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The Interplay Between Gender and Structure: Dynamics of Adolescent Friendships in Single-Gender Classes and Mixed-Gender Classes

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This study reviews theories on striving for closure in adolescent networks related to trust issues of adolescents and further examines whether adolescents in mixed-gender and single-gender classes are different in striving for closure. Stochastic actor-based models for network dynamics are applied to test our hypotheses based on longitudinal friendship nominations of 406 Taiwanese adolescents in mixed-gender, all-boy, and all-girl classes. The results show that adolescents strive for closure through connections of friends' friends. Further, the results reveal that while the tendency toward closure is stronger for girls in mixed-gender classes, such tendency toward closure is stronger in all-boy classes than in all-girl classes. Testing effects between types of classes supports the indications of variances in striving closure.

Making friends is an essential part of life for adolescents at school. Adolescent friendships have received a great deal of attention in interdisciplinary research as an important component in adolescents' relationships (Brown, Eicher, & Petrie, 1986; Cohen, 1977; Coleman, 1961; Giordano, 2003; Wentzel, 2009). In light of extensive surveys on the influence of friendships on adolescents' learning and adjustment, an increasing number of studies have adapted a network perspective in constructing friendships as relational networks and argue that it is the structural feature of friendship networks that influences adolescents (e.g., academic performance, substance use, and sexual relationships; Knecht, 2008; Knecht, Burk, Weesie, & Steglich, 2010; Mercken, Snijders, Steglich, Vartiainen, & De Vries, 2010a; Steglich, Snijders, & Pearson, 2010). Nevertheless, investigations into friendship networks remain few because the main application is teenagers' behavior rather than the friendships themselves.

Closure is a prominent network feature and, as documented in earlier studies, refers to the extent to which friends of a friend also become friends of the focal actor (Coleman, 1990; Davis, 1970). In adolescent research, we identified 25 empirical studies based on longitudinal networks of early or late adolescents reporting such a positive tendency. However, we point out three components that are generally different or ignored by those studies. First, the majority of the studies focus on the coevolution of networks and behavior such as alcohol use, the carrying of weapons, or other deviant behavior rather than specifically on the tendency to build closed networks (Baerveldt, Völker, & Van Rossem, 2008; Dijkstra et al., 2010; Kiuru, Burk, Laursen, Salmela-Aro, & Nurmi, 2010; Knecht, 2008, ch. 3; Knecht, Baerveldt, Snijders, Steglich, & Raub, 2010; Knecht, Burk et al., 2010; Light & Dishion, 2007; Mercer & Derosier, 2010; Mercken, Snijders, Steglich, & De Vries, 2009; Mercken et al., 2010a; Mercken, Snijders, Steglich, Vartiainen, & De Vries, 2010b; Ojanen, Sijtsema, Hawley, & Little, 2010; Snijders & Baerveldt, 2003; Steglich, Sinclair, Holliday, & Moore, 2012; Steglich et al., 2010; Van Zalk, Kerr, Branje, Stattin, & Meeus, 2010). Limited attention is given as to why closure (measured as

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transitivity (see transitive closure in measurement below; see Smångs, 2010; Snijders, Van de Bunt, & Steglich, 2010) should be a preferred network characteristic, opting instead to include closure merely as a control. Second, while gender is an important factor for adolescents' socialization (Lobel, Nov-Krispin, Schiller, Lobel, & Feldman, 2004; Perry & Pauletti, 2011), the majority of studies only test whether gender makes a difference in striving for closure, failing to draw any theoretical arguments (Burk, Kerr, & Stattin, 2008; Burk, Steglich, & Snijders, 2007; Lomi, Snijders, Steglich, & Torló, 2011; Preciado, Snijders, Burk, Stattin, & Kerr, 2012; Schaefer, Light, Fabes, Hanish, & Martin, 2010; Weerman, 2011). Third, even though studies by Lubbers, Snijders, and Van der Werf (2011) and Mercken et al. (2010a) did include theoretical arguments on gender differences, the findings remain inconclusive on distinctive closure effects between male and female adolescents. Given these suggested weaknesses, this study builds up theoretical arguments on closure and further examines whether there are variances in closure between girls and boys in different types of classes. Last, because we have (as will be explained in more detail below) mixed-gender classes and single-gender classes, we can also compare the differences in tendencies toward closure between mixed-gender and single-gender classes for boys and girls.

Adolescent Friendship Networks and Closure

Adolescence is the crucial period to develop self-identity, and friends are a key source in shaping self-identity. Adolescents typically want their friendships to be trustworthy and loyal, allowing them to feel understood and comfortable seeking support (Brown, Mory, & Kinney, 1994; Giordano, 2003; Sherif & Sherif, 1964; Way & Silverman, 2012). Empirical findings have shown that adolescents prefer friends who keep their promises and provide steady support (Betts & Rotenberg, 2007; Giordano, 1995; Sherif & Sherif, 1964), revealing that adolescents seek reliable friendships. Such an important element of friendship, from a developmental perspective, is closely connected to the theoretical arguments on striving for closure, which aforementioned studies tend to ignore.

