with ecological models of human development (Bronfenbrenner 1979; Bronfenbrenner & Morris 1998; Magnusson & Stattin, 1998; Sameroff, 1995), and showcasing the interactions among individuals, social groups, and their environments as central drivers of human development. Within this framework, we explore the association between the social centrality (i.e. the number of nominations received from influential peers in a classroom social network) that 4th grade students attain and their levels of direct forms of aggressive behavior. We do this, while accounting for key gender differences, the role of psychological attributes of these children, attributes of their closest peers, and the environments in which these interactions take place.

Gender and Social Centrality

Consistent with the role of social ecologies in the development of aggressive behavior, prior research has identified three primary phenomena (Brechwald & Prinstein, 2011; Crick et al., 2009; Dishion & Tipsord, 2011). First, a mounting body of evidence suggests a unique and positive association between the social centrality students attain in their classroom networks and their own aggression (Faris & Felmlee, 2014; 2011; Garandeau, Ahn & Rodkin, 2011; Cillessen & Mayeux, 2004), as well as has indicated that these associations are moderated by the gender of the participants (Rodkin, Farmer, Pearl & Van Acker, 2000; Xie, Farmer &

Cairns., 2003). Second, research shows that gender acts as a powerful organizer of child relationships, and that its effects are not confined to individual differences in baseline levels of direct aggression, but that in elementary school classrooms, it also acts as a compositional predictor and moderator of aggression (Dishion & Tipsord, 2011; Gest, Graham-Bermann and Hartup 2001; Molano et al., 2013). Third, the psychological characteristics of the actors, and the structural conditions under which relationships occur, play an important role in determining the strength and direction of the link between social relationships and child behavior (Molano et al., 2013; Garandeau et al., 2011; Ahn et al., 2010; Vitaro et al., 2009).

To the first point, research suggests that aggressive children are more likely than their non-aggressive peers to be central members of their social groups (Garandeau et al., 2011; Xie et al., 2003). For example, Gest, Graham-Bermann and Hartup (2001) report from a sample of elementary grade students, a unique and positive association between the number of times a child is nominated as member of a social group and their aggressive behavior. There is also evidence to suggest that the gender of both aggressors and victims plays an important role, particularly in the relationship between social centrality and aggressive behavior (Faris & Felmlee, 2011). For example, Farmer and Rodkin (1996) report an association between aggressive behavior and social centrality for boys, but not for girls. Faris and Felmlee (2011) report that among adolescents, social centrality increases aggression towards peers of their own gender, especially for youth who are able to tend bridges between social groups. While this latter work focuses on an overall indicator of aggressive behavior, the authors report consistent results when considering unique indicators of physical and verbal aggression; forms of direct aggression that have been shown to differ across gender lines (Card & Little, 2006).

To the second point, gender also has shown to play an important role as a setting-level phenomenon. For example, from a structural perspective, Faris and Felmlee, (2011) report that youth with multiple cross-gender friendships who are in schools where such ties are scarce are particularly aggressive toward classmates of their same and other gender. Similarly, Rodkin and Berger (2008) find that, among a Midwest U.S. population of elementary school students, social status was partly influenced by to whom students directed their aggression. According to the authors, boys who directed their aggression towards other boys were identified as central by both teachers and peers, whereas boys who were aggressive toward both girls and boys were rated as unpopular.

Building in part from this work, direct aggression among male children has been conceptualized as means to establish and maintain prominence within their social groups (Xie et al., 2003), and has been explained with gender-normative theory (Crick & Dodge, 1994; Crick & Rose, 2000), particularly at the elementary school level when gender segregation seems to be a key factor influencing social relationships (Molano et al., 2013). As such, boys who exhibit high levels of aggression tend to be recognized as central members of their classrooms to the extent that their behavior conforms to gender stereotypes, and according to Rodkin and Berger (2008), the behavior is directed primarily toward other boys. In comparison, girls who exhibit higher levels of aggressive behavior tend to face peer rejection (Farmer & Rodkin, 1996), suffer more victimization (Faris & Felmlee, 2014), and attain less central roles in the social group than their male counterparts.

