Titel/Title: The social ecology of intergenerational closure in school class networks. Socio-spatial conditions of parents' norm generation and their effects on students' interpersonal conflicts

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Veröffentlichungsversion/Published version: Postprint

Publikationsform/Type of publication: Artikel/Aufsatz

Empfohlene Zitierung/Recommended citation:

Michael Windzio, Raphael H. Heiberger (2022) The social ecology of intergenerational closure in school class networks. Socio-spatial conditions of parents' norm generation and their effects on students' interpersonal conflicts, Social Networks, https://doi.org/10.1016/j.socnet.2021.12.009

Verfügbar unter/Available at:
(wenn vorhanden, bitte den DOI angeben/please provide the DOI if available)

https://doi.org/10.1016/j.socnet.2021.12.009

Zusätzliche Informationen/Additional information:

Accepted for publication in Social Networks.
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The social ecology of intergenerational closure in school class networks.

Socio-spatial conditions of parents' norm generation and their effects on students' interpersonal conflicts.

Introduction

Context matters. This has been a prevalent sentiment for around a decade among researchers interested in social networks (e.g., Doreian and Conti, 2012; Drouhot, 2017; Entwisle et al., 2007; Mollenhorst, Volker, and Flap, 2014; Müller et al., 2020; Small, Deeds Pamphile, and McMahan, 2015). While micro-mechanisms of network formation (e.g., homophily, reciprocity) have been studied extensively (Leszczensky and Pink, 2019), the question of how micro-level processes (i.e., individual networks) correspond with different meso or macro structures remained open in many studies. McFarland et al. (2014) made a compelling case for moderating effects caused by networks' specific environments. Therein, features of a "network ecology" interact with micro-level mechanisms and lead to potentially different outcomes at the network level.

The main paradigmatic twist by considering network ecologies is to switch the unit of observation. Instead of relying on a single network, or just a few networks, an ecological approach considers many networks across different settings. The ecology becomes a *variable* that represents a variety of social contexts. Ecological analyses of networks allow researchers to account for a network's dependence on its environment. Networks can so be viewed as social systems with particular attributes, e.g., a good classroom climate corresponds with a specific configuration of network ties. Thereby, higher-level conditions of networks (such as other networks, organizations, or neighborhoods) exert either direct selective pressure on behavior and network ties, or moderate mechanisms at the network level.

McFarland et al. (2014) used organizational features of schools (size, differentiation, composition, climate) to examine how a school's ecology shapes students' modes of association (homophily, hierarchy, balance). Many other contextual features influence network ties among school children or adolescents, for instance, the ethnic composition of school classes (Smith et al., 2016), joint course-taking (Frank, Muller, and Mueller, 2013), sport assignments (Jones et al., 2016), or classroom climate (Rijsewijk et al., 2018). Others refer to higher-level social structures and investigate, for instance, the influence of (violent) neighborhoods on adolescent behavior (Chan Tack and Small, 2017; Harding, 2010).

Sociological "classics" like Simmel or Blau have already pointed to the importance of space and spatial propinquity for the study of social ties and the importance of neighborhoods for the everyday life of adolescents is well documented today (Sharkey and Faber, 2014). A recent overview underscores that tie formation is often affected by spatial composition and configuration (Small and Adler, 2019). Yet, the influence of socio-spatial structures on *negative* tie formation (i.e., conflicts) is much less understood, and, in particular, how school environments shape conflicts in classroom networks.

We will focus in our study on *socio-spatial properties of neighborhoods* as network ecologies and their (in)direct effects on tie formation in school classes. More precisely, and in line with research in urban sociology (Sampson, 2004), we investigate how demographic and socio-economic compositions of school neighborhoods influence and moderate network ties of *interpersonal conflict*. In contrast to previous studies on network ecology (e.g., Smith et al., 2016), we do therefore not only investigate friendships or other positive relations; we study network ecologies that potentially undermine social cohesion and social capital within social systems of school classes (Paluck, Shepherd, and Aronow, 2016; Wittek et al., 2020).

Questions that naturally arise are how conflicts might be limited or avoided, and what potential interventions might look like (Valente, 2012). Our (necessarily partial) answer applies a classic argument by James Coleman on intergenerational closure (IC). IC represents a specific network constellation in which parents of befriended children are connected, a 4-cycle. We combine Coleman's approach with the idea of network ecology and argue that ties of interpersonal conflict depend on IC on the micro-level. Moreover, we investigate how factors of the socio-spatial environments of schools increase or decrease conflicts among students and highlight how the effect of IC on conflict is conditional on the *networks' environments*. In particular, we will discuss how the share of immigrants in school neighborhoods and the local situation moderate the correspondence of IC with conflict ties. Thus, unlike many other studies that limit the perspective to (intra-)organizational features of schools' neighborhoods, we ask if (a) IC potentially decreases conflict, (b) how social properties at the district-level (e.g. education, immigration) influence conflict, and (c) whether the immigrant concentration and the economic situation of a neighborhood moderate the association between IC and conflicts.

For that purpose, we employ a two-step procedure. First, we determine the varying strengths of how k=135 school class-networks (N=3,143 students) tend towards intergenerational closure. We do this by assessing how strongly friendships among students correspond with ties among parents in Exponential Random Graph Models (ERGM). The strength of these associations varies between the k=135 social systems under investigation. After transforming the respective coefficients into probability ratios (*PR*), we then regress (standardized) densities of interpersonal conflict networks on the strength of the social systems towards intergenerational closure and on neighborhood characteristics.

In this second step, we regard school class-networks as social systems that are more or less prone to IC. According to our assumption, social systems can generate more binding social norms the more prevalent these 4-cycles are. Our results reveal that intergenerational closure is indeed associated with fewer ties in networks of interpersonal conflict. IC thus creates an "unfavorable" environment for conflict ties, whereas school classes in neighborhoods with high shares of immigrants exhibit higher degrees of conflict. There is, however, an important interaction effect: In neighborhoods with relatively high immigrant concentration, the protective effect of IC is particularly strong. Thus, our results provide evidence for a potential intervention to reduce interpersonal conflicts in school classes in particularly affected neighborhoods: interventions should support relations among parents (e.g., by providing opportunity structures for parents to meet or shared activities).