Closure is defined in sociological literature as the extent to which friends of a focal individual are connected in networks (it was documented quite early in Coleman, 1990; Davis, 1970; Davis & Leinhardt, 1967). The advantage of network closure is that it facilitates trust; findings have shown that network closure enables the emergence of trust in social and economic exchanges (Buskens & Raub, 2002, 2013; Coleman, 1990). By the common connections between actors, trust within more closed networks develops as actors keep an eye on each other (Coleman, 1990). In the scenario of adolescent friendships, if a friend within a closed network does anything inappropriate, such as telling secrets to others outside his or her own network, it will soon be known by other friends and cause negative consequences for the gossiper, such as refusal to talk to him or her anymore. As failing to get acceptance by peers is an unwanted situation for adolescents (Coleman, 1961; Giordano, 1995, 2003), making friends know each other, namely promoting a closed network, would decrease the possibility of a situation where friends did not support each other or be made to feel insecure.

Interaction Between Gender and Closure

Earlier developmental literature on adolescence has documented differences between boys and girls in seeking intimacy from their friends. Those findings show that especially adolescent girls use sharing feelings and personal issues with their friends to enhance and sustain their friendships (Hussong, 2000; Leaper, 1994; Maccoby, 1994; Paul & White, 1990; Shulman, Laursen, Kalman, & Karpovsky, 1997). However, previous approaches only see a gender divide; they are not able to consider friendship quality—intimacy that both boys and girls want from their friendships (McNelles & Connolly, 1999; Way, 2004; Way & Silverman, 2012). Apart from other researchers, Radmacher and Azmitia (2006) showed that boys and girls both seek intimacy, but by different means. For late adolescents, girls obtain intimacy from emotional support with friends while boys obtain it from shared activities. That is, such an explanation opens a dialog of gendered pathway to friendship intimacy. Moreover, it implies that the tendency of striving for closure, although relevant to adolescents, is not uniform due to such a pathway.

Still, research reveals that girls exhibit deeper intimacy, higher commitment levels, and the tendency to be closer than boys (Branje, Frijns, Finkenauer, Engels, & Meeus, 2007; Hall, 2010; Johnson, 2004). In contrast, boys' friendships through shared activities may allow for more connections to others outside one's circle than girls' (Eder & Hallinan, 1978; Hussong, 2000; late adolescent boys tend to engage in shared activities while shying away from expressing intimate emotions

(Fehr, 2004; Korobov & Thorne, 2006; Radmacher & Azmitia, 2006). Therefore, we argue that forming and sustaining trustworthy friendships has a higher value for late adolescent girls than for boys due to the gendered pathway. Late adolescent girls' self-disclosure requires a more trustworthy environment, implying that the likelihood of establishing friendships with friends' friends is relatively higher for late adolescent girls than for boys.

Mixed-Gender and Single-Gender Classes

Schools influence peer norms during adolescence because adolescents build up networks with others in classes through formal curriculums and informal activities (Eccles & Roeser, 2011; Epstein, 1983). Perry and Pauletti (2011) point out that gender composition in classrooms should be seen as a context that generates gender differences. We argue that it is necessary to examine both single-gender and mixed-gender classrooms in order to unravel the complications in the interaction between gender and closure. In mixed-gender classes, adolescents explore potential romantic relationships, leading to more complex and dynamic friendships (Bearman, Moody, & Stovel, 2004). Also, even though gender homophily is the rule of thumb, in mixed-gender classes the presence of the other gender is an opportunity for mixed-gender friendships. According to Fehr (2004), adolescent girls are better listeners for adolescent boys, as gender socialization encourages boys' masculinity. It explains why research has shown that adults of both genders are in general more tolerant of their cross-gender friendships than of their same-gender ones (Felmlee, Sweet, & Sinclair, 2012). On the other hand, adolescents' friendship networks in all-girl and all-boy classes are understood by differences between adolescent girls and boys in creating intimacy with friends (discussed in the previous section). In sum, mixed-gender, all-girl, and all-boy classes are expected to have closure tendencies of unequal extent. To our knowledge, no studies compare the three different types of classes in terms of their friendship networks. It remains inconclusive as to what extent closure tendencies vary by type of class.

This Study

Our study disentangles the tendency of closure in mixed-gender and single-gender classes using longitudinal network data. We first formulate hypotheses based on the arguments provided above about the tendency toward closure in general in friendship networks, and further we argue that such a tendency may exist to different degrees in single-gender and mixed-gender settings.

Based on the arguments related to the need for trust in adolescents' trust networks, the first hypothesis concerning the uniform effect of the tendency toward closure reads: (H1) *adolescents are more likely to choose friends of friends as friends than to choose other classmates as friends*. Following the arguments on differences between boys and girls formulated above, we qualify this hypothesis further in the subsequent hypothesis. Therefore, the second hypothesis concerning gender differences in closure reads: (H2) *adolescent girls are more likely than adolescent boys to choose friends of friends as friends than to choose other classmates as friends*. As for the dynamics of closure in mixed-gender and single-gender classes, we do not specify any hypotheses but explore whether Hypotheses 1 and 2 hold true in both single-gender and mixed-gender classes, providing robust evidence for these two hypotheses in both contexts, or whether the evidence is restricted to one type of context, suggesting that the theoretical argument needs elaboration to understand the differentiating tendency toward closure.