Finally, to the third point, the bulk of the literature highlights the role of intra-individual psychological processes in the development of aggressive behavior. For example, according to social information processing theory (Dodge, Bates, & Pettit, 1990), variability in how individuals understand and represent stimuli from the social environment is a key predictor of their likelihood of choosing aggression to achieve their goals, or as a response to perceived provocation (Aber, Brown & Jones, 2003; Crick & Dodge, 1994; Gershoff & Aber, 2003). As such, research shows hostile attributional bias, or the tendency to perceive as hostile the undeclared intentions of other social actors, to be a key predictor of the use of aggression in social interactions (Molano et al., 2013).

Another key intra-individual predictor of aggression is internalizing symptomatology described as depression and anxiety symptoms (Diamantopoulou, Verhulst & van der Ende, 2011). In this literature, gender differences are prevalent, as many studies report externalizing problems, including aggression, to be higher on average for boys than for girls, and the prevalence of internalizing problems, including depressive symptomatology and anxiety, to be higher for girls than for boys (Bongers, Koot, van der Ende & Verhulst, 2004). Importantly, these phenomena interact in interesting ways. For example, among aggressive and delinquent adolescents, more girls than boys exhibit elevated levels of depression (Wiesner & Kim, 2006). Similarly, current research stresses that depressive symptomatology should be considered a significant risk factor for the development of aggression and delinquency, more so for girls than for boys (Costello, Mustillo, Erkanli, Keeler & Angold, 2003).

Taken together, this body of work is consistent with a multiple risk factor model (Greenberg, Speltz, Deklyen, & Jones, 2001) which suggests that it is unlikely that a single factor, either psychological or structural, will sufficiently predict the development of externalizing problems as aggression. Rather, current literature suggest that multiple factors, at multiple levels provide the best prediction of externalizing behavior and aggression among children and adolescents (Evans, Li & Sepanski, 2013; Castelao & Kroner-Herwig, 2013; Sulik, Blair, Mills-Koonce, Bery, Greenberg & The Family Life Project Investigators; 2015).

Given this landscape, a main goal of our work is to explore the extent to which social centrality and direct forms of aggression are associated, and its association is moderated by key structural features of the peer networks and classrooms in which these interactions take place. Based on previous work, we focus on the role of gender, both as an individual-and-setting-level predictor, to explore the extent to which boys and girls attain different levels of social centrality, depending on who they relate to across gender lines. Considering the claims of Faris & Felmlee (2011), we evaluate these associations, net of other psychological and environmental factors that may explain individual behavior.

The present study

The studies summarized above represent important contributions to the literature on social interactions among children, yet for the most part they share a common limitation: they fail to integrate the different levels of the individual, school and classroom ecology into the analysis, while addressing the associations between social status and aggression. To address

these limitations, we capitalize on rich information about social interactions available from the New York City Study of Social and Literacy Development (Jones, et al., 2011, 2010), to describe the structure of elementary school students' social networks and the social centrality individuals attain within them. Specifically, we employ Social Network Analysis (Wasserman & Faust, 1994) to describe: (a) the social position that students occupy among their classroom peers, and (b) the structure of the relationships and the school as represented by the proportion of cross-gender ties students report. After estimating these descriptive indices, we bring them together with multilevel modeling.

Using this unique data, we ask whether gender differences are observed in the association between social centrality and direct aggression, after statistically controlling for psychological and demographic predictors of aggression. Following the work of Farmer and Rodkin (1996) and Gest et al. (2007), we expect a positive association between social centrality and aggressive behavior that is moderated by gender. Specifically, for boys we expect a positive association, while for girls we expect a negative one.

Similarly, we ask whether gender moderates the association between centrality and aggression, not only as an individual-level attribute, but also indirectly through the effect of the proportion of cross-gender peers that each participant is reported to have. Following Faris and Felmlee (2011), we hypothesize that boys who attain higher levels of social centrality in a context of relationships dominated by other boys will exhibit higher levels of aggression, when compared to their male and female counterparts who have fewer gender segregated interactions.

Finally, we explore the extent to which our individual level estimates are moderated by features of the schools in which these interactions take place. Here, we focus on indicators of gender segregation at the school level. Consistent with Faris and Felmlee (2011) we hypothesize that in schools where cross-gender friendships are rare, the effect of higher levels of social centrality on aggression will be larger than it is in schools that are less segregated.