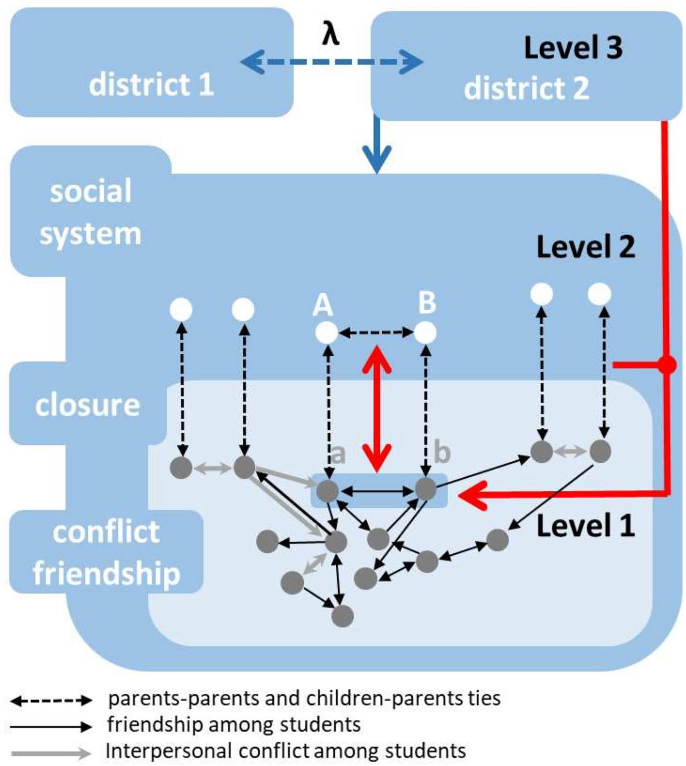
The multilevel structure of network ecologies

When Chicago School sociologists observed the rapid growth of their city, they wondered how to find regularities in the apparent chaos of various interwoven social processes, such as immigration, competition between ethnic groups, economic deprivation, residential segregation, and assimilation (Park and Burgess, 1969; Park et al., 1967). Although this research was focused on micro-level social processes and behaviors, e.g., crime and delinquency in urban areas, the theoretical focus was on the overall "web of community life" and the interdependence of the social and ethnic groups' activities (Turner and Machalek, 2018: p. 104-106). Inspired by Darwin's elaboration of unplanned evolutionary processes, Chicago School sociologists assumed that ethnic groups and their economic and social practices had to find their niches in a competitive urban environment (Park and Burgess, 1969).

In this evolutionary view, social structures, organizational forms and behavioral regularities in given social systems result from sequences of variation and selection (Turner and Machalek, 2018: p. 106-109). According to the organizational ecology tradition, for instance, the selective survival of organizations depends on the interaction of environmental factors, such as niche density, or organizational structures and routines, which strongly correlate with an organization's age and size (Hannan and Freeman, 1989). In our view, the same holds for ties in social networks, for positive ties (e.g., friendship) as well as negative ties (e.g., interpersonal conflict). Depending on the respective local environment and on actor attributes, not all attempts at establishing or maintaining network ties are successful.

In our study, we analyze 135 school classes as social systems with clearly defined boundaries that are nevertheless open to the influence of environmental factors. Elements of these systems are ties in children's social networks, but also ties among students' parents, who usually interact outside of the school class (Level 2 in Figure 1). We align a multilevel approach to selective environments with the network ecology approach on social networks (McFarland et al., 2014). Targets of selection are ties in networks of interpersonal conflict, and units of observation are social systems.

Figure 1: Multilevel theoretical model of network ecologies



Caption: Analytically, social systems such as school classes consist of two levels. At the lower level (Level 1), there are multidimensional ties among children (grey nodes), in our case friendships (black solid arcs) and conflicts (gray solid arcs). At Level 2, there are networks among children's parents (white nodes). For instance, consider the 4-cycle subnetwork A-B;B-b;a-b;a-A. Therein, children's friendship ties and ties among their parents constitute intergenerational closure (IC). The other two dyads shown between parents are unconnected: although children are befriended, there is no contact among their parents. According to our hypothesis, a high tendency towards IC reduces interpersonal conflict among students (grey arcs). The school-class social system, in turn, is embedded in Level 3, which is the school's neighborhood which might exert direct and moderating effects on lower levels. The letter lambda (λ) represents the strength of spatial autocorrelation.

We assume dyadic network ties at the lowest Level 1 to be dependent on their ecology, that is, the surrounding environment (Level 2, cf. Figure 1). While McFarland et al. (2014) examined the influence of organizational settings, we focus on a particular 4-cycle sub-network of children and their parents, which Coleman called *intergenerational closure* (IC) (Coleman, 1987). A norm-generating ecology at Level 2 exerts selective pressure against norm-violating interpersonal behavior at Level 1. This Level 2 ecology can also buffer socio-spatial neighborhood factors (Level 3), which otherwise would increase interpersonal conflicts. In other words, the environment can exert a direct as well as a moderating influence on children's networks of interpersonal conflict (red arrows in Figure 1).

At the lowest Level 1, we assume dyadic networks ties to depend on their ecology at Level 2. According to the IC argument, the network ecology for interpersonal conflicts at this level consists of the 4-cycle sub-network of children and their parents. This ecology at the system's second level exerts selective pressure against norm-violating interpersonal behavior at Level 1. The system's selective capacity results from a micro-mechanism described in Coleman's foundations of social theory: Actors benefit from the mutual exchange of rights to control their actions so that ego can control alter's actions and vice versa (Coleman, 1990: p. 242-243). As a result of this exchange, actors refrain from generating negative externalities to others because the micro-level social exchange facilitates the emergence of social norms.

IC is a specific network topology where friendship ties among young adolescents are embedded in ties among their parents. Closed 4-cycle sub-networks facilitate the flow of information among parents (Level 2) and between children and parents (Levels 1 + 2). It is due to this structure that parents of different families can reach agreement on social norms and coordinate norm enforcement due to their linkages to other parents. Consequently, if the social system of a school-class tends more towards IC, parents can enforce norms more easily and create an unfavorable selective environment against networks of interpersonal conflict (Coleman, 1990: p. 242-243). Coordinated norm enforcement and intervention prevent negative ties of bullying, hassle, quarrel, violence, or other kinds of conflicts. In this perspective, the degree of IC in the respective system is a major factor of why there are comparatively "bad" or "good" school classes with respect to interpersonal conflicts among students. Deviant behavior cannot maintain "a viable environmental relationship" (Hawley 1986) if networks in school classes tend to be closed across generations and thereby facilitate the emergence of a normative environment.

In Coleman's initial elaboration, IC itself depends on a specific ecology (Coleman, 1987; Coleman, 1990). The degree of closure is high if parents socialize in local organizations, such as clubs and churches. As expected by Coleman and in line with social disorganization theory (Sampson, 2004), the degree of social capital in a neighborhood correlates with average socio-economic status and with immigrant concentration (Sampson et al., 1997: p. 921-22). Moreover, the effect of immigration and cultural diversity on social capital has been widely discussed in the wake of Putnam's (2007) "constrict theory" (cf. Tolsma and van der Meer, 2014), which predicts decreasing trust to the out-group *and* the in-group when diversity increases ("hunkering down") (Putnam 2007: p. 149). Unlike Putnam though, who analyzed the effect of ethnic diversity on levels of trust in 41 communities in the U.S., our research focus is on a smaller scale but allows us to directly measure social capital by a specific network structure, i.e., the closed 4-cyle that IC is (Figure 1).

Existing research shows that parents in some immigrant communities in Germany have denser networks than native German parents and are thus *better* integrated (Windzio, 2012; 2015). This result is not surprising in light of the discussion about the "other side" of embeddedness (Waldinger, 1995; Portes, 1998), namely dense and tight networks and high degrees of informal social control in some ethnic groups. While network ties of friendship and conflict depend on the ecology of IC, IC itself is, in our view, embedded in the (socio-spatial) ecology of a school's neighborhood (Level 3). Therefore, environmental properties, such as the share of immigrants in a school's neighborhood, moderate if, and how, the strength of IC shapes the formation of students' networks.