To examine the hypotheses, network panel data are required. The "Taiwan Youth and Life Course Survey" has as its target group late adolescents of around 16 years old (United States: 10th grade). It contains friendship nomination data in five waves, as well as the collection of adolescents' individual characteristics at four mixed-gender and five single-gender high schools. The nominations can be transformed to complete network data, and the information about adolescents' gender can be assessed. As mentioned earlier, hardly any study in adolescent research has longitudinal network data from single-gender schools. That is, our data have the advantage that adolescent boys and girls in single-gender classes do not have easy access to the other gender from which to choose friends, so we can study the closure effect without the hindrance of the gender homophily effect. It also enables us to provide explicit analyses for investigating the pure effects of network characteristics within boy-only and girl-only classes. To overcome the interdependencies of observed networks over time and within classes, we employ stochastic actor-based models for network dynamics, tailormade to estimate such effects (Snijders, 2001; Snijders et al., 2010).

METHOD

Data

The data set used is from the "Taiwan Youth Growth and Life Course Survey" conducted by Academia Sinica, Taiwan, in 2008. The survey targets high school pupils in three counties in southern Taiwan. A multistage sampling method was deployed in randomly selected schools from mixed-gender and single-gender high schools (all-girl and all-boy senior high schools), and then one class from each of those schools is selected. Consequently, the data set contains nine classes from five single-gender senior high schools (three male and two female) and four mixed-gender senior high schools. In total, it consists of 410 sixteen-year-old adolescents in the first semester of their second year of high school (Table 1).

Friend nominations were collected in a short questionnaire:—"Please list your good friends' names, ranked according to closeness (not including your boyfriend or girlfriend) with a maximum of 16 names"—five times between September 2008 and February 2009. Based on adolescents' answers, we constructed adjacency matrices composed of adolescents in the rows naming their friends in columns per class for modeling network features. A longer version of the questionnaire collected adolescents' demographic information, adjustment to school life, perception of school performance, and attitude toward their classmates. Adolescents' gender was thus accessed from this questionnaire.

This is a suitable data set for three reasons. First, the friendship nominations from this data set were collected in five waves, enabling us to construct the networks from consecutive observed time points and investigate changes in the network of four equally spaced time periods. Second, when the survey was conducted, the adolescents in the sample had recently been reassigned to different classes according to academic track. (At the end of the first year, all high school students in Taiwan must choose between three tracks—"liberal arts," "sciences with a focus on physics and chemistry," and "sciences with additional biology courses"; see Tsai, 2004 for the details of the education system in Taiwan.) Hence, it was expected that friendships would be quite dynamic during the time of data collection, ensuring that we could estimate relevant effects. Last, the data set contains single-gender classes, which allows for disentangling the pure effects of network characteristics from the effect of gender within classes. The mixed-gender classes in the data set allow for testing whether effects of different network characteristics vary by gender within such classes.

TABLE 1
Descriptive Statistics

	N	*M* or %	*SD*	*Missing Ties (%)*
Gender				
Male	230	0.57		
Female	176	0.43		
Age		16.33	0.49	
Friend nominations (sending ties)				
Wave 1	406	6.89	1.23	1.27
Wave 2	406	6.08	0.62	1.73
Wave 3	406	6.59	0.65	1.01
Wave 4	406	5.89	1.05	1.57
Wave 5	406	5.78	0.79	3.50

Note. The percentage of missing ties = (missing ties)/(maximal possible number of ties) times 100%.

Missing data are handled under two different situations. First, friendship nomination ties from those respondents who did not nominate others are coded as missing ties in network matrices. Because they did not nominate any classmates as friends, but others nominated them as friends, we decide to retain the data and code their sending relations with others as missing. Table 1 shows that the percentages of missing ties are below 5% in all waves, far less than the 20% that would likely lead to a concern of disturbance of model estimation (Ripley & Snijders, 2010). Second, four of the original 410 respondents were removed from the data set, as they neither nominated others nor received nominations from others until the last wave, or they did not provide gender information.

Method

We apply stochastic actor-based models for the longitudinal network data to capture the tendency of closure and its interaction with gender over time (using the statistical package of Simulation Investigation Empirical Network Analysis version 4.0 within an R environment—RSiena; Ripley & Snijders, 2010). This method estimates the probabilities of the focal actor's choice of making a tie change in terms of various network features, such as *reciprocity* (so-called objective function; Snijders et al., 2010). This method treats the nomination network matrices in the first wave as the starting point and then models the changes between two observed time points to estimate the objective function (Ripley & Snijders, 2010). For example, *reciprocity* is estimated by whether a tie is more or less likely to be estab-

lished if it is a reciprocal tie with another actor based on more than two waves of network data. Furthermore, the method can include attributes of actors (e.g., gender) or behavior changes (e.g., drinking behavior) in the estimations. In the present study, gender of actors is included for the analysis.

Measures and Model Specifications

To estimate the tendency of closure and its interaction with gender in different contexts in the actor-based models, we summarize two measures—change of ties, which are based on friendship nominations, and gender. Later, we introduce effect specifications (objective function).

Changes of ties. A tie is defined as an adolescent nominating a classmate as a friend in a wave of the short questionnaire. A change of tie counts when an adolescent nominates A as friend in the previous but does not nominate A in the following wave. Actor-based models require changes of ties above certain numbers (i.e., more than 40 changes across waves; Snijders et al., 2010). Yet, the changes between waves also must not be too great because such high numbers of changes will violate the assumption of the method that waves are consecutive observations of a gradually changing network (Snijders et al., 2010). Hence, we use the Jaccard index to assure that ties have a reasonable number of changes between wave transitions (Table 2; see Snijders et al., 2010 for the formula of the Jaccard index). Table 2 shows that the Jaccard index between each wave transition is between .47 and .52, which indicates that changes of ties are reasonably stable (Snijders et al. (2010) proposed the number to be higher than .3).

