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# Keeping to the code: How local norms of friendship and dating inform macro-structures of adolescents' romantic networks

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ABSTRACT

Even though romantic partnerships are often understood as pairwise relationships, there is value in conceptualizing the dating patterns of adolescents as network phenomena, particularly as related to the spread of sexually transmitted infections. The current study adopts this perspective to evaluate how a local norm guiding the coexistence of dating and friendship informs macro-level romantic network structures. Using twelve months of romantic relationship data from the Peers and the Emergence of Adolescent Romance (PEAR) study, we find that the global dating network resembles a chain-like, spanning tree structure consistent with that observed by Bearman and colleagues (2004) in their foundational study. Then, through the application of temporal ERGMs, we uncover evidence that adolescents adhere to a social norm against dating their friends' previous romantic partners. We use these findings to empirically ground a series of network simulations, which demonstrate that the romantic network's structure becomes less redundant and more clustered as the norm against dating friends' previous partners is relaxed. By understanding how local norms shape patterns of friendship and dating, we can better conceptualize the macro-level structural patterns of romantic networks and their implications for infectious disease diffusion.

## Introduction

While the COVID-19 global pandemic pushed social networks and their structural properties into mainstream conversation, scholars have long recognized the importance of network structure for disease diffusion (Dezső and Barabási, 2002; Morris, 1993; Valente, 2012). Different network topologies carry unique implications about which actors are at the highest risk of experiencing detrimental outcomes and can inform best practices for public health interventions. Knowledge of macro-level network structures can therefore make the difference between a successful prevention program and a deadly outbreak. However, not only is it difficult to define network boundaries and collect global network data, but the actors embedded in these social systems also tend to have limited awareness of broader, structural patterns. In the current project, we take advantage of sociocentric network data collected in three community-based schools to focus on how macro-structures coevolve with local norms to govern individual and pairwise behavior. When the unwritten rules about who can be tied to whom shape large-scale network structures, these observed associations carry direct implications for curtailing disease diffusion and understanding network evolution.

The link between local norms and global network structure has provided particular insight into how school-based, adolescent romantic networks can facilitate the spread of sexually transmitted infections (STIs). Most notably, Bearman et al. (2004) found that the patterns of adolescent romantic relationships resemble spanning trees defined by long chains and few short cycles. These structures are interesting from an epidemiological standpoint because they simultaneously expose large numbers of network members to infection but are also extremely vulnerable to intervention. Bearman and colleagues argued that this unique structure results from an unstated local norm whereby "persons do not date the former (or current) partner of their former (or current) partner" (2004:74). In other words, the spanning tree structure that defines adolescent dating networks is an artifact of social norms that

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discourage the formation of four-cycles, or instances where actors date the previous partner of their current partner's previous partner.

Although innovative and important, Bearman et al.'s (2004) study is limited by the tenuous face validity of their proposed norm. Few adolescents would recognize a norm against dating "the former partner of their former partner," primarily because it fails to embed adolescent romantic relationships and their dissolution in the broader peer contexts that dominate the high school experience (Sprecher et al., 2006; Kreager and Haynie, 2011). Our study fills this gap by examining the dating and friendship relationships of adolescents enrolled in a Dutch school district. In addition to reconsidering Bearman et al.'s (2004) structural analysis in a contemporary adolescent context, we also propose an alternative, micro-level mechanism that connects adolescent romantic relationships with peer friendships to produce the chain-like structures that define spanning trees. Namely, we draw on Duck's (1982) and Rollie and Duck's (2006) relationship dissolution model to argue that one of the social consequences of adolescent romantic breakups is a prohibition against dating a friend's previous partner (e.g., "Girl Code" or "Bro Code"). We propose that this multi-relational norm has greater face validity than the mechanism presented by Bearman et al. (2004) and creates similar romantic relationship spanning tree structures. To verify this, we conduct empirically-grounded simulations that evaluate how our proposed micro-level mechanism impacts the structure of the broader network. In sum, we expand upon an important prior study with more recent network data and methods, while also proposing and testing a new theoretical mechanism that underlies the observed aggregate network structure.

## Local norms and macro-level network structures

Social network research has long focused on local network structures, such as dyads, triads, and more recently, tetrads (Faust, 2010; Hallinan, 1974; McMillan and Felmlee, 2020; Simmel, 1902). Patterns of social ties within these small groups reflect agreed upon norms or social processes that guide interpersonal interaction. For example, the norm of reciprocity (Gouldner, 1960) encourages actors to return the dyadic ties they receive, whereas the desire for balance, or cognitive consistency (Heider, 1946), manifests through the development of transitive triads (i.e., $a \rightarrow b$, $b \rightarrow c$, and $a \rightarrow c$) (Holland and Leinhardt, 1971).

In addition to encapsulating local norms, small-scale network structures are of interest because the patterns of interaction that connect two to four actors frequently hold implications for macro-level social processes. In the aggregate, observing high numbers of mutually connected pairs corresponds with broader network structures defined by clusters of same-status actors. Alternatively, many asymmetric dyads can result in systems of rigid stratification, with unreciprocated links cutting across the rungs of the social hierarchy (Davis and Leinhardt, 1972). A network characterized by an overrepresentation of transitive triads suggests a structure defined by simultaneous tendencies toward stratification and clustering (Holland and Leinhardt, 1971), creating tight-knit communities with many in-group ties and few between-group ties. Micro-level patterns and their associated local norms also carry implications for broader diffusion processes (Moody, 2011). The sequence of tie formation in a small group, as well as the tendency for actors to maintain concurrent relationships, can either promote or inhibit the spread of information, opportunities, and disease.

By altering the micro-level patterns observed in a network, it becomes clear that many local norms have ramifications for the broader structures of various social networks. For instance, removing the weak connections implied by Granovetter's (1976) "forbidden triad" (i.e., the open triad, $a - b$, $b - c$, but no tie between $a$ and $c$) transforms cohesive graphs into pockets of disconnected subgroups (Friedkin, 1980; Onnela et al., 2007). Open triads are necessary for connecting the broader network because they play a crucial role in bridging pockets of actors who would otherwise be disconnected. Although local patterns do not always scale up to macro-level structures in the ways we expect (Martin, 2009), they remain important building blocks that can explain the emergence of larger groups and institutions.

## Local patterns in adolescent dating networks

Although romantic and sexual relationships are typically understood as intimate, dyad-level processes, a network perspective represents an ideal means to situate this local phenomenon in broader structures of interaction (Connolly et al., 2004; Dunphy, 1963; Furman and Rose, 2015). When patterns of amorous ties occur in a bounded setting, it is possible to construct global, socio-centric networks and observe the ways that individual preferences shape the structures of romantic or sexual exchange. For instance, we know that spatial proximity and structural boundaries lead individuals to seek out romantic partners with whom they share demographic characteristics (Kalmijn and Flap, 2001; Qian and Lichter, 2007). By analyzing the patterns of communication on online dating platforms, previous research finds that these tendencies result in highly clustered networks that are segregated by race, age, and level of physical attractiveness (Felmlee and Kreager, 2018; Lewis, 2013).

In the context of adolescent dating, Bearman et al.'s (2004) enduring study on the structures of teenagers' romantic and sexual networks demonstrates the value of applying this network perspective to link local preferences to macro-level structures. Using survey data from Add Health on respondents' romantic and sexual partners, the authors construct a socio-centric dating network of Jefferson High School, a large public school of over 1000 students located in a predominately White, semirural Midwestern town. Although not nationally representative, Jefferson represents an ideal context for studying adolescent romantic networks because it was the town's only public high school and its relative geographic isolation provided young people few opportunities to date peers outside of school. Contrary to the core-periphery structures common in several adult sexual networks (Aral, 2000; Hethcote and Yorke, 1984; Steen et al., 2000) Bearman and colleagues find that adolescent romantic relationships are arranged as spanning trees, defined by sparse, chain-like structural patterns. This unique network topology leaves large proportions of the population at risk of indirect exposure to STIs, even if they report only one or two direct romantic connections. At the same time, spanning tree networks are extremely fragile and vulnerable to interventions, including those that randomly target small numbers of participants.