As mentioned before, while our focus remains at exploring the association between social centrality and aggressive behavior, and the ways in which it is moderated by setting-level representations of gender segregation, we evaluate our hypotheses while addressing central claims from the sociological literature. Specifically, we evaluate all our estimates while statistically controlling for key demographic (i.e. age and ethnicity) and psychological (i.e. hostile attributional styles and depressive symptomatology) predictors that past literature has associated with aggressive behavior. Similarly, attending to recent debates about base-rate differences in different forms of direct aggression between boys and girls (Archer, 2004; Card et al., 2008), we conduct sensitivity analyses of our results for physical and verbal aggression.

Method

Sample

We employ data collected by Jones, Brown and Aber (2010; 2011) as part of the evaluation of the 4Rs Program (Reading, Writing, Respect and Resolution). From these data, we focus on a cross-sectional sample obtained in the Fall of 2005, when participants were in the 4th grade of elementary school. Our initial sample contains records for 848 students, nested in 74 classrooms across 18 schools. The mean age of the participants was 8.62 years ($SD = 0.69$), where 51.3% were male, 44.7% were Hispanic, 41.9% were African-American, and only 4% were Non-Hispanic Whites. Calculated at the end of the academic year, the overall consent rate was 65.5% across schools (range = 44% - 79%) (see Jones et al., 2011, 2010). Descriptive statistics for additional demographic and compositional variables for this sample are presented in Table 1.

Procedures

Data were collected by trained research assistants during the fall of the 2005 academic year. On average, 103 days ($SD = 14.51$) passed from the beginning of the academic year to the day of measurement. Dates of data collection were unique for each school, and they range across schools from 84 to 129 days since the beginning of the academic year. At data collection, students completed questionnaires rating their own behaviors, demographics, and identifying the groups of peers in their homeroom classrooms, while teachers rated the aggressive behavior of each consented child in their classrooms. From these data, we derive two important sources of information. First, for every participating student we employ individual level data describing their behavioral profiles and key demographics. Second, we use detailed data about the interpersonal relationships that each student within each classroom is perceived by other students to have with his/her classroom peers. Specifically, participants were asked to identify any kids in their classrooms who “*hang around together a lot*”, following the Social Cognitive Mapping (SCM) procedure described by Cairns et al. (1995). Given the elementary school nature of our sample, this procedure asked students about the relationships they formed with peers with whom they spent most of their school day. From this second source of information, we construct a matrix for each classroom in which rows and columns identify the consented participants in the study. Cells in this matrix contain the number of times that any pair of students was perceived by his/her peers to hang around together in the classroom. We further simplified the data by dichotomizing these counts, recoding the existence of a tie based on the agreement in the report of at least two members of the classroom. From these data, we estimate the values of specific indices representing the relational structure of the classroom employing version 2.4 of the package *sna* (Butts, 2016), available in R.

Measures

Aggression—Measured for each child by the average response on 13 teacher-rated items from the Behavioral Assessment System for Children – II (BASC-II) (Reynolds & Kamphaus 2001). Each item asked teachers to rate the aggressive behavior of their students (fights, hits, says mean things, spread rumors) during the last month, on a four-point Likert scale ranging from never to almost always. Children’s mean scores ranged from 1.00 to

4.00, with higher values representing more frequent displays of direct aggression ($\alpha = 0.95$). To conduct our proposed sensitivity analyses we created from these items a composite for physical aggression (7 items, $\alpha = 0.83$), and one for verbal aggression (6 items, $\alpha = 0.76$)

Social Centrality—A child-level predictor that summarizes the number of social relationships that each child has within his/her classroom, weighted by the number of social ties for each peer to whom the child is connected. In this measure of centrality, the social position of each actor is “recursively related” to the centralities of the individuals to whom they are inter-connected (Wasserman & Faust, 1994). Values of the index range from 0 to 1, with higher values identifying actors who are connected to more central peers. This measure, known as *eigenvector centrality* (proposed by Bonacich & Lloyd, 2001), allows us to incorporate information about the peers to whom each individual is connected, and to explore the interdependencies between individuals from an ecological perspective.

Gender—A dichotomous individual-level predictor coded 1 for male and 0 for female. In our sample, exactly 410 participants are boys and 438 are girls.

