Breaking Up is Hard to Do, Unless Everyone Else is Doing it Too: Social Network Effects on Divorce in a Longitudinal Sample

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Abstract

Divorce represents the dissolution of a social tie, but it is also possible that attitudes about divorce flow across social ties. To explore how social networks influence divorce and vice versa, we exploit a longitudinal data set from the long-running Framingham Heart Study. The results suggest that divorce can spread between friends. Clusters of divorces extend to two degrees of separation in the network. Popular people are less likely to get divorced, divorcees have denser social networks, and they are much more likely to remarry other divorcees. Interestingly, the presence of children does not influence the likelihood of divorce, but each child reduces the susceptibility to being influenced by peers who get divorced. Overall, the results suggest that attending to the health of one's friends' marriages may serve to support and enhance the durability of one's own relationship, and that, from a policy perspective, divorce should be understood as a collective phenomenon that extends beyond those directly affected.

According to the National Center for Health Statistics (Bramlett & Mosher, 2001), about 43% of marriages will end in divorce within the first 15 years of marriage, and, as of 2007, the annual incidence of divorce stands at 36 per 1,000 people (National Vital Statistics Reports, 2007). Moreover, remarriage, while common, tends to be even less successful than first marriage, resulting in higher rates of divorce with each successive trip down the aisle (Krieder & Fields 2002). These numbers matter because the individual health and welfare consequences for those who get divorced and the influence of divorce on subsequent child development can be significant. But they also raise questions about whether there is an "epidemic" of divorce and, if so, whether there is a role of social contagion in this "epidemic." Anecdotal examples of miniature "epidemics" among celebrity networks abound, including the announced divorces of Al Gore and his daughter around the same time. But does such a process play out more generally?

A great deal of work in sociological theory addresses the determinants of marriage and the bases of divorce. Some of this work posits marriage as a form of social exchange, whereby internal benefits (sex) and costs (time) are calculated and weighed relative to external costs (money) and benefits (social approval) (Becker, 1991). From this perspective, externally imposed stressors, such as financial strain, for example, might potentiate the risk of divorce (Conger et al., 1990; Sayer & Bianchi, 2000). Under this model, the risk of divorce rises when the rewards of staying in a marriage diminish relative to the costs, or when one or both partners perceive better alternatives to exist (Amato et al., 2007). Employment prospects, as well as the degree and type of outside activities, certainly affect prospects for the availability of suitable alternative partners (South and Lloyd, 1995).

Evaluations of the intrinsic costs and benefits of relationships, however, take place relative to one's social reference group; thus, norms regarding fairness, loyalty, or other aspects of relationships would likely influence interpretations of the value of any given relationship and the permissibility of divorce. Moreover, social reference groups are relevant to the prospect of finding other partners (Frisco & Williams, 2003; Lennon & Rosenfield, 1994). These

assessments are, of course, influenced by gendered norms and expectations concerning the institution of marriage itself (Kalmijn & Poortman, 2006; Thompson & Walker, 1989). From this relatively individual-centered, cost-benefit-assessment perspective, those who experience high costs and low rewards are more likely to divorce (Nock, 1995; Sanchez & Gager, 2000). However, such individual or dyadic approaches often fail to explore the ways in which a couple's social situation and community network can also affect the status of their marriage and their prospects for marital dissolution.

Here, we examine the effect of divorce among one's peers, and even among others farther away in the social network, on one's own divorce risk. One possibility is that people who get divorced *promote* divorce in others by demonstrating that it is personally beneficial (or at least tolerable) or by providing support that allows an individual to contemplate and endure a rupture in their primary relationship. People in an unhappy relationship may be happier either on their own, embedded in a wider network of friends, or with a different partner. Another possibility is that people who get divorced *inhibit* divorce in others by demonstrating that it may be more personally costly than expected. People who watch another's painful process of divorce may decide that their own unhappiness is worth bearing in order to avoid the cost of breaking up on themselves or their children. If the inhibitory effect of divorce is weaker than the promotion effect, then divorce might spread through a social network via a process of social contagion (involving a variety of mechanisms) from person to person to person.

Hence, the question remains whether contact with others reinforces a decision by unhappy spouses to stay in suboptimal relationships, or whether deeply engaged friends instead potentiate fissure in such relationships, in part by providing more effective forms of support. More broadly, little is known about how inter-personal connections affect divorce, and prior literature has not explored the wider possibility of person-to-person-to-person effects on divorce, although the logic of such investigation seems clear. If one person's divorce affects another's likelihood of initiating marital disruption, why wouldn't such effects diffuse through society in a more widespread manner?

The association between the divorce status of individuals connected to each other, and the clustering of divorce within a social network, could be attributed to at least three processes: 1) *influence* or *contagion,* whereby one person's divorce promotes or inhibits divorce in others; 2) *homophily*, whereby people with the same divorce status choose one another as friends and become connected (i.e., the tendency of like to attract like) (McPherson et al. 2001); or 3) *confounding*, whereby connected individuals jointly experience contemporaneous exposures (such as an economic downturn or co-residence in a wealthy neighborhood) that influence the likelihood of divorce. To distinguish among these effects requires repeated measures of divorce (Carrington et al., 2005), longitudinal information about network ties, and information about the nature or direction of the ties (e.g., who nominated whom as a friend) (Fowler & Christakis, 2008b; Christakis & Fowler 2013).

There are two issues here, two distinct ways that social networks might affect divorce risk. First, the *structure* of the network in which one is embedded can itself affect risk of divorce. For example, the greater the transitivity of the network around a married couple (the more their friends are friends with each other), the lower their risk of divorce might be (similar, for example, to the effect Bearman and Moody found with respect to suicide risk in adolescent girls (2004)). Or, possibly, the more peripheral a couple is in the social network, the greater their risk of divorce might be. Second, regardless of structure, processes of social *contagion* could operate within the network. Here, the issue is what kinds of attitudes and behaviors are evinced by one's network neighbors, and what effects these might have. So, the greater the incidence of divorce among one's friends, the higher the likelihood one would follow suit. Prior work on how the architecture of social networks affects divorce risk is limited. Similarly, prior work on how attitudes towards divorce might diffuse through social networks is also scarce.

Network Structure and Divorce

The existing literature on divorce offers some evidence regarding the impact of social support networks on the likelihood of marital rupture. Some older work suggests that spouses who share the same friends are less likely to get divorced than those who do not (Ackerman, 1963). Other research from a nationally representative sample indicates that weaker network ties to one's spouse increase chances for marital infidelity, a factor that predisposes partners to divorce (Treas & Giesen, 2000). Yet such relationships are neither simple nor straightforward in nature. As Booth et al. (1991, 222) write: "simple embeddedness in the social fabric of society may not be sufficient to explain why some marriages endure and others break up."

To examine more subtle aspects of the influence of networks on marriage, additional work has explored a more nuanced characterization of social network support, examining different types of relationships. Bryant & Conger (1999) studied three types of influence to examine whether network support helps encourage a couple to stay together or instead drives them apart. First, they studied outside support for the relationship from friends and family to see whether approval for the relationship provides an important predictor of relationship success, as some earlier work suggested (Johnson & Milardo, 1984). Second, they examined whether shared social network contacts enhanced marital satisfaction, including whether liking each other's friends can improve marital happiness. Last, they investigated whether personal support *within* the relationship improved chances for marital success. An important aspect of this last component relates to a sense of reciprocal equality in the relationship, or whether one person feels he or she gives more than the other within the context of the marriage. Interestingly, only outside support from friends and family predicted marital success in the time period examined.

The authors suggest an endogenous mechanism is at work among those who achieve success in relationships: "The greater the feelings of satisfaction, stability and commitment that partners have for their relationships, the greater the evidence for supportive extramarital relationships. In turn, the more supportive network members are, the greater are feelings of

satisfaction, stability and commitment that partners have for their marital relationships. (448)" This provides some insight into the reasons why popularity, as defined by increased social exposure, approval, and support, may decrease the risk of divorce. If a spouse is popular, they may be more able to solicit and receive the kind of supportive extramarital friendships that strengthen their marital bonds than those who have less social resources to depend on in times of marital trouble.

Only one longitudinal panel study (Booth et al., 1991) has addressed the question of whether a greater number of social ties, and more frequent interaction among them, decreases the likelihood of divorce. The authors of this study defined *communicative integration* as the degree to which individuals remain embedded in a large social network and *normative integration* as a lack of divorce among one's reference group members. They found a small negative effect of communicative integration on divorce, but only for those who had been married less than seven years. Importantly, they found that normative integration reduced the likelihood of divorce, regardless of how long people had been married: "When one's reference group includes siblings or friends who have divorced, the individual is more likely to divorce." (221). Part of the reason for this may be that when friends become divorced, more convenient and familiar options for new partnerships open up to those in the same network. This suggests the hypothesis that divorced people might be more likely to marry one another.

