Helpful Thirds and the Durability of Collaborative Ties*

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Abstract

In this article, we examine the role of third parties on the durability of collaborative ties. We build on extant theory that has viewed the role of third parties in cohesive networks in two primary ways: as mediators who actively resolve situations and conflict and as individuals who encourage the development and adoption of cooperative norms. We argue that collaborations where third parities facilitate cooperative norms persist, whereas collaborations without helpful thirds become unstable and dissolve after the loss of the third party. We use a unique dataset comprising of scientific collaborations among pairs of research immunologists who lost a third collaborator to an unexpected death. We use this quasi-random loss as a source of exogenous variation to examine whether collaborations that lose helpful thirds—as measured by acknowledgements—are more durable than collaborations that lose less-helpful co-authors. Furthermore, we find that one potential reason why helpful thirds increase the endurance of others' collaborations is by making their co-authors more helpful themselves.

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Introduction

Social ties provide a rich array of benefits and resources to individuals (Coleman, 1988). In particular, individuals who have long-standing relationships with friends, co-workers, and collaborations often fare better than individuals whose relationships are newer. People joined by enduring relationships are able to engender trust, tolerate asymmetries, and are more efficient in their efforts (Dahlander and McFarland, 2013; Krackhardt, 1999). The benefits of such relationships are present in many domains. Scientists with longer lasting collaborations are more productive; businesses with long-lasting relationships to their buyers and suppliers are better able to endure volatile economic conditions; and people with long-lasting friendships have greater well-being. An important set of theoretical accounts suggest that ties are more likely to endure when the individuals involved share important characteristics, complement each other's skills, and have previously had successful and productive interactions. Tie durability is thus a function of good matches; instability, an outcome of poor ones (Fafchamps, Leij and Goyal, 2010).

Sociologists on the other hand have long argued that third-parties—individuals who are present in the dyadic relationships of others—create stable environments that are conducive to strong and durable relationships (Krackhardt, 1999; Burt and Knez, 1995; Caplow, 1956; Mills, 1958). Third parties, usually shared co-workers, collaborators or friends, are thought to create stability through two primary channels. The first account relies on the third-party's role as an active participant in the relationship between the two individuals (Simmel, 1902). The third party facilitates cooperation by downplaying the differences between dyads, transmitting and translating their points of views, and reducing the strength of any one individual's threats or demands. In the absence of the third party, however, conflicts and misunderstandings arise and begin to stifle the dyadic relationship, causing it to decay.

An alternative perspective suggests that third-parties also affect the vibrancy and durability of a relationship by helping their connections develop easily referenced normative frameworks. Such frameworks arise when dyads transition to triads and, in essence, become groups (Krackhardt, 1999). Groups develop appropriate norms of behavior and etiquette that guide interaction (Krackhardt, 1999; Feldman, 1984). When confusion, disagreement or conflicting interests arise, shared norms serve as convenient points of reference for individuals who are determining how to act. More importantly, however, these shared norms can create a sense of community (Vaisey, 2007) that increases commitment to the group. These norms, as a shared culture, can then persist and guide action even when the people who facilitated the creation of that culture are no longer there (Van Maanen and Schein, 1979).

These two essential roles played by third parties raise a puzzle for understanding the dynamics of social relationships. The two mechanisms—both of which increase relational stability when a third is present—offer fundamentally different predictions about what happens when they are not. The first mechanism suggest that in the absence of the third, conflicts will necessarily arise and are more likely to go unresolved. Thus, the probability that a tie will persist is lowered when third parties are no longer present. The second mechanism, posits that third parties establish frameworks independent of the individuals involved. This mechanism suggests that even in the absence of the third, shared frameworks structure interaction and facilitate cooperation. Thus, the frameworks can help individuals resolve conflicts by referring them to shared norms and thereby increasing the likelihood that relationships persist even in the absence of the third.