Gender of connected peers—Calculated at the individual level as the proportion of male peers to whom each participant is directly connected within each classroom. We obtain values of this predictor by identifying classroom members who are reported to hang around with each actor (e.g. we employ the egocentric function in the sna package in R (Butts, 2014) to identify only those actors who share a direct connection with each participant), and calculating the ratio of the number of male peers to the total number of directly connected peers. Values range from 0 (all directly connected peers are female) to 1 (all directly connected peers are male). We center this predictor at the classroom level, by deviating individual values from the classroom mean to account for variability between classrooms in the extent to which equal proportions of boys and girls are available for actors to form social relationships.

School gender segregation—A continuous predictor representing the level of gender segregation for each participating school. We construct this predictor by contrasting the observed and expected patterns of relationships across gender lines for each school. We define the expected patterns of relationships across gender as random, following the work of Freeman (1978). Values range from -1 to 1 , where 1 indicates that all observed relationships are same-gender, 0 indicates that same and cross-gender ties are equally likely, and -1 indicates that all observed relationships are cross-gender.

Control covariates—To account for other potential explanations of observed differences in aggressive behavior, we include a vector of demographic, psychological and classroom-level attributes previous research have shown as related to individual aggression. At the individual level, we include the age of the child measured in months (range 87 to 135), and their race/ethnicity (represented by a vector of indicator variables). To characterize the psychological profile of our participants, we include a measure describing the attributional style of the children, and a measure describing their experience with depressive symptomatology. The first construct is measured with an adaptation of the Home Interview Questionnaire (Dalhberg, Toal & Behrens 1996). This measure, includes six vignettes that

depict ambiguous but provocative social scenarios, where participants were asked to select possible causal attributions regarding the intent of the provocateur. Two attributions refer to the provocateurs' intent as benign or accidental (rated 0), and two refer to it as hostile or purposeful (rated 1). We employ the average individual response to these six items to represent hostile attributional bias ($\alpha = 0.81$).

Depressive symptomatology was measured via self-reports of depressive symptoms on the Diagnostic Interview Schedule for Children Predictive Scales (Lucas et al., 2001). This questionnaire contains six items that ask children about whether they have experienced depressive symptoms (e.g. "Has there been a time when nothing was fun for you and you just weren't interested in anything?") since the New Year. Items are rated on a 2-point scales ($no = 0$; $yes = 1$; $\alpha = 0.83$). Finally, to characterize the socio-economic makeup of children and schools we include a measure of classroom size ($M = 19.23$, $SD = 5.18$), and a composite of community risk exposure constructed from parent reports ($\alpha = 0.89$).

Analytic Procedure

To evaluate our hypotheses, we fit a taxonomy of multilevel Tobit regression models. (McDonald & Moffit, 1980; Takeshi, 1984). Preliminary inspection of the univariate distribution of our outcome indicates a large proportion of participants for whom teachers rate aggression at the minimum value of the scale ($N = 201$, $n_{\text{female}} = 106$, $n_{\text{male}} = 75$), suggesting a limited capacity of the scale to detect and record infrequent episodes of direct aggression. This evidence suggests the use of a Tobit model to account for the censoring of students at the lowest levels of our outcome.

An assumption of the Tobit regression model (McDonald et al., 1980; Takeshi, 1984) is that children for whom teacher reports of aggression is the lowest (1.00), could in fact display infrequent, yet existent, levels of aggressive behavior that are not detectable by the established levels of the scale. In consequence, children who otherwise would have obtained a score less than 1.00 are censored and seem – in the sample univariate distribution of the outcome – to pile up at the lowest value. Under this assumption, the dependent variable is regarded as a latent variable that is observed (and has a continuous value) for values greater than 1.00 and censored for values less than or equal to 1.00.

In addition, for all models, we account for the clustering of students in schools by including a random effects component. We estimate this variance component as an indicator of the proportion of variability between schools in teacher reports of child aggression. We fit the following general multilevel Tobit model to test our hypotheses:

$$\begin{aligned} Aggression_{ij}^* = & \left[\beta_{0ij} + \beta_{1ij}(Centrality)_i + \beta_{2ij}(Male)_i + \beta_{3ij}(Centrality \times Male)_i + \beta_{4ij}(\%Male\ Peers)_i \right. \\ & + \beta_{5ij}(\%Male\ Peers \times Centrality)_i + \beta_{6ij}(\%Male\ Peers \times Male)_i + \beta_{7ij}(\%Male\ Peers \times Centrality \times Male)_i \\ & \left. + \alpha_{8ij}(Individual\ Covariates)_i + \gamma_{9ij}(School\ Gender\ Segregation)_j \right] + \left[\mu_j + \varepsilon_{ij} \right] \end{aligned}$$

where $\varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2)$ and $\mu_j \sim N(0, \sigma_u^2)$