Finally, despite the tremendous attention paid to the influence of divorce on children, relatively less interest has been dedicated to the impact of children on the probability of divorce. Waite & Lillard (1991) found that firstborn children enhance marital stability until the child reaches school age. Additional children improve the prospects for marital stability only while they remain very young. Having children prior to marriage, or having older children, portends poorly for marital endurance. In sum, these authors find that children only provide a marginal improvement in the likelihood of a marriage surviving twenty years. It may be that the financial and time stresses associated with having children place a heavy burden on married couples, but they are too busy to attend to anything but the immediate needs of their children until they are

self-sufficient. Once children are older, the parents may feel there is less need to remain together "for the sake of the children" if the central relationship itself has become strained to the point of breaking. Heaton (1990), using a regression analysis on a current population sample, reported the stabilizing influence of up to three children on a marriage, noting that five or more children increased risk of divorce. This similarly suggests that while some people may stay together because of children, too many can push couples over the tipping point where cooperation, even for the sake of children, may no longer seem possible. Commensurate with the Waite & Lillard (1991) findings, Heaton (1990) also indicated that as children get older, the risk of divorce rises until the youngest child left home.

Network Contagion and Divorce

Existing work in person-to-person transmission has focused particularly those related to parent-to-child intergenerational transfer of divorce risk. One common hypothesis is that parents who divorce are significantly more likely to produce progeny who also show an increased propensity to experience ruptured marriages; this tendency becomes exacerbated when both partners have parents who experienced divorce themselves (Bumpass et al., 1991; Feng et al., 1999; Keith & Finlay, 1988; Kulka & Winesgarten, 1979; Mueller & Pope, 1977.). In particular, daughters of divorced parents are more likely to divorce (Feng et al., 1999); one large study found that the risk of divorce in the first five years of marriage increased 70% among daughters of divorced parents (Bumpass et al, 1991). This risk may transfer differentially to daughters because such women display a stronger commitment to employment and plan to have fewer children, reducing their expected economic dependence on men (Goldscheider & Waite, 1991). While wives' employment can ease financial stress in a marriage, it simultaneously potentiates conflict over household chores and childrearing, making marriages less enjoyable for both partners (Hochschild, 1989). Wives' financial independence makes divorce more economically feasible for such women

Demographic patterns play an important mediating role in the association between parental and child divorce (for an excellent review, see Amato, 1996). For example, age of marriage strongly influences prospects for success; young marriages are less likely to survive, and children of divorce tend to marry younger (Glenn & Kramer, 1987; Keith & Finlay, 1988). Another factor which rivals age in inducing marital stability appears to lie in holding similar religious beliefs; in general, intrafaith unions suffer divorce less frequently than interfaith ones (Lehrer & Chiswick, 1993). Children of divorce also seem to be more likely to cohabit prior to marriage, which some have argued is associated with increased divorce rates (Bumpass et al., 1989, Thornton, 1991; but see Elwert, 2007). In addition, compared with children from intact families, children of divorce attain less educational status, make less income, and have lower-level jobs, all of which combine to enhance the risk of divorce (Conger et al., 1990; Mueller & Cooper, 1986). In addition to these demographic factors, some work suggests that specific behaviors play a key role in potentiating the risk of divorce. For example, children may learn destructive traits, like jealousy or distrust, from their parents, and import such problematic tendencies into their own relationships, or they may fail to learn important interpersonal skills, like the ability to communicate clearly or compromise effectively (Amato 1996; Wallerstein & Blakeslee, 1989). Teachman's (2002) work shows how the intergenerational transfer of divorce may result from the inheritance of personality traits, which lead, in turn, to lower levels of social functioning and higher risk of divorce. Parental investment in social network support may also provide a model to children as well, such that more popular parents offer more and better opportunities for potential mates and other forms of social support to their children as well. All these factors thus affect parent-child transmission of divorce risk.

Moreover, marriage, like friendship, may sort according to degree of such functioning, with higher functioning individuals being both more likely to find and keep suitable mates and also more able to find social support outside marriage in other friendships (should the relationship prove challenging).

Hence, most of the work exploring the relationship between social networks and divorce has concentrated on person-to-person effects, and has not even tried to explore person-to-person to –person effects, or the extent to which a divorce by one couple might affect those separated by two degrees. But earlier work on outcomes such as happiness highlight the possibility that complex social processes such as divorce might be affected by social network processes (Fowler & Christakis, 2008a).

Limitations of Previous Work

Distinct from the foregoing, the literature has not addressed how – conversely – divorce can affect networks. As Bryant & Conger conclude in their own study: "Most of the existing work only presents evidence of networks influencing relationships, rather than relationships influencing networks (448)." That is, almost none of the literature has examined the reciprocal impact of divorce on the surrounding social network. This is curious, since the act of divorce directly affects the structure of a network by removing an existing tie, and since divorce in one person might also affect the risk of divorce among his or her friends and other social contacts. We explore here the possibility that divorce can affect social networks, just as social networks can affect divorce, precisely because a shift in one person's marital status may influence the marital status of others in that network as occurs, for example, when two divorced people remarry one another.

Note also that these extant studies focus almost exclusively on parent-to-child transmission of risk factors for divorce, ignoring the potentially important impact of the peer-to-peer influence we explore here. In addition, outside of intergenerational transmission, little work has explored the relative importance of type of relationship on social influence in divorce. Can friends who live far away influence their geographically remote friends' prospects for divorce? What about coworkers who a person might see every day, but with whom they might not feel especially close? Will such individuals in our network affect prospects for divorce more or less than a sibling or parent?

Finally, previous studies have been relatively less able to address questions of causality because of a lack of longitudinal data. Here, we use a 32-year longitudinal study that contains information about marital and other network ties. We hypothesize that structural features of the network in which people are embedded will affect their divorce risk, that divorce can diffuse through the social network from person to person, and that divorce can in turn modify social network structure. We use a variety of analytic approaches to partially address thorny problems of causal inference in this setting.

DATA AND METHODS

Sample

The study was approved by the institutional review boards of Harvard Medical School and the University of California, San Diego. The Framingham Heart Study (FHS) is a population-based, longitudinal, observational cohort study that was initiated in 1948 to prospectively investigate risk factors for cardiovascular disease. In this article, we focus on two separate but related cohorts from the FHS: (1) the "Original Cohort" enrolled in 1948 (N=5,209); and (2) the "Offspring Cohort" (the children of the Original Cohort and spouses of the children) enrolled in 1971 (N=5,124). For recruitment of the Original Cohort, FHS administrators impaneled the majority of the adult residents of Framingham, Massachusetts, in 1948, and there was little refusal to participate. In 1971, researchers composed the Offspring Cohort, which included children of the Original Cohort and their spouses. Although generalizability from these samples to the U.S. population is limited by the fact that nearly all participants are white, Kannel et al. (1979) suggest that the offspring cohorts are typical "for families with parents born in the late 19th or early 20th century" (for additional details about sample composition and study design for these cohorts see Cupples & D'Agostino, 1988 and Quan et al., 1997).

Continuous surveillance and serial examinations of these cohorts provide longitudinal data. All of the participants are personally examined by FHS physicians and nurses (or, for the small minority for whom this is not possible, evaluated by telephone) and watched continuously for outcomes. At each evaluation, participants complete a battery of questionnaires (including their marital status), a physician-administered medical history (including review of symptoms and hospitalizations), a physical examination administered by physicians on-site at the FHS facility, and a large variety of lab tests.

The Offspring study has collected information on health events and risk factors roughly every four years. The Original Cohort has data available for roughly every two years. For the purposes of the analyses reported here, exam waves for the Original cohort were aligned with those of the Offspring cohort, so that all participants in the social network were treated as having been examined at just seven waves (in the same time windows as the Offspring, as noted in Table 1).

Importantly, even participants who migrate out of the town of Framingham (to points throughout the U.S.) remain in the study and, remarkably, come back every few years to be examined and to complete survey forms; that is, there is no necessary loss to follow-up due to out-migration in this dataset, and very little loss to follow-up for any reason (e.g., only 10 cases out of 5,124 in the Offspring Cohort are unaccounted for).

The Offspring Cohort is the key cohort of interest here, and it is our source of the focal participants, or the *egos* in our network. However, individuals to whom these egos are linked – in either the Original or the Offspring cohort – are also included in the network. These linked individuals are termed *alters*. Non-clinical personnel at the FHS maintained records of social contacts in order to track participants. These tracking sheets comprehensively identify spouses, friends, neighbors (based on address), co-workers (based on place of employment), and relatives.

To ascertain network ties, we computerized information from these archived, handwritten documents.