To explain the origins of the spanning tree patterns characterizing the observed adolescent dating networks, Bearman et al. (2004) suggest that adolescents follow an unstated local norm such that individuals do not enter partnerships with the previous or current romantic partner of their own former or current partner. Despite the norm's abstract and unarticulated nature, the authors argue that young people associate dating the ex-partner of their ex's current partner as resulting in a public loss of status, with direct implications for local network patterns. More specifically, the unwritten dating rule manifests as an under-representation of four-cycles wherein there are fewer instances where adolescent $a$ dates adolescent $b$, $b$ dates $c$, $c$ dates $d$, and $d$ dates $a$ than would be expected by random chance. Simulations prohibiting four-cycles support this hypothesis and produce networks with the same spanning tree, or chain-like, structure observed in the sampled school.

A handful of recent studies replicate Bearman and colleagues' spanning tree finding across alternate samples and through the application of different methods with varying degrees of success. Given the limited empirical data on adolescents' dating networks, most replications analyze the structures of other romantic or sexual networks, such as television characters' fictional dating networks (adams, 2015) or the adult sexual networks from a community experiencing a gonorrhea outbreak (Marcum et al., 2016). Even in these rather distinct samples, patterns of romantic relationships tend to culminate in chain-like, spanning tree networks, which are typically quantified by uncovering significant aversions to the formation of four-cycles (adams, 2015;

Marcum et al., 2016). Alternatively, a recent analysis focusing on the time ordering of dating relationships fails to find evidence for a significant avoidance of four-cycles in the Jefferson High School network analyzed by Bearman and colleagues (Stadtfeld et al., 2017). Instead, Stadtfeld et al. (2017) argue that the chain-like structure of the dating network results from alternative local norms, such as the tendency for adolescents to be involved in one romantic relationship at a time. The propensity to avoid four-cycles could also vary according to the relational sequence that defines the tetrad, given that individuals are more likely to be aware of their current partner's previous partners than their previous partners' current partners (Moody, 2011). Despite debate over which norms determine the macro-level structure of dating networks, research consistently provides evidence that many dating networks resemble spanning trees and highlights the ways that local patterns inform these structures.

In our study, we return to Bearman et al.'s (2004) original thesis by first mapping the structure of an adolescent romantic relationship network collected from a contemporary site that is, in many ways, quite similar to Jefferson High. We analyze longitudinal network data from the Peers and Emergence of Adolescent Romance (PEAR) study, a project focused on the friendship and romantic relationships of secondary schoolchildren residing in a semirural Dutch town during the 2014–15 school year. Even though our data represent a different cultural context measured almost twenty years after Add Health, the size of the student body, level of racial homogeneity, and degree of relative isolation is comparable to that of Jefferson High. We conceptualize respondents' dating nominations as a socio-centric network and evaluate whether our sample of adolescent romantic relationships comprises a spanning tree network (Research Question 1). Following Bearman et al. (2004), we assess the macro-level structure of our network by considering the prevalence of four-cycles, as well as other global network measures.

## Multiplicity in the local norms of dating networks

Bearman et al. (2004) acknowledge that the rule they introduced to explain the absence of four-cycles in Jefferson High's dating network, "the prohibition against dating an ex-partner's current partner's ex-partner," is a mouthful and would be unrecognizable to the average adolescent. The reason for this obtuseness, we argue, is that Bearman et al. focus on dating to the exclusion of the broader adolescent social context.

Developmental scholars have long recognized that romantic relationships, whether adolescent or adult, are embedded in broader social contexts and that the formation, maintenance, and dissolution of dating ties is shaped by other social connections, particularly platonic friendships. Whereas evidence is mixed as to whether friendships are likely to transition into romantic relationships (Connolly et al., 2000; Kreager et al., 2016), patterns of dating and sexual activity both shape and are shaped by friendships external to amorous dyads. For example, romantic relationships among college students are defined by higher levels of stability if the partners in the couple perceive that their friends approve of the relationship (Felmlee, 2001). In the context of adolescence, Dunphy (1963) recognizes that romantic and sexual relationships tend to be associated with peer popularity and that heterosexual dating among popular youth prompts mixed-sex friendship groups common to late adolescence (see also Furman et al., 2009). Similarly, research finds that adolescent sexual and romantic relationships can increase peer acceptance, although this is a highly gendered process (Kreager et al., 2016).

Given the interconnected nature of dating and friendship ties, norms that guide the coexistence of these distinct relationships should provide insight into how local patterns, such as the aversion to four-cycles, link to macro-level network structures. Global structures, like Bearman et al.'s (2004) spanning trees in adolescent sexual networks, may be better informed by norms that encompass various relationship types, rather than those that focus exclusively on micro-level dating patterns. In our project, we propose an alternative norm that incorporates the competing expectations that arise from the coexistence of dating and friendship in adolescents' social worlds. Specifically, we argue that adolescents will avoid dating their *friends'* previous partners, and that adherence to this social rule will lead to an underrepresentation of four-cycles in the network of romantic and sexual relationships. This friendship-based "no seconds" norm, we assert, has greater face validity among adolescents than the dating-only norm presented by Bearman et al. (2004).

That adolescents promote a rule against dating the ex-partners of friends is consistent with Duck's (1982) and Rollie and Duck's (2006) stage model of relationship dissolution. Accordingly, once romantic partners accept that their relationship is ending, they enter the "social phase" of relationship dissolution and turn to their social networks for support and the creation of public narratives that save face and place blame outside themselves (e.g., toward the partner). Friends are then forced to pick sides and demonstrate loyalty to the partner who is the closer friend and, given the strong sex segregation typical of adolescent friendship networks (Poulin and Pedersen, 2007), that friend is likely to be of the same sex. A prohibition against dating the friend's ex-partner (e.g., colloquially "Girl Code" or "Bro Code") thus provides a clear means of simultaneously demonstrating social support and loyalty, while also placing blame on the (opposite-sex) partner. Furthermore, this allegiance to same-sex friendship is not surprising given that adolescence is a point in the life course where individuals begin experimenting with romantic relationships but still rely on the more familiar bonds of friendship for emotional support (Roisman et al., 2004).

To illustrate how loyalty to same-sex friends over different-sex romantic partners can lead to an aversion of four-cycles, we provide a hypothetical scenario in Fig. 1. At the first time point, adolescents $i$ and $j$ are in a mixed-sex romantic relationship, while also reporting same-sex friendships with actors $k$ and $l$, respectively. If the romantic relationship between adolescents $i$ and $j$ remains intact, various platonic ties should develop across the group of four due to triadic closure and the increased time that the individuals spend together. After the partnership between adolescents $i$ and $j$ dissolves, we suspect that the original, same-sex friendships will prevail. Not only will friends $k$ and $l$ dissolve their friendships with the ex-partner, but because of their support for the same-sex friend, they will also avoid dating the friend's previous partner for the foreseeable future. The four adolescents in Fig. 1 will instead look outside the group when they establish later romantic partnerships, resulting in the two short chains pictured in Panel 3. If this local tendency guides most relevant tetrads in an adolescent social network, then these chains should expand in length and lead to the development of spanning tree network structures.

