

Panel Data 1: Discrete Time Methods for the Analysis of Event Histories

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Often, we are interested not only in whether an event occurs, but how quickly it happens (if at all). What factors speed up or delay death? Why do some friendships last longer than others? What causes some conflicts to be resolved quickly, while others drag on for years or even decades? Why do some individuals get tenure sooner than do others? Why do some people marry at young ages while others wait until they are much older?

Stata has a whole manual and suite of commands devoted to Survival Time Analysis. As Allison (1982, 1984; 2014; see exact citations later) points out, however, in some situations basic logistic regression techniques can be used. He refers to such approaches as *Discrete Time Methods for the Analysis of Event Histories*. To use such methods, you have to have Panel Data, e.g. repeated measures on the same individuals collected at multiple points in time on a regular basis, such as annually. At each time point, the dependent variable of interest is either coded 0 (the event has not happened yet) or 1 (the event occurred during the current interval, although you may not know exactly when). After the event occurs no additional records are included for that case. The analysis of Allison's tenure data that we discussed before is actually an example of a discrete time analysis: data were collected annually from biochemists, records were created for each individual for each year, and records stopped being created when and if the scientist received tenure. The coefficients for the logistic regression then tell you what factors speed up or slow down the pace at which the event in question occurs.

Allison explains how his procedure addresses problems that would be difficult to deal with via conventional regression techniques. First, the event may not occur (if it occurs at all) until after the data collection has ended; that is, the data may be *right censored*. (Somewhat more problematic is *left-censoring*, e.g. you don't know when exposure to risk began. For example, you might not know when a friendship or marriage started or when a person began an academic career. Still, Allison offers some ideas on what to do.) Second, his method allows the use of *time-varying covariates*, i.e. independent variables whose values change across time. For example, if somebody suddenly starts publishing more papers, that could speed up the rate at which they get tenure; or if they start smoking they might die more quickly.

The rest of this handout actually consists of the classic 1987 ASR paper, *The Stability of Students' Interracial Friendships*, by Maureen Hallinan and Richard Williams. (First I will provide excerpts and then the entire paper.) Alas, I was apparently less well organized 30+ years ago, and I can't find any of the original materials or data sets. You can skim the opening sections, but pay close attention to the methodology section that begins on p. 655, especially the procedures part on pp. 656-657. Then pay close attention to the logistic regression results section that begins on p. 659. If I can ever find the data I will try to rework some of these analyses in class, but if not we'll just have to trust my much younger self.

Allison's 1982 paper, or his 1984 book, are also highly recommended if you want to learn more about these techniques. See the course readings page. For the 2014 2nd edition of his book, see <http://www.amazon.com/Survival-Analysis-Quantitative-Applications-Sciences/dp/1412997704>.

Excerpts from "The Stability of Students' Interracial Friendships", by Maureen Hallinan and Richard Williams

In 1976-77, a large, longitudinal data set was obtained from 1,477 students in 48 classes in six public and four private schools in northern California. The sample contains 229 black students and 226 non-black students. The students were given a sociometric questionnaire six times during the school year at approximately six-week intervals. The students were given a list of their classmates and, next to each name, were the categories: "Best Friend", "Friend", "Know", "Don't Know", and "My Name". They were asked to circle the appropriate category for each student and encouraged to name as many best friends and friends as they wished.

To examine the determinants of interracial friendship stability, a dyadic-level analysis is required. In each dyad, P is designated the chooser and O the student who can be chosen. We examine those dyads in which P chooses O as Best Friend at some time during the course of the school year. Our interest is the stability of that choice. The dependent variable for the descriptive analysis in Table 2 is the termination of P 's choice of O (Dissol), coded as unity if the friendship dissolved and zero if the friendship continued. The dependent variable is the same for the inferential analyses reported in Tables 3, 4, and 5, except that coding is reversed (1 = continuation, 0 = dissolution) to facilitate interpretation of parameter estimates. The best friend choices are used instead of the weaker friend choices because the latter are likely to contain more response error.

To obtain the dyadic-level data file for the analysis, records were created for all possible dyadic combinations of students within each of the 16 classrooms. Each dyad is included in the sample twice; in the first case, one member of the dyad is designated as P , the chooser, and the other member as O , the person chosen. In the second case, the chooser and chosen designation is reversed. This redundancy is necessary because friendship choices need not be mutual. To prevent standard errors from being inflated, each dyad is weighted by one-half in the inferential analysis.

Analyzing the stability of dyadic friendship choices is not straightforward. It is tempting to do a conventional regression analysis in which the observed duration of the friendship is the dependent variable. However, Allison (1984) has outlined a number of reasons why such a strategy is inappropriate for individual-level data. The basic problems are the same for dyadic-level data.

First, the ultimate duration of a friendship choice is not known for choices that were still in existence at the end of the school year. These observations are said to be "right-censored." Simply using the observed duration clearly underestimates the true duration and can produce substantial biases. Further, it has been shown that excluding the censored observations is also highly problematic (Sorensen 1977; Tuma and Hannan 1978).

Second, even during the school year, it is not known exactly when the friendship choices began or ended. Only the status of the friendship at each of the six observational periods is known. Assumptions of methods that require precise interval-level measurement may be violated.

Third, the values of some explanatory variables of interest can change across time (e.g., whether or not both members of the dyad are in the same reading group, or whether or not friendship choices are reciprocated). Changes in the values of variables might affect the stability of the friendship choice. Conventional regression techniques do not provide any convenient means of incorporating time-varying explanatory variables in the analysis.

Finally, many of the dyads are not only right-censored, but left-censored as well. Over half of the friendship choices already existed by the first observational period. These choices were made either extremely early in the school year or before school begun, but it is impossible to tell exactly when. Thus, again, the true value of duration is not known. Further, it seems reasonable to suspect that friendship choices made prior to the school year may differ substantially from those formed during it.

Allison (1982, 1984) has proposed a technique for dealing with the first three of these problems. The strategy treats each discrete time unit for each dyad as a separate observation or unit of analysis. If the friendship choice ended after four time periods, four different observations would be created. On the first three observations, dissolution would be coded 0 while on the last observation it would be coded unity. Time periods in which the friendship choice did not yet exist, was just being reported for the first time, or after the friendship choice had already terminated, are excluded from the analysis because the friendship choice was not at risk of dissolving at those times. Explanatory variables for each of these new observations are assigned whatever values they had at that particular unit of time. The final step is to pool the observations and compute maximum likelihood estimates for the logistic regression model.