Patterns of residential segregation are often accompanied by spatial interdependence of neighborhoods with respect to social problems (Weatherburn and Lind, 1997). Adjacent neighborhoods are often similar to one another – either because the social composition of the population is similar, or because there is diffusion of information and behavior across proximate districts. We therefore assume each district to be embedded in its own spatial community of other neighborhoods and, in so doing, also include spatial "spill-over" effects in the analysis of school-class networks and their consequences.

The bold red arrows in Figure 1 summarize our main argument. School-class networks are social systems that tend to varying degrees to IC and conflict. We are interested in the effect of IC on conflicts and expect that the more a system tends towards closure, the lower is the density of conflict networks. However, the effect of IC (Level 2) on conflict (Level 1) might be moderated by network ecologies (Level 3), and the latter might have independent (main) effects on conflicts as well.

Behavioral consequences of intergenerational closure

Network ties at the parental level facilitate the creation, coordination, and enforcement of social norms, as well as the handling of children's problems, such as disputes, bullying, or aggressive behavior. As Coleman puts it: "Power, which in the absence of intergenerational closure is in the hands of the children […], is in the hands of parents when such closure exists. They are armed with a set of norms and aid one another in the enforcement of the norms" (Coleman, 1987: p. 189). As we will argue, comparing *social systems* with respect to their propensity towards IC follows directly Coleman's reasoning. For instance, the IC effect against crime in neighborhoods is due to the fact that parent-children 4-cycle networks are more prevalent in neighborhoods with higher degree of social organization. In Coleman's view, social capital is therefore not an individual characteristic, but resides "… in the structure of social organization" (Sampson et al., 1999: 634; cf. Coleman 1987: p. 188; 1990: p. 302). In most communities, IC is a matter of *degree*: not all ties are intergenerational 4-cycles.

Coleman's assumption of a favorable influence of IC on students' academic achievement and decreasing deviant behavior yielded a lot of follow-up research with mixed results (Halpern, 2006: p. 152-153). While the mechanism of IC (parents know each other → enforcement of norms → better achievements) holds for strong-tie school-based networks among parents (Fletcher, Hunter, and Eanes, 2006) and communities with appropriable norms, e.g. Catholics (Morgan and Todd, 2009), other studies find negative effects of IC on achievement in public schools (Morgan and Sørensen, 1999) or high-poverty schools (Fasang, Mangino, and Brückner, 2014). Depending on the outcome of interest, the benefit of closure does not necessarily outweigh its costs, namely tightly-knit ethnic communities, parochialism, "negative" social capital (Waldinger, 1995; Portes, 1998), and limited supply of fresh and diverse information from weak-tie networks (Coleman, 1987: p. 190).

A recent study using network panel data did not find IC-effects on grades (Geven and Werfhorst, 2020) – a change in the exposure to closure does not significantly increase grades within the same individual. The only detectable effect is between individuals, which the authors attribute to unobserved heterogeneity between students. Furthermore, Asian children exhibit strong academic performance even though Asian families only have low levels of IC (Bankston and Zhou, 2002).

In addition, a neighborhood's tendency towards IC depends on its affluence and residential stability, as predicted by social disorganization theory (Sampson et al., 1999; Sampson, 2004). If regular contact to other parents corroborates parents' assumption that other children's parents would sanction deviant behavior as well, they will be more inclined to intervene in the behavior of their own children. Forms of social organization in neighborhoods, e.g., by membership in churches and local organizations, thus correspond with the evolution of normative expectations and an effective normative environment (Oberwittler, 2004: p. 223). Yet, *collective efficacy* theory (Sampson et al., 1997) suggests that visual cues indicating the neighbors' inclination to intervene increase one's own preparedness to do so (and discourage potential norm violators (Keizer et al., 2008)) – a mechanism that also works among *un*connected neighbors. However, given that there *are* networks among parents of befriended children in our research setting, which is based on primary and secondary schools in Germany, we expect IC to facilitate norm generation among parents and thus to appropriately respond to conflicts among children. Regarding IC and its effect in school classes, we thus focus more on a mechanism elaborated in social disorganization theory than in collective efficacy theory.

As with academic achievement, however, empirical evidence on behavioral consequences of IC is ambiguous, which also depends on the variety of analyzed outcomes. Mangino (2009) studied African-American boys and showed that adolescents who exclusively belong to only one peer group tend to be less delinquent compared to boys who hold positions as "social bridges" between groups. Mangino explained this result by the higher influence of parents in more disconnected peer networks (Mangino, 2009). Dijkstra and colleagues tested the functional effect of communities around high schools in the Netherlands and found at least a small negative effect of IC on delinquency (Dijkstra et al., 2004). Others find that IC reduces inconsistent condom use (Moore, 2010: p. 35), but IC is ambivalent with respect to teenage sexual behavior and does not affect the number of sexual partners (Moore, 2010: p. 33). Moreover, while collective efficacy significantly reduces delinquency, the effect of IC can even have a *positive* sign, given the same levels of collective efficacy (Valasik and Barton, 2017), which challenges the assumption of consistently desirable effects of IC. Yet, since collective efficacy is a *global* measure of social capital, the authors conclude that IC might work at a *local* level (i.e., networks) (Valasik and Barton, 2017: p. 1667).

It is a relatively broad definition of IC and an indirect measurement, for instance, to use 5 personal items at the local level, like most studies in the past have done (Sampson, Morenoff, and Earls, 1999). Instead, we propose a multilevel theoretical perspective and suggest to measure IC *directly* by using social network data. Matching ties between parent(A)-parent(B) and child(a)-child(b) (Figure 1) provides a direct metric for Coleman's initial notion of IC, namely a closed 4-cycle network.

While most studies take contact among parents as a given due to clubs, religious, and social organizations in neighborhoods, social network analysis is able to uncover more fine-grained mechanisms. In public schools, children naturally establish friendships with their peers and often start to meet their friends after school, while parents establish ties with one another due to their involvement in these activities (Windzio, 2015). This is especially important in the case of Germany where public schools are clearly predominant. Pre-organized local communities, such as religious groups or (religious) private schools, play instead a less important role than they do, for instance, in the U.S. (Jungbauer-Gans et al., 2012).

Besides obtaining knowledge on parents' relations, another obstacle that previous studies on IC have been facing is how parents use those connections (Carbonaro, 1999). IC is particularly influential if parents show interest in their children's activities and enforce norms, explaining why normative communities like Catholic schools have strong effects. We therefore use items indicating mothers' controlling behavior (see Table 1). We computed school-class-specific mean values of mothers' controlling behavior and tested if school classes with high levels of control tend less towards interpersonal conflict, and whether controlling behavior moderates the IC effect.

In sum, we advance research on IC by aligning it to the network ecology approach and applying it to students' ties of interpersonal conflict. Our empirical model focuses on local-level school class networks, and we generally expect that those school classes where friendship ties among students correspond more strongly with ties among parents are more resilient to interpersonal conflict. Since spatial properties not only influence the degree of conflict density in neighborhoods (Small and Adler, 2019), but also the social capital as a condition of closure, we test direct effects of school classes' embeddings (level 3 → level 1). Following the network ecology approach (McFarland et al., 2014), we also examine moderating effects of the environment's structure on IC, namely the effect of high immigrant concentration in the schools' neighborhoods, and the formation of interpersonal conflict ties.