As Add Health researchers gathered two waves of friendship and dating nomination data in Jefferson High, it is theoretically possible to extend Bearman et al.'s (2004) cross-sectional study into a longitudinal examination of the two networks and test our proposed hypothesis. However, measurement issues severely curtail such analyses. The first two waves of Add Health, which included within-school network nominations, asked all respondents to report their closest friends. However, only the tenth through twelfth grade cohorts were surveyed about their romantic relationships, prohibiting the inclusion of ninth grade dating ties from the network. Additionally, both waves of data were collected from 1995 to 1996 across two different academic years. This resulted in a cohort of students graduating at the end of Time 1 and another cohort joining the sample between the two survey waves. Panel network data is therefore unavailable for *more than half* of the students attending Jefferson High. Additionally, because romantic nominations did not refer to the past year (i.e., "In the last 18 months, have you had a romantic relationship with anyone?") and over 15% of the Wave 2 romantic nominations are missing date information, an additional one-third of the dating ties are not useable due to inconsistent dates or not clearly falling between the two waves. The longitudinal networks in Jefferson High are

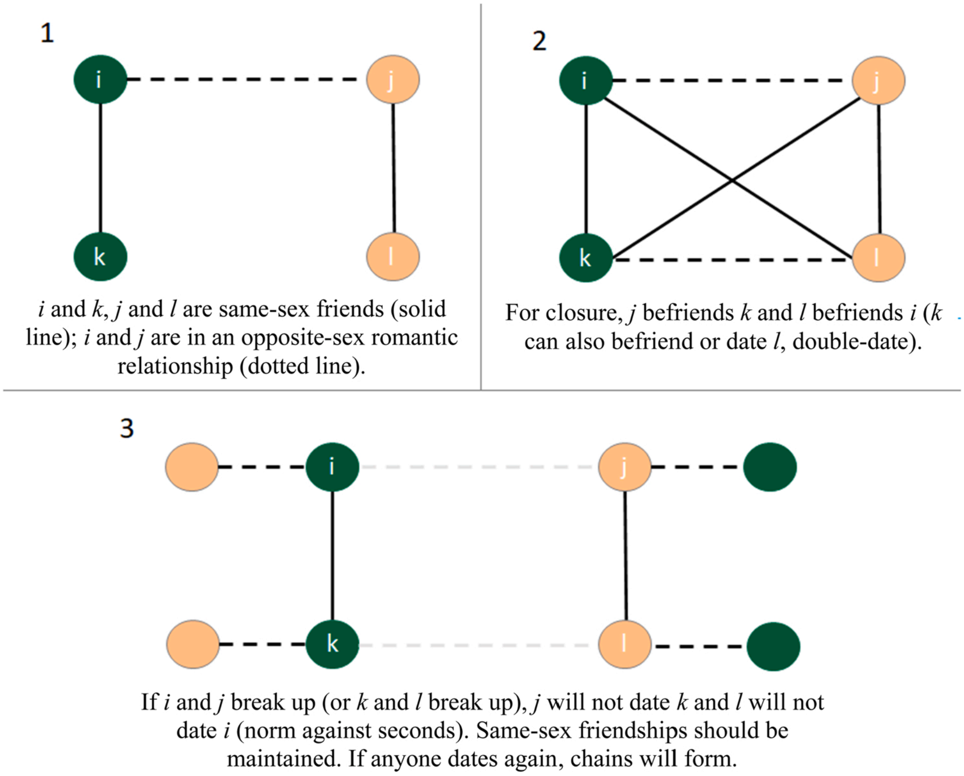


**Fig. 1.** Visual depiction of a social norm against dating friends' previous partners.

then too sparse and unreliable for the analyses we propose.

Instead, we use more recent longitudinal adolescent friendship and dating data that overcome the limitations of Add Health to test whether the romantic networks of adolescents are defined by a social norm against dating a previous partner of a friend (Research Question 2). We then evaluate whether the proposed social norm informs the macro-level structure of adolescent dating networks (Research Question 3). More specifically, we consider whether adjusting actors' tendency to adhere to the norm varies the extent to which a network is defined by a chain-like structure.

## Data

We use data from the Peers and the Emergence of Adolescent Romance (PEAR) study, a two-wave longitudinal survey on adolescent romantic and sexual development. The sample consisted of all students attending four high schools located in a geographically isolated, semi-rural community in the north of the Netherlands. Wave 1 was collected in Fall 2014 and Wave 2 in Spring 2015, with the data collection for each wave occurring within a single month. Students were invited to participate in paper-and-pencil surveys completed in classrooms at the four sampled schools. Of the 2159 students enrolled in the schools, 94% ($n = 2029$) participated in either Wave 1 or Wave 2.

In line with La Roi et al. (2020), we dropped one of the four schools from our sample. This small trade school ($n = 242$ students) required students to spend much of the academic year participating in internships outside of the classroom and thus had a response rate lower than 75%. Of those students who attended the three remaining schools, we dropped students without sex information ($n = 6$), those who changed schools between the two waves of the study ($n = 13$), and respondents who did not report any within-community romantic relationships during the period of the study ($n = 1309$). While our sample had a higher percent of dating isolates than the Jefferson High School network from Add Health, this is because the students in our sample tended to be younger (mean age of the full PEAR sample at Wave 1 = 14.87, SD = 1.59; mean age of the full Jefferson High sample at Wave 1 = 15.73, SD = 1.20). It is important to note that our sample is neither nationally representative, nor does it represent all adolescents in the community. This is because we only focused on respondents involved in at least one within-community romantic partnership during the period of interest.

There are other important differences between our sample and the sample analyzed by Bearman et al. (2004). In addition to data collection occurring over two decades apart, each sample represents a social context potentially defined by different norms about sexuality and dating. For example, Dutch parents and peers tend to situate adolescents' sexual relationships in contexts of romance and social responsibility, whereas American culture focuses on young people's perceived biological impulses and lack of self-restraint (Schalet, 2000). Additionally, the students enrolled in Jefferson High all attended school in the same physical building, while the PEAR study participants attended school in multiple community locations. Finally, the educational tracking systems differ between the American and Dutch contexts. American students tend to complete high school in the same cohorts (graduating together upon completing 12th grade), whereas Dutch youth typically begin secondary education at age 12 (7th grade in the U.S.) and enter an academic tract of varying duration: preparatory vocational secondary education (*VMBO* - 4 years in duration), senior general secondary education (*HAVO* - 5 years in duration), and university preparatory education (*VWO* - 6 years in duration). Compared to Jefferson High, PEAR respondents exit schooling at different ages depending on their tract, with only *VWO* students completing the 12th grade. Together, these cultural and educational differences could result in distinct school-based friendship and dating patterns across the two countries.

Despite these differences, the samples also share many characteristics that enable meaningful network comparisons. First, the PEAR sample includes 607 students, which is roughly the same size as the number of adolescents involved in the within-school dating network of Jefferson High (573 students). Also like Jefferson High, the PEAR dating network is defined by a fairly-even sex ratio (49.26% female) and limited racial/ethnic diversity (72.65% Dutch). Finally, youth from both contexts lived in relatively isolated communities and had limited opportunities to form romantic partnerships with peers outside of the school-based networks.

### Measuring and constructing dating networks

At both waves of the survey, PEAR students were asked to nominate their current and previous dating partners. The first wave instructed students to report up to five romantic partners from the past nine months, or since the start of the previous winter holiday, while the second wave asked respondents to limit their nominations to partners from the past three months (i.e., since the initial fall survey). The latter helped to clearly delineate the relationships that persisted, began, or ended *between* the two survey waves. To construct socio-centric dating networks, we considered only within-community nominations as this allowed us to link each nominated partner to their individual-level data. Note that a key strength of our study design is that we were able to identify cross-school and cross-grade nominations, and these are included in the dating network. Following Bearman et al. (2004), we weakly symmetrized all dating tie nominations (e.g., if adolescent $i$ reports dating adolescent $j$, but adolescent $j$ does not report dating adolescent $i$, then we assume a relationship exists between $i$ and $j$).