However, some third parties may better facilitate cooperative frameworks than others because of their behaviors. One set of pro-cooperative behaviors is the sharing of resources as well as time and advice (Oettl, 2012; Shibayama, Walsh and Baba, 2012). Such behaviors are likely to become reference points that structure how recipients of helpful behaviors act towards others. More fundamentally, such helpfulness can facilitate norms that shift the interpretation of the dyadic relationship from being short-term to one that is long-term. Specifically, a more helpful social environment can make people interpret relationships less as direct exchange—where individual provide resources with expectations of immediate returns–and more as generalized exchange—where relationships are thought to be ongoing and durable (Shibayama, Walsh and Baba, 2012; Bearman, 1997; Takahashi, 2000). This fundamental shift should affect how individuals resolve disagreements, asymmetry, and other imbalances or conflicts in a relationship. When relationships are viewed as inherently long-term, individuals are more likely to effectively settle disagreements and tolerate asymmetry and conflict (Uzzi, 1996, 1997). Consequently, thirds that are better able to foster long-term oriented environments through helpfulness will facilitate more sustained ties among their peers, even in their absence.

Yet, prior research has found it difficult to determine whether the third party's power arises due to the active monitoring mechanism, the enacting of norms, or both (Dahlander and McFarland, 2013; Krackhardt, 1999). Teasing out the mechanisms through which the third affects the sustained relationships of others is empirically challenging for three primary reasons (Manski, 1993; Hartmann et al., 2008). First, in most settings the effect of the third party is measured by comparing dyads with and without thirds. This comparison is fundamentally problematic as individuals are likely to self-select into dyadic or group based structures and thus, we are generally unable to tease out the effect of third parties from the endogenous process of selection (Aral, Muchnik and Sundararajan, 2009). Similarly, examining third party effects on dyads that naturally lose third parties to those that do not also faces similar selection problems. Thus, a precondition for identifying the effect of third parties requires comparison of dyads where the presence or absence of a third party is unrelated to unobserved factors in the relationship. Second, third parties should vary on dimensions, such as helpfulness, that are likely to affect the likelihood that dyads share pro-cooperative frameworks.

Third, the data must be longitudinal so that the long-term effects of the third on the likelihood of dyads can be estimated.

One domain where the role of the third parties has become increasingly important is in scientific collaboration. Scientists and inventors who have enduring ties to people with information, resources, and the right connections are able to produce breakthrough innovations at faster rates. Moreover, in recent years there has been a significant increase in the size of scientific teams (Wuchty, Jones and Uzzi, 2007; Guimera et al., 2005). Given this shift, the role of shared collaborators—i.e. third parties—has become even more pronounced. Third parties in this context are critical in the management of tensions within collaborations. They arbitrate conflicting scientific perspectives, manage status dynamics, and instantiate frameworks for the smooth functioning the team. Given the fundamentally dynamic and relational nature of scientific production, it is a useful setting to adjudicate between the two conflicting perspectives on the impact of third parties on the endurance of relationships.

In this article we use a unique data set comprising of the scientific collaborations—published articles in peer reviewed journals—among 11,084 pairs of research immunologists who lost a third collaborator due to an unexpected death. We argue that these deaths were exogenous and essentially random. Furthermore, we argue that the unexpected loss of the third is likely to have affected the relationship between the collaborating pair. We find that, on average collaborations decline after the loss of a third collaborator as the monitoring mechanism suggests. However, some collaborations, particularly those where the lost third was considered helpful by her peers—as indicated by acknowledgements in journal articles—are more likely to persist. Our results suggest that third parties can exert significant effects on collaboration. However, third parties that are able to establish cooperative frameworks are likely to facilitate enduring collaborations.