The key fact that makes these administrative records so valuable for social network research is that, given the compact nature of the Framingham population in the period from 1971 to 2007, many of the nominated contacts were themselves also participants of one or the FHS cohorts. As a result, it is possible to know which participants have a relationship (*e.g.*, spouse, sibling, friend, co-worker, neighbor) with other participants. On average, each ego has ties to nearly 11 alters in the overall data set. Of note, each link between two people might be identified by *either party* identifying the other; this observation is most relevant to the "friend" link, as we can make this link either when A nominates B as a friend, or when B nominates A (and, as discussed below, the directionality of this nomination is methodologically useful). People in any of the FHS cohorts may marry or befriend or live next to each other or work with one another. Finally, given the high quality of addresses in the FHS data, the wealth of information available about each participant's residential history, and new mapping technologies, we determined who is whose neighbor, and we computed distances between individuals (Fitzpatrick & Modlin, 1986).

Measures

Our measure of divorce was derived from marital status self-reports on surveys at each exam and also, separately, a detailed analysis of the spouse named on the tracking sheet for each individual. The self-report was the response to the question: "What is your marital status? (1) Single; (2) Married; (3) Widowed; (4) Divorced; (5) Separated. We combined self-reports with tracking sheet information because sometimes subjects would list themselves as "married" on the self-report, but the tracking sheet record showed that they were previously married to a *different*

individual, implying a divorce had occurred between the exams if the previous spouse was still living. We code divorce as a dichotomous variable for each subject at each exam, with a 0 meaning never divorced and a 1 meaning the subject had been divorced at least once on or prior to the date of the current exam.

Tables 2 and 3 show summary statistics for divorce, network variables, and control variables we use to study the statistical relationship between divorce and social network structure and function. It is important to note that our sample exhibits a low average divorce rate because it is primarily white, middle class, and better educated than a representative sample for the U.S. population (for comparison, see Norton and Miller, 1992; Krieder, 2005). Figures 1 and 2 also show how the incidence of divorce has changed from one exam to another, and how it varies by age group and years of education. Divorce rates in our data are not as high as contemporary rates since many of the participants come from older cohorts, and divorce was rare at the beginning of our survey range (for comparison, see Norton and Miller, 1992; Krieder, 2005). Figure 1 shows that people in all cohorts are more likely to get divorced in later exams; the increase in divorce rates has increased for all age groups, but it has increased fastest for the younger age groups. Table 3 shows that rates of divorce for men and women in the study are about the same.

Analytic Methods

To determine whether the clustering of divorced people shown in Figure 3 could be explained by chance, we implemented a quadratic assignment procedure (QAP) method (Hubert and Schultz 1976; Krackhardt 1987, 1988). In this permutation test, we compared the observed network to 1,000 randomly generated networks in which we preserved the network topology and the overall prevalence of divorce but in which we randomly shuffled the assignment of the

divorce value to each node (Szabo & Barabasi, 2007). If clustering in the social network is occurring, then the probability that an ego is divorced given that an alter is divorced should be higher in the observed network than in the random networks. This procedure also allows us to generate confidence intervals and measure how far, in terms of social distance, the correlation in divorce between ego and alter reaches.

For longitudinal statistical analyses, we measured the association between divorce and social network variables net of control variables. In these models, we focus on those egos who were not divorced in the previous exam and we conducted regressions of ego's current divorce status as a function of ego's age, gender, education, and the alter's divorce status in the previous exam. This lagged model is specifically recommended by Shalizi and Thomas (2010) and Vanderweele (2011) as an alternative to previous models that focused on contemporaneous effects because it helps to better control for homophily (the tendency of people to form social ties with others who have similar characteristics, e.g., religiosity, an affinity for marriage, etc.) (Christakis and Fowler 2013). And in another departure from previous models, in this setting we include only egos who were not divorced at the prior exam and who maintained a social tie with the alter since the previous exam. This helps control for homophily since it eliminates any potential correlation between ego's divorce status and alter's divorce status at the inception of the relationship between ego and alter (Christakis and Fowler 2013).

For the longitudinal analyses, we used generalized estimating equation (GEE) procedures to account for multiple observations of the same ego across waves and across different ego-alter pairings (Liang & Zeger, 1986). We assumed an independent working correlation structure for the clusters (Schildcrout & Heagerty, 2005). Mean effect sizes and 95% confidence intervals were calculated by simulating the first difference in alter contemporaneous divorce status (changing from 0 to 1) using 1,000 randomly drawn sets of estimates from the coefficient

covariance matrix and assuming all other variables are held at their means (King, Tomz, & Wittenberg, 2000). The models also include exam fixed effects, which, combined with age at baseline, account for the aging of the population and different norms regarding divorce in different age groups (see Figures 1 and 2). The sample size is shown for each model, reflecting the total number of all relevant *ties*, with multiple observations for each tie if it existed in more than one exam, and allowing for the possibility that a given person can have multiple ties. (Standard errors were adjusted for this using GEE procedures.)

We evaluated the possibility of omitted variables or confounding events explaining the associations by examining how the type or direction of the social relationship between ego and alter affects the association between ego and alter (a "network directionality" test, see Christakis and Fowler 2013) If unobserved factors drive the association between ego and alter divorce status, then directionality of friendship should not be relevant. Divorce status in the ego and the alter will move up and down together in response to the unobserved factors. In contrast, if an ego names an alter as a friend but the alter does not reciprocate, then a causal relationship would suggest that the alter would significantly influence the ego, but the ego would not necessarily influence the alter.

We explored the sensitivity of our results to model specification by conducting numerous other analyses each of which had various strengths and limitations, but none of which yielded substantially different results than those presented here. For example, we experimented with different error specifications. Although we identified only a single close friend for most of the egos, we studied how multiple observations on some egos affected the standard errors of our models. Huber-White sandwich estimates with clustering on the egos yielded very similar results. We also tested for the presence of serial correlation in all GEE models using a Lagrange multiplier test and found none (Beck, 2001).

Additionally, we conducted a sensitivity analysis specifically recommended by Vanderweele (2011) in which we estimate the bias in the association between ego and alter divorce that might be caused by an omitted variable that is correlated with the prevalence of divorce in both ego and alter. This class of omitted variables includes those that explain friendship formation based on the trait (homophily) and those environmental factors that could affect ego and alter independent of their relationship (confounding). These sensitivity analyses show how the association changes given differences in prevalence of a binary omitted variable that are conditional on the alter's trait and given the size of the effect of the omitted variable. We vary the prevalence from 0.5 for egos connected to divorced alters and 0.5 for egos connected to non-divorced alters (in other words, the omitted variable does not explain any relationship between egos and alters) to 1 for egos connected to divorced alters and 0 for egos connected to non-divorced alters (in other words, the omitted variable perfectly explains the relationship between egos and alters). We also vary the strength of the omitted variable from a risk ratio of 1 (no effect) to 3 (the omitted variable triples the risk of the trait).

A Comment on Analytic Methods

The original work on networks in the Framingham Heart Study (Christakis and Fowler 2007) drew a lot of attention to the methods used, and this burgeoning literature is reviewed in Christakis and Fowler (2013). Here, we briefly elaborate on some of the issues this literature has addressed.

One paper claimed that the longitudinal network model does not adequately control for homophily (Cohen-Cole and Fletcher 2008a) and argued that fixed effects for each individual should be included in the model. But Monte Carlo simulations show that the model correctly identifies influence effects in the presence of homophily on the outcome variable (Fowler and

Christakis 2008b; Fowler et al. 2011) and a re-analysis of the Framingham Heart Study data using fixed effects showed the same results as the model without (Fowler and Christakis 2008b).

Another paper (Cohen-Cole and Fletcher 2008b) claimed that the longitudinal network model can be used to show the spread of phenomena in adolescents that were assumed to be intrinsically incapable of spread, such as acne, headaches, and height. However, in addition to not being statistically significant at conventional levels, the effect sizes for these phenomena were also substantially smaller than the effects observed, for example, for obesity and smoking. Indeed, the effects for acne, headaches, and height are not robust to sensitivity analyses for the role of homophily or shared context (VanderWeele 2011). There are other limitations to this critique as well (see Christakis and Fowler 2013).

A number of papers have explored the strengths and limitations of the network directionality test (Anagnostopoulos, Kumar and Mahdian 2008; Bramoulle, Djebbaria and Fortin 2009; Noel and Nyhan 2011). In particular, Shalizi and Thomas (2010) identify two important conditions that together may cause the directional test to fail: (1) the influencers in a population may differ systematically in unobserved attributes from the influenced; and (2) there may be heterogeneity in the effect of these unobserved attributes on the outcome variable. How likely such circumstances are to occur in real social networks is unknown, and how big any resulting biases might be is also unknown.