To evaluate Research Question 1 (i.e., Are dating adolescents connected by a spanning tree network structure?), we constructed a dating network that combined students' partner nominations from both the first and second waves of the survey. Collapsing our longitudinal data was necessary for observing the global structure of dating networks because the tendency for individuals to date one partner at a time results in sparse networks at single, discrete time points. Combining students' responses across survey waves resulted in a network of romantic partnerships across 12 months. While this represents a shorter time period than Add Health's Jefferson High School dating network, our study design benefited from the within-year data collection because the sample remains highly consistent across waves. To make our findings comparable to those from Bearman et al. (2004), we excluded same-sex dating relationships ($n = 48$ ties, or 9.21%). However, supplemental analyses demonstrate that results are substantively similar when same-sex relationships are included (see Supplemental Materials, Part A).

To evaluate the macro-level structure of the dating network quantitatively, we calculated a variety of global network measures. First, we counted the number of four-cycles that were present in the network. We defined four-cycles as tetrads in which adolescent $i$ dates adolescent $j$, $j$ dates $k$, $k$ dates $l$, and $l$ dates $i$, but no other dating ties are present within the group of four. Given the restrictions placed on our sample, all four-cycles included two female and two male actors. Because the total number of four-cycles present depends on the number of opportunities for such configurations to form, or the number of three paths (e.g., $i$ dates $j$, $j$ dates $k$, and $k$ dates $l$), we also calculate Robins and Alexander's (2004) bipartite clustering coefficient. The coefficient is equal to the number of closed three paths divided by the number of all three paths and ranges from 0 to 1. Next, we calculated a network-level measure of betweenness centralization. Betweenness centralization also ranges from 0 to 1, with a measure of 1 suggesting that a single actor sits on the shortest path of all other actor pairs, whereas a measure of 0 indicates that all actors have equivalent betweenness centrality (Freeman, 1978). Finally, we calculated three measures focused on the largest connected component (LCC) of the observed dating network. Measures included: (a) the number of nodes in the component, (b) the average geodesic distance, or shortest path length, between each pair, and (c) the diameter, or the maximum geodesic distance.

### TERGMs

We evaluated Research Questions 2 (i.e., Is there a social norm against dating a previous partner of a friend?) and 3 (i.e., Does the proposed norm inform the macro-level structure of adolescent dating networks?) by estimating temporal exponential random graph models (TERGMs) (Cranmer et al., 2021; Hanneke et al., 2010). TERGMs represent an extension to traditional ERGMs for cross-sectional data and are ideal for analyzing how the structural patterns of a network change over discrete periods of time (e.g., Faris et al., 2020; McFarland et al., 2014; McMillan et al., 2020; Schaefer et al., 2011). Through the application of TERGMs, one can determine whether the patterns in an observed network significantly differ from what would be expected by random chance while controlling for various individual-level, dyadic, and structural patterns. Most notably, TERGMs enable the inclusion of parameters that relate to both the time point when the dependent network was observed, as well as from earlier points in time.

To estimate TERGMs on the dating networks of our sample, we collapsed respondents dating nominations into two discrete time periods. This resulted in two $n \times n$ matrices (where $n$ equals the number of actors): $\boldsymbol{Y}^1$, the dating network from the initial time period, and $\boldsymbol{Y}^2$, the dependent dating network at the final time point. The TERGM estimates that $\boldsymbol{Y}^2$ will occur, given a set of network actors and covariates such that:

$$P(\boldsymbol{Y}^1|\boldsymbol{Y}^2, \theta) = \frac{\exp[\theta^T h(\boldsymbol{Y}^1, \boldsymbol{Y}^2)]}{k(\theta, \boldsymbol{Y}^1)}$$

Here, $\theta$ is a vector of coefficients that are hypothesized to shape tie patterns in the dependent network and $h(\boldsymbol{Y}^1, \boldsymbol{Y}^2)$ is a vector of network statistics that are calculated from the adjacency matrices at either of the two time points. Finally, $k(\theta, \boldsymbol{Y}^1)$ serves as a normalizing factor to ensure that we are predicting a legitimate probability distribution.

We used TERGMS rather than stochastic actor-oriented models (SAOMs) (Ripley et al., 2021; Snijders, 2001) because it was not possible to incorporate the observed dating data that occurred before the first survey and between survey waves within an SAOM framework. This is because SAOMs rely on a series of micro-steps that simulate the formation and dissolution of relational ties between waves of panel data. We found that it was necessary to control for all previous relationships that occurred across time, rather than only those that existed at discrete time points, because prior relationships are a strong predictor of future relationships.

#### *TERGM dependent network*

We constructed our dependent dating network ($\boldsymbol{Y}^2$) by considering respondents' nominations of their romantic partners at the second wave of the study. To evaluate our research questions, it was necessary to limit our dependent network to include only those romantic relationships that were *currently* intact. If a respondent reported a romantic relationship during the last 3 months that ended before the second wave of the survey was administered, that relationship was not included in the dependent network but instead conceptualized as a previous dating tie that occurred during the first time period. We focused on current romantic relationships because this allowed us to make precise comparisons with the network data collected on friendships, which we discuss in the following section.

#### *TERGM parameters*

Our key parameter of interest is a dyad-level covariate that indicates whether a pair of actors can violate the proposed dating norm by dating their friends' Time 1 romantic partner in the Time 2 dating network. In addition to asking respondents about their romantic partners, students were also instructed to nominate an unlimited number of their current, within-community best friends at both waves of the study. Using the weakly symmetrized versions of both relational networks, we constructed a binary variable that takes on a value of 1 for each cross-sex dyad where the formation of a Time 2 dating tie would represent a respondent dating a friend's previous romantic partner. More specifically, the input for the norm violation parameter is an $n \times n$ matrix where an $(i,j)$ cell will equal 1 if there exists a respondent, $k$, who is currently dating $j$ at Time 1, $i$ and $k$ are friends at Time 1, and no current romantic relationship is reported between $i$ and $j$ at Time 1. Given our focus on mixed-sex partnerships, we considered only those triads where adolescents $i$ and $k$ report the same sex and respondent $j$ reports a different sex. Additionally, we weakly symmetrized the norm violation matrix so that $(i,j) = 1$ when either respondent $i$ or $j$ can violate the proposed norm because the dependent network variable is symmetric. As a result, a negative value of the parameter's coefficient would suggest that there exists a tendency to avoid dating your friends' previous partners at later time points.

We included various individual-level, dyadic, and structural parameters to serve as controls in our model and to isolate the independent effect of our parameter of interest (i.e., the norm against dating a friends' ex-partner). At the level of the individual, we constructed a set of parameters to account for actors' indegree centrality in the Time 1 friendship matrix because receiving friendship nominations and adolescent participation in romantic relationships tend to be positively correlated (Furman and Rose, 2015; Miller et al., 2009; Savickaitė et al., 2020). We constructed a measure of friendship indegree using nominations received from any peers who participated in the PEAR study, regardless of whether they reported a within-school romantic partnership and were included in our final sample. In addition to an individual-level variable that tested whether adolescents with higher Time 1 friendship indegree were more likely to report current romantic relationships at Time 2, we included a quadratic version of this parameter to account for a potential curvilinear relation between friendship nominations and dating.

Our model included several dyad-level parameters to control for other processes that shape the co-occurrence of dating and friendship ties. To account for the temporal nature of or data, we first controlled for whether each dyad reported a shared history of romantic relationships prior to the second time point of the study. We constructed this measure by collapsing respondents' nominations for previous dating partners from both survey waves. During the first wave of the survey, all respondents were asked to nominate partners they were currently dating or dated in the past nine months, while the second wave asked students about their current partners and the peers they dated during the three months since the prior survey. The input for the dyad-level parameter is a binary matrix where $(i,j) = 1$ if respondent $i$ or $j$ reported a relationship during the nine months prior to the first wave of the survey, at Wave 1, or during the three months between Waves 1 and 2.