Collaborative Endurance and Third Parties

Informal relationships such as collaboration, friendship, and romance, are prone to natural processes of decay (Burt, 2000, 2002). Two processes in particular are important predictors of this decay. The first are frictions—consisting of conflicts and disagreements—that are natural byproducts of purposeful, though informal, social interaction among individuals who consider themselves to be of equal standing (Ghosh and Rosenkopf, 2014). Consequently, conflict is common and to some extent expected in most informal relationships. Among collaborating scientists, friction, and thus conflict, may arise because of disagreement about research questions or method as well as authorship and credit (Blume and Sinclair, 1973). When such conflict is either too severe or too frequent, a collaboration may be stressed to the point of dissolution. The inability to resolve such conflict is heightened when extra-dyadic means—i.e. formal hierarchical relationships or professional norms–are unavailable to resolve the conflict (Blau, 1968). For instance, a conflict may be more easily resolved in a collaboration between an advisor and advisee than between two scientists with equal standing. The second process that may precipitate a collaboration's decay is a natural process of drift (Shipilov, Rowley and Aharonson, 2006). In the course of any relationship, the individuals may drift apart because other obligations emerge, tastes change, or opportunities for interaction decline. In the absence of opportunities that facilitate interaction such as seminars, co-location or committees, interaction and consequently collaboration becomes less likely.

Sociological theory holds that a common force creating stability in informal dyadic relationships is the *third party* (Burt and Knez, 1995). Third parties are other individuals who have a shared relationship with the two primary individuals in a dyad. This third may be another collaborator, colleague or friend. Third parties hold a privileged position as they are conduits of information, resources and trust (Rousseau et al., 1998). They are also enforcers of norms, mediators of conflict and function as the structural glue that holds networks and communities together (Krackhardt, 1999). Scholars who have studied the stabilizing role of the third often conceptualize her social function in two ways. One set of arguments view third parties as active participants in the relationships of those she interacts with (Krackhardt, 1999); whereas another set of mechanisms view her as an architect of norms that are shared by members of the groups to which they belong (Rousseau et al., 1998). The third—either through active means *external* to the dyad or by facilitating cooperative norms—can help mitigate conflict as well as the natural process of drift, thereby helping sustain collaboration.

The most common view of the third is as an external agent that actively manages the dyadic relationship between two other individuals. The third can pursue actions that temper conflicts but also arrest a natural tendency for drift. Extant theory posits two primary mechanisms through which a third party can act as a conciliator when disagreements arise. Because the third party is viewed as impartial, she can help the disagreeing parties arrive at a solution agreeable to both (Fisher, 1972). A third does this by presenting conflicting positions in a rational way, stripped of their affective qualities. Doing so allows the disputing parties to see the positions with more clarity; thereby increasing the likelihood that the conflict is resolved. Second, a trusted third can herself unilaterally impose a decision that resolves a conflict. She is able to do this because her distance from the conflict allows her to impartially weigh the merits of each position. Further, the mere presence of another party can lead to more conformist behavior (Goldfarb et al., 2015), potentially reducing the natural tendency to drift apart in the dyad.

In addition to serving as an impartial translator and arbitrator, a third can actively bring people together in more constructive ways. For example she can propose collaborative projects involving all three individuals, serving as a "joiner"(Obstfeld, 2005). She can also highlight similarities and complementarities that the dyad members may themselves not see. Moreover, she can informally bring individuals together at lunches or other social gatherings that increase the likelihood of sustained interaction. Thus, whether the third is actively controlling conflict or more constructively bringing individuals together, she can play an integral role in keeping a dyad together and thus facilitating their sustained collaboration (Sasovova et al., 2010).