Finally, Shalizi and Thomas (2010) also argue that "latent homophily" caused by omitted variables that explain both the outcome and the tendency to make friends may bias results from the longitudinal network model. In fact, they claim that it is not possible to rule out spurious effects. But they do not quantify the size of these effects. It is therefore important to learn the empirical circumstances under which these problems might generate flawed inferences. A recent paper by Iwashyna et al. (2011) tests the longitudinal network model on network data generated

by agent-based models with varying processes of friend selection and influence. They show that the model works well to detect influence, with a very high sensitivity and high specificity. In particular, they test a specification where people make friends based on an unobservable characteristic related to the outcome, and yet they still find the model yields high sensitivity and specificity for detecting influence. Thus, while there may be some theoretical objections based on unknown amounts of bias that could be present, applied research is generally pointing to the utility of the approach in generating informative estimates of the possible inter-personal influence present. Similar results have been reported by other authors, as summarized in Christakis and Fowler (2013).

RESULTS

Network Clusters of Divorce

In Figure 3, we show a portion of the social network that suggests a clustering of divorced (red nodes) and non-divorced (yellow nodes) people. The left panel of Figure 4 shows a significant relationship between ego and alter divorce status, and this relationship extends up to two degrees of separation. In other words, a person's tendency to divorce depends not just on his friends' divorce status, but also extends to his friends' friends. The full network shows that participants are 75% (95% C.I. 58% to 96%) more likely to be divorced if a person (obviously other than their spouse) that they are directly connected to (at one degree of separation) is divorced. The increase in likelihood for people at two degrees of separation (e.g., the friend of a friend) is 33% (95% C.I. 18% to 52%). At three degrees of separation the association disappears (–2%, 95% C.I. –12% to 9%).

The right panel of Figure 4 shows that the decline in the association with social distance contrasts to a *lack* of decline in the association as people become more geographically distant from one another. Although the association in divorce status is stronger among people who co-reside in the same household (category 1 in Figure 4, $p<0.001$), geographic distance appears to have no effect on the strength of the association among those who do not reside together. We confirmed this result by testing an interaction between distance and the effect size. These results suggest that a divorced friend or family member who lives hundreds of miles away may have as much influence on an ego's risk of divorce as one who lives next door.

Network Structure and Divorce

Given the strong clustering of divorce outcomes that are present in the network, we explored the possibility that the structure of the network itself has an effect on divorce rates (and vice versa). Table 4 shows that although the number of family ties and the number of people the ego names as a friend do not appear to be related to the future likelihood of divorce ($p=0.64$ and $p=0.23$, respectively), the number of people who name the ego as a friend has a strong and significant effect. Each additional person who names the ego as a friend reduces her probability of divorce by 10% (95% C.I. 4% to 17%).

Table 5 shows that the causal arrow also points in the opposite direction: divorce may have a significant effect on the structure of the network. People who go through a divorce experience a 4% (95% C.I. 0% to 8%) decrease in the number of people who name them as friends. Moreover, they name about 7% (95% C.I. 3% to 12%) fewer friends on average.

Table 6 shows that divorce also has an effect on the pattern of ties between ones' friends. A measure of *transitivity* – the probability that two of ones' contacts are connected with one another – is significantly related to previous divorce status (even controlling for the total number

of contacts, which is structurally related to transitivity). The implication is that people who go through a divorce tend to immerse themselves in denser groups with fewer ties outside these groups. In contrast, transitivity appears to have no effect on the future likelihood of divorce (p=0.37). Moreover, we find that sharing the same friends with one's spouse does not significantly mitigate the likelihood of divorce. The correlation between sharing at least one friend and getting divorced at the next exam is negative but not significant (Pearson rho = –0.012, p=0.20). Similarly, the correlation between fraction of shared friends and getting divorced at the next exam is negative but not significant (Pearson rho = –0.011, p=0.22). Taken together, these results suggest that divorce has a stronger effect on the structure of the network than the structure of the network has on divorce.

Table 7 shows that, not surprisingly, divorced people exhibit strong homogamy with other divorcees. After controlling for age, education, gender, and baseline divorce rates at each exam, people who have been divorced are much more likely to remarry someone who has gone through the same experience. Compared to others, divorcees are more than twice as likely to marry someone who was divorced *prior* to the last exam (increase of 138%, 95% C.I. 44% to 313%). And the association is even stronger for recent divorcees. Those who became divorced in the previous exam are four times more likely to marry a divorcee (increase of 303%, (95% C.I. 118% to 638%).

Network Contagion and Divorce

To study the possibility of person-to-person effects, we examined the direct ties and individual-level determinants of ego divorce status. In the models we present in Table 8, we control for several factors as noted earlier, and report the association between "Ego Currently Divorced" and "Alter Previously Divorced" in the first row. People who have a friend who has

previously gotten divorced are 270% (95% C.I. 60% to 650%) more likely to get divorced themselves by the time they come to their next exam. Among friends, we can distinguish additional possibilities. Since each person was asked to name a friend, and not all of these nominations were reciprocated, we have ego-perceived friends (denoted here as "friends") and "alter-perceived friends" (the alter named the ego as a friend, but not vice versa). We find that the influence of alter-perceived friends is not significant (the estimate is 80%, 95% C.I. –40% to 310%). If the associations in the social network were merely due to shared experience, the associations for different types of friendships should be similar. That is, if some third factor were explaining both ego and alter divorce decisions, it should not respect the directionality of the friendship tie.(Christakis and Fowler 2013)

Note that the lack of an effect by alter-perceived friends contrasts with the fact we noted above that, when more people name a person as a friend, it decreases their likelihood of divorce. Thus, for alter-perceived friends it is the *structure* of the network and not what might be flowing through the network that ultimately affects a person's marital behavior.

We do not find significant associations between ego and alter divorce for other kinds of alters, including siblings, neighbors, and coworkers (see Table 8). This suggests that potential confounders due to shared environment are not driving the result for friends. We also conducted sensitivity analyses to test whether an omitted variable that explains both divorce and the tendency to choose similar friends (homophily) could be driving the result. Vanderweele (2011) provides a method to adjust the point estimate and standard errors from regression and logit models under two assumptions about the omitted variable. The first assumption is the strength of homophily or confounding, which can be measured by the prevalence of the omitted variable conditional on the outcome. In other words, how much does divorce influence the omitted variable? The second assumption is the strength of the effect of the omitted variable on the

outcome variable. In other words, how much does the omitted variable increase the risk of divorce? Although these two values are usually unknown for omitted variables, one can test a variety of scenarios to show how potent a confounder would have to be to drive the estimated effect size to zero.

The results of these analyses in Table 9 show that the association between friend's previous divorce and ego's divorce does not fall to 0, even when the strength of unobserved confounding is at its maximum and the confounder triples the risk of divorce. Confidence intervals in parentheses in Table 9 show that the estimated effect of friend's divorce on own divorce remains significant for all but those omitted variables in the lower right of the table (where the first number in parenthesis is negative). This level of robustness is similar to that found for other well-established associations like the relationship between parental exposure to lead in the workplace and lead poisoning in children (Rosenbaum 2002). It is also similar to results for obesity (Christakis and Fowler 2007) and smoking contagion (Christakis and Fowler 2008), both of which were tested for sensitivity by Vanderweele (2011). For those studies, Vanderweele concluded the results were "reasonably robust to latent homophily or environmental factors for which control was not made." (p.252)

The Role of Children

We examined whether children would have a protective effect with respect to divorce. As noted earlier, most literature and cross-sectional data suggest that children reduce the likelihood of divorce slightly, and that childlessness can precipitate divorce. Table 10 shows the relationship between number of children and divorce and we find no such effect; in fact, the main effect of children on divorce is slightly positive, albeit not significant (p=0.15). However, when we also include an interaction between the alter's previous divorce status and ego's

number of children at the previous exam, we find that each additional child significantly (p=0.04) reduces the association between alter's divorce status and ego's likelihood of getting divorced. For couples with no children the effect is much stronger than average: an alter who was previously divorced in the last exam nearly quadruples the current risk of divorce in the ego (+390%, 95% C.I. 80% to 900%). But by the time a person has a third child, the effect of alter's divorce status becomes insignificant (+50%, 95% C.I. –40% to 190%) and by the fifth child it completely vanishes (+0%, 95% C.I. –70% to 160%). These results suggest that the protective effect of children acts may act specifically on a parent's susceptibility to influence by peers who have gotten divorced.

DISCUSSION

Using a long-term longitudinal data set, we explored how social network structures and processes influence divorce and vice versa. First, we show that divorce tends to occur in clusters within the network. These results go beyond previous work intimating a person-to-person effect to suggest a person-to-person-to-person effect. Individuals who get divorced may influence not only their friends, but also their friends' friends as the propensity to divorce spreads. Importantly, this effect is not mitigated by geographic distance but does decline with social distance, suggesting that whatever causal mechanism underlies this effect likely depends on psychological or normative factors, as opposed to logistical or practical factors that are more likely to require the physical presence of other parties. Moreover, the lack of decay with geographic distance militates against an explanation that relies on local exposures (e.g., to local counseling resources, local churches, or local norms against divorce) that might confound causal inference.