Data and methods

Data

To investigate the influence of socio-spatial ecologies on interpersonal conflicts in school classes, Germany is an interesting case because it combines a stratified secondary school system with a relatively homogenous population (e.g., Kruse and Kroneberg, 2019). As a result, while social status and academic performance differs strongly *between* school types, school classes are rather homogenous internally. The socio-spatial structures in Germany vary by neighborhood, though to a much lesser degree than in U.S. cities. Ecological effects and the importance of IC should therefore be less pronounced in Germany than in countries with more heterogeneous school classes and neighborhoods, providing us with a "conservative case". Put differently, if we find that socio-spatial ecologies influence school network formations here in Germany, then it is highly likely that those effects are at work in more segregated communities too.

We collected our data in a research project on social integration and interethnic friendship ties in primary and lower secondary schools. In the year 2009, we gathered data from 105 fourth grade primary school classes in Northern Germany, and between 2010 and 2012 we collected three-wave panel data on 1,676 students across grades 5-7 in 94 classes ( ). Respondents are thus 9 to 12-year-old pupils. The overall population in the three-wave panel study consisted of 149 fifth grade school classes, out of which 94 classes in 55 registered schools participated in Wave 1 (year 2010). The response rate varied between these three waves; 1,087 children in 58 school classes completed the questionnaire in Wave 2, and 1,561 children from 65 classes in Wave 3. The majority of school principals were willing to cooperate, but teachers could decide for themselves on participation. Non-response occurred predominantly at the class-level. At the children-level, response rates varied between 75.4 % (Wave 1 in 2010), 80.4 % (Wave 2 in 2011), 80.4 % (Wave 3 in 2012) and 73.89 % in the fourth grade cross-section in 2009 ( ). We included only classes where at least N=16 pupils were present during the survey in the network analysis.[1] Moreover, the project's research question went beyond the analysis of complete social networks, so that

[1] According to our experience, N=16 nodes is the absolute minimum because networks with fewer nodes show a much higher tendency towards non-convergence in the ERGM, or at least towards showing inconsistent results (high coefficients with high standard errors)

interviewers collected data even though the number of participating children in a class was very low. We thus had to drop many classes where the number of children was lower than 16 for the network analysis or where there was no information available on the neighborhood. For this reason, the analysis of networks is limited to N=135 networks.

Pupils completed the questionnaire under the guidance of the interviewer in the classroom, so information on networks is available within classes. To guarantee the anonymity of the information we placed clearly visible ID numbers on the pupils' desks during the survey. Students filled their own ID number into the questionnaire and recorded network contacts with classmates by noting their respective ID numbers. Due to data privacy regulations, numbers were stored in the schools in order to link the observations between the panel waves. Reliability analysis supports our procedure: Matching the information on ego's attendance at alter's birthday party from both perspectives – host and guest – leads to a rate of agreement of 95.44% (wave 1), and a good inter-rater reliability of 0.725 (Cohen's kappa coefficient).

Table 1 shows descriptive statistics of our three networks in the upper panel and actor attributes in the lower panel. While the average density in the friendship networks is 23%, densities in networks of parental contact (4%) and interpersonal conflict in the school class (6%) are considerably lower.

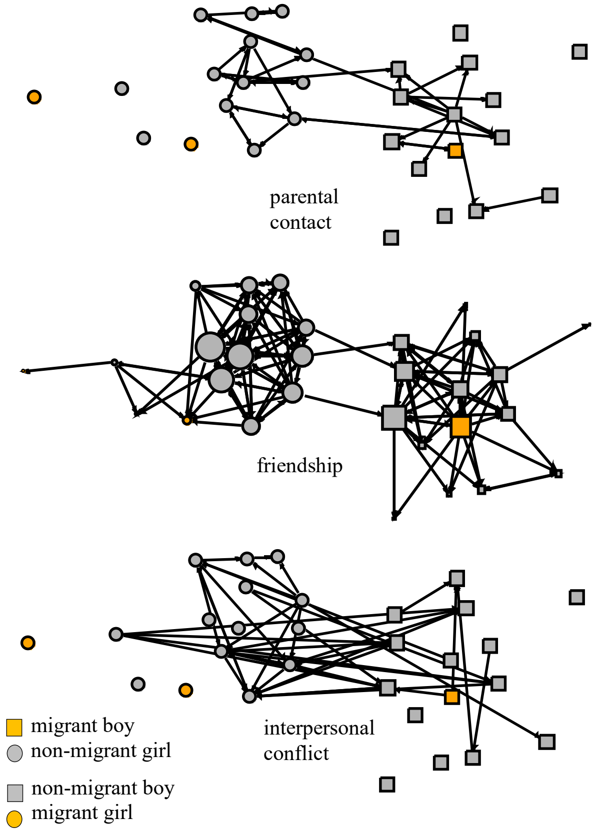
We combined four indicators of mothers' controlling behavior by calculating the mean. The first three items refer to students' leisure time, whereas the fourth item measures the degree of their mother's involvement in school issues. These items load on one factor and a test of their reliability gives a Cronbach's alpha of 0.844. "Mother's control" is an aggregate measure at the level of 135 school classes, which indicates how strongly parents – on average – tend to exert control over their children.

Table 1: Descriptive statistics of k=135 classes, N=3,143 measurements of students

	wording	mean	sd	min	max
Network dimensions					
friendship	Which classmates are your friends?	0.23	0.06	0.09	0.41
parental contact	Do your parents know other classmates' parents (so that they sometimes meet up or phone)	0.04	0.03	0.01	0.28
interpersonal conflict in class	1) Which classmates sometimes say mean things to you or annoy you, and not for fun? 2) With whom do you sometimes have serious arguments or problems?	0.06	0.05	0.01	0.30
Actor attributes					
girl	boy=0; girl=1	0.46	--	0	1
gpa	Grade point average in Maths, English, German, higher = better grades	3.09	0.83	0	5
no. books at home	Number of books in children's household	146.2	67.1	33.5	285.6
own room at home	Respondent has his/her own room at home	0.69	--	0	1
mother's control	Mean of four 4-category items over 135 school classes (1. never, 2. sometimes, 3. often, 4. always) My mother … 1. … knows what I do during leisure time; 2. … knows where I am during leisure time; 3. … knows who I am with during leisure time; 4. … usually asks me how it was at school, One factor, Cronbach's alpha=0.844	3.38	.20	2.46	3.86

Source: own computation

Figure 2: Networks of parental contact, friendship, and interpersonal conflict



Caption: Figure 2 shows the structure of a school-class social system consisting of network ties in three dimensions: contact among parents, friendship, and interpersonal conflict. Squares indicate boys, circles girls, orange color migrant students, and the vertex size in the friendship network indicates degree (see Table A2, appendix, for frequencies of ethnic categories).

Our focus on the behavioral ecology of students' interpersonal conflicts and its relation to intergenerational closure requires data on different dimensions of social networks ("multiplexity"). Figure 2 exemplifies that the friendship network is strongly segregated along gender and its density is considerably higher compared with the network of interpersonal conflict, and in particular ties among parents, which is a consistent pattern over all networks used in our analysis (see densities in Table 1). According to our multilevel theoretical model, our approach is to assess the interdependence between these networks, and consider thereby their neighborhood ecologies.