Allison's technique addresses each of the first three concerns we presented. Dyads in which duration of a friendship choice is censored contribute exactly what is known about them that the friendship choice did not end in any of the time periods in which they were observed. The method does not require that the duration be precisely measured; simply knowing the status of the friendship choice at each of the different observational periods is sufficient. Timevarying explanatory variables are easily incorporated into the analysis because each six-week interval the friendship choice is at risk is treated as a distinct observation.

The final problem of left-censoring is not so easily dealt with. One approach is to simply discard the initially censored intervals (Allison 1984). However, an examination of differences between friendship choices formed before the school year and those formed during it may be of interest. Therefore, we perform analyses on the total sample and separate analyses for the left-censored and non-left-censored observations.

Since there are only two possible outcomes for each friendship choice (continuation or dissolution), we analyze the data using a logistic regression model.

A positive beta coefficient implies that the friendship choice dyads that have a higher value on the independent variable X will tend to survive longer, while a negative coefficient implies that a higher value on the independent variable will lead to shorter friendship choices.

Table 3. Multivariate Logistic Regression of Friendship Stability on Organizational and Dyadic-Level Variables for Full Sample

Variable	Total (N = 3,103)	Bl-Wh (N = 586)	Wh-Bl (N = 366)	Bl-Bl (N = 1,358)	Wh-Wh (N = 793)
Intercept	1.34** (.50)	.04 (1.23)	4.15* (1.75)	.71 (.83)	.75 (1.15)
Recip	1.01*** (.10)	.72** (.24)	1.14*** (.31)	.88*** (.14)	1.44*** (.21)
Sex-P	-.25** (.09)	.00 (.20)	-.52 (.30)	-.49*** (.13)	-.13 (.19)
Samesex	.80*** (.10)	1.05*** (.24)	.98** (.40)	.73** (.14)	.99*** (.29)
Rankdiff	.01 (.01)	.03** (.01)	.01 (.02)	-.00 (.01)	.01 (.01)
Grade	.02 (.06)	.21 (.15)	-.36 (.20)	.14 (.13)	.06 (.14)
Classize	-.02 (.01)	-.01 (.02)	-.07* (.03)	.00 (.02)	-.02 (.02)
Read Same	.07 (.10)	-.01 (.24)	.49 (.34)	-.09 (.15)	.21 (.21)
Prop Black	.64*** (.19)	-.27 (.48)	1.89** (.65)	.05 (.44)	1.80** (.70)
Climate	-.31*** (.08)	-.53** (.18)	-.17 (.25)	-.51** (.18)	-.19 (.14)
Period 1	− 1.02*** (.09)	− .92*** (.19)	− 1.45*** (.28)	− .84*** (.13)	− 1.14*** (.18)

Note: Standard errors are in parentheses.

* Significant at the .05 level.

** Significant at the .01 level.

*** Significant at the .001 level.

DISCUSSION

One might think that because students' interracial friendships are fairly uncommon, they are also unstable. Our research shows that this is not the case. Interracial friendship choices in the desegregated classrooms in our sample were fairly stable. While they generally did not last the entire school year, they did continue for several weeks and often months. Indeed, students' interracial friendship choices were almost as stable as their same-race choices. This surprising result may be because interracial friendships are unlikely in the first place and are made only if there is a strong attraction between a black and white student that then sustains the relationship over time.

This research has several policy implications. Clearly, dyadic-level characteristics have the strongest impact on the stability of interracial friendship choices. However, it is also clear that schools are not powerless in this area. If school personnel wish to support interracial sociability in desegregated schools, they should try to provide a classroom environment that promotes stable interracial friendship choices. Our study shows that this can be done by paying attention to the racial composition of the class and to the class climate. The ratio of black to white students can afford opportunities for black and white students to interact with each other to foster positive sentiment between them. The classroom climate can decrease major status differences between black and white students by providing opportunities for all students to win the esteem of their peers. Thus, by manipulating the environmental and organizational factors that affect interpersonal attraction and the cohesiveness of relationships, school administrators and teachers can help sustain interracial friendship ties once they are made.

THE STABILITY OF STUDENTS' INTERRACIAL FRIENDSHIPS*

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In this paper we study the determinants of the stability of schoolchildren's interracial and same-race friendships. We argue that classroom organizational features and student characteristics affect the cohesiveness of social ties with consequences for friendship stability. The hypotheses are tested on longitudinal data from 375 fourth-through seventh-grade students in 16 desegregated classrooms. Descriptive and inferential analyses show that interracial friendships are almost as stable as same-race ones. Further, while the stability of interracial and same-race friendships is influenced by classroom characteristics, it is more strongly influenced by ascribed and achieved characteristics of students. We conclude that while individual characteristics of students are the strongest determinants of interracial friendship stability, schools can adopt policies and practices that promote stable friendships between black and white students.

While social scientists have long been interested in the determinants of friendship formation, they have given surprisingly little attention to the processes that govern the longevity of friendships. This is particularly true of interracial friendships. Psychologists have identified personality and attitudinal variables that predict the formation of interracial friendships (e.g., Duck and Gilmour 1981), and sociologists have pointed to structural and organizational features of the environment that promote interracial friendships (Patchen 1982; Schofield 1982; Grant and Rothenberg 1981; Hallinan and Teixeira 1987 a, b). But while this research contributes to the theoretical understanding of race relations, it neglects the important question of how long interracial friendships persist. It is not known whether interracial friendships are transitory and basically unstable, or whether, once formed, they persist for a considerable period.

Determining the stability of interracial friendships is critical to understanding both how blacks and whites interact in different settings and what significance they attach to interracial friendships in desegregated schools. Learning how long students' interracial friendships persist should reveal the importance of school factors in influencing interracial friendships. If, for example, interracial friendships are fleeting, then

teachers' attempts to influence their formation may be less important than their efforts to sustain friendships that already exist. Consequently, it is important to study how organizational and environmental features of classrooms and the personal characteristics of students link to stabilize interracial friendship choices.

PSYCHOLOGICAL PERSPECTIVES ON FRIENDSHIP STABILITY

There are a few psychological perspectives on friendship stability and dissolution (see Duck 1982 for a review of these perspectives). The simplest, and perhaps most naive, view is that friendship dissolution is the inverse of friendship formation. That is, factors that affect the establishment of friendships, such as similarity, also explain their dissolution. Duck and Allison (1978) show that pairs who formed friendships had more similar personality characteristics than those who did not; moreover, friendships that dissolved had more dissimilar members than those that persisted.