Second, while past work indicated that spouses who share friends are less likely to divorce, we do not replicate this finding in our sample. We do demonstrate that more popular people are less likely to get divorced. This may relate to an argument put forward by Bryant & Conger (1999) suggesting the reciprocally supportive role of marital relationships and friendship networks (those with a good relationship also possess a strong, supportive friendship network, and vice versa). In addition, people with better social skills may select into better marriages and also have access to more supportive friendship networks as a result of those same benefits. Those supportive friendship networks may also make it easier for individuals to weather inevitable marital stresses without having to resort to marital rupture. Some evidence does suggest that marital well being results more from self-selection into better marriages than from the marriage itself causing happiness (Mastekaasa, 1992). However, the prospective models we use here control for network characteristics in the previous period, suggesting that the relationship is not solely driven by selection.

We also show that divorce exerts a significant impact on the structure of a person's social network and that those who divorce become less popular. This may result partly because they are likely to lose members of their spouse's social network as friends. In addition, newly single people may be perceived as social threats by married friends who worry about marital poaching. Moreover, divorcees tend to embed themselves in networks where there is greater likelihood that a person's friends are also friends with each other, and they exhibit strong homogamy in remarriage, often (not surprisingly) choosing other divorcees as new partners. While our results do not explain *why* divorcees choose each other, they do suggest that homophily on divorce status may be an important source of clustering in the overall social network.

Third, while past work concentrated on parent-to-child transmission of divorce, we examined the possibility of peer-to-peer transfer among friends, siblings, neighbors, and

coworkers. The results show significant associations between alter's previous divorce status and ego's current divorce status for friends but not for other social relationships. Interestingly, while children may provide some protection against divorce, they appear to do this not directly, but rather indirectly, by reducing the association with peers who get divorced.

It is important to note that there are no detectable gender interactions with any of the effects shown (results available on request). Men and women appear to be equally susceptible to splitting up if their friends do it. Moreover, unlike previous analyses of smoking and happiness (Christakis & Fowler 2008; Fowler & Christakis 2008a), the analysis of divorce fails to produce any associations with measures of network centrality, core-periphery, or other global characteristics of the network. This may possibly relate to the finding that divorce only clusters out to two (and not three) degrees of separation.

A limitation of all social network analyses is that the studies are necessarily bound to their sample, and ties outside the network cannot be discerned in such a sociocentric study. The compact nature of the Framingham population in the period from 1971 to 2003 and the geographic proximity of many of the subjects mitigate this constraint, but we nevertheless considered whether the results might have changed with a larger sample frame that includes all named individuals who were themselves not participants in the Framingham Heart Study. For instance, when we regress the number of contacts a person names outside the study on a person's divorce status, we find an insignificant relationship (p=0.37). This result suggests that the sampling frame is not biasing the average risk of divorce in the target individuals we are studying. Other limitations in our analysis are that our sample has a restricted demographic range (e.g., the sample is virtually entirely white), and that we cannot observe same-sex unions. Finally, some scholars have argued that there may be bias in the methods used to estimate network effects in observational data and that it is not possible to rule out spurious effects

(Shalizi and Thomas 2010); however, increasingly, both theoretical (Fowler and Christakis 2008b; Fowler et al. 2011; Iwashnya 2011) and empirical research (Fowler and Christakis 2008b; Iwashyna 2011; VanderWeele 2011; Christakis & Fowler 2013) suggests that these biases are small in practice, and experimental work (Fowler and Christakis 2010; Rand, Arbesman, and Christakis 2011; Bond et al. 2012) is confirming that social contagion of a wide variety of phenomena is real.

Romantic and sexual practices as diverse as contraceptive use, sexual behaviors, and fertility decisions are all strongly influenced by the existence of these behaviors within one's network (Christakis and Fowler, 2009). Hence, divorce fits in with a pattern wherein such seemingly deeply personal matters are in fact partly determined by collective, social network processes. For example, one study of 8,000 American families followed since 1968 found that the probability that a person will have a child rises substantially in the two years after his or her sibling has a child; the effect is not merely a shift in timing, but a rise in the total number of children a person chooses to have (Kuziemko, 2009). Similar effects have been documented in the developing world where decisions about how many children to have and whether to use contraception spread across social ties (Bloom, 2008). And, as an example of the spread of sexual behaviors, adolescents who believe that their peers would look favorably on being sexually active are more likely to have casual, non-romantic sex (Manning et al., 2005).

Divorce is consequential, and a better understanding of the social processes contributing to this behavior offers the promise of possibly being able to reduce the adverse effects of divorce. For example, one recent study showed that, on average, women's standard of living declines by 27% while men's standard of living increases by 10% following divorce (Peterson, 1996). Divorce also appears to exert a decisive effect on overall mortality; married people have higher longevity than unmarried (Ben-Schlomo et al., 1993; Goldman, 1993; Elwert and

Christakis, 2006). These mortality rates typically differ by gender, such that men demonstrate greater effects (Koskenvuo et al., 1986), but unemployed women and unskilled male workers in particular may suffer lower rates of life expectancy in the wake of divorce (Hemstrom, 1996). In addition, divorced people tend to have more health problems (Joung et al., 1997; Murphy et al., 1997; Elwert and Christakis, 2008)

Social networks can play a role in coping with divorce. One study reported that 67% of adjustment to divorce in men could be explained by social network size, income, family stress and the severity of the divorce, with social network size and severity of the divorce being directly related to outcome. In women, 20% of adjustment could be explained by the severity of the divorce, and the size of social network did *not* seem to exert a decisive effect on post-divorce adjustment, largely because wives had wider social networks, and possibly better social skills, even prior to divorce (Plumber & Koch-Hattemm, 1986). Additional work indicates that lack of social support portends poorly for post-divorce adjustment (Marks, 1996; Ross, 1995).

Given its high prevalence, our study indicates that approaching the epidemiology of divorce from the perspective of an epidemic may be apt in more ways than one. The contagion of divorce can spread through a social network like a rumor, affecting friends up to two degrees removed. Yet adopting a strategy of social isolation so as to avoid being affected (a fanciful idea) does not provide a realistic solution since friendship networks also provide protection against myriad forms of social distress. Rather, it remains important to understand the reciprocal influence between divorce and networks in developing programs designed to provide protection for individuals and children who may suffer social dislocation in the wake of its consequences.

If divorce is indeed seen as a public and social problem, rather than solely as an individual or couple-level phenomenon, interventions based on previous successful public health campaigns may prove beneficial for mitigating its effects, if not its prevalence. After all,

alcoholism has come to be conceptualized as an illness and not as a personal failing, and it is largely treated through social interventions. Similarly, social support structures designed to address the particular medical, financial, and psychological risks experienced by divorced individuals might help ameliorate the health and social consequences of those subject to marital rupture. Successful interventions could, in turn, lower the risk for divorce among progeny of such dissolved marriages.

We have shown that divorce appears to spread through the social network we examined, and, in turn, that the spread of divorce exerts effects on the structure of the network itself. We suggest that attending to the health of one's friends' marriages might serve to support and enhance the durability of one's own relationship. Although the evidence we present here is limited to a single network, it suggests that marriages endure within the context of communities of healthy relationships and within the context of social networks that encourage and support such unions.

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Table 1. Survey Waves and Sample Sizes of the Framingham Offspring Cohort

Survey Wave/ Physical Exam	*Time period*	*N alive*	*Number Alive and 18+*	*N examined*	*% of adults participating*
Exam 1	1971-75	5124	4914	5,124	100.0
Exam 2	1979-82	5053	5037	3,863	76.7
Exam 3	1984-87	4974	4973	3,873	77.9
Exam 4	1987-90	4903	4903	4,019	82.0
Exam 5	1991-95	4793	4793	3,799	79.3
Exam 6	1996-98	4630	4630	3,532	76.3
Exam 7	1998-01	4486	4486	3,539	78.9

Table 2. Summary Statistics

Variable	*Mean*	*S.D.*	*Min.*	*Max*
Divorced	0.09	0.28	0	1
Number of Friends	0.24	0.55	0	8
Number of Family	2.42	3.24	0	29
Transitivity	0.59	0.40	0	1
Female	0.52	0.50	0	1
Years of Education	12.34	3.26	0	17
Age	55.89	15.5	18	103

Table 3. Distribution of Number of Divorces Observed

Variable	**All**	**Men**	**Women**
Divorced Once	863	413	450
Divorced Twice	70	34	36
Divorced Thrice	3	2	1

Note: These numbers only reflect divorces that occurred after the inception of exam 1. The number of male and female divorces are not equal because some divorced spouses did not participate in the Framingham Heart Study. For the data in this study, we also counted individuals as divorced if they claimed to be divorced when asked at the first exam, but since those divorces were not observed, they are not included in this table.