To collect data on socio-spatial characteristics of each neighborhood, we used official statistics from the "Bremen Kleinräumig" data base[2], which provides information on

[2] https://www.statistik-bremen.de/soev/statwizard_step1.cfm

unemployment, share of immigrants, and shares of students in higher secondary education in the respective school's district.

Methods

Since our research analyzes attributes of social systems (i.e., complete networks), we need to maximize the number of observations at this level. While a subset of the data comprises three waves, we would lose many networks, and, hence, observations if we estimate longitudinal models like Siena. Therefore, we view our data as cross-sectional and analyze them accordingly. We apply a two-stage analysis strategy: First, we estimate exponential random graph models (ERGMs) (Harris, 2014). ERGMs maximize the probability of observing the realization of the empirical network out of the huge set of possible networks by using simulation methods. Among other effects in our model, ERGMs provide the log-odds of how strongly ties among parents correspond with students' friendships. We use the strength of this association as an indicator of the strength of intergenerational closure. The higher the coefficient, the more the social system tends towards embeddedness of children's friendships in ties among their parents. However, it is not possible to compare coefficients across models with fixed residual variances (Long, 1997: p. 70). We use the log odds coefficient $\beta_{closure(k)}$ to compute the change in the *probability* of a friendship corresponding with an increase in closure. The baseline of this probability-change is the density of the friendship network $\beta_{0(k)}$; more precisely, *$\beta_{0(k)}$ is the log odds of the density*.

Although our procedure is similar to discrete unit effects, it is not the same. Discrete unit effects usually result from inserting sample means for all explanatory variables into the estimated equation (Long, 1997: p. 137; Greene, 2000: p. 816). We follow the approach described in Liao (1994: p. 20) and Pampel (2000: p. 25), who suggest computing marginal effects or discrete changes in probabilities in logistic regression models at different fixed probability levels. Instead of overestimating the effects and computing the maximum effect by inserting 0.5, we use the *empirical* density of each friendship network, which brings our procedure very close to the usual discrete unit effect.

$$PR_k = \frac{\exp(\beta_{0(k)} + \beta_{closure(k)}) / (1 + \exp(\beta_{0(k)} + \beta_{closure(k)}))}{\exp(\beta_{0(k)}) / (1 + \exp(\beta_{0(k)}))}, \text{ where } \beta_{0(k)} = \log\left(\frac{density_{(friends(k))}}{1 - density_{(friends(k))}}\right)$$

We applied the ERGMs in the first step to estimate what we call the probability ratio (PR) in the above equation. In the second step, we switch to the school-class social system level and estimate how strongly the PR corresponds with the densities of interpersonal conflict networks. Since human capacity to establish and maintain social ties is generally limited (Dunbar, 2016: p. 72), network densities usually decrease with increasing numbers of nodes. We therefore standardized the densities of the interpersonal conflict networks by dividing the empirical density by [$n/(n-1)$], where n is the number of nodes in the respective network. This procedure downweighs the density, but the weight decreases with increasing network size.

Each school class network shows a specific *strength* of IC as well as a specific (standardized) density of the interpersonal conflict network. According to our theoretical arguments on network ecology effects, the tendency towards IC as well as the densities of the interpersonal conflict networks depend on the ecological embeddedness of these networks in the schools' neighborhoods. Moreover, interpersonal conflicts should correlate negatively with IC, since closure enables parents to develop and enforce norms and thereby create an unfavorable environment for antisocial behavior.

We then shift our perspective from the edge-level in the ERGM to the social system-level. Units of observation are multiplex school class networks of friendship, intergenerational closure and interpersonal conflict. We apply spatial regression models and regress intergenerational closure and conflicts on characteristics of a school's neighborhood as well as on indicators of the school classes. For instance, we argue that not only IC is associated with interpersonal conflicts, but also the average level of parents' tendency to exert social control over their kids. Since educational issues are in many cases at the responsibility of the mother, and since there is a considerable share of female-headed households where fathers are absent and do not substantially contribute to the education of the children, we accounted for mothers' controlling behavior (see Table 1).

As a robustness check, we also compute "bivariate" ERGMs, where we compute the association of parental ties with children's friendships without any further covariates, and use these simplified probability ratios as determinants of ties in the interpersonal conflict network. We perform an additional robustness check by computing the simple change in log odds of friendship ties due to ties among parents (see Table 1B, appendix).

Since schools recruit students from different neighborhoods and students bring their learned routines and practices to school, neighborhoods might not be independent from each other. In order to test this non-independence, we estimate a spatial error model (Ward and Gleditsch, 2008: p. 65). The spatial error model adds an additional term λ, which represents the correlation of the error's spatial component (ξ) due to proximity of neighborhood *i* to *j* defined by the matrix $\boldsymbol{w}_j$. The linear spatial error model[3] is thus:

$$y_i = \boldsymbol{x}_i\boldsymbol{\beta} + \lambda \boldsymbol{w}_j \xi_i + \varepsilon_i$$

Results

Intergenerational closure and friendship ties

We use ERGMs (Harris, 2014) to capture the *tendency towards IC* for each school class social system and combine the results in a random effects (RE) meta-analysis. In accordance with other studies (Kruse et al., 2016; Leszczensky and Pink, 2019), we find that friendship ties are highly mutual, transitive, and driven by homophily with respect to gender and socio-economic status (here operationalized by "having own room") (Model (1) in Table 2).

The likelihood of being friends is more than 5 times (exp(2.3780)) higher if the parents know each other too. That means we find a strong association of IC with friendship ties.[4] Model (2) also includes effects of the continuous covariates "number of books at home" and "gpa maths, german, english", and in- and outdegree, but the effects are small and insignificant and do not strongly alter the IC coefficient. The same is true for Model (3), which does not include any actor attributes, but only network structural effects as well as the dyadic covariate IC. We use coefficients from Model (1) to compute the PRs.

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[3] The cell in the matrix includes 1 if two school classes are in the same neighborhood, 0.5 if the other school class is in an adjacent neighborhood, and 0.25 if the other school is in an adjacent neighborhood of an adjacent neighborhood (that is, one has to cross one intermediary neighborhood), and zero otherwise. Models with spatially lagged dependent variables produced the same result.

[4] We decided to analyze ties in the friendship network as an outcome because the density of parental networks is much lower (Table 1), which would result in more convergence problems. To be sure, a causal interpretation would be inappropriate not only due to the missing dynamics, but also because ties in the parents' network could also be the cause of ties in friendship networks. Nevertheless, the higher the coefficient the more tends the respective social system towards IC.

Table 2: Intergenerational closure. Effects of parent's ties on children's friendships, Exponential Random Graph Models, RE meta-analyses

	(M1)	(M2)	(M3)
edges	-4.8052***	-5.1455***	-4.1544***
mutuality	1.6055***	1.7401***	2.1128***
gwesp (alpha=0.1)	1.3645***	1.3086***	1.6035***
both are girls	1.1748***	1.2534***	--
same ethnic origin	-0.0283	-0.0031	--
outdegree(n. books at home)	--	-0.0007	--
indegree(n. books at home)	--	-0.0002	--
absdiff(n. books at home)	-0.0001	0.0002	--
outdegree (gpa math, germ., engl.)	--	0.0317	--
indegree (gpa math, germ., engl.)	--	0.0640	--
absdiff(gpa math, germ., engl.)	0.0404	0.0357	--
both have own room at home	0.2815***	0.2864***	--
intergenerational closure			
ties in parents' network	2.3780***	2.4339***	2.4582***
Number of networks	k=135	k=132	k=139

$^{+} p < .1$, $^{*} p < .05$, $^{**} p < .01$, $^{***} p < .001$

Caption: Our model of interest, M1, includes k=135 networks. M2 includes more covariates which leads to three more non-converging models, so k=132, while M3 includes fewer covariates, so fewer models did not converge and k = 139.