Gender. We use "female" as the dummy variable, leaving male adolescents as the reference group. In our data, adolescent boys are about 57% of the respondents and adolescent girls are 43% (Table 1).

TABLE 2
Tie Changes Across Waves

Transitions	*Mean Number of Changes per Class*	*Jaccard Index*
Wave 1 to Wave 2	196	.487
Wave 2 to Wave 3	177	.516
Wave 3 to Wave 4	174	.514
Wave 4 to Wave 5	182	.476

Tendency of closure. In the hypotheses of whether adolescents are more or less likely to become friends with friends' friends, transitivity is the underlying concept to predict the effect of closure in friendship formation (Goodreau, Kitts, & Morris, 2009; Holland & Leinhardt, 1972). We use a simple illustration to explain transitivity, shown in Figure 1a. Because actor I nominates J as a friend, and J nominates K as a friend, the triad of I, J, and K would not be transitive as long as I would not nominate K as a friend. The tendency toward transitivity in directed relations corresponds with the tendency that adolescents choose friends' friends as friends.

We specify two indicators—*transitive triplets* and *transitive ties*, as both refer to the likelihood that triads become transitive. *Transitive triplets* measures the likelihood of a transitive tie (i.e., I nominates K as a friend, Figure 1) based on the number of triads that can be made transitive, that is, the number of Js that I nominates as friends, while these Js nominate K as a friend. *Transitive ties* measures the likelihood of a transitive tie based on the existence of at least one friend of a friend, that is, whether there exists at least one J nominated by I who nominates K (Ripley & Snijders, 2010). Our analysis strategy is that by including both variables in the model we can distinguish whether the effect of the first friend of a friend differs from that of subsequent friends of friends.

These distinctions cause some difficulty in understanding the interpretation of both coefficients, as both coefficients refer to the effect of closure. Therefore, we have to combine the coefficient of *transitive ties* and the coefficient of *transitive triplets* to obtain the correct interpretation of the total effect of closure and the effect of the first friend's friend. In addition, interactions between female and *transitive triplets (Female × Transitive triplets)*, as well as between female and *transitive ties,* are included (*Female × Transitive ties*). They are estimated only for the four mixed-gender classes because only in those classes can we directly test for gender differences in transitivity.

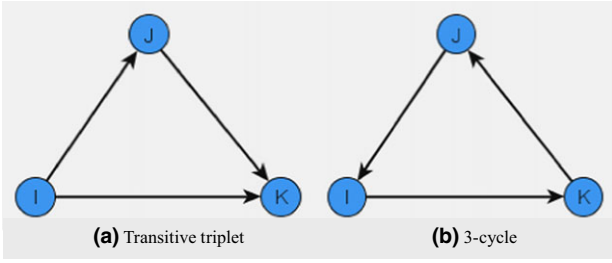

FIGURE 1 Illustrations of a transitive triplet and a 3-cycle.

Controls. Gender homophily refers to the tendency that adolescents are more likely to make same-gender friends (McPherson, Smith-Lovin, & Cook, 2001). As this influences the effect of adolescents' mixed-gender friendships, it is necessary that it be controlled in mixed-gender classes. It is operationalized by the *gender similarity* effect in RSiena. The *gender similarity* effect is the only control based on adolescents' attributes estimating the difference in likelihood of forming friendships between two adolescents from the same gender compared to two from different genders. The rest of the specifications of additional variables are chosen for model convergence and for controlling effects on tie changes, as network features are interdependent (Ripley & Snijders, 2010; Snijders et al., 2010): *outdegree, reciprocity, outdegree popularity, indegree popularity, 3-cycles, outdegree time dummies, class dummies,* and *class dummies on rates* (Appendix A provides a list of the variables).

1 The effect of *outdegree* refers to the likelihood of nominating others by person I. The effect of *reciprocity* refers to the likelihood of reciprocal ties, that is, the likelihood that I nominates another person J if J also nominates I. *Reciprocity* and *outdegree* strongly influence tie changes in similar data sets, so they are usually treated as the default effects (Ripley & Snijders, 2010; Snijders et al., 2010).
2 The effects of *outdegree popularity* and *indegree popularity* refer to the likelihood that someone is nominated depending, respectively, on this actor's outgoing and incoming ties in the previous wave. However, *outdegree popularity* and *indegree popularity* are generally better estimated by using the square root of the degrees, as the effects with the square root mean can account for the effects leveling off with higher degrees (Ripley & Snijders, 2010; Snijders et al., 2010). This also turned out to be the case for our data; therefore, we use the version that implements the square root of the degree—*outdegree popularity (sqrt)* and *indegree popularity (sqrt)*.
3 The effect of *3-cycles* is the likelihood that J nominates I as a friend when I nominates K as a friend and K nominates J as a friend (Figure 1b depicts the relationship). Such a *3-cycle* is intransitive, and although it can be seen as closure, in such a triad it is *not* the case that actors choose friend's friends as friends. We control for the effect of *3-cycles,* as it is still closely related to transitivity (Snijders et al., 2010).
4 By specifying the variables *outdegree time dummies* (between Waves 2 and 3, Waves 3 and 4, and Waves 4 and 5; the reference group being between Waves 1 and 2), we control for the possibility that tendencies to nominate others may vary over time. Such a consideration is crucial to heterogeneity effects between time transitions and classes in the network panel data.
5 Specifying *class dummies* (denoted as Classes 1, 2, etc.) controls for the differences between classes in numbers of nominations. By specifying *class dummies on rates*, we control for the differences between classes on the rates of changing ties.