Individuals are more likely to meet and interact with their connections' connections, whether these social ties be defined by friendship, dating, or other pro-social relationships (Davis, 1970). To control for this tendency, we included a parameter that accounts for the social distance between each actor pair. Constructing the input matrix for the social distance control consisted of three steps. First, we created a network that combined respondents' friendship and current dating nominations such that two actors were linked if they nominated one another for either relationship type during the first wave of the study. Then, we used this cumulative network to calculate the geodesic distance between each pair of actors in the combined network of current dating and friendship ties reported at the first survey wave. In this cumulative network, a geodesic distance of 1 indicates that a pair were either dating, friends, or reported both relationship types at Wave 1. A geodesic distance of 2 suggests that a dyad had one mutual connection in common through bonds of friendship, dating, or a combination of these two relationships. Finally, we dichotomized this measure such that geodesic distances greater than 2 were assigned a value of 1, indicating a relatively high social distance, whereas pairs with geodesic distances of 2 or less were assigned a value of 0. We used these cut-points to create the dichotomized social distance variable to compare dyads that could violate the proposed dating norm to other pairs who were connected by an equivalent social distance. All mixed-sex dyads that could date a friend's prior partner were, by definition, connected by a geodesic distance of either 1 or 2 in the combined network.

Given the norm proposed by Bearman et al. (2004), we also included a dyad-level control that indicates the presence of open three paths in the Time 1 dating network that could close at Time 2. More specifically, the parameter considers an input matrix where each $(i,j)$ cell equals 1 if at Time 1, respondent $i$ dated respondent $k$, respondent $j$ dated $l$, respondent $k$ dated $l$, but respondent $i$ and $j$ did not date. A negative and significant value of the closed three path coefficient would indicate that adolescents tend to avoid dating the exes of their previous partners' partners. Additionally, we included two dyad-level controls to account for actors' positions in the friendship networks at both time points of the survey. The first parameter evaluates wheter sustained friendships, or ties that persisted across the two waves of the survey, inform the dependent network, whereas the second considers dissolved friendships (i.e., Time 1 friendships that were no longer reported at Time 2). To construct both parameters, we considered the weakly symmetrized versions of the Time 1 and Time 2 friendship networks, which resulted in input matrices that were also symmetric.

Next, we accounted for homophily in the dating network by controlling for matching on school, grade level (7th through 12th), and ethnicity. Students hailed from one of the three different schools in the community and multiple grade levels. For grade level, only the *VWO* students were in the 12th grade cohort and only the *VWO* and *HAVO* students were in the 11th grade cohort. Ethnicity was constructed by considering students responses to two questions about their country of birth and their parents' country of birth. We coded participants as ethnic minority members if either they or their parents were born in non-Western countries, whereas other participants were coded as ethnic majority members (see La Roi et al., 2020). In additional models (see Supplemental Materials, Part A), we included measures for homophily on various individual-level behaviors and attitudes (e.g., smoking, drinking, religiosity). The findings are substantively similar to those presented here.

Given our project's focus on mixed-sex partnerships, all models induced structural holes between same-sex dyads. This was accomplished by including two dyad-level parameters that account for same-sex mixing. One focused on pairs where both actors reported being male and the other accounted for dyads where both individuals reported being female. Instead of estimating the coefficients of the two parameters (which is not possible given the definition of our sample), we fixed the coefficient of each to equal negative infinity.

Finally, we included two structural parameters in our TERGMs. The first accounted for skew in the dependent network's degree distribution (or the lack thereof). By incorporating this parameter, we controlled for the tendency of adolescents to date one person at a time. The second accounted for the number of edges in the dependent network, or its density, by including a statistic that is equal to the number of current dating relationships reported at Time 2.

## Network simulations

After achieving adequate convergence and goodness of fit (see Supplemental Materials, Part 3), we used the estimated TERGM coefficients to produce empirically-grounded simulations of our Time 2 dating network (for additional details, see Handcock et al., 2008). First, we produced a baseline simulation where all coefficients remained at their observed level. Then, to test our third research question, we adjusted the size of the coefficient for the dyad-level parameter that indicates whether each pair can form a relationship that violates the proposed dating norm. All other TERGM coefficients were kept at their observed level, except for the value of the edges coefficient. It was necessary to adjust the size of the edges coefficient given the interdependent nature of the network processes that TERGM parameters capture. Increasing the size of the dating norm coefficient results in more dating ties that connect individuals to their friends' previous partners, and this produces simulated networks with greater densities than the observed network. By reducing the size of the edges coefficient, we could ensure that network density remained constant when comparing structural patterns across the simulated networks.

Each set of adjusted coefficients produced a network representing the expected dating patterns at Time 2. Because we keep density constant across all simulated Time 2 dating networks, all graphs are exceptionally sparse (density = 0.0005). The sparsity of the networks and the general infrequency of the norm violation make it difficult to observe dramatic structural changes in the simulated networks. Thus, we consider a wide range of coefficients for the norm violation coefficient (−2 to 3). Large, positive coefficient values are unlikely to characterize many observed dating networks, but we include such scenarios because they illuminate the structural implications of situations where daters increasingly ignore the norm.

Because the global dating network structures developed over time, rather than instantaneously, we next constructed a series of cumulative dating networks that merged the observed, previous dating data with the Time 2 simulated dating networks. Each collapsed dating network included all current and previous relationships observed at the first survey wave, all observed relationships that occurred and dissolved between the two waves, and a simulated network of current relationships at Time 2. For each scenario of interest, we simulated 1000 current Time 2 dating networks and combined these with the observed relational data. This resulted in 1000 cumulative networks for each set of adjusted TERGM coefficients.

To compare the macro-structures of the cumulative networks across the different conditions, we calculated the average count of four-cycles and Robins and Alexander's (2004) clustering coefficient across the cumulative networks for each scenario. Then, we identified the LCC of each cumulative network and calculated the size (in number of actors), diameter, and mean geodesic distance. Because measures of geodesic distance are positively correlated with the number of nodes in a network, we normalized the LCC diameter and mean geodesic distance by dividing each measure by the natural log of the number of nodes in each LCC. Chain-like spanning tree networks are expected to have few cycles, low redundancy, and sparse densities (Bearman et al., 2004). If the norm contributes to the chain-like structure of adolescent dating networks, then increasing the coefficient for the friendship-dating norm should lead to more four-cycles, as well as larger LCCs with shorter diameters and smaller mean geodesic distances.

## Results

### *Network structure*

We visualize the adolescent dating network in Fig. 2. Here, time is suppressed, so dating ties reported across both study waves are presented. The 12-month dating network resembles a spanning tree where actors are connected through long, chain-like links of romantic relationships, not unlike the structures observed in Jefferson High School. Quantitative measures give further support to these visual patterns (see Table 1). The cumulative network was exceptionally sparse (density = 0.005) and betweenness centralization was low (0.060). Few four-cycles were present (8 total) and only 0.41% of Time 1 three paths closed to form a Time 2 four-cycle. Even though the average degree of each actor was 1.84 and nearly half of the sample (48.64%) reported only one romantic partner during the period of interest, roughly 28.89% of different-sex actor pairs were reachable in the dating network.

The dating network consisted of many components (143 in total) ranging from disconnected dyads to large groups. Similar to Jefferson

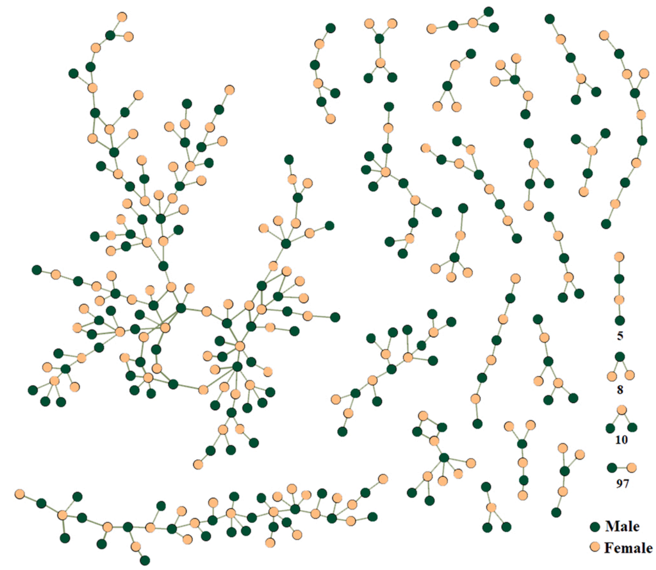


**Fig. 2.** Observed dating network with all waves collapsed and the largest connected component presented in the upper-left corner.