Table 4. Association Between Network Degree and Future Probability of Divorce

	Dependent Variable: *Current Divorce Status*		
	Coef.	*S.E.*	*p*
Previous Number of Inward Friendship Ties	**-0.33**	**0.10**	**0.00**
Previous Number of Outward Friendship Ties	-0.12	0.10	0.23
Previous Number of Family Ties	0.00	0.01	0.64
Age	-0.06	0.00	0.00
Years of Education	0.01	0.02	0.45
Female	0.03	0.08	0.71
Exam 3	0.20	0.10	0.05
Exam 4	-0.39	0.13	0.00
Exam 5	-0.27	0.14	0.06
Exam 6	-0.29	0.16	0.08
Exam 7	-0.54	0.19	0.00
Previous Divorce Status (1 = divorced)	48.49	0.08	0.00
Constant	-0.51	0.36	0.16
Deviance	649		
Null Deviance	2711		
N (Person-Exam Observations)	25080		

Results for logit regression of ego's current divorce status (1 = divorced), on previous divorce status, number of inward friend ties (people who named ego as a friend), outward friendship ties (people whom the ego named as a friend), and family ties.

Table 5. Association Between Probability of Divorce and Future Network Degree

	Dependent Variable:								
	Current Inward Friendship Ties			*Current Outward Friendship Ties*			*Current Family Ties*		
	Coef.	*S.E.*	*p*	*Coef.*	*S.E.*	*p*	*Coef.*	*S.E.*	*p*
Previous Divorce Status	**-0.01**	**0.00**	**0.06**	**-0.02**	**0.00**	**0.00**	**-0.04**	**0.01**	**0.00**
Previous Inward Friendship Ties	0.90	0.01	0.00	0.02	0.00	0.00	-0.01	0.01	0.36
Previous Outward Friendship Ties	0.01	0.00	0.14	0.84	0.01	0.00	-0.02	0.01	0.00
Previous Family Ties	0.00	0.00	0.08	0.00	0.00	0.00	0.95	0.00	0.00
Age	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Years of Education	0.00	0.00	0.08	0.00	0.00	0.49	0.00	0.00	0.02
Female	0.01	0.00	0.00	0.00	0.00	0.72	0.00	0.01	0.67
Exam 3	0.03	0.00	0.00	0.03	0.00	0.00	-0.22	0.01	0.00
Exam 4	0.03	0.00	0.00	0.01	0.00	0.00	-0.19	0.01	0.00
Exam 5	-0.01	0.00	0.00	-0.02	0.00	0.00	-0.22	0.01	0.00
Exam 6	0.00	0.00	0.95	0.00	0.00	0.67	-0.28	0.01	0.00
Exam 7	0.00	0.00	0.91	0.00	0.00	0.99	-0.24	0.01	0.00
Constant	0.06	0.01	0.00	0.09	0.01	0.00	0.14	0.02	0.00
Deviance	1344			1350			4636		
Null Deviance	7167			5146			284104		
N (Person-Exam Observations)	25080			25080			25080		

Results for linear regression of ego's current friendship and family ties on previous divorce status, number of inward friendship ties (people who named ego as a friend), outward friendship ties (people whom the ego named as a friend), and family ties.

Table 6. Association Between Divorce and Transitivity

	Dependent Variable:					
	Current Transitivity			*Current Divorce Status*		
	Coef.	*S.E.*	*p*	*Coef.*	*S.E.*	*p*
Previous Transitivity *(probability that two contacts are in contact with one another)*	0.87	0.00	0.00	**0.12**	**0.14**	**0.37**
Previous Divorce Status	**0.02**	**0.01**	**0.00**	48.21	0.08	0.00
Previous Degree (total number of contacts)	0.00	0.00	0.00	0.00	0.01	0.69
Age	0.00	0.00	0.00	-0.04	0.00	0.00
Years of Education	0.00	0.00	0.12	-0.02	0.03	0.54
Female	-0.01	0.00	0.03	-0.01	0.10	0.89
Exam 3	0.03	0.01	0.00	-0.19	0.13	0.15
Exam 4	0.02	0.01	0.02	-0.64	0.17	0.00
Exam 5	0.03	0.01	0.00	-0.69	0.19	0.00
Exam 6	0.04	0.01	0.00	-0.86	0.23	0.00
Exam 7	0.04	0.01	0.00	-0.71	0.23	0.00
Constant	0.13	0.02	0.00	-0.86	0.49	0.08
Deviance	480			377		
Null Deviance	1753			1465		
N (Person-Exam Observations)	11550			11550		

Results for linear regression of ego's current transitivity (i.e. the probability that two contacts are in contact with one another) and logit regression of ego's current divorce status (1 = divorced) on previous transitivity and divorce status, total number of social contacts, and other covariates.

Table 7. Association Between Ego and Alter Divorce Status Among Newlyweds

	Dependent Variable: *Ego Divorce Status*		
	Coef.	*S.E.*	*p*
Alter Divorced Since Previous Exam	**6.67**	**0.55**	**0.00**
Alter Divorced Prior to Previous Exam	**5.49**	**0.69**	**0.00**
Alter Age	-0.01	0.02	0.69
Alter Years of Education	0.02	0.06	0.78
Alter Female	0.24	0.27	0.38
Exam 3	-0.02	0.34	0.95
Exam 4	0.32	0.49	0.51
Exam 5	0.60	0.51	0.24
Exam 6	1.99	0.81	0.01
Exam 7	0.43	0.63	0.49
Constant	-6.48	1.41	0.00
Deviance	57		
Null Deviance	127		
N	2597		

Regression of ego divorce status on alter divorce status and control variables among all newly married spouses. Exam 2 is not included as a dummy variable in the regression because it is the baseline observation. Exam 1 is excluded because all observations require lagged variables and information prior to Exam 1 was not observed.

Table 8. Association of Ego Divorce Status and Alter Divorce Status, By Alter Type

	Dependent Variable: *Current Ego Divorce Status*				
	---------- ***Alter Type*** ----------				
	Friend	*Alter-Perceived Friend*	*Sibling*	*Same Block Neighbor*	*Small Firm Coworker*
Alter Previously Divorced	**1.28**	0.45	0.02	0.14	0.09
	(0.42)	(0.51)	(0.12)	(0.29)	(0.26)
Ego Age	-0.04	-0.07	-0.03	-0.05	-0.06
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Ego Female	0.08	0.09	-0.12	-0.01	-0.11
	(0.26)	(0.33)	(0.11)	(0.25)	(0.34)
Ego Education	-0.04	0.05	-0.01	-0.07	-0.12
	(0.05)	(0.08)	(0.03)	(0.06)	(0.09)
Exam 3	-0.27	0.08	-0.28	0.07	0.01
	(0.31)	(0.43)	(0.15)	(0.34)	(0.41)
Exam 4	-1.62	0.07	-0.81	-0.62	0.09
	(0.47)	(0.47)	(0.19)	(0.39)	(0.46)
Exam 5	-1.65	-0.69	-0.85	-0.63	-0.24
	(0.64)	(0.68)	(0.20)	(0.48)	(0.59)
Exam 6	-1.91	-1.03	-0.81	0.45	---
	(0.65)	(0.87)	(0.24)	(0.60)	---
Exam 7	-1.71	0.08	-0.81	-0.43	-0.60
	(0.67)	(0.85)	(0.25)	(0.74)	(0.82)
Constant	-0.51	-0.89	-1.01	0.34	1.07
	(1.01)	(1.54)	(0.52)	(1.08)	(1.59)
Deviance	75	45	961	172	149
Null Deviance	77	45	974	175	151
N	2821	2593	23689	5081	4695

Coefficients and standard errors in parenthesis for logit regression of ego divorce status in current period on alter divorce status in previous period among all egos who were not divorced at the previous exam. Observations for each model are restricted by type of relationship (*e.g.*, the leftmost model includes only observations in which the alter is a friend named by the ego). Same block neighbors live within 25 meters, and small firm coworkers are those at firms where 10 or fewer FHS subjects work. Exam 2 is not included as a dummy variable in the regression because it is the baseline observation. Exam 1 is excluded because all observations require lagged variables and information prior to Exam 1 was not observed. Exam 6 is dropped from the co-worker model because it is perfectly predicted by other variables in the model.