RESULTS

Three types of classes (mixed-gender classes, all-boy classes, and all-girl classes) were distinguished to estimate the effects. Further, we constructed one combined network for the estimation in each of these three groups of classes because this combined-class network provided a better and more stable estimation of effect sizes than if we had estimated effects for each class separately (Ripley & Snijders, 2010). "Structural zeros" were assigned to relations between classes within the three groups, reflecting the prohibition of adolescents from different classes nominating each other. Tables 3 through 5 show the models for each of these three groups of classes. The interpretation of the coefficients is the same as that for coefficients in logistic regression (Ripley & Snijders, 2010).

Tendency of Striving for Closure Across All Types of Classes

In mixed-gender classes, when we only include the main variables and default variables, the parameters of *transitive triplets* and *transitive ties* are significant (Table 3, Model 1), and they remain significant after including control variables and interaction variables in Models 2 and 3. This supports H1, predicting that adolescents prefer to establish friendships with friends' friends. Apart from confirming the hypothesis, further interpretations would be useful. However, precise quantification of the size of effects is almost impossible due to the interdependencies of network features; for example, *transitive triplets* and *transitive ties* with the variable *3-cycles*. The best we can do is to use the total effect of closure from Model 1 (*transitive triplets*: coefficient = 0.133, $p < .001$; *transitive ties*: coefficient = 0.592, $p < .001$; the same applies for the models that follow). The odds that an

TABLE 3
Estimated Effects and Standard Errors on Friendship Choices for the Mixed-Gender Classes (176 Adolescents in 4 Classes)

	Model 1		*Model 2*		*Model 3*	
	Coefficient	*SE*	*Coefficient*	*SE*	*Coefficient*	*SE*
Main variables						
Transitive triplets	0.133***	.008	0.261***	.011	0.260***	.011
Transitive ties	0.592***	.055	0.611***	.061	0.647***	.059
Female × Transitive triplets					−0.005	.016
Female × Transitive ties					0.424**	.126
Control variables						
Gender similarity			0.361***	.043	0.346***	.041
Outdegree	−2.300***	.048	−1.588***	.102	−1.573***	.101
Reciprocity	1.210***	.047	1.662***	.060	1.667***	.060
Outdegree popularity (sqrt)			−0.455***	.047	−0.480***	.047
3-cycles			−0.178***	.025	−0.169***	.023
Ego is female			0.107*	.044	−0.269*	.112
Alter is female			−0.064	.046	−0.089	.046
Outdegree time 1–2 (ref.)						
Outdegree time 2–3			0.272***	.050	0.270***	.053
Outdegree time 3–4			−0.038	.052	−0.042	.054
Outdegree time 4–5			0.278***	.052	0.275***	.053
Class 1 (ref.)						
Class 2			−0.084	.056	−0.085	.057
Class 3			−0.080	.053	−0.074	.055
Class 4			−0.038	.060	−0.036	.063
Class 1 on rate (ref.)						
Class 2 on rate			−0.089	.072	−0.095	.076
Class 3 on rate			0.180*	.075	0.174*	.075
Class 4 on rate			−0.081	.086	−0.082	.087

*$p < .05$; **$p < .01$; ***$p < .001$.

adolescent creates a tie increase by 106% ($e^{0.133 + 0.592} = 2.06$) if there is one friend of a friend compared to no friend's friends because both *transitive triplets* and *transitive ties* increase by one.

In all-boy and all-girl classes (Tables 4 and 5), we find consistent positive significant effects for *transitive triplets* and *transitive ties*. This also provides support for H1 in which we predicted that adolescents prefer to choose friend's friends as friends for all-boy classes as well as for all-girl classes. In sum, this part of the analysis reveals that the closure tendency through testing effects of *transitive triplets* and *transitive ties* is supported across all types of classes, as is evident from many studies. Nevertheless, single-gender classes enable us to examine the gender differences that are elaborated in the next part.

Gender Differences in Striving for Closure and Class Variances

First, in testing for Hypothesis 2 in single-gender classes, the effect of *transitive ties* for all-boy classes is significant (coeff. = 0.482, $p < .001$), as well as *transitive triplets* (coeff. = 0.125, $p < .001$; Table 4,

TABLE 4
Estimated Effects and Standard Errors on Friendship Choices for the All-Boy Classes (137 Adolescents in 3 Classes)

	Model 1		*Model 2*	
	Coefficient	*SE*	*Coefficient*	*SE*
Main variables				
Transitive triplets	0.125***	.009	0.236***	.011
Transitive ties	0.482***	.055	0.583***	.058
Control variables				
Outdegree	−2.000***	.045	−1.475***	.095
Reciprocity	0.964***	.047	1.409***	.054
Outdegree popularity (sqrt)			−0.361***	.044
3-cycles			−0.160***	.025
Outdegree time 1–2 (ref.)				
Outdegree time 2–3			0.316***	.051
Outdegree time 3–4			0.057	.050
Outdegree time 4–5			0.124*	.046
Class 5 (ref.)				
Class 6			−0.012	.043
Class 7			0.005	.042
Class 5 on rate (ref.)				
Class 6 on rate			−0.434***	.070
Class 7 on rate			−0.547***	.068

*$p < .05$; ***$p < .001$.