In this model, subscripts identify a model that is constructed for student i , in school j . Parameter β_{3ij} , the slope associated with the interaction between predictors *Centrality* and *Male*, represents the difference in the estimated slope of the relationship between aggression and social centrality for male participants, over and above the relationship for girls. Parameter β_{5ij} represents the difference in the estimated slope of the relationship between aggression and social centrality according to the proportion of gender segregated relationships each participant is reported to have, and β_{7ij} represents the estimated difference in the association between social centrality and aggression for male participants according to different proportions of gender segregated relationships these actors are reported to have. Finally, α_{7ij} represents a vector of individual level covariates including both demographic characteristics and psychological attributes hypothesized to be associated with aggressive behavior.

In this model, we represent the school level predictor *gender segregation* (see Method section) with the parameter γ_{9ij} . After estimating the effect of our individual level predictors, we add this predictor to our model as main effect and include it in cross-level interactions between significant predictors at the individual and classroom level. This addition expands and builds from the analytical model presented above. To evaluate these hypotheses, we grand-mean center all our setting-level predictors, following the procedure documented by Enders and Tofghi (2007). Finally, as a test of the robustness of our findings, we estimate our final fitted analytical model for sub-scales of physical and verbal teacher reports of aggression. We present these detailed results in an appendix (Tables A1 and A2), and discuss them below.

Results

We present means and standard deviations of teacher-report of aggressive behavior (outcome), social centrality and the proportion of male peers by gender in Table 2. According to these preliminary results, on average boys are reported as more aggressive by their teachers and associate with slightly more male peers than girls. However, basic mean contrasts do not indicate a statistically significant difference in the social position that boys and girls attain ($t = -0.002$, $p = 0.7$). Building from this preliminary evidence, we present parameter estimates and approximate p -values for fitted models specified to address our major hypotheses in Table 3, and discuss them below.

Centrality and Aggression by Gender

As shown in Model 1 of Table 3, we are able to reject the null hypothesis of a zero association between teacher-reports of aggression and social centrality in the population for both genders. In the case of girls, we detect a negative association ($\beta_3 = -0.43$, $SE = 0.25$), indicating that higher levels of social centrality are associated with lower levels of aggressive behavior among girls. At the same time, we detect a positive association between social centrality and aggression for boys ($\beta_5 = 1.03$, $SE = 0.34$). With a one-unit difference in social centrality associated with 0.60 units difference in the teacher report of aggression for boys ($\chi^2 = 6.32$, $p < 0.01$). Taken together, these two coefficients suggest that boys with higher levels of social centrality have higher levels of aggression, on average, while for girls

higher levels of centrality are associated with lower levels of aggression. To illustrate the magnitude of these differences, in Figure 1 we present fitted relationships between aggression and social centrality for prototypical boys and girls while holding all other predictors in the model at their averages.

In addition, as shown in Table 3 (Model 1) we find a positive and statistically significant association between depressive symptomatology and aggressive behavior. We also find a significant association between the participant age and aggressive behavior: older participants are regarded as more aggressive by their teachers. Finally, there is no association between hostile attributional bias and aggression, after controlling for all other variables in the model.

Centrality and Peer-Gender Segregation

We turn to our second estimated model (Model 2 in Table 3) where we examine the association between the proportion of male peers identified for each participant and their own aggressive behavior. While there isn't a significant main effect of peer-gender segregation, or a significant interaction between this indicator and centrality or gender, there is a statistically significant three-way interaction indicating that boys with high levels of social centrality in social relationships with other boys, are more aggressive than their female or less gender segregated male counterparts ($\beta_8 = 4.85$, $SE = 1.64$). To illustrate these differences, in Figure 2 we present the association between aggression and social centrality for prototypical boys and girls who are identified as having social ties with mostly male or mostly female peers.