**Table 1**
Descriptive results at the level of the network, dyad, and individual.

| | Value |
|---|---|
| *Network-level* | |
| Density | 0.005 |
| Betweenness centralization | 0.060 |
| Number of four-cycles | 8 |
| Clustering coefficient | 0.048 |
| Reachability | 0.289 |
| Diameter of LCC | 24 |
| Average geodesic distance in LCC | 9.576 |
| | (4.245) |
| *Dyad-level* (n = *92,029 mixed-sex pairs)* | |
| % who date during the period of interest | 0.51% |
| % that date before T2 | 0.46% |
| % that date at T2 | 0.09% |
| Number of dyads that could violate norm | 1980 |
| % who violate the rule at T2 | 0.20% |
| Number of dyads that could close a four-cycle | 486 |
| % who form a four-cycle at T2 | 0.41% |
| *Individual-level* (n = *607 actors)* | |
| % female | 49.26% |
| % ethnic minority | 12.69% |
| School | |
| School 1 | 43.16% |
| School 2 | 47.94% |
| School 3 | 8.90% |
| Grade level | |
| 7th | 18.45% |
| 8th | 17.96% |
| 9th | 24.22% |
| 10th | 28.34% |
| 11th | 8.90% |
| 12th | 2.14% |
| Average T1 friendship indegree | 7.745 |
| | (3.771) |

*Notes*: Network-level descriptive statistics refer to the time-collapsed dating network. Standard deviations are in parentheticals. Network-level statistics do not include isolated dyads (following Bearman et al., 2004). Findings are similar when isolated dyads are included.

High School, the dating network for our sample was defined by one large component of 142 adolescents that included several of the high degree actors from whom several short, chain-like branches originate. These branches connected many adolescents who reported only one dating connection across the 12 months of the study (or roughly 43% of actors in the LCC). Despite reporting a single romantic relationship, these adolescents remained reachable to all 141 of their peers in the LCC, though most were only accessible through long distances. The average geodesic distance of the LCC was 9.58 and the diameter was 24, meaning that the two most distant adolescents were separated by 24 dating relationships.

Unlike the Jefferson High School dating network, the LCC encompassed a plurality, but not majority of the adolescents who reported previous romantic and sexual relationships (23.7% of adolescents in the sample). 250 respondents (41.2%) were contained in components of three or fewer actors (e.g., isolated dyads and open triads). The remaining third of adolescents in our sample were part of intermediate sized components (ranging from 4 to 44 nodes), which were largely absent from the dating network of Jefferson High School.

### *Local patterns*

By focusing on the level of the dyad, we evaluated how often adolescents violated our proposed dating norm at Time 2 (see Table 1). There are 1980 mixed-sex (*i*,*j*) dyads where adolescents *i* and *j* did not date at Time 1, but adolescent *j* dated a different sex adolescent *k* who was simultaneously friends with adolescent *i*. At Time 2, four of these dyads (0.2%) reported a romantic relationship, meaning that actor *i* dated friend *k*'s previous partner and violated the proposed norm. Whereas most adolescents who could date a friend's previous partner failed to do so by Time 2, dating was more common among pairs where a norm violation was possible than it was in the full sample at Time 2 (0.09% of mixed-sex dyads). Although this latter finding suggests that adolescents date their friends' previous partners more frequently than would be expected by chance, it does not account for other factors correlated with an individual's odds of dating and reporting friends. For this, we estimated multivariate TERGMs.

Table 2 presents the TERGM results and provides evidence that, net of covariates, adolescent daters were significantly less likely to date friends' previous partners ($b = -1.347, p < .05$). If adolescent *i* reported a same-sex friendship with adolescent *k* at Time 1 and adolescents *k* and *j* were simultaneously involved in a mixed-sex romantic relationship, then adolescents *i* and *j* had roughly 74% lower odds of dating at Time 2, controlling for all other variables in the model. In other words, adolescent *k* is expected to follow a social norm that discourages adolescents from dating their friends' previous romantic partners. In supplemental analyses, we evaluated whether there were sex differences in violating the social norm (i.e., are female adolescents more or less likely to date their friends' previous partners than male adolescents?) and found no evidence of a significant difference (see Supplemental Materials, Part A).[3]

**Table 2**
TERGM results for Time 2 dating network.

| | Coef. | SE | |
|---|---|---|---|
| Potential to violate dating norm | -1.347 | 0.583 | * |
| Romantic relationship history | 1.799 | 0.327 | *** |
| Socially distant | -2.077 | 0.353 | *** |
| Closed three path | 0.949 | 0.765 | |
| T1 friendship indegree | 0.012 | 0.088 | |
| T1 friendship indegree squared | -0.002 | 0.005 | |
| Stable friendship (T1 + T2) | 2.896 | 0.354 | *** |
| T1 friendship only | 1.021 | 0.450 | * |
| Same grade | 0.909 | 0.299 | *** |
| Same school | 1.300 | 0.371 | *** |
| Same ethnicity | 0.204 | 0.328 | |
| Both female | -Inf | 0.000 | *** |
| Both male | -Inf | 0.000 | *** |
| GW degree ($\alpha = 0.1$) | 3.808 | 1.104 | *** |
| Edges | -14.042 | 2.354 | *** |
| *n* | 607 | | |

*Notes*: * $p < .05$, *** $p < .001$.

In addition to our hypothesized dating norm, we found evidence that several other factors contributed significantly to the observed patterns of Time 2 dating ties. At the level of the dyad, a history of romantic relationships was associated with higher odds of adolescent daters reporting a current romantic relationship at Time 2 ($b = 1.799$, $p < .001$). A pair who dated prior to Time 2 was roughly 6 times more likely to date at the second time point than pairs who did not share this romantic history. The positive direction of this coefficient results from couples staying together across both time points, as well as couples breaking up between waves of the survey and then reconnecting before the second survey was administered. Our data do not enable us to peel apart these two processes.

After controlling for the tendency for adolescents to avoid dating their friends' previous partners, we did not find a significant tendency for adolescents to avoid forming four-cycles in the Time 2 dating network ($b = 0.949$, $p = .21$). We argue that this finding supports our argument that the abstract nature of the norm against dating the ex-partner of your previous partners' current partner can be articulated more succinctly by considering the co-existence of dating and friendship. Socially distant dyads were less likely to date than socially close pairs ($b = -2.077$, $p < .001$). More specifically, if a pair was reachable through one or two Time 1 friendship or dating links, their odds of currently dating at Time 2 were more than 8 times greater than pairs who could not reach one another at these distances. We also found evidence that certain friendships were associated with higher odds of dating at Time 2. Mixed-sex friendships that remained stable across the two waves were 18 times more likely to lead to current Time 2 romantic relationships within our sample of dating adolescents ($b = 2.896$, $p < .001$). Friendships that were only present at the first wave of the study were almost 3 times more likely to result in Time 2 dating ties ($b = 1.021$, $p < .05$). Finally, we uncovered evidence for homophily by grade and school level in the Time 2 dating network ($b = 0.909$, $p < .001$; $b = 1.300$, $p < .001$), but did not find that adolescents were more likely to date same ethnicity peers than would be expected by random chance ($b = 0.204$, $p = .532$).