Another viewpoint emphasizes the importance of communication within a friendship dyad. Inadequate interactions between friends lead to their break up. Perhaps those with poor communication skills are unable to reveal their common characteristics, even where they exist. The cause of poor interactions may not stem from dyad members' characteristics, but from inadequate communication.

A third psychological perspective on friendship dissolution explains that one or both members of the dyad obtain new information about the other that damages the relationship. In this view, the factors dissolving friendships bear little relationship to those that build friendships.

While these perspectives seem plausible, they have limited application. By failing to specify either the relation between the individual

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qualities of the dyad members or the types of friendship interactions, the perspectives cannot explain or predict. More importantly, they fail to consider the context of friendships and, consequently, ignore the contribution of environmental factors to the stability of interpersonal relationships. Clearly, sociological analysis must supplement psychological theories of friendship dissolution. Our paper does this.

ORGANIZATIONAL AND ENVIRONMENTAL EFFECTS ON FRIENDSHIP STABILITY

The duration of a friendship is determined by the strength of the bond between two persons. Levinger (1976) calls the strength of this bond *cohesiveness*. He argues that three components influence the cohesiveness of a social relationship: a) the attractiveness of the relationship itself; b) the attractiveness of actual or potential alternatives to the relationship; and c) the barriers that contain persons in the relationship. The more attractive a relationship, the fewer the actual or potential alternatives to the relationship, and the greater the barriers to dissolving the relationship, the more stable the relationship is likely to be.

Most research on relationship dissolution has focused on marital dissolution (Duck 1982; Duck and Gilmour 1981) and has concentrated primarily on the interpersonal attraction component of cohesiveness. This research views relationship dissolution as the inverse of relationship formation. Yet attraction is only one of several important components that affect cohesiveness.

We argue that organizational and environmental factors affect the stability of friendships by influencing the three components of cohesiveness. First, change in interpersonal attraction is caused by changes in propinquity, personal similarity, and prestige or status. Propinquity is a necessary, but not a sufficient, condition for interpersonal attraction. Contact is needed, especially among youth, to provide the rewards of social relationships. Similarity has a dynamic relationship to interpersonal attraction. Once a friendship has been established, interaction between dyad members either creates new similarities or produces an awareness of previously unnoticed or irrelevant dissimilarities. When dyad members become more similar over time, interpersonal attraction increases; in contrast, dissimilarity reduces attraction. Finally, an individual's status among peers may change over time. If the status of both members of a friendship dyad increases, interpersonal attraction is likely to stabilize or increase. But if status changes create too much discrepancy

between the dyad members, their attraction likely decreases.

The major classroom characteristics that affect the bases of interpersonal attraction are the organization of instruction, classroom racial composition, and classroom climate. Each of these characteristics affects one or more of the bases of interpersonal attraction. The assignment of students to grades, classrooms, and instructional groups affects pupil propinquity. The racial composition of a class stimulates or limits opportunities for interracial interaction. Assigning students to the same instructional unit exposes them to similar educational activities and experiences that produce new similarities. The racial composition of the class affects student opportunities to transcend racial differences and focus on existing similarities. Classroom climate, which reflects teachers' values and attitudes, affects how students evaluate their similarities, such as academic performance, for their friendships. Finally, organizational and contextual features of a classroom affect student status. Assigning students to tracks or ability groups locates them on a visible status hierarchy; classroom climate stresses certain status characteristics and devalues others. By affecting each base of interpersonal attraction, classroom characteristics influence the first, and possibly most important, component of friendship cohesiveness.

The second component of cohesiveness, the attractiveness of actual or potential alternatives to a relationship, is also influenced by classroom factors. Interracial friendships are expected to be less stable in classrooms where a large number of same-race friends are available because same-race peers compete for friendship choices. The way instruction is organized creates opportunities for students to interact with peers they may not have sought out otherwise. These interactions may lead to new friendships that are more rewarding than existing ones. Classroom climate underscores some pupil characteristics that students might otherwise have ignored, opening up new possibilities for friendships that might not have occurred in another environment.

Finally, organizational and environmental features of a classroom affect the third component of cohesiveness, barriers to terminating friendships. Classroom racial composition may offer students in the numerical minority who are reluctant to make interracial friendships few opportunities for friendships. This situation would prevent the termination of existing friendships since few alternatives are available. Where classroom social climate supports existing friendships, peer sanctions against terminating a friendship could stabilize friendships. Similarly, when friendships emerge among

students assigned to the same instructional groups, the required work-related contacts may lead them to view friendship dissolution as too costly.

Characteristics of individual students, such as sex, achievement level, and reciprocity, will likely influence the duration of interracial friendships. Because similarity is a basis of interpersonal attraction, interracial friendships of the same sex will likely endure more than interracial friendships between boys and girls. Students tend to admire their successful peers, so they may prefer friends whose class rank is higher than their own. Hence, achievement difference may positively affect the stability of the friendship choices of lower-ranking students. This suggests that the interracial friendship choices of blacks may be more stable than those of whites, since whites typically rank higher in achievement. Since reciprocated choices are more rewarding than unreciprocated ones (Gouldner 1960), interracial friendships are likely to be more stable where both members of the dyad regard the other as a friend.

This paper has two aims: (1) to determine the length of interracial friendships for a sample of students in desegregated classrooms and to compare their stability to same-race friendships; (2) to examine the effects of classroom organizational characteristics and individual student characteristics on the stability of interracial and same-race friendships. This inferential analysis will show whether contextual factors that have been ignored in psychological research on friendship dissolution do, as we have argued, affect the stability of students' interracial friendships. It will also reveal whether factors that promote the dissolution of interracial friendships have a similar impact on same-race ones.

METHODOLOGY

Sample

In 1976-77, a large, longitudinal data set was obtained from 1,477 students in 48 classes in six public and four private schools in northern California. The data examined determinants of students' social relationships and academic achievement. The schools and classes were selected to represent varying organizational characteristics and racial compositions. Sixteen classes in this sample were desegregated and contained at least three students of a racial minority, whether black or white. The 455 students in these classes comprise the sample. The classes included 4 fourth grades, 4 fifth grades, 4 sixth grades, 3 seventh grades, and one sixth-seventh grade combination.