The meta-analysis of Model (1) in Table 2 rests on 135 classes. In our analysis at the ecology-level, we will use the varying strengths of the associations between IC and friendship derived from each *class-level* ERGM as an indicator of the strength of IC in the respective class. According to our argument, stronger tendencies towards closure result in environments unfavorable to interpersonal conflicts in school classes.[5]

[5] We also calculated a model including e.g. sender and receiver effects for gender. Moreover, we used the nodematch-term for "migrant" instead of ethnic origin. Although the results of this model provide some interesting insights (e.g. there is homophily among either migrants or non-migrants; migrants seem to be more social), this is not the model we based our spatial regression on. Introducing these effects increases convergence problems and reduces

The spatial distribution of IC and the (standardized) density of the interpersonal conflict network is shown in Figure 3, where the colors represent the *strength of both variables' association* in the respective neighborhood.[6] Darker green colors represent *high IC* combined with *low levels of conflict*, darker red colors represent *low IC* combined with *high levels of conflict*. To represent the strength of the association we first computed the mean values of IC and conflict density over all school-classes within each neighborhood. Subsequently, for computing the mean of both variables for each neighborhood, we z-standardized both scales and reversed the conflict-scale by multiplying -1 (cf. caption of Figure 3), so that the latter measures "low conflict density": the higher the value, the *less* conflict-prone are classes the respective neighborhoods on average. Finally, we computed the mean over both scales for each neighborhood. We already see a positive association of IC and low conflict density in Figure 3. As suggested by Coleman (1990), most districts exhibit considerable associations between IC and low conflict density. The overall correlation of IC and low conflict at the level of 35 neighborhoods is 0.38, p=0.02.

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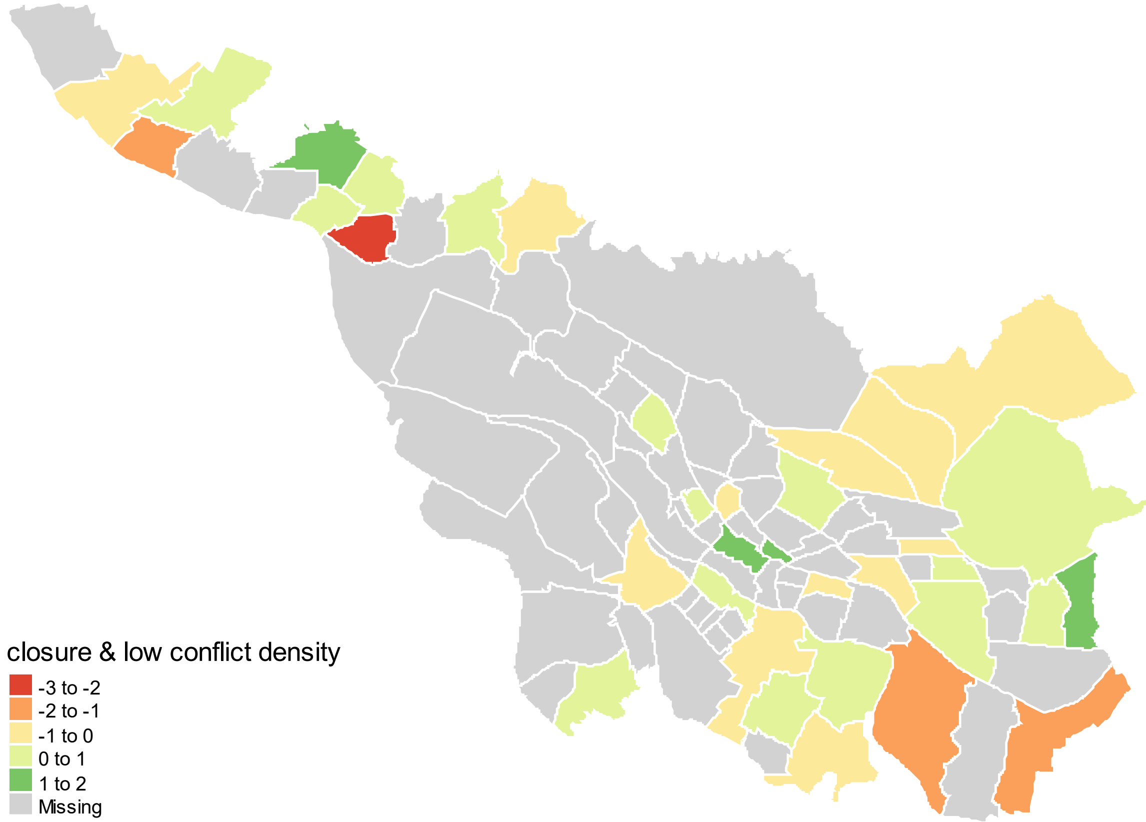
the number of suitable networks to k=76. However, our ecological analysis should be based on a larger sample that represents as much ecological variance as possible. Yet, results are almost the same regarding the relevant effects (compare the intercept and the effect of "ties in parents' network" between M1 in Table 2, and MA1 in Table A3 of the Appendix).

[6] The grey areas represent missing values. Most of them result from the fact that the district has no schools (e.g., industrial areas, harbour).