TABLE 5
Estimated Effects and Standard Errors on Friendship Choices for the All-Girl Classes (93 Adolescents in 2 Classes)

	Model 1		*Model 2*	
	Coefficient	*SE*	*Coefficient*	*SE*
Main variables				
Transitive triplets	0.149***	.014	0.285***	.018
Transitive ties	0.276***	.062	0.346***	.063
Control variables				
Outdegree	−1.953***	.049	−1.258***	.130
Reciprocity	1.259***	.055	1.715***	.072
Outdegree popularity (sqrt)			−0.430***	.062
3-cycles			−0.207***	.036
Outdegree time 1–2 (ref.)				
Outdegree time 2–3			−0.008	.061
Outdegree time 3–4			−0.079	.061
Outdegree time 4–5			−0.060	.063
Class 8 (ref.)				
Class 9			−0.081	.047
Class 8 on rate (ref.)				
Class 9 on rate			−0.018	.075

***$p < .001$.

Model 1). This means that the odds for adolescent boys to make friends with friends of friends, if there is one friend of a friend compared to no friend's friends, increase by 83% ($e^{0.125 + 0.482} = 1.83$). The effect of *transitive ties* (coeff. = 0.276, $p < .001$) and the effect of *transitive triplets* (coeff. = 0.149, $p < .001$) for the female-class group (Table 5, Model 1) are significant. When an adolescent girl has one indirect tie with a friend of a friend compared to no friends' friends, the odds that she nominates this classmate as a friend increase by 52% ($e^{0.149 + 0.276} = 1.52$). To compare all-boy and all-girl classes, we perform *t*-tests (formula shown in Appendix B) to determine whether there is a significant difference regarding the effect of *transitive triplets* and *transitive ties* between all-boy classes and all-girl classes. The *t*-test (*t*-value = 2.16, $p < .05$, one-tailed) shows that the combined effects of *closure* are significantly larger for all-boy classes than for all-girl classes. This finding contradicts H2 that predicts adolescent girls are more likely to make friends of friends than adolescent boys.

As for mixed-gender classes, testing H2 is through the interaction variables (*Female* × *Transitive triplets* and *Female* × *Transitive ties* in Table 3), the interaction effect between adolescent girls and *transitive ties* is significant (coefficient = 0.424, $p < .001$), while the interaction effect between adolescent girls and *transitive triplets* is not significant (coefficient = −0.005, *SE* = .016). This provides support for H2 in the sense that it is more likely for adolescent girls than for adolescent boys to establish a friendship with a friends' friend. The first friend of a friend increases the odds of a friend's friend being chosen by 53% ($e^{0.424} = 1.53$) more for adolescent girls than for adolescent boys.

Overall, comparing the findings from single-gender classes to mixed-gender classes, H2 is rejected in the former but is supported in the latter. Such inconsistent results indicate that context variances may matter for the tendency of closure. Thus, we employ *t*-tests to compare mixed-gender classes to all-boy classes and all-girl classes to ensure whether context variances are supported statistically. The difference between mixed-gender classes and all-boy classes reaches a slightly statistically significant level (*t*-value = 1.49, $p < .10$), while that difference between mixed-gender classes and all-girl classes is statistically significant (*t*-value = 3.56, $p < .05$). As can be seen, the tendencies of striving for closure among three types of classes are different, and, especially for girls, the logic of closure seems different between contexts.

Controls and Additional Analyses

There are several results regarding control variables, and we discuss them all together (Tables 3 through 5; we decide to exclude *indegree popularity (sqrt)* to sustain good convergence for the rest of the variables in the final models).

Across all three types of classes (mixed-gender classes, all-boy classes, and all-girl classes), the effects of *3-cycles* are significant with a negative direction, providing support that intransitive triads are less likely to occur.

Outdegree popularity (sqrt) has a significant negative effect in all three groups of classes, showing that adolescents are less likely to make friends with those who indicate many others as friends.

Results for *outdegree time dummies* in the mixed-gender group suggest that there are significant differences in the effect of nominating others as friends between Waves 2 and 3 and Waves 4 and 5, compared to that in the reference category (between Waves 1 and 2). For the all-boy classes, differences in the effect of nominating others are also found between Waves 2 and 3 and Waves 4 and 5 compared to that in the reference category. No significant differences are found for the female classes.

As for effects of *class dummies* and *class dummies on rate*, only the effect of *class dummies on rate* for one mixed-gender class (Class 3) and for two

all-boy classes (Classes 6 and 7) is found to be significant, indicating that the effects of changing friendships across four transitions for those classes differ from the reference groups (Class 1 in the mixed-gender classes and Class 5 in the all-boy classes).

We perform an additional analysis to assess the robustness of the effects from combined classes by testing classes separately (results not shown). The same significant effects are found, revealing that the results are consistent across mixed-gender and single-gender classes. In addition, one may question whether adolescent girls are distinctively different from adolescent boys in mixed-gender classes also related to other network dynamics or whether they are only different in the tendency of striving for closure. Hence, we check whether adolescent girls might also be different from male adolescents in the effects of *gender similarity*, *reciprocity*, and *3-cycles* (results in Appendix C). Only *Female* × *Reciprocity* has a positive effect, implying that the reciprocity tendency for female adolescents is stronger than for male adolescents. The incorporation of these effects does not change the substantive implications related to the tests of our main hypotheses.