Table 9. Sensitivity Analysis for Association Between Friend's Divorce and Ego's Divorce

Strength of Homophily / Confounding	Effect of Omitted Factor on Likelihood of Divorce (Risk Ratio)				
	1	1.5	2	2.5	3
0.5	270 (60 to 650)	270 (60 to 650)	270 (60 to 650)	270 (60 to 650)	270 (60 to 650)
0.6	270 (60 to 650)	242 (48 to 592)	224 (40 to 556)	212 (35 to 532)	203 (31 to 514)
0.7	270 (60 to 650)	215 (36 to 539)	183 (22 to 474)	162 (13 to 430)	147 (7 to 400)
0.8	270 (60 to 650)	191 (26 to 489)	147 (7 to 400)	119 (-5 to 343)	99 (-14 to 304)
0.9	270 (60 to 650)	168 (16 to 443)	114 (-7 to 334)	81 (-22 to 267)	59 (-31 to 221)
1	270 (60 to 650)	147 (7 to 400)	85 (-20 to 275)	48 (-36 to 200)	23 (-47 to 150)

Strength of homophily/confounding indicates prevalence (π_1) of omitted variable in divorced egos. We assume prevalence of omitted variable in non-divorced egos is $\pi_0 = 1 - \pi_1$. A value of $\pi_1 = 0.5$ indicates no confounding/homophily, and $\pi_1 = 1$ indicates maximum confounding/ homophily.

Table 10. The Number of Children Decreases Influence from Friends

	Dependent Variable: *Current Ego Divorce Status*		
	Coef.	*S.E.*	*p*
Alter Previously Divorced	**1.80**	**0.57**	**0.002**
Alter Previously Divorced x Ego Number of Children	**-0.49**	**0.24**	**0.04**
Ego Number of Children at Previous Exam	0.12	0.09	0.15
Ego Age	-0.04	0.01	0.00
Ego Years of Education	0.04	0.26	0.88
Ego Female	-0.10	0.06	0.07
Exam 3	0.63	0.17	0.00
Exam 4	0.76	0.21	0.00
Exam 5	0.70	0.27	0.01
Exam 6	0.76	0.32	0.02
Exam 7	1.09	0.35	0.00
Constant	0.23	1.09	0.83
Deviance	263		
Null Deviance	269		
N	3040		

Coefficients and standard errors in parenthesis for logit regression of current ego divorce status on previous alter divorce status among all egos who were not divorced at the previous exam. Observations are restricted to alters named by the ego as a friend. Exam 2 is not included as a dummy variable in the regression because it is the baseline observation. Exam 1 is excluded because all observations require lagged variables and information prior to Exam 1 was not observed.

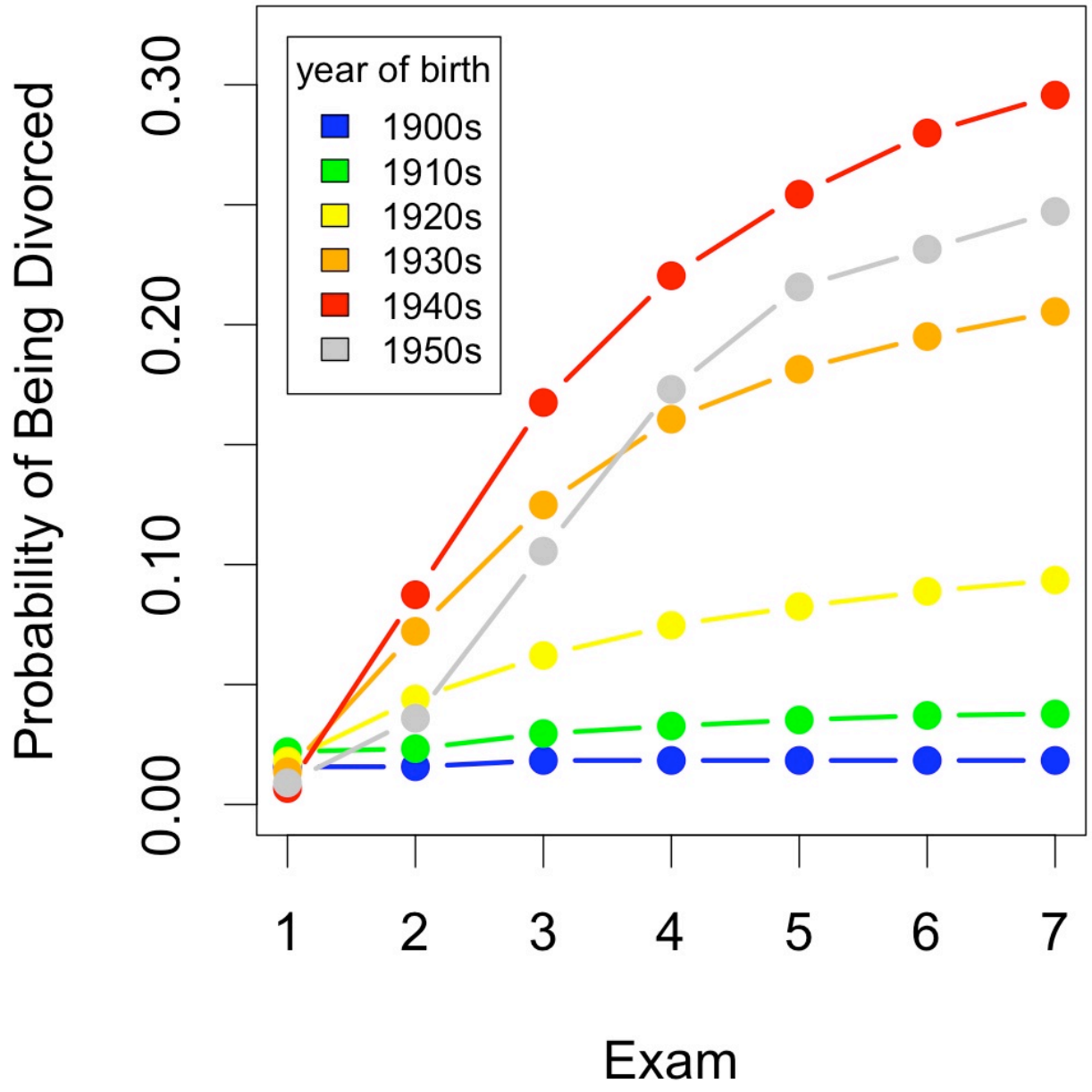

Figure 1. This figure shows that the probability of divorce tends to go up across exams within each age group (30s = subjects aged 30 to 39, 40s = 40 to 49, and so on).