Figure 3: The socio-spatial association of IC and low conflict density

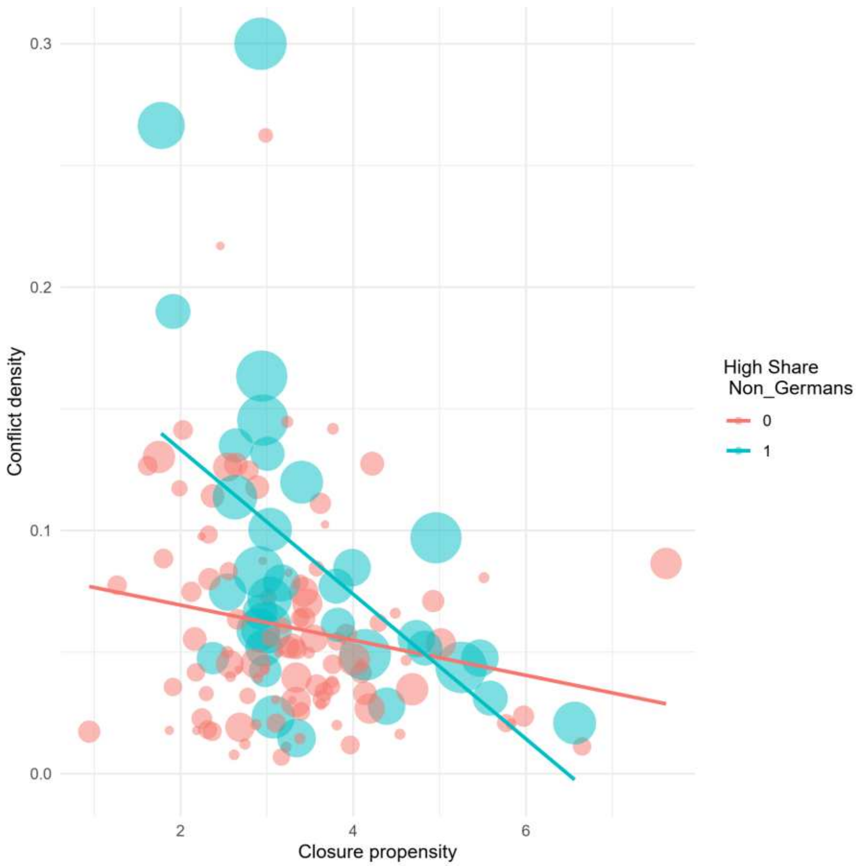


Caption: Figure 3 shows the mean of the combined scales of IC and *low* conflict density across neighborhoods. The darker the green or the red color, the stronger the correspondence of intergenerational closure and low conflict density – the more we see the association suggested by Coleman (1990) of either both high (darker green) or both low values (darker red). However, both variables have different scales. To ensure an intuitive interpretation, before taking the mean over both variables we z-standardized them and reversed the conflict-scale by multiplying -1 (so higher values represent lower conflict density).

Network ecology, intergenerational closure, and interpersonal conflicts

We regard the neighborhood of schools as their social ecology, i.e., the environment which structures how people act and what they do. We assume that the formation of our units of observation (here: school class networks) depend on their ecologies so that some conditions facilitate certain relations while others hinder them. Figure 4 shows the bivariate association between IC and the density of the interpersonal conflict network separately for neighborhoods with a high concentration of immigrants (defined as the highest quartile, which is greater than or equal to 21.39% immigrants in a neighborhood), which we call *diverse neighborhoods*.

Figure 4: The association between IC and the density of the interpersonal conflict network, k=135 classes, by immigrant concentration in neighborhood.



Caption: The lines represent linear regression lines. The size of points corresponds to continuous values for shares of non-Germans in a neighborhood.

As expected according to Coleman's argument, the association of IC and conflict is negative in both types of neighborhood, but the association is particularly strong in diverse neighborhoods. In these neighborhoods, there are some cases with very high conflict densities, while at the same time the propensity towards IC is low. Nevertheless, the overall trend is clear: There is a negative association between IC and the density in the interpersonal conflict network.

Table 3: Network-ecological models for densities of the interpersonal conflict network and IC, linear regressions with a spatial error component.

	(M1) density *conflict* network (sd.)	(M2) density *conflict* network (sd.)
class-level effects		
closure propensity (IC)	-0.008*	-0.009*
mother's control (class mean)	-0.056*	-0.057*
mean no. books in class	-0.018+	-0.017+
mean school well-b. in class	0.008	0.011
% migrants in class	0.000	0.000
% own room at home in class	0.001*	0.001*
neighborhood-level effects		
% unemployed in neighborhood	-0.000	-0.001
diverse neighborhood (1, else 0)	0.032*	0.035**
% migrant stud. higher second.	-0.001	-0.001+
% stud. higher second.	0.000	0.000
interaction effects		
IC X mother's control	--	0.011
IC X unempl. in neighborhood	--	0.000
IC X diverse neighborhood	--	-0.029**
Constant	-0.016	-0.017
Lambda		
Constant	0.156	0.059
Sigma		
Constant	0.043***	0.042***
Observations (networks)	135	135

+ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Following the descriptive trail of Figure 4, we test whether the negative association between IC and conflicts remains robust when we control for relevant confounders. In Model 1 (M1) in Table 3, we see a significantly negative effect of closure propensity, i.e., the propensity towards IC, on conflict density (-0.008*). Moreover, the higher the average tendency of mothers to control their children's leisure time and their school day, the lower the conflict density (-0.056*). This means that in addition to the network-structural effect of closure, the degree of conflict between students depends on norm enforcement by their mothers. The strong effect of mother's control supports Carbonaro's (1999) notions that parents' norm enforcement is not only influenced by IC but also by parents' propensity to intervene. In addition, classes where the average "cultural capital" (operationalized by the number of books at students' homes) is high show lower densities in the interpersonal conflict network (-0.018, significant at the 10% level). Against our intuition, the share of students who have their own room at home is positive, which indicates that when living conditions at home are largely *not* precarious, this has a (small) positive effect on the density of the conflict network.

On the level of school's environment, we find one consistently strong effect. In diverse neighborhoods, i.e., those with high immigrant concentration (greater than the highest quartile, 21.39%), the density of the interpersonal conflict network is significantly increased. In contrast, the higher the share of migrant students in higher secondary schools (the German Gymnasium) in a neighborhood, the lower the density of the conflict network (but not significant in M1).

Model 2 (M2) is the same as M1, but includes interaction effects between IC and neighborhood characteristics in order to test potential moderating influences of network ecologies (see Figure 1). And indeed, M2 confirms the same pattern already seen in Figure 4: The negative main effect of IC on conflict density remains significant, but the effect is amplified for diverse neighborhoods. The interaction effect thus runs contrary to the positive main effect (i.e. increased conflicts) of diverse neighborhoods. As we saw in Figure 4, school classes showing the highest densities of the conflict network are in diverse neighborhoods. Thus, as suggested by the network ecology approach, the environment moderates school class network effects. IC strongly *decreases* tendencies towards denser conflict networks in *diverse* districts.

As we know from existing studies, IC tends to be stronger in some immigrant communities, for instance in the Turkish group, which is the largest minority in Germany (Windzio, 2012). The unequal distribution of IC over minority and majority groups suggests that the effect of IC on conflict might be conditional on the concentration of immigrants in the school environment. In this regard, the interaction effect is straightforward because IC rests on norm enforcement capacities. Our results suggest that in ethnically diverse districts (i.e. relatively low shares of the majority) with high levels of IC, parents are especially important generators and "carriers" of norms. We thus regard IC as a crucial aspect of social capital, which in our case reduces the propensity of social systems (i.e., school class networks) towards interpersonal conflict. However, we also see that not all school class networks in immigrant neighborhoods can benefit from this social capital because in some networks, the propensity towards IC is generally low. These are simultaneously the schools with the highest levels of conflicts and might represent particularly disadvantaged communities (Figure 4).[7]

Discussion

Inspired by network ecology (McFarland et al., 2014), we took a multilevel perspective on interpersonal conflicts in social networks and applied a two-step method to analyze ecological effects in multiplex social networks. At the individual level, we used ERGMs to predict ties in friendship networks as outcomes. In order to determine the strength of intergenerational closure (IC), we predicted *how strongly* friendship ties among students correspond with ties among their parents. IC is a higher-level ecological condition, creating a selective environment for students' network ties, particularly for ties of interpersonal conflict behavior. In line with Coleman's (1987) classic argument, IC is a network's environment and, at the same time, a structural condition of norm generation and norm enforcement. If parents become involved, they can communicate about norms and behavioral standards and enforce those with their children. Our empirical analysis shows that school classes vary considerably with respect to their propensity towards IC. And indeed, network ties of interpersonal conflict do depend on intergenerational closure.