Additionally, the set of individual-level controls for respondents' indegree in the Time 1 friendship network suggested a curvilinear relation between receiving friendship nominations and reporting Time 2 dating relationships, but neither coefficient was statistically significant ($b = 0.012$, $p = .89$; $b = -0.002$, $p = .62$). In supplemental analyses, we also considered same- and mixed-sex friendships separately. We found some evidence that receiving high numbers of nominations from different-sex peers at Time 1 was associated with higher odds of dating at Time 2, while the reverse association held for same-sex friends. However, coefficients were not statistically significant, and we continued to observe a significant tendency to avoid dating friends' previous partners (see Supplemental Materials, Part A).

Coefficients for the structural parameters were in the expected directions. The coefficient for the geometrically weighted degree term was positive and significant ($b = 3.808$, $p < .001$). This finding suggests that the Time 2 current dating network was defined by a relatively uniform degree distribution, an artifact that resulted from the tendency for individuals to date one partner at a time. Finally, the coefficient for the edges term was negative and significant ($b = -14.042$, $p < .001$), which reflects the sparsity of the dependent network.

[3] We also considered whether adolescents were more likely to date their friends' previous partners if the partner attended a different school and if adolescents with multiple partners were more likely to violate the norm. In both cases, we found no evidence of a statistically significant difference.

*TERGM simulations*

Next, we used the observed coefficients to simulate current Time 2 dating networks under five alternative scenarios. Results suggest that adolescent dating networks exhibit increasingly more four-cycles when the social norm is relaxed (see Fig. 3). When the coefficient for violating the dating norm remained at its observed level ($b = -1.347$), combining the simulated Time 2 network with the observed dating networks from prior time points resulted in a network defined by an average of 8.541 four-cycles. Alternatively, when we simulated a dating network in which there was no social norm that prohibited dating friends' previous partners ($b = 0$), the cumulative dating network of our sample was expected to include a slightly greater number of four-cycles, 8.837 on average. Of even more note, when we reversed the dating norm by assigning a positive coefficient to the parameter, there was a continuous increase in the number of four-cycles observed across the cumulative networks. For example, when we set the coefficient equal to 3, suggesting a strong tendency toward dating friends' previous partners, we would expect to see an average of 11.361 four-cycles in the combined network. Variations in the clustering coefficient across simulated scenarios further suggest that the increasing number of four-cycles is not solely the result of more opportunities to close three paths. Instead, the proportion of closed three paths increased for larger values of the dating norm coefficient.

The observed trends for other global measures also suggest that networks become less chain-like as we relax the norm against dating friends' previous partners, but differences are less pronounced (see Fig. 3). For instance, the average diameter and mean geodesic distance of the LCC tend to decrease as the size of the term's coefficient increases, although there are some exceptions. We also observed a positive correlation between the average size of each cumulative network's LCC and the dating norm coefficient. Taken together, these trends suggest that dating ties become more redundant as we relax actors' adherence to the dating norm.

The differences in these global measures may appear modest across scenarios, but we maintain that these variations are noteworthy. This is because the simulated networks are exceptionally sparse, and all the cumulative networks include the same 1980 romantic relationships observed in the first nine months of the study. More specifically, each simulation run varies the position of only 84 relationships that occurred during the last three months of the study. After altering the position of only these dating ties, we were still able to uncover convincing evidence for an association between our proposed social norm and the macro-level structure of the adolescent dating network. As a robustness

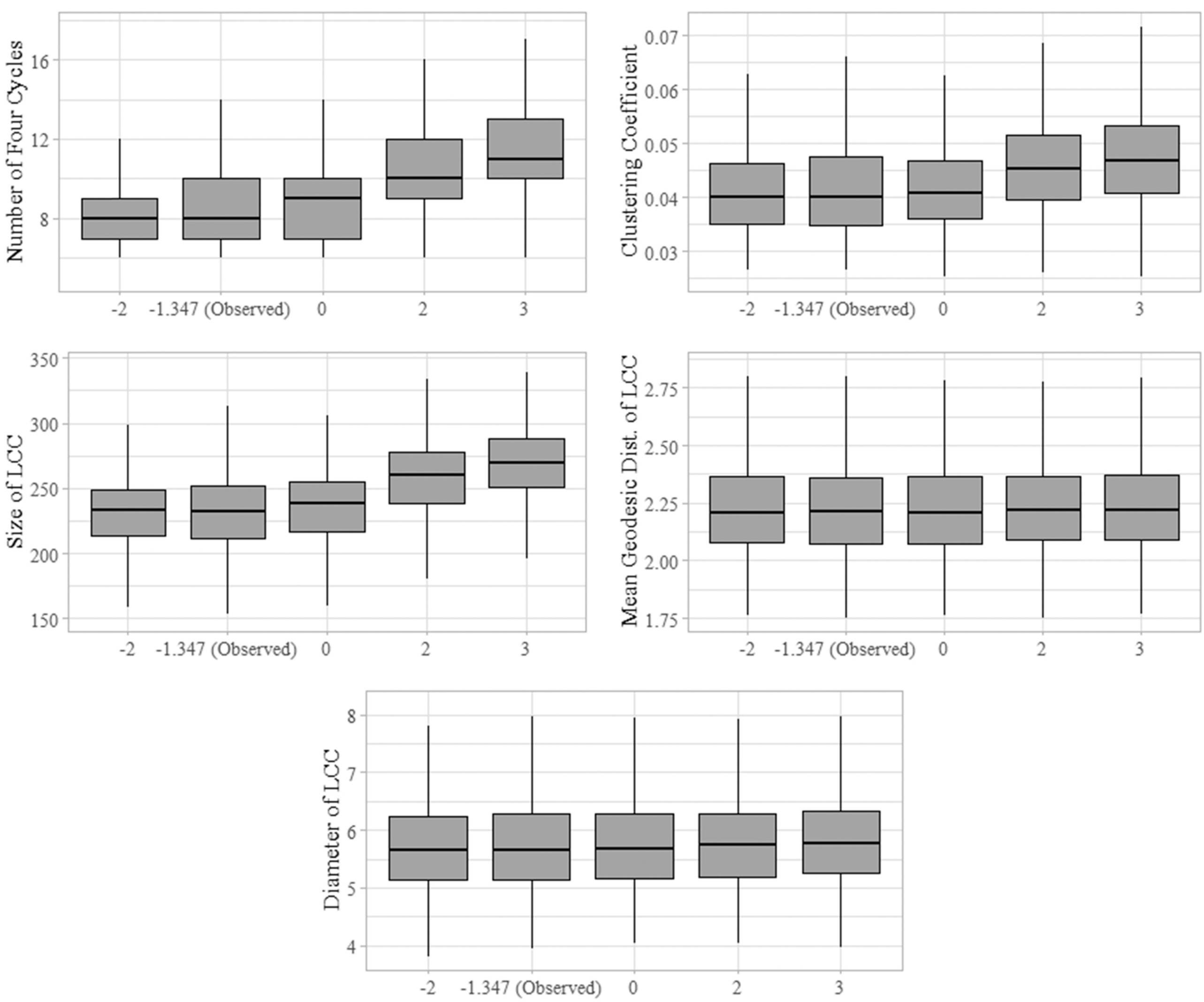


**Fig. 3.** Descriptive measures for simulation analyses across observed and fixed coefficient values. Results are based on 1000 simulations per scenario. All measures refer to networks that collapse the observed dating network before Time 2 and the simulated network at Time 2. Geodesic distances and diameters are normalized according to the size of the LCC in nodes. Outliers (defined as observations outside of the median ± 1.5 × the interquartile range) are removed for the purpose of visualization. Averages and standard deviations for all measures are presented in the Supplemental Materials, Part B.

check, we performed additional simulations that followed the same procedure, but changed the coefficient value of the socially distant term. This parameter was not expected to relate to the spanning tree structure but was similar in size and direction to the norm violation coefficient. While some variations emerge across the scenarios, they were minimal and not in the expected directions (see Supplemental Materials, Part B).