As shown in the left panel of Figure 2, boys who attain higher levels of centrality within a context of mostly female peers are reported to be more aggressive than their female counterparts. In addition, in the right panel of Figure 2, we present the corresponding association between social centrality and aggressive behavior, by gender, for participants who *hang around* with mostly male peers (75%). In this case, as indicated by the significant three-way interaction, boys with higher levels of social centrality are estimated as significantly more aggressive than their female counterparts ($\chi^2 = 28.03$, $p < 0.001$).

School-level Gender Segregation

With regard to our final hypothesis, the results presented in Model 3 (Table 3) suggest a negative association between the school level predictor *Gender Segregation* and teacher report of aggression ($\beta_9 = -0.09$, $SE = 1.26$), yet this association is not statistically significant. With this evidence, we do not find any indication of a moderating role of School Gender Segregation on the relationship between social centrality, gender and the proportion of male peers.

Sensitivity Analyses

To evaluate the sensitivity of our findings to different forms of aggression (Little, Henrich, Jones & Hawley, 2003), we estimate all our models using a reclassification of our aggression outcome. We created a physical and verbal aggression variable by including only selected items from the BASC-II scale (Reynolds & Kamphaus 2001). Male participants were rated

by teachers on average 0.05 units lower in verbal aggression, and 0.48 units higher in physical aggression than girls. When we estimate our models using physical and verbal aggression as outcomes we observe that the direction and magnitude of our key parameters do not change importantly. These results are presented in tables A1 and A2 and are available in the appendix.

Among these results, it is worth noting an important finding for physical aggression. Here, while we only find a trend association between *centrality* and *gender* that is moderated by the *percent of male peers* each participant is reported to have ($\beta = 5.72$, $SE = 3.18$), we do find an important effect for this same association that is moderated by both the *percent of male peers* and the *school gender segregation* index. It appears that the association between social centrality and physical aggression is stronger among boys who share a higher proportion of male peers and who are also in schools with greater numbers of boys than girls. While these results are interesting, and seem to support our school-level moderation hypothesis, they only appear on a measure of aggressive behavior where male students are consistently reported as obtaining higher estimated values ($\beta_{\text{male}} = 0.48$, $SE = 0.16$; Model 3 – Table A2). Due to these reasons, we prefer our model specification and results obtained from a more comprehensive measure of aggressive behavior. These observed differences should, nonetheless, be explored by further research.

Discussion

While a fundamental principle of developmental–contextual theories (Bronfenbrenner et al., 1998; Magnusson & Stattin, 1998; Sameroff, 1995) is that development is driven by the interactions among individuals, social groups, and their environments, only recently have we been able to represent and test such models with rigorous quantitative methods. In this paper, we represent multiple levels of classroom and school social ecologies to test hypotheses about relationships between gender, social position and aggressive behavior.

Our results, obtained from a set of multilevel Tobit models, provide a window into the complex dynamics at play between ecological levels. First, at the individual level, we find that boys who are connected to multiple central peers within their classrooms are also those who are reported to have higher average levels of aggression. For boys, differences in their social centrality are associated with higher levels of aggressive behavior. For girls, however, our results suggest that the same differences in social centrality are negatively associated with their aggressive behavior.

These results are consistent with Xie et al. (2003; 2002) and Rodkin et al. (2013) and Rodkin et al. (2006) in that they suggest that among elementary school children, social status is evident in aggressive boys, despite “official” adult narratives about the undesirability of this behavior within school settings (Rodkin et al., 2006). However, our results extend the definition of social centrality to one that highlights the social connections to other central peers: boys who are rated as aggressive by their teachers, are also those who are connected to other central individuals within the classroom.

While our results do not address potential mechanisms that could explain these associations, two possibilities stand out as tentative explanations that could guide further research. On the one hand, aggression may be used by boys as an instrument to establish social ties selectively with other central peers in their classrooms. As such, consistent with Faris and Felmlee, (2011), Estell et al. (2002) and Xu et al. (2004), it may be that within clusters of students there is an alternative social rule that validates the use of aggressive behavior resulting in students who exhibit the higher levels being perceived as more attractive to other children.