The sample contains 229 black students and 226 non-black students. The latter, referred to as

white hereafter, include a few Asian and Chicano students but not enough to create a separate category for analysis. The white students, on the average, came from higher socioeconomic backgrounds than their black classmates. The classes were fairly evenly divided between majority black and majority white, with three classes approximately racially balanced (between 40 percent and 60 percent black).

Not all the students received parental permission to participate in the study and some chose not to take part. In addition, some students were absent from class on the days the friendship information was collected. While efforts were made to obtain these data when the child returned to school, this was not always possible. As a result of these factors, the final sample contained complete information on 375 of the 455 students (82 percent) in the 16 classes. Classroom observation revealed no systematic differences in the social interactions of the students who were included in the sample and those who were not.

The students were given a sociometric questionnaire six times during the school year at approximately six-week intervals. The first data collection was scheduled during the first two weeks of the academic year. The students were given a list of their classmates and, next to each name, were the categories: "Best Friend", "Friend", "Know", "Don't Know", and "My Name". They were asked to circle the appropriate category for each student and encouraged to name as many best friends and friends as they wished. They were also told it was not necessary to name any friends if their friends were in a different class or school.

In addition to the friendship data, information on the students' background and achievement was obtained from school records. Standardized achievement test scores in reading were recorded for all the students. When different standardized tests were used, the scores were changed to the same metric using the transformations of the Anchor test study (Loret 1974). Information was also obtained from the teachers about the classroom climate and about their pedagogical practices, including the assignment of students to instructional groups.

To examine the determinants of interracial friendship stability, a dyadic-level analysis is required. In each dyad, P is designated the chooser and O the student who can be chosen. We examine those dyads in which P chooses O as Best Friend at some time during the course of the school year. Our interest is the stability of that choice. The dependent variable for the descriptive analysis in Table 2 is the termination of P 's choice of O (Dissol), coded as unity if the friendship dissolved and zero if the friendship

continued. The dependent variable is the same for the inferential analyses reported in Tables 3, 4, and 5, except that coding is reversed (1 = continuation, 0 = dissolution) to facilitate interpretation of parameter estimates. The best friend choices are used instead of the weaker friend choices because the latter are likely to contain more response error.

The independent variables include organizational-, dyadic-, and individual-level variables. The organizational variables are PROPORTION BLACK (PROP BLACK), CLASSROOM CLIMATE (CLIMATE), CLASS SIZE, and GRADE. The climate variable measures teacher emphasis on objective measures of academic achievement. It was obtained by factor-analyzing questionnaire data provided by the teachers. The items that loaded on the climate factor are emphasis on good grades, mastery of the curriculum, and basic skills. A low score implies little emphasis on these items. Class size is a control variable because the majority black classes tended to be larger than the majority white ones. Grade is as much a developmental factor as an organizational one and represents a control for student age or level of maturity.

Three dyadic variables pertaining to ability group membership are included: whether or not the dyad members are in the same reading group (READ-SAME), different groups (READ-DIFF), or in ungrouped classes (READ-UNGR). These dichotomous variables are coded as unity if the dyad members are in the same reading group, in different groups, or in ungrouped classes, and zero otherwise.

Other dyadic and individual level variables are: sex of *P* (SEX-P), coded as unity for female and zero for male; whether the members of the dyad are the same sex (SAMESEX), coded unity if yes and zero otherwise; reciprocity (RECIP), or whether *O* chooses *P* as Best Friend at the time period of interest, coded unity if yes and zero otherwise; and difference in rank in achievement (RANK DIFF), measured as the difference between *P*'s and *O*'s rank in class, based on the students' scores on a standardized achievement test in reading.

The variable old friends (OLD FRNDS) distinguishes friendship choices formed prior to the school year (or within the first two weeks of school) from those choices formed during the year. It is coded as unity if the friendship existed at the first time data were collected and zero otherwise. As noted below, each time period that a friendship choice is at risk of dissolution is treated as a separate observation or unit of analysis. To see whether friendship choices are especially unstable shortly after their formation, the variable, PERIOD 1, is included. It is coded as unity if the record is from the first time period

the friendship choice is at risk of dissolution and zero otherwise.

Procedures

To obtain the dyadic-level data file for the analysis, records were created for all possible dyadic combinations of students within each of the 16 classrooms. Each dyad is included in the sample twice; in the first case, one member of the dyad is designated as *P*, the chooser, and the other member as *O*, the person chosen. In the second case, the chooser and chosen designation is reversed. This redundancy is necessary because friendship choices need not be mutual. To prevent standard errors from being inflated, each dyad is weighted by one-half in the inferential analysis.

Of the almost 13,000 dyads in the sample, 3,103 dyads were identified in which one student named the other as best friend at some point in time before the end of the school year. An additional 519 friendship choices that were not made until the last observational period were excluded from the analysis. Since these late-forming friendship choices were not at risk of dissolving until after data collection had been completed, nothing is known about their stability. There were 586 dyads in which a black student chose a white peer as best friend, 366 in which a white chose a black as best friend, 1,358 in which a black chose a black as best friend, and 793 in which a white chose a white as best friend. The same-race friendship choices are included in the analysis as a baseline against which to interpret the stability of interracial friendship choices and the factors that affect it. The duration of these friendships is the subject of interest here.

Analyzing the stability of dyadic friendship choices is not straightforward. It is tempting to do a conventional regression analysis in which the observed duration of the friendship is the dependent variable. However, Allison (1984) has outlined a number of reasons why such a strategy is inappropriate for individual-level data. The basic problems are the same for dyadic-level data.

First, the ultimate duration of a friendship choice is not known for choices that were still in existence at the end of the school year. These observations are said to be "right-censored." Simply using the observed duration clearly underestimates the true duration and can produce substantial biases. Further, it has been shown that excluding the censored observations is also highly problematic (Sørensen 1977; Tuma and Hannan 1978).

Second, even during the school year, it is not known exactly when the friendship choices began or ended. Only the status of the friendship at each of the six observational periods is

known. Assumptions of methods that require precise interval-level measurement may be violated.

Third, the values of some explanatory variables of interest can change across time (e.g., whether or not both members of the dyad are in the same reading group, or whether or not friendship choices are reciprocated). Changes in the values of variables might affect the stability of the friendship choice. Conventional regression techniques do not provide any convenient means of incorporating time-varying explanatory variables in the analysis.