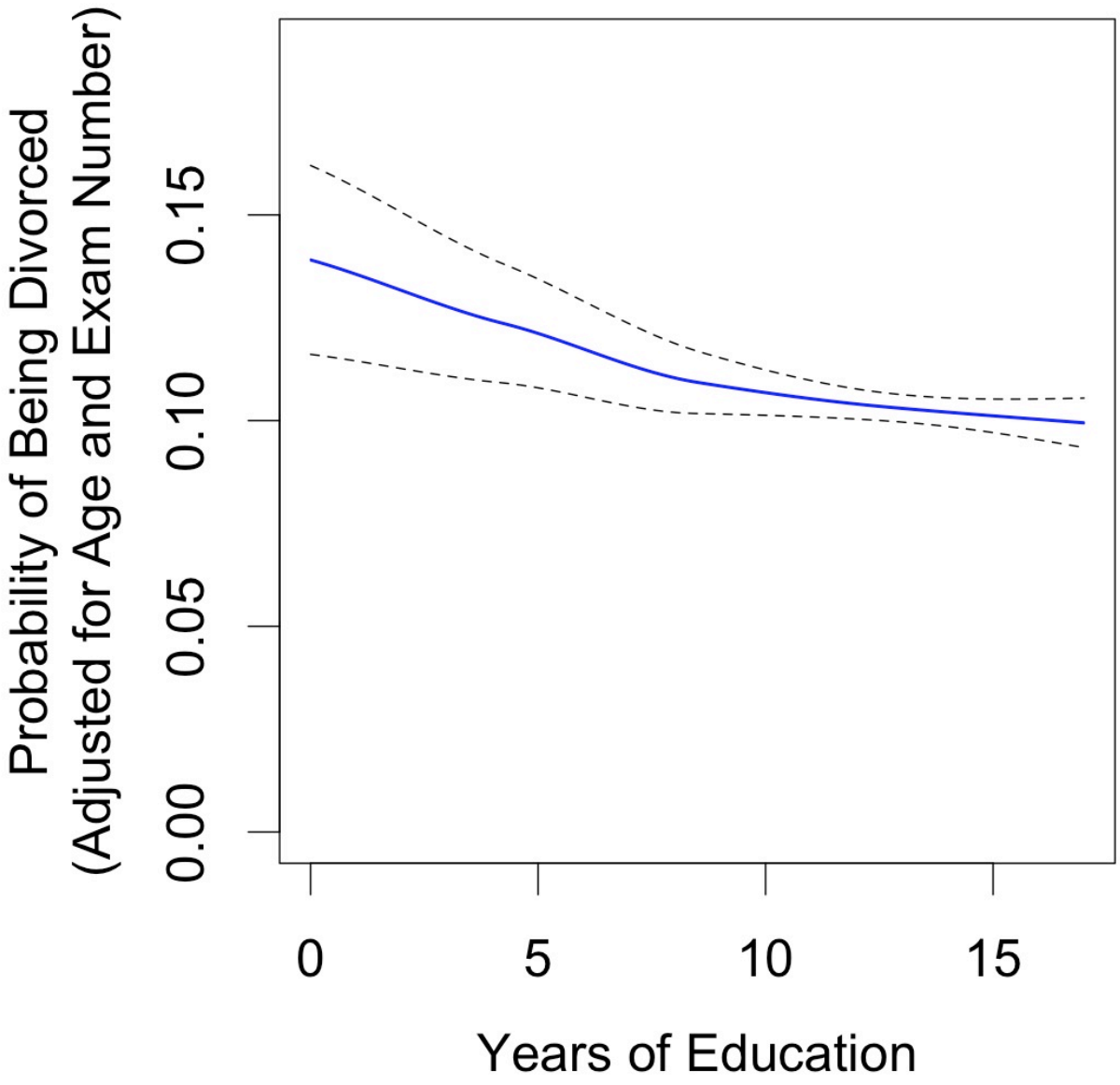

Figure 2. Note: smoothed LOESS plots of probability of being divorced, by education. Divorce rate adjusted for age and exam number. Dotted lines show 95% confidence intervals.

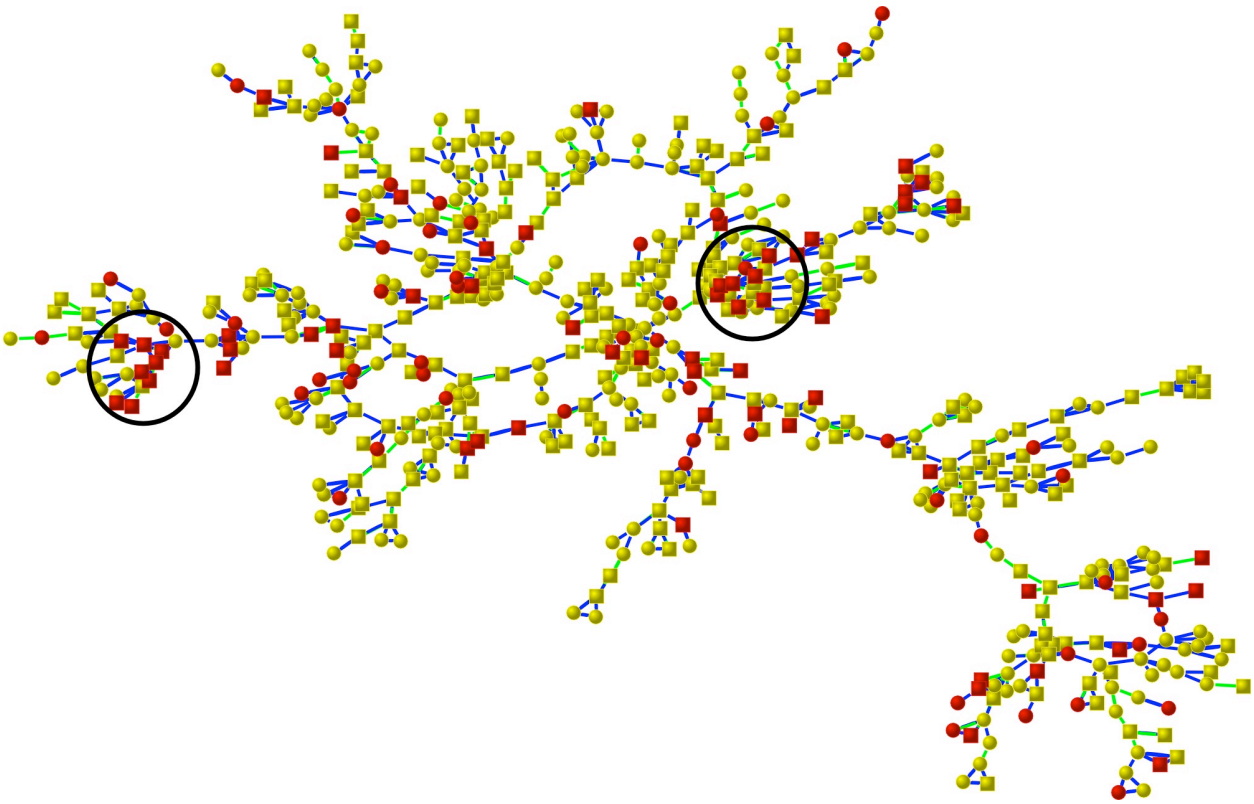

Figure 3. This graph shows the largest connected set of friends and siblings at exam 7 (centered on the year 2000). There are 631 individuals shown. Each node represents a participant and its shape denotes gender (circles are female, squares are male). Lines between nodes indicate relationship (blue for siblings, green for friends). Node color denotes which subjects have ever been divorced (red for divorced, yellow for never divorced). The graph suggests social clustering of people who experience divorce (as noted in the two circled regions), which is confirmed by statistical models discussed in the main text.

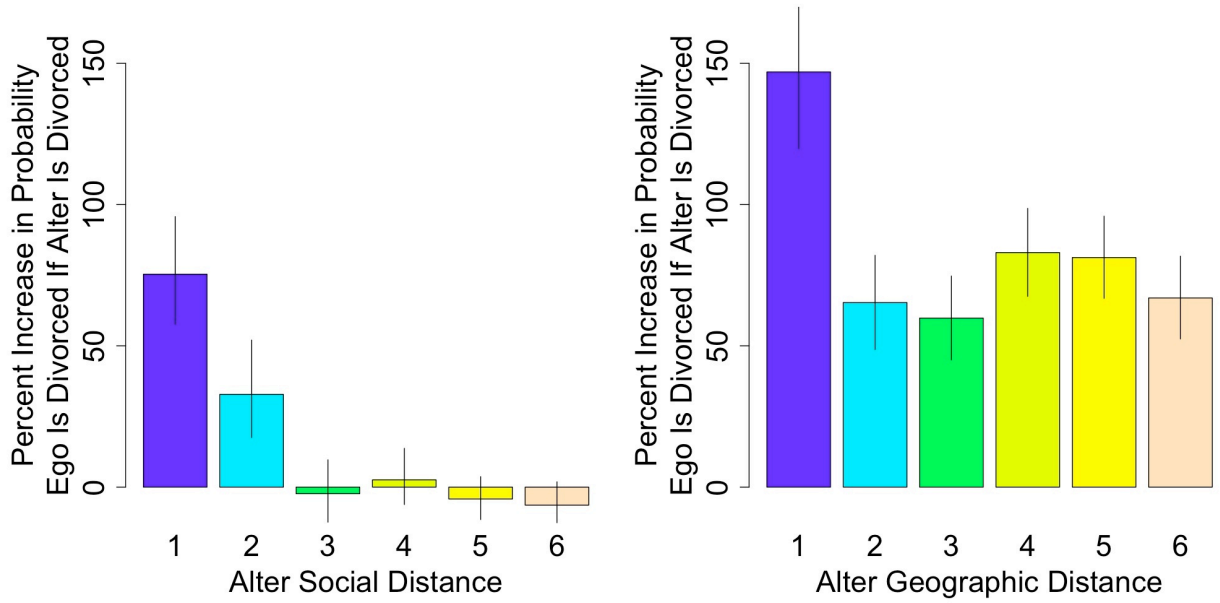

Figure 4. Panels show the effect of social and geographic distance from divorced alters on the probability that an ego is divorced in the Framingham Heart Study Social Network. A divorced subject is someone who has been divorced at least once. The effects were derived by comparing the conditional probability of being divorced in the observed network with an identical network (with topology preserved) in which the same number of divorcees is randomly distributed. In the panel on the left, alter social distance refers to closest social distance (or degree of separation (between the alter and ego (e.g. direct friend = distance 1, friend's friend = distance 2, etc.). The association between ego and alter divorce status remains significant up to two degrees of separation. In the panel on the right, we ranked all physical distances between homes of directly connected egos and alters (*i.e.*, just those pairs at one degree of separation) and created six equally sized groups (1 = closest, 6 = farthest). The average distances for these six groups are: 1 = 0 miles; 2 = 0.26 miles; 3 = 1.5 miles; 4 = 3.4 miles; 5 = 9.3 miles; and 6 = 471 miles. There is no trend across physical distance except a significant increase in effect size for those who live in the same residence (category 1). Error bars show 95% confidence intervals based on 1,000 simulations.