On the other hand, our results could be explained by bias embedded in the measure we used on which teachers were asked to rate the aggressive behavior of their students. While an assumption of the BASC-II (Reynolds & Kamphaus, 2001) is that teachers rate each of their students' behavior independently, it is possible that teachers use information about the social connections of boys implicitly or explicitly in their judgments about their behavior (Veenstra et al., 2008). As participant observers of the classroom, teachers are in a unique position to understand multiple relational dynamics occurring simultaneously (Achenbach, McConaughy & Howell, 1987), and as such, it is possible that their judgments about the behavior of their students is influenced by their own perception of the centrality of boys within the classroom.

Our second set of results suggest that the effects of gender may extend beyond its characterization as an individual level attribute into a descriptor of the social interactions in which participants engage during their childhood and adolescence (Faris & Felmlee, 2011). In this paper, we describe the immediate social context of participants by identifying the proportion of their direct social connections that are gender segregated. Our results suggest that boys who attain higher levels of social centrality among a male dominated peer group are also identified as more aggressive than their male and female counterparts who hang around with fewer boys. This finding suggests that, even though prior work has identified girls as showing lower aggression in the context of higher centrality, when we consider the proportion of male peers that each participant has, boys who attain higher levels of social centrality among a gender segregated peer group are also those who exhibit the highest levels of aggressive behavior. These results highlight that aggression is exacerbated, for boys, by a social context in which most of their directly connected peers are also boys. This is somewhat consistent with Dishion et al. (2011) who suggest that aggressive behavior in the peer context is frequently accompanied by peer reinforcements characterized by deviant stories, endorsement of deviant attitudes, norm-violation, and suggestions for subsequent deviant activities. Dishion et al. (2011) also suggests that these sources of social reinforcement are more frequent among male dominated peer groups (Piehler & Dishion, 2007).

Finally, the results reported here were obtained while statistically controlling for other important predictors of aggressive behavior. For example, our estimates of the role of intra-individual psychological processes and risk factors suggests that net of the effect of social centrality and cross-and-within gender relationships, students who report higher levels of depressive symptomatology are also more likely to be identified as aggressive by their teachers. These results provide some support to recent models exploring the co-morbidity of

internalizing and externalizing behaviors (Diamantopoulou et al. 2011; Bongers et al., 2004), and suggest that a portion of the variance of the aggressive response of individuals could be explained by anxiety evoking mechanisms. More importantly, the consideration of these psychological predictors in our work, allows us to directly address a central claim of Faris and Felmlee (2011): Aggression is in fact associated with social status, yet status by itself does not explain the entire phenomenon. Psychological, structural and ecological factors interact in complex ways to explain social and human development.

Limitations and Future Directions

Although this research sheds light on the association between important dimensions of children's peer interactions and their aggression, there are several features that limit the internal and external validity of our inferences. First, all our estimated associations are obtained from cross-sectional, observational data, and as such cannot support directional causal inferences. Second, as noted before the consent rates for this study range from 44% to 79% across schools. While this condition may introduce important bias to individual level estimates, the extent in which they distort the social structure described by social network analysis techniques remains an open question (Kossinets, 2008). For now, we can only assume this issue introduces important sources of bias to our estimates. Finally, it is important to recognize that generalizations of our results are restricted to similar populations of urban elementary-school students. While some of our findings replicate those reported by Faris and Felmlee (2011) from a middle school cohort from three different counties in North Carolina, and those of Garandau et al. (2011) from a sample of elementary school students in the Midwest, only the application of meta-analytic techniques could effectively evaluate how similarities and differences between samples and findings signal important population level dynamics.

Despite these limitations, this paper constitutes an important addition to the literature on peer social relationships in educational contexts; it provides additional evidence of how detailed data on the structure of social relationships among classroom members could be effectively employed to better understand individual behavior. With current theoretical conceptualizations of social relationships within schools and classrooms as a system of multiple nested layers, as well as the increasing use of social network analytic techniques and multilevel analysis, in this paper we attempt to establish a link between a specialized methodological literature and the developmental literature that focuses on the role of social relationships in child behavioral development.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Estimated association between social centrality and teacher report of aggression.
Prototypical values obtained from estimates of Model 1 – Table 3. Sample covariates centered at average.

Figure 2.

Estimated association between social centrality and teacher report of aggression for prototypical boys and girls with low and high proportion of male peers. Prototypical values obtained from estimates of Model 3 – Table 3. Sample covariates centered at average.

Table 1

Univariate Descriptive Statistics on Key Sample Characteristics.