Finally, many of the dyads are not only right-censored, but left-censored as well. Over half of the friendship choices already existed by the first observational period. These choices were made either extremely early in the school year or before school begun, but it is impossible to tell exactly when. Thus, again, the true value of duration is not known. Further, it seems reasonable to suspect that friendship choices made prior to the school year may differ substantially from those formed during it.

Allison (1982, 1984) has proposed a technique for dealing with the first three of these problems. The strategy treats each discrete time unit for each dyad as a separate observation or unit of analysis. If the friendship choice ended after four time periods, four different observations would be created. On the first three observations, dissolution would be coded 0 while on the last observation it would be coded unity. Time periods in which the friendship choice did not yet exist, was just being reported for the first time, or after the friendship choice had already terminated, are excluded from the analysis because the friendship choice was not at risk of dissolving at those times. Explanatory variables for each of these new observations are assigned whatever values they had at that particular unit of time. The final step is to pool the observations and compute maximum likelihood estimates for the logistic regression model.

Allison's technique addresses each of the first three concerns we presented. Dyads in which duration of a friendship choice is censored contribute exactly what is known about them—that the friendship choice did not end in any of the time periods in which they were observed. The method does not require that the duration be precisely measured; simply knowing the status of the friendship choice at each of the different observational periods is sufficient. Time-varying explanatory variables are easily incorporated into the analysis because each six-week interval the friendship choice is at risk is treated as a distinct observation.

The final problem of left-censoring is not so easily dealt with. One approach is to simply discard the initially censored intervals (Allison

1984). However, an examination of differences between friendship choices formed before the school year and those formed during it may be of interest. Therefore, we perform analyses on the total sample and separate analyses for the left-censored and non-left-censored observations.

Using Allison's approach, 9,286 records can be created from the 3,103 dyads in the total sample. Of these, 3,040 records are obtained from the 1,412 dyads in which *P* first chooses *O* as Best Friend at some point during the school year (the friendship choices that are not left-censored), and 6,246 records are created from the 1,692 dyads in which *P* chose *O* as Best Friend at some point prior to the first observational period (the left-censored cases).

Since there are only two possible outcomes for each friendship choice (continuation or dissolution), we analyze the data using a logistic regression model. Specifically, we estimate a model of the form: $\text{Pr}(\text{frndshp choice continues})/\text{Pr}(\text{frndshp choice dissolves}) =$

$$\exp(\alpha + \sum \beta_j X_j).$$

A positive beta coefficient β_j implies that the friendship choice dyads that have a higher value on the independent variable X_j will tend to survive longer, while a negative coefficient implies that a higher value on the independent variable will lead to shorter friendship choices.

RESULTS

Descriptive Analyses

The means and standard deviations of the independent variables in the analysis are presented in Table 1 for the total sample and broken down by the race of each dyad type. The black-white dyads are those in which the chooser, *P*, is a black student and the chosen, *O*, is a white student, while the white-black dyads are those in which *P* is white and *O* is black. The left-censored and uncensored dyads are pooled in Table 1 because most of the differences in the means for the two samples are small. A few noteworthy exceptions are pointed out below.

The independent variables were measured at the beginning of the school year except for the time-varying variables (RECIP, READ-SAME, READ-UNGR, READ-DIFF), which were measured at each time period the friendship choice was at risk. The reading group measures varied little in value over time, so only their means for the first period at risk are presented in Table 1. The mean for reciprocity is given both for the first time interval and over all intervals.

Table 1. Means and Standard Deviations of Organizational, Dyadic, and Individual Level Variables—Full Sample

Variable	Total (N = 3,103)	Bl-Wh (N = 586)	Wh-Bl (N = 366)	Bl-Bl (N = 1,358)	Wh-Wh (N = 793)
Recip(1) ^a ($\alpha = .000$)	.41 (.49)	.25 (.44)	.41 (.49)	.44 (.50)	.47 (.50)
Recip(k) ^a ($\alpha = .000$)	.47 (.50)	.32 (.47)	.49 (.50)	.48 (.50)	.54 (.50)
Sex-P ($\alpha = .008$)	.44 (.50)	.53 (.50)	.44 (.50)	.41 (.49)	.43 (.50)
Samesex ($\alpha = .000$)	.79 (.40)	.76 (.43)	.85 (.36)	.73 (.44)	.90 (.30)
Rankdiff ($\alpha = .000$)	.86 (10.93)	7.81 (9.74)	-5.49 (9.92)	.01 (10.59)	.09 (10.21)
Grade ($\alpha = .000$)	5.27 (1.10)	4.96 (.99)	5.07 (1.03)	5.58 (1.17)	5.07 (.96)
Classize ($\alpha = .000$)	29.91 (4.58)	29.10 (4.99)	28.94 (4.88)	31.17 (3.35)	28.78 (5.36)
Read-Ungr ($\alpha = .000$)	.30 (.46)	.27 (.45)	.33 (.47)	.38 (.48)	.16 (.37)
Read-Same ($\alpha = .196$)	.24 (.43)	.22 (.41)	.25 (.44)	.23 (.42)	.28 (.45)
Read-Diff ($\alpha = .000$)	.46 (.50)	.51 (.50)	.42 (.49)	.39 (.49)	.56 (.50)
Prop Black ($\alpha = .000$)	.52 (.26)	.44 (.23)	.49 (.23)	.70 (.17)	.28 (.15)
Climate ($\alpha = .000$)	.41 (.85)	-.11 (.81)	-.02 (.80)	.25 (.78)	-.16 (.94)
Period 1 ($\alpha = .216$)	.33 (.47)	.35 (.48)	.36 (.48)	.32 (.47)	.33 (.47)
Old Frds ($\alpha = .000$)	.55 (.50)	.53 (.50)	.41 (.49)	.58 (.49)	.57 (.50)

Note: Standard deviations are in parentheses.

^a Recip(1) refers to reciprocation during the first interval the dyad is at risk, while Recip(k) refers to the average reciprocation over all intervals.

Table 1 shows that, during the first time interval the friendship choice is at risk, *O* reciprocates *P*'s friendship choice (RECIP(1)) 41 percent of the time. For all time intervals taken together, the average rate of reciprocation (RECIP(K)) is 47 percent. Blacks who choose whites as friends are by far the least likely to have their choices reciprocated. Separate analyses (not shown) reveal that the reciprocation rate is 40 percent to 60 percent higher for the pre-existing friendship choices than for those formed during the school year. The one exception is the black-white dyads, in which the rate of reciprocation is about the same for the friendship choices made before and after school started.