CONCLUSION AND DISCUSSION

In this study, we provide theoretical arguments on striving for closure of adolescent networks related to trust issues of adolescents. Furthermore, we elaborate as to why it can be expected that female adolescents have a stronger preference for closure in their friendship networks than male adolescents with the possibility to test whether adolescents in mixed-gender classes and single-gender classes are different in their striving for closure. Longitudinal network data in five waves from Taiwanese adolescents in nine different high schools were used to test the hypotheses, providing an advantage of including single-gender classes in the data set.

The results across mixed-gender classes, all-boy classes, and all-girl classes reconfirm a large number of earlier studies showing that adolescents strive for closure in their networks. We emphasize as an explanation of the tendency of striving for closure that a closed network facilitates trust through connections of friends' friends. This argument was less explicit in previous studies.

As for gender differences in relation to the tendency for closure, interestingly, we found a discrepancy regarding gender difference in the effects of closure in mixed-gender, all-boy, and all-girl classes. We expected adolescent girls to be more likely to strive for closure, but that is only supported in the mixed-gender classes. In contrast, adolescent boys have a stronger preference for closure in the all-boy classes than adolescent girls do in the all-girl classes. This finding supports our argument that types of classes may result in variances of the effects, although we did not have a clear hypothesis for contexts. After examining whether the effect differences reach statistical significance, we conclude that the three types of classes have significant differences, but especially between the all-boy and all-girl classes and between the mixed-gender and all-girl classes. We are careful about generalizing our findings to other contexts, but we provide a main explanation on cultural contexts and a supplementary one on boy's masculinity development here open for further scrutiny in future research.

As Way and Silverman (2012) reflect that the majority of adolescent research is based on American adolescents, they urge that more research in other societies is seriously required because adolescents' behavior is closely related to the education systems and cultural backgrounds within their societies. In our case, the specificity of Taiwanese adolescents should be paid more attention to and be understood in Taiwanese contexts. Yi and Wu (2004) and Chang (2013) describe how the life of Taiwanese adolescents involves long hours of studying at school followed by several additional hours in the evening at cram schools to prepare for college entrance examinations, highlighting that adolescent respondents in our study, in comparison with American adolescents, have fewer opportunities to meet other adolescents outside their classes. Yi, Wu, Chang, and Chang (2009) find that school contexts are more important for the well-being of Taiwanese adolescents than family. These studies indicate that Taiwanese adolescents try to balance their life between coping with academic competitions and winning friendships. In addition, the general belief in Taiwan is that the academic performance of single-gender schools is better than that of coeducational schools because boys and girls can concentrate on their studies because single-gender schools reduce opportunities of romantic relationships (Wu, 1991). Hence, incorporated with our findings, Taiwanese boys in all-boy classes, in facing severe competition, may choose classmates they can confide in as friends and make friendships with a higher tendency toward striving for closure. For Taiwanese girls, all-girl classes could provide girls with the freedom to develop their academic acumen in a sexism-free environment (as some Western

studies point out; see Bigler & Signorella, 2011; for a review, see Lee & Bryk, 1986) and thus make friendships with a lower tendency toward striving for closure. When it comes to mixed-gender classes, Taiwanese girls have to compete with boys, which may lead to the tendency that they strive for higher closure than boys.

The supplementary explanation draws from a qualitative approach on adolescents' sexual development in which several studies discuss especially the importance of developing masculinity for adolescent boys' friendships (Connell, 1995; Foster, Kimmel, & Skelton, 2001; Way, 2004). To keep or strengthen masculinity in front of male peers and prevent themselves from being teased as gay, keeping emotions to themselves and being tough are necessary for adolescent boys (Chu, 2005; Oransky & Marecek, 2009; Woody, 2003). Hence, adolescent boys in an all-boy environment in our study could find it more important to choose trustworthy friends to keep anything that may harm their masculinity from leaking to classmates. As a result, adolescent boys in all-boy classes strive for closure more than adolescent girls in all-girl classes. As for boys in mixed-gender classes, it is plausible that boys can use mixed-gender friendships to release the tension of performing masculinely. Thus, the higher tendency of striving for closure in boy's friendships is not seen in mixed-gender classes.

We point out two data limitations upon which further research can improve. First, lacking data on school attributes implies that we are unable to investigate whether mixed-gender high schools and single-gender high schools attract different types of pupils, which may affect adolescents' dynamic friendships. For example, single-gender high schools and mixed-gender high schools might differ in the extent to which they select pupils according to the levels of academic performance. Hence, adolescents may have different attitudes toward their prospects of current studies and life due to different subcultures between schools with such distinctions (Coleman, 1961; Knecht, 2008; Perry & Pauletti, 2011). Thus, we cannot completely exclude that the differences we find between mixed-gender and single-gender classes are due to other factors than the gender composition of the classes. In other words, with school attributes, further research can advance an understanding of the extent to which school contexts influence dynamic friendship formations. Second, we could not test for age difference in the effect of closure because all adolescents in the data were within a very close age range from a developmental perspective. Further research could collect data from various age groups and analyze differences in effects between different age groups.

To conclude, our study showed the complexity of the interplay between structure in terms of striving for closure and gender differences in three types of classes in friendship networks, which other studies have so far failed to observe or explain. The inconsistency in tendency toward closure between the mixed-gender and the single-gender contexts calls for further theoretical elaboration on the precise reasons for striving for closure in networks among girls and boys, as well as for more extensive empirical research to confirm the differentiation of the tendency toward closure between different contexts.