In order to determine the interplay of the effect with the socio-spatial structure in which schools are embedded, we had to switch the analytic perspective to the level of social systems and use many networks as units of observation rather than just analyzing a single network (135 networks with over 3000 student measurements). From this perspective, IC is the ecology for ties in the network of interpersonal conflict. This allows us to answer our focal question, namely how the variance of ecological characteristics influences the variance of interpersonal behavior in social systems. As we have seen, for instance, there is a direct effect of neighborhoods with high immigrant concentration on the density of interpersonal conflict networks. The most important result of our study, however, is the negative effect of IC on the network of interpersonal conflict. As the interaction term underlined, this effect has an even higher magnitude in diverse

[7] In Table 4, we do not find significant spatial autocorrelation (λ). Rerunning M1 only in a bivariate form (not shown here) produces significant spatial autocorrelation at the 10% level, but, as we see in Table 4, this correlation is not significant in the extended models.

neighborhoods. With respect to interpersonal conflicts in school classes, some of these neighborhoods are better than others in mobilizing their social capital.

To date, we do not precisely know the conditions of these differences, but the effect corroborates our theoretical model that explicitly accounts for moderating factors at different levels. Yet, concluding that immigrants show higher levels of social capital could be an ecological fallacy – perhaps *native families* strongly increase IC in neighborhoods with high concentration of immigrants. Nevertheless, robust effects in all models lead to the conclusion that IC is an important resource generated in the students' living environment. Most neighborhoods would benefit from better structural conditions of norm generation so that interpersonal conflicts among students do not undermine the social cohesion in school classes.

IC might therefore be an underutilized measure to reduce deviant behavior of adolescents. While many studies refer to social networks and, for instance, point to effects of social isolation for substance abuse (Copeland et al., 2018), IC as well as its potential moderating effect on schools' ecology are mostly neglected. Given that interpersonal conflicts are crucial for children's development and might also prevent deviant behavior in later life (Paluck et al., 2016), we deem the decrease of conflict associated with IC – particularly in diverse neighborhoods with relatively high conflict potential – a promising basis for further studies and practical applications.

In addition, the negative relationship might point to underlying homophily mechanisms. If we assume that the ethnic segregation in German cities is not randomly distributed but clustered along ethnic affiliations (Windzio and Trommer, 2019), we would expect a greater ethnic similarity of certain minorities in non-majority neighborhoods. While we control for ethnic homophily at the micro-level, homophily in ethnically segregated neighborhoods might so correlate with both, the effect of IC and a lower potential for conflicts due to similar norms. This would underline the importance to investigate IC further as a moderator of lower conflicts.

While our sample rests on German schools and neighborhoods, we regard it as "lower boundary case". If we can identify relatively strong and consistent effects of IC in rather weakly segregated German cities, and if these effects are even amplified in neighborhoods with higher shares of minorities, then it seems highly likely that the influence of IC might be present in more segregated cities (e.g., in the U.S.) as well.

For the purposes of further research, our study might also provide some methodological guidance. Linking 135 school classes with administrative socio-spatial data containing rich information on neighborhoods enabled us to quantify the "ecological footprint" that a school's environment leaves on student conflict networks. The two-way approach (ERGM to assess strength of IC in each class; spatial regression to calculate direct and indirect influence of neighborhoods net of class-level effects) might help to improve our knowledge on the interplay of networks' ecology and (negative or positive) ties in other contexts too.

Appendix A

Table A1: Descriptive statistics of ecological regression model (cf. Table 4)

Variable	k	mean	sd	min	max
density conflict network (sd.)	135	0.07	0.05	0.01	0.30
closure propensity (PR)	135	3.35	1.10	0.94	7.62
(log) closure propensity	135	1.16	0.32	-0.06	2.03
mother's control (centered)	135	0.00	0.20	-0.92	0.48
mean no. books in class (centered)	135	1.46	0.67	0.34	2.86
mean school well-being in class	135	6.75	0.62	4.83	8.00
% migrants in class	135	41.16	20.63	6.67	92.59
% own room at home in class	135	69.97	17.13	22.22	100.00
% unemployed in neighborhood	135	15.65	7.17	4.40	31.90
diverse neighborhood (>=21.39%)	135	7.01	3.51	0.92	13.97
% migrants in neighborhood (age 10-15)	135	14.65	9.81	1.88	37.50
% migrant students higher secondary	135	13.71	7.93	0.00	66.67
% students higher secondary	135	16.29	4.87	6.82	26.90

Table A2: Descriptive statistics of k=135 classes, N=3,143 students, ethnicity

	Freq.	Percent
Germany	2,174	69.17
Turkey	318	10.12
Poland	103	3.28
Serbia/Croatia/Bosnia	41	1.30
Russia/Kazakhstan/Ukraine	178	5.66
Africa	99	3.15
Other	230	7.32
Sum	3,143	100

Source: own computation

Table A3: Intergenerational closure. Effects of parent's ties on children's friendships, Exponential Random Graph Models, RE meta-analyses, extended model specification

	(MA1)
edges	-5.6445***
mutuality	2.0541***
gwesp (alpha=0.1)	1.2582***
both are girls	1.2233***
indegree(girls)	0.1412*
outdegree(girls)	0.0959
both are migrants	0.1797**
indegree(migrants)	0.1119
outdegree(migrants)	0.3148***
absdiff(n. books at home)	0.0003
indegree(n. books at home)	-0.0002
outdegree(n. books at home)	-0.0009
absdiff(gpa math, germ. engl.)	0.0104
indegree(gpa math, germ. engl.)	0.0610
outdegree(gpa math, germ. engl.)	0.0104
both have own room at home	0.0859
indegree (own room at home)	-0.1064
outdegree (own room at home)	0.9109***
intergenerational closure	
ties in parents' network	2.4208***
Number of networks	k=76

$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix B

Table 1B: Network-ecological models for densities of the interpersonal conflict network and IC, linear regressions with a spatial error component. Bivariate Models*

	(M1) density *conflict* prob. ratio	(M2) density *conflict* prob. ratio	(M3) density *conflict* log odds	(M4) density *conflict* log odds
class-level effects				
closure propensity (IC)	-0.011**	-0.011**	-0.015**	-0.014
mother's control (class mean)	-0.056*	-0.058*	-0.058*	-0.058*
mean no. books in class	-0.017+	-0.013	-0.019*	-0.018*
mean school well-b. in class	0.007	0.009	0.008	0.011
% migrants in class	0.000	-0.000	0.000	0.000
% own room at home in class	0.001*	0.001	0.001***	0.001***
neighborhood-level effects				
% unemployed in neighborhood	-0.000	-0.000	0.000	0.000
diverse neighborhood (1, else 0)	0.031*	0.034**	0.031*	0.027*
% migrant stud. higher second.	-0.001	-0.001+	-0.001+	-0.001+
% stud. higher second.	0.001	0.000	0.001	0.000
interaction effects				
IC X mother's control	--	0.011	--	0.031
IC X unempl. in neighborhood	--	0.000	--	0.000
IC X diverse neighborhood	--	-0.033***	--	-0.029*
Constant	-0.006	0.001	-0.052	-0.064
Lambda	0.119	-0.004	0.075	-0.009
Sigma	0.043***	0.040***	0.043***	0.042***
Observations (networks)	135	135	135	135

+ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

* bivariate models: IC predicted without controls. IC always centered because of interaction

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