The sample has slightly more females than males. The chooser is more likely to be female in black-white dyads and male in the other dyad types. About 80 percent of the Best Friend choices are between students of the same sex, but blacks are substantially more likely than whites to name friends of the opposite sex. White students rank considerably higher in academic achievement than their black peers. Therefore, the average differences in rank in achievement are large in interracial friendships and trivial in same-race friendships. About 24

percent of the Best Friend dyads are in the same ability group for reading, 46 percent are in different groups and 30 percent are in ungrouped classrooms. The classes, on the average, are slightly more than 50 percent black. Thirty-three percent of the records for the Best Friend dyads come from the first time interval the friendship choice is at risk (Period 1). About 55 percent of the friendship choices existed before the first data collection (Old Friends), with white-black friendships the least likely to have formed before the school year. *F*-tests were performed to determine whether differences in the means across the dyad types are statistically significant. The significance levels for these tests also are reported in Table 1. Most differences between groups are statistically significant.

The maximum number of weeks friendship choices could last if they were formed during the school year is 30. In the full sample, the Best Friend choices are observed to last, on the average, about three-and-a-half intervals or 21 weeks (data not shown). The non-left-censored dyads have a shorter observed duration (about 16 weeks) and the left-censored dyads a longer one (about 26 weeks). Thus friendship choices that began before or at the very beginning of the

school year have greater longevity than those formed during the school year.

Observed durations are affected by both left- and right-censoring, and by when the friendship choice was made during the school year. To provide a clearer picture of friendship survival, the means and standard deviations of the dependent variable, dissolution, are presented in Table 2 for the total sample and for the left-censored and non-left-censored subsamples. These statistics are also broken down for each dyad type by race. The statistics show that the dissolution rate of Best Friend choices is highest during the first time interval the friendship is at risk. Twenty-six percent of the Best Friend choices were withdrawn within six weeks after they are first observed. On the average, however, only 15 percent of the friendship choices dissolved during each six-week period of exposure to risk, implying that friendship choices that survive an initial high period of risk have a much greater likelihood of survival during the later time periods.

The means indicate that a large proportion of the same-race and interracial best friend choices made by the students in the sample last for at least six weeks. The friendship choices in same-race dyads are more likely to endure for more than a six-week period than are those in the interracial dyads. The friendship choices in black-white dyads have the greatest risk of terminating in any one period (19 percent) and those in white-white dyads the least likelihood (14.9 percent). Differences in survival rates

across dyad types are significant at the .08 level during the first time interval and at the .02 level across all the time intervals.

Friendship choices in left-censored dyads have a far lower risk of dissolving than those in non-left-censored dyads (by a factor of about 2.5). Thus friendship choices formed before or at the very beginning of the school year are much more stable than those formed during the school year. On the whole, 38 percent of the friendship choices made during the school year end within six weeks of their formation. Conversely, only 16 percent of the pre-existing friendship choices end within the first six weeks after they are initially observed.

The observed durations (not shown) indicate that the length of Best Friend choices across dyad types differ by only a few tenths of an observational period (the equivalent of one or two weeks). Even the means of the more appropriate dissolution measures in Table 2 reveal only small, though statistically significant, differences in stability. This may seem surprising, but these data are right-censored and cannot reveal the duration of friendship choices that continue to exist at the end of the school year. A great deal of difference could exist in these dyads as they respond to differential influences, such as residential patterns, outside the school environment.

Logistic Regression Analysis

The dependent variable in the multivariate, logistic regression model is *P*'s choice of *O* as

Table 2. Means and Standard Deviations of Friendship Dissolution

<i>A. Full sample</i>					
Variable	Total (N = 3,103)	Bl-Wh (N = 586)	Wh-Bl (N = 366)	Bl-Bl (N = 1,358)	Wh-Wh (N = 793)
Dissol(1) ($\alpha = .079$)	.26 (.44)	.30 (.46)	.30 (.46)	.23 (.42)	.25 (.43)
Dissol(k) ($\alpha = .025$)	.15 (.36)	.19 (.39)	.16 (.37)	.15 (.35)	.14 (.35)
<i>B. Friendships formed during the school year (non-left-censored)</i>					
Variable	Total (N = 1,412)	Bl-Wh (N = 277)	Wh-Bl (N = 217)	Bl-Bl (N = 574)	Wh-Wh (N = 344)
Dissol(1) ($\alpha = .573$)	.38 (.48)	.40 (.49)	.38 (.49)	.35 (.48)	.40 (.49)
Dissol(k) ($\alpha = .351$)	.26 (.44)	.30 (.46)	.24 (.43)	.25 (.43)	.27 (.44)
<i>C. Friendships formed prior to the school year (left-censored)</i>					
Variable	Total (N = 1,691)	Bl-Wh (N = 309)	Wh-Bl (N = 149)	Bl-Bl (N = 784)	Wh-Wh (N = 449)
Dissol(1) ($\alpha = .221$)	.16 (.36)	.21 (.41)	.18 (.39)	.15 (.36)	.13 (.34)
Dissol(k) ($\alpha = .079$)	.10 (.30)	.13 (.33)	.09 (.29)	.10 (.30)	.08 (.28)

Note: Dissol(1) refers to friendship dissolution during the first interval the dyad is at risk, while Dissol(k) refers to average friendship dissolution over all intervals.

Best Friend or non-Best Friend. The independent variables are those that have an effect on the survival of a friendship choice. The independent variables READ UNGR and READ DIFF are excluded from the final model because they had no effect on friendship survival either in preliminary bivariate analyses or in the multivariate analysis. We also conducted analyses with mutual best friend choices as the dependent variable. Our present analyses, which include a control for reciprocation, produce virtually the same results.

Table 3 reports the parameter estimates for the full sample. Proportion black and class climate emerge as important determinants of the stability of interracial friendship choices. In the total sample, and for white choosers in the subsamples, proportion black has a significant positive effect on the stability of friendship choices, as predicted. The greater the ratio of black to white students in a class, the more stable are white interracial and same-race friendship choices. The results are in the opposite direction for black-white choices, although the estimates are not statistically significant.