APPENDIX A

LIST OF INDEPENDENT VARIABLES

Variables	*Description*	*Predicted Direction*
Transitive triplets	Tendency to make friends with friends' friends based on the number of indirect ties between ego and the third party in a triad	+
Transitive ties	Tendency to make friends with friends' friends based on the existence of at least one indirect tie between ego and the third party in a triad	+
Female × Transitive triplets	Interaction of being female with transitive triplets	+
Female × Transitive ties	Interaction of being female with transitive ties	+
Gender similarity	Tendency to make friends with same-gender adolescents	+
Outdegree (default effect)	General tendency to make friends	−
Reciprocity (default effect)	Tendency to make reciprocal ties	+
Outdegree popularity (sqrt)	Tendency to make friends with adolescents who nominate many others as friends	No prediction
Indegree popularity (sqrt)		No prediction

Appendix A (Contd.)

Variables	*Description*	*Predicted Direction*
	Tendency to make friends with adolescents who receive many others' nominations	
3-cycles	Tendency to make friends in a way that closes cyclic relations in triads	–
Ego female (male as reference)	Tendency for females to make friends	No prediction
Alter female (male as reference)	Tendency to make female friends	No prediction
Outdegree time dummies (Wave 1–2 is the reference group)	Control different outdegree effects at different time points	No prediction
Class dummies (Classes 1, 5, and 9 as reference)	Control different outdegree effects between classes	No prediction
Class dummies on rate (Classes 1, 5, and 9 as reference)	Control different changes outdegree effects between classes on time transitions	No prediction

APPENDIX B

FORMULA FOR *T*-TEST BETWEEN GROUPS

The test statistic in comparison of two estimated parameters in the independent groups is:

$$(\hat{\beta}_a - \hat{\beta}_b) \Big/ \sqrt{SE_a^2 + SE_b^2}.$$

The null hypothesis states the equal parameters in standard normal distribution (Ripley & Snijders, 2010). In our study, we compare whether there is a difference in the effect of closure, which is the sum of the effects of *transitive ties* and *transitive triplets* between the male-class group and the female-class group. The formula of the test statistic is modified to:

$$(\hat{\beta}_{(trans.tri.+trans.ties)groupA} - \hat{\beta}_{(trans.tri.+trans.ties)groupB}) \Big/ \sqrt{\left(\sqrt{SE^2_{trans.tri.} + SE^2_{trans.ties}}\right)^2_{groupA} + \left(\sqrt{SE^2_{trans.tri.} + SE^2_{trans.ties}}\right)^2_{groupB}}.$$

APPENDIX C

TESTS ON *FEMALE* × *GENDER SIMILARITY*, *FEMALE* × *RECIPROCITY*, AND *FEMALE* × *3-CYCLES* ON FRIENDSHIP CHOICES FOR MIXED-GENDER CLASSES (176 ADOLESCENTS IN 4 CLASSES)

	Model 1		*Model 2*		*Model 3*	
	Coefficient	*SE*	*Coefficient*	*SE*	*Coefficient*	*SE*
Main variables						
Transitive triplets	0.260***	.011	0.261***	0.012	0.261***	.012
Transitive ties	0.648***	.062	0.650***	0.060	0.654***	.057
Female × Transitive triplets	−0.004	.016	−0.008	0.017	−0.026	.022
Female × Transitive ties	0.420**	.123	0.389**	0.124	0.420**	.128
Female × Gender similarity	−0.007	.018				
Female × Reciprocity			0.214*	0.105		
Female × 3-cycles					0.051	.039
Control variables						
Gender similarity	0.346***	.042	0.339***	0.045	0.341***	.043

Appendix C (Contd.)

	Model 1		Model 2		Model 3	
	Coefficient	*SE*	*Coefficient*	*SE*	*Coefficient*	*SE*
Outdegree	−1.577***	.098	−1.593***	0.097	−1.609***	.100
Reciprocity	1.664***	.062	1.668***	0.059	1.669***	.058
Outdegree popularity (sqrt)	−0.477***	.044	−0.468***	0.045	−0.463***	.046
3-cycles	−0.170***	.024	−0.175***	0.025	−0.177***	.025
Ego is female	−0.271	.113	−0.299	0.117	−0.270	.115
Alter is female	−0.083*	.036	−0.106*	0.045	−0.096*	.047
Outdegree time 1–2 (ref.)						
Outdegree time 2–3	0.272***	.053	0.272***	0.055	0.274***	.052
Outdegree time 3–4	−0.041	.055	−0.040	0.054	−0.039	.053
Outdegree time 4–5	0.275***	.052	0.277***	0.055	0.280***	.051
Class 1 (ref.)						
Class 2	−0.082	.057	−0.091	0.056	−0.087	.054
Class 3	−0.075	.056	−0.088	0.052	−0.085	.053
Class 4	−0.032	.062	−0.038	0.061	−0.036	.056
Class 1 on rate (ref.)						
Class 2 on rate	−0.097	.073	−0.104	0.076	−0.101	.077
Class 3 on rate	0.178*	.076	0.168*	0.077	0.169*	.079
Class 4 on rate	−0.080	.084	−0.092	0.083	−0.086	.081

*$p < .05$; **$p < .01$; ***$p < .001$.

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