## Discussion

Although romantic partnerships are often conceptualized as intimate, pairwise processes, key insights about adolescent dating patterns can be gained by focusing on the dynamics that occur outside of the dyad. Applying a network approach, Bearman and colleagues (2004) find that adolescent romantic networks adopt chain-like, spanning tree structures, which carries implications for disease diffusion and raises questions about local norms prohibiting romantic four-cycles. In our project, we examined the macro-structure and micro-level mechanisms of an adolescent dating network from a different national context and collected nearly two decades after the network analyzed by Bearman and colleagues. Remarkably, the dating network of our sample exhibited a similar tree-like structure defined by few four-cycles and long geodesic distances, suggesting this structure is endemic to many secondary schools across time and space. By considering how bonds of friendship shape the development of dating, we also found evidence for a newly proposed social norm guiding youth dating patterns. Namely, the adolescents in our sample tended to avoid dating their friends' previous partners. Not only does this norm guide adolescents' local dating decisions, but it also carries implications for the broader structure of the dating network. If young people did not avoid dating their friends' previous partners, the romantic networks of adolescents would be increasingly redundant, less chain-like, and more robust to public health interventions.

As in Bearman et al.'s (2004) Jefferson High, the 12-month dating network from our Dutch sample consisted of many disconnected clusters, including a largest connected component (LCC) that encapsulated a sizeable percentage of the sample's daters. Such network structures are known to promote the spread of sexually transmitted infections (STIs), particularly to low-risk segments of the population. Most adolescents in the network's LCC report only one or two partnerships, for example, but can reach large proportions of their peers through indirect links of dating connections. While STIs may spread rapidly through spanning tree networks, this capacity for diffusion is accompanied by high levels of fragility (Bearman et al., 2004). Intervention efforts can successfully curtail an outbreak's spread by targeting small, random samples of actors embedded in these structures because there are few redundant connections to keep the broader structure intact. Finding repeated evidence of a chain-like structure in a more recent and Western European dating network suggests a continued relevance and generalizability of the public health policies implied by Bearman et al.'s (2004) study.

Even though the metrics that define our sample's dating network are largely similar to those of Jefferson High, important differences also emerged. Mid-sized components ranging from four to a couple dozen actors were prevalent in our network, as opposed to Jefferson High where there were relatively few. We suspect that this difference is the result of the shorter time span of our data compared to the Add Health study (12 versus 18 months) rather than differences between U.S. and Dutch contexts. If we could continue to observe the dating patterns of our sample for another half year, we predict that new dating relationships would form to link these midsized clusters to the largest component, resulting in a LCC that includes the majority of daters.

To investigate how local norms determine the macro-level structure of adolescents' romantic networks, we considered the co-occurrence of dating and friendship ties. We found that there exists a strong tendency to avoid dating friends' previous romantic partners after accounting for other individual and dyadic factors that shape adolescent dating. More specifically, an adolescent is less likely to date a different-sex peer if that peer dated their same-sex friend at an earlier time point. This finding is consistent with the sex segregation typical of adolescent friendship networks and Duck's (1982) and Rollie and Duck's (2006) "social phase" of relationship dissolution where individuals draw on close friends to demonstrate loyalty by vilifying the ex-partner and placing them "off-limits" as a future romantic relationship.

A norm against dating the ex-partner of a friend (e.g., "Girl Code" or "Bro Code") would also protect adolescents from the status loss Bearman et al. (2004) associated with four-cycles in dating networks. Whereas romantic and sexual activity is typically associated with a boost in status (Furman and Rose, 2015; Miller et al., 2009; Savickaitė et al., 2020), dating the ex-partner of a friend could cause the loss not only of that friendship, but also other platonic bonds. For example, the broader peer group may judge that an adolescent who dates the ex-partner of a friend as having sabotaged the friend's earlier romantic relationship, behavior that would be accompanied with severe social penalties and stigmatization. In sum, allegiances to friends and strong desires not to lose status have direct ramifications for adolescents' decisions about who to date and who to avoid.

Through a series of simulations, we found that the local norm against dating a friend's previous partner carries implications for the broader structure of the network. Even though our simulations modified few romantic ties, networks exhibited more four-cycles, higher clustering coefficients, and smaller average distances between individuals as the norm was relaxed. This pattern was particularly evident when the norm was reversed such that students were *more* likely to date those peers with whom their friends had previous relationships than would be expected by chance. The redundant connections that develop when adolescents date friends' previous partners leads to graphs that look less like spanning trees and more closely resemble a macro-structure implied by the core model of STI diffusion (Aral, 2000; Hethcote and Yorke, 1984). According to core models, romantic networks are characterized by dense, interconnected pockets of high-risk individuals who have limited ties to peers outside the cluster. While transmission from core to non-core actors is less efficient in these networks, public health officials need to be purposeful when deciding which actors to enroll in interventions that target these populations. Recruiting random participants is less likely to curtail an infection's spread because those who are highly embedded play a disproportionate role in connecting the broader network.

By recognizing a local norm that incorporates the network patterns of dating and friendship simultaneously, we can gain insight into why adolescent dating networks resemble spanning trees rather than cores or other macro-level structures. The social fabric that connects students in a secondary school is not only intricate, but also carries implications for various individual-level outcomes (Coleman, 1961; Kreager and Haynie, 2011; Sprecher et al., 2006). In contrast to other periods of the life course, friendships are uniquely salient during the "fishbowl" of adolescence and youth are consistently found to prioritize being accepted by their peers and fitting in with their friend group (Laursen and Veenstra, 2021). Among populations where core models are successfully applied to explain patterns of amorous relationships (e.g., adult labor migrants living in a Tanzanian mining community, Steen et al., 2000), we suspect that friendships are less significant and associated with fewer social rewards and costs. Dating a friend's previous partners should carry minimal consequences when friendship and peers are less integral to daily life, and, as a result, redundant ties and dense cores may come to define a population's romantic network. When public health officials work to combat STI outbreaks they should not only consider the social norms that guide dating and sexual relationships, but also those that dictate the platonic bonds of friendship. In contexts where friendship is more salient, networks of romantic ties should more closely resemble spanning trees. Thus, intervention programs are expected to be as, or even more, effective when participants are enrolled randomly, rather than selected according to individual-level measures of risk.

There are also limitations that qualify our findings. First, our study only focused on romantic relationships between male and female adolescents. While supplemental analyses demonstrate that findings are similar when same-sex romantic relationships are included, future research focused on the dating patterns of sexual and gender minority youth is required. Second, we restricted our analytic sample to include only those adolescents who reported at least one within-community dating connection during the course of the study. As a result, our findings do not necessarily hold for non-dating youth. We suspect that the tendency to avoid dating the previous partners of friends would be even stronger if non-daters could be included in our models because non-daters, by definition, cannot violate the proposed norm. Finally, we considered only within-community dating ties in the analyses presented here. Unlike much previous work on school-based social networks, we are able to consider some cross-school dating ties in our analyses, but the survey design prohibited the inclusion of romantic ties to partners outside of the three schools in the community (e.g., partners who had exited secondary education). Depending on the salience of friendship across the various foci where cross-community dating ties formed (e.g., neighborhoods, religious institutions, online), their inclusion may either increase or restrict adherence to the social norm, which would result in consequences for the network's structure.

In sum, our project uncovers a crucial, yet understudied, mechanism that governs the macro-level patterns of young people's dating networks. Adolescents are significantly less likely to date their friends' previous partners, and this local norm has ramifications for the sparse, chain-like structure commonly observed in young people's romantic networks. By focusing on the connection between micro-level norms and global structures of interaction, our findings highlight the importance of adopting a multiplex network perspective when studying the romantic relationships of adolescents. The unique structures observed across multiple adolescent dating networks is not the result of local norms that focus solely on young people's dating behaviors, but also of patterns of friendship.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.socnet.2021.11.012.

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