Classroom climate has a negative effect on the stability of friendship choices in the full sample and for all four dyad types, although it is statistically significant only for black-white and black-black dyads. This finding indicates that the interracial friendship choices of blacks are more stable in classrooms where teachers

deemphasize objective measures of academic achievement, such as grades and success in mastering the curriculum. This is also true for the same-race choices of black students.

The impact of the remaining three organizational variables on the stability of friendship choices is minor. The effects of grade and assignment to the same reading group are insignificant for the total sample and for the four racial groups. Class size has a weak negative effect that is barely statistically significant for white-black dyads.

The two individual level characteristics that have the strongest effects on friendship choice are reciprocity and same gender. Table 3 shows that having a Best Friend choice reciprocated has a statistically significant positive effect on the stability of a friendship choice for all four dyad types. The same is true of choosing a peer of the same gender.

Sex of *P* and difference in rank in achievement have weak effects on stability. Except in black-white dyads, female friendship choices are less stable than those of males, although the gender effect is only statistically significant in black-black dyads. Difference in rank in achievement has a positive effect on the stability of black-white choices, which suggests that blacks are attracted to their higher achieving white peers. Finally, Period 1 has a strong negative effect on the stability of friendship choices in the total sample and for all four dyad types. This

Table 3. Multivariate Logistic Regression of Friendship Stability on Organizational and Dyadic-Level Variables for Full Sample

Variable	Total (N = 3,103)	Bl-Wh (N = 586)	Wh-Bl (N = 366)	Bl-Bl (N = 1,358)	Wh-Wh (N = 793)
Intercept	1.34** (.50)	.04 (1.23)	4.15* (1.75)	.71 (.83)	.75 (1.15)
Recip	1.01*** (.10)	.72** (.24)	1.14*** (.31)	.88*** (.14)	1.44*** (.21)
Sex-P	-.25** (.09)	.00 (.20)	-.52 (.30)	-.49*** (.13)	-.13 (.19)
Samesex	.80*** (.10)	1.05*** (.24)	.98** (.40)	.73** (.14)	.99*** (.29)
Rankdiff	.01 (.01)	.03** (.01)	.01 (.02)	-.00 (.01)	.01 (.01)
Grade	.02 (.06)	.21 (.15)	-.36 (.20)	.14 (.13)	.06 (.14)
Classize	-.02 (.01)	-.01 (.02)	-.07* (.03)	.00 (.02)	-.02 (.02)
Read Same	.07 (.10)	-.01 (.24)	.49 (.34)	-.09 (.15)	.21 (.21)
Prop Black	.64*** (.19)	-.27 (.48)	1.89** (.65)	.05 (.44)	1.80** (.70)
Climate	-.31*** (.08)	-.53** (.18)	-.17 (.25)	-.51** (.18)	-.19 (.14)
Period 1	-.1.02*** (.09)	-.92*** (.19)	-.1.45*** (.28)	-.84*** (.13)	-.1.14*** (.18)

Note: Standard errors are in parentheses.

* Significant at the .05 level.

** Significant at the .01 level.

*** Significant at the .001 level.

result, which was observed earlier in the descriptive analysis, indicates that the interracial and same-race friendship choices of all the students are at greater risk of dissolving shortly after they are first observed than later in the friendship.

Tables 4 and 5 present the multivariate models for the non-left-censored and left-censored dyads, respectively. Comparing the statistically significant effects of the independent variables for the total sample shows that proportion black, class size, and Period 1 have stronger effects on the stability of friendship choices formed during the school year (Table 4), while classroom climate, reciprocity, sex-*P*, and same-sex have stronger effects on the stability of friendship choices made at or before the beginning of the school year (Table 5). These differences are maintained across most of the dyad types. The effect of class size in both samples is small; the effect of Period 1 is stronger in the uncensored dyads because they have not been in existence as long as the censored friendships. It appears that individual and dyadic level variables have a stronger impact on the stability of pre-existing friendship choices than on choices made for the first time during the school year. Organizational characteristics affect the stability of friendship choices in both left-censored and non-left-censored dyads. Classroom climate has a stronger effect on the stability of pre-existing friendship

choices, while class racial composition has a greater influence on those made during the school year.

In general, the multivariate analysis shows that organizational as well as dyadic and individual level variables influence the stability of the interracial and same-race friendship choices of black and white students. Classroom racial composition and classroom climate, in particular, exert a significant influence on the stability of students' interracial friendship choices and, to a lesser degree, students' same-race friendship choices. The other organizational characteristics, assignment to the same reading group and class size, have little influence on the stability of either interracial or same-race friendship choices. Of the dyadic and individual level characteristics examined, reciprocity and same sex are of greatest importance to the survival of a cross-race friendship choice. The results show that while the dyadic and individual level variables are stronger determinants of the stability of interracial friendship choices, organizational factors are also important predictors of the duration of these choices.

DISCUSSION

One might think that because students' interracial friendships are fairly uncommon, they are also unstable. Our research shows that this is not the case. Interracial friendship choices in the

Table 4. Multivariate Logistic Regression of Friendship Stability on Organizational and Dyadic-Level Variables for Friendships Formed during the School Year

Variable	Total (N = 1,412)	Bl-Wh (N = 277)	Wh-Bl (N = 217)	Bl-Bl (N = 574)	Wh-Wh (N = 344)
Intercept	2.07** (.73)	-.84 (1.69)	8.20*** (2.46)	1.43 (1.28)	.72 (1.80)
Recip	0.71*** (.14)	.47 (.34)	.72 (.42)	.67** (.21)	.96*** (.30)
Sex-P	-.19 (.13)	-.28 (.30)	-.20 (.39)	-.26 (.19)	-.12 (.28)
Samesex	.53*** (.14)	.87** (.35)	.60 (.48)	.38 (.20)	.85* (.40)
Rankdiff	.01 (.09)	.03* (.02)	.02 (.02)	.01 (.01)	.00 (.13)
Grade	-.05 (.01)	.31 (.23)	-.79** (.29)	.12 (.19)	.07 (.21)
Classize	-.04** (.02)	-.01 (.03)	-.12** (.05)	-.04 (.03)	-.03 (.03)
Read Same	.02 (.15)	.24 (.34)	.24 (.45)	-.18 (.23)	.05 (.30)
Prop Black	.88*** (.28)	-.30 (.72)	1.53 (.81)	.54 (.65)	1.50 (1.30)
Climate	-.25* (.11)	-.52* (.26)	.25 (.32)	-.54* (.26)	-.21 (.20)
Period 1	-.105*** (.13)	-.80** (.28)	-.144*** (.39)	-.88*** (.19)	-.127*** (.27)

Note: Standard errors are in parentheses.