Variable	Analytic Sample (n = 848)		
	Mean	Std. Dev.	Min -Max
<i>Outcome</i>			
Teacher report of Aggression	1.51	0.59	1 – 4
<i>Main Predictors</i>			
Centrality (Composite)	0.19	0.14	0 – 1
Male	0.51	0.50	0 – 1
% of Male Peers *	0.51	0.28	0 – 1
School Segregation *	0.0	0.05	–1 – 1
<i>Control Covariates</i>			
Race – Ethnicity			
Black	0.42	0.49	0 – 1
Latino/a	0.45	0.50	0 – 1
White	0.04	0.20	0 – 1
Other Ethnicity	0.09	0.29	0 – 1
Age (months)	103.37	7.52	87 – 135
Hostile Attributional Bias	0.44	0.34	0 – 1
Depressive Symptomatology	0.33	0.26	0 – 1
Community Risk	2.03	0.58	1 – 4

* Note: Table presented raw values for all the variables. % of Male peers obtains a mean of 0.10 and a standard deviation of 0.09 when centered on each classroom mean.

Table 2

Sample Descriptive Statistics of Teacher-report of Aggression, Social Centrality and Peer Aggression, by Student Gender (n=848).

	Boys		Girls		Difference Test		
	Mean	SD	Mean	SD	dif.	t-test	Sig.
Teacher report of aggression	1.65	0.64	1.37	0.49	0.28	7.11	0.001
Social Centrality	0.19	0.14	0.19	0.13	0.01	0.26	0.792
% of Male Peers	0.48	0.50	0.41	0.49	0.07	2.89	0.004

Note: differences on % of Male Peers estimated on the raw scale (see table 1).

Table 3
Estimated Parameters and Approximate p-values from Three Fitted Multilevel Tobit Regression Models.

	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Intercept	0.34	(0.40)	0.33	(0.39)	0.23	(0.40)
Male	0.12	(0.08)	0.12	(0.08)	0.13~	(0.08)
Centrality	-0.43*	(0.21)	-0.49*	(0.21)	-0.48*	(0.20)
% Male peers			-0.05	(0.16)	-0.05	(0.16)
Male $\times$ Centrality	1.03**	(0.34)	0.93**	(0.34)	0.92**	(0.34)
Male $\times$ % Male Peers			-0.37	(0.22)	-0.39~	(0.23)
% Male Peers $\times$ Centrality			-0.37	(1.22)	-0.69	(1.24)
% Male Peers $\times$ Centrality $\times$ Male			4.85**	(1.64)	5.27**	(1.66)
School gender Segregation (SGS)					-0.09	(1.25)
SGS $\times$ Male					-0.99	(1.51)
SGS $\times$ Centrality					-6.71	(4.83)
SGS $\times$ Centrality $\times$ Male					6.83	(6.68)
SGS $\times$ % Male Peers					1.71	(3.24)
SGS $\times$ % Male Peers $\times$ Male					-6.67	(4.31)
SGS $\times$ % Male Peers $\times$ Centrality					-6.46	(9.95)
SGS $\times$ % Male Peers $\times$ Centrality $\times$ Male					-17.60	(33.95)
Hostile Attributional Bias	0.08	(0.06)	0.07	(0.07)	0.07	(0.07)
Depressive Symptomatology	0.24*	(0.06)	0.23**	(0.08)	0.25*	(0.08)
African American	0.30~	(0.13)	0.29~	(0.13)	0.32*	(0.13)
Latino	0.03	(0.13)	0.03	(0.13)	0.06	(0.13)
Other	-0.16	(0.14)	-0.18	(0.15)	-0.15	(0.15)
Class size	-0.01~	(0.01)	-0.02*	(0.01)	-0.01*	(0.01)
Age	0.01*	(0.00)	0.01*	(0.00)	0.01*	(0.00)
Community Risk	0.06~	(0.03)	0.06	(0.03)	0.06~	(0.03)
<i>Random Effects</i>						
<i>Individual Level</i>						
		0.63	0.62			0.62

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	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
<i>School Level</i>						
<i>Deviance (-2ll)</i>		1583.83	0.17	1563.22		0.15
<i>Deviance</i>			20.61***			7.57

Key:

* $p < .05$,

** $p < .01$,

*** $p < .001$

Note: % of Male Peers and School Gender Segregation (SGS) are introduced in the model as centered predictors.