* Significant at the .05 level.

** Significant at the .01 level.

*** Significant at the .001 level.

Table 5. Multivariate Logistic Regression of Friendship Stability on Organizational and Dyadic-Level Variables for Friendships Formed Prior to the School Year

Variable	Total (N = 1,691)	Bl-Wh (N = 309)	Wh-Bl (N = 149)	Bl-BJ (N = 784)	Wh-Wh (N = 449)
Intercept	1.44*	.86	-2.02	1.24	.82
	(.73)	(1.90)	(3.47)	(1.19)	(1.57)
Recip	1.14***	1.18**	1.58**	.95***	1.62***
	(.14)	(.39)	(.53)	(.20)	(.30)
Sex-P	-.29*	.23	-1.00	-.60**	-.21
	(.13)	(.29)	(.53)	(.19)	(.28)
Samesex	.87***	1.09**	2.08**	.81***	.97*
	(.16)	(.37)	(.83)	(.22)	(.43)
Rankdiff	-.00	.02	-.02	-.02	.01
	(.04)	(.02)	(.02)	(.01)	(.01)
Grade	.06	.14	.12	.06	.06
	(.09)	(.21)	(.34)	(.18)	(.20)
Classize	-.01	-.03	-.01	.01	-.02
	(.02)	(.04)	(.06)	(.03)	(.03)
Read Same	.05	-.33	.62	-.04	.36
	(.15)	(.33)	(.61)	(.21)	(.31)
Prop Black	.47	.02	2.90**	-.15	1.67
	(.28)	(.68)	(1.17)	(.63)	(.93)
Climate	-.41***	-.66*	-.90*	-.38	-.26
	(.12)	(.28)	(.45)	(.25)	(.21)
Period 1	-.71***	-.70**	-.97*	-.59**	-.68**
	(.13)	(.27)	(.47)	(.19)	(.27)

Note: Standard errors are in parentheses.

* Significant at the .05 level.

** Significant at the .01 level.

*** Significant at the .001 level.

desegregated classrooms in our sample were fairly stable. While they generally did not last the entire school year, they did continue for several weeks and often months. Indeed, students' interracial friendship choices were almost as stable as their same-race choices. This surprising result may be because interracial friendships are unlikely in the first place and are made only if there is a strong attraction between a black and white student that then sustains the relationship over time.

Contrary to the impression left by some psychological models of friendship stability, our research demonstrates that friendship dissolution cannot be understood without taking into account the context of the relationship. Admittedly, personality characteristics, attitudinal measures, and the quality of interpersonal interactions are major determinants of friendship stability. But these variables operate within an organizational structure and environment. Organizational and contextual factors influence the attractiveness of a relationship, provide alternatives to an existing friendship, and affect the strength of the barriers to friendship dissolution. As a result, models of friendship dissolution that ignore the setting can only inadequately explain this important social process.

Our study shows that two classroom factors—racial composition of the class and class climate—have a pronounced impact on the stability of interracial friendship choices. Inter-

estingly, these variables do not affect blacks and whites in the same way. The racial composition of a class primarily affects the stability of white interracial friendship choices, with white choices being more stable in classes with a high proportion of black students. The effect of class racial composition on black interracial choices is negligible. Since class racial composition is related to opportunities for interaction, these findings suggest that one way to stabilize interracial friendship choices, at least for whites, is to create classrooms in which the racial composition, or within-class organization, provides many opportunities for students to choose compatible peers of a different race as friends.

Classroom climate affects the stability of the interracial friendship choices of blacks and, to a lesser degree, whites. Blacks are more likely to withdraw their interracial friendship choices in classrooms with a strong emphasis on successful academic performance. This same tendency is found for whites, especially for friendship choices made before or at the beginning of the school year. In classrooms where objective measures of academic success are given priority, academic status discrepancies between blacks and whites likely assume considerable importance and act as a deterrent to friendship stability. Consequently, if school personnel are interested in fostering stable friendships between black and white students, they may need to

create a classroom climate that provides opportunities for black students to be held in esteem by their white peers. Greater status equality along various dimensions should decrease the negative impact of academic differences on the interracial friendship choices of both black and white students. Programs that create a more uniform distribution of academic achievement across black and white students should also increase the stability of interracial friendships.

The differential impact of class racial composition and class climate on black and white friendships suggests that different processes govern the stability and dissolution of interracial friendship choices for black and white students. The interracial friendship choices of blacks respond more to a classroom climate that influences the status hierarchy of the class, while the interracial choices of white students respond more to organizational factors that affect opportunities for interracial interaction. These findings may indicate that the components of cohesiveness assume differential weights for black and white students in their ongoing friendships. Future research should address this issue to discover the reasons for these differences.

The dyadic level variables, primarily same sex and reciprocity, have stronger effects on the stability of interracial friendship choices than do the organizational or environmental variables. This is not surprising. Personal characteristics of dyad members are usually more easily observed than organizational factors during the everyday interactions of dyad members.

Finally, our study shows that friendships formed prior to the school year are more stable than those formed during it. This is probably because many of the weaker friendships formed prior to the school year dissolved by the time the school year began. However, even pre-existing friendship choices are vulnerable to the impact of classroom factors. The racial composition of a class and the class climate represent new environments that pre-existing friendship choices must adapt to, and one mode of adaptation is to terminate the friendship choice. It may be that the environmental factors that influenced the interracial friendship choice made before the school year started, such as neighborhood proximity or unavailability of other peers, disappear in the classroom environment and are replaced by contextual factors that no longer support the friendship choice.

This research has several policy implications. Clearly, dyadic-level characteristics have the strongest impact on the stability of interracial friendship choices. However, it is also clear that schools are not powerless in this area. If school personnel wish to support interracial sociability in desegregated schools, they should try to

provide a classroom environment that promotes stable interracial friendship choices. Our study shows that this can be done by paying attention to the racial composition of the class and to the class climate. The ratio of black to white students can afford opportunities for black and white students to interact with each other to foster positive sentiment between them. The classroom climate can decrease major status differences between black and white students by providing opportunities for all students to win the esteem of their peers. Thus, by manipulating the environmental and organizational factors that affect interpersonal attraction and the cohesiveness of relationships, school administrators and teachers can help sustain interracial friendship ties once they are made.

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