The prior mechanisms all presume that the third is present, informed, and actively engaged in the various nuances of a dyad's relationship. As such, the active third carries a heavy burden and so must be vigilant as to ensure that the structures surrounding her do not collapse. However, this burden may not be so severe if a third is able to encourage the individuals to whom she is connected to enact norms that help them resolve conflict and prevent drift (Gintis, 2003). These norms, consisting of rules, habits, heuristics, and other behaviors and attitudes may originate with a third, but are likely to be adopted by other members of the group as well (Heckathorn, 1990; Jasso and Opp, 1997; Morris, 1956). Norms development may unfold over many interactions and in a variety of ways. Individuals may learn about norms through the mere observation of the behavior of third as well as direct learning (Hasan and Bagde, 2013). For instance, individuals may see thirds resolve conflict in a certain way by reframing a dispute. Similarly, and individual may observe behaviors that bring people together—i.e. the organizing of informal lunches. If enough observations occur, an individual may adopt such strategies themselves. In addition to learning through observation, a third can also teach and instill norms through more direct approaches as well. For instance, a third may tell her collaborators manifestly that a certain set of norms are the appropriate ones and thus should be adopted.

When cooperative norms emerge, individuals begin to understand not only how they themselves should act, but also how others are expected to act (Fehr and Fischbacher, 2004). Therefore, even if norms are not formalized, they can both constructively guide behavior or serve as credible deterrents that prevent non-conforming behaviors. Moreover, these norms act as templates that structure interaction by creating easily reproducible social opportunities where interactions are reinforced (Feld, 1981). If all the individuals in a group adopt such a frame, by regulating their own and other's behavior, a third party can produce the effects of active monitoring without the active monitoring itself.

Because both the mechanisms, arguing for the active external role of the third as well as the normative mechanism, predict stability in the presence of a third party, it is useful to think about situations where evidence for one mechanism can be distinguished from the other. Extant theories on the role of third parties primarily focus on the contemporaneous effects of third parties and hence compare triads to isolated dyads (Dahlander and McFarland, 2013; Krackhardt, 1999). In such cases, the presence of third parties activates both mechanisms and induces stability, whereas their absence produces the opposite effect. However, when the role of the third party is viewed in dynamic terms—i.e. when two parties lose a critical third—the two mechanisms make different predictions. The external mechanism, for instance, relies heavily on the actions that the third takes to either resolve a conflict that arises between two individuals or bring them together with enough frequency to sustain a collaborative relation over a long period of time. Yet, when the third is not present, conflicts are still likely to emerge, but cannot be resolved through the mediation or arbitration by the third party. Hence, collaboration decays.

On the other hand, the cooperative norm mechanism offers an alternative prediction. If norms are referenced independently of active third party reinforcement, then the should affect dyadic interaction and collaboration even after a third party is no longer present to enforce these norms (Heckathorn, 1990). Consequently, norms can continue to serve as mechanisms for resolving conflict or coordinating activity even in the absence of a third party.

These differing predictions pose a puzzle for empirical research that aims to better understand third party effects. On one hand, the external enforcement and cooperative norm mechanism are confounded when the role of the third is evaluated in the cross-section. On the other hand, the effect of the mechanisms produce differing predictions when collaboration is viewed dynamically, and thus have the potentially to cancel each other out. Thus, we have two hypotheses which produce opposite effects, depending on which mechanism is dominant.

Hypothesis 1a: *In the absence of a third party who actively mediates, the probability that a collaboration persists is lower.*

Hypothesis 1b: *In the absence of a third party who facilities cooperative norms, the probability that a collaboration persists is higher.*

The Helpfulness of Thirds and Collaborative Endurance

However, it may be possible to get a clearer picture by considering how certain kinds of third parties may be more likely to be active mediators and some more likely to create persistent norms. Thus, one way to determine whether the normative mechanism is operative is to examine whether dyadic collaborations persist for thirds that are better able to establish more collaborative frameworks versus those who are unable to do so.

Recent research suggests that one dimension on which scientists may vary and through which they can affect others' research and collaborative outcomes is the extent to which they offer help to others without an expectation of direct reciprocity (Oettl, 2012; Shibayama, Walsh and Baba, 2012). Such helpfulness can take several forms and can vary in how costly the behavior is to the third. At one extreme of the helpfulness spectrum are thirds that offer no help without direct reciprocation (Cook et al., 1983). For instance, such a third may offer ideas or comments as well as data and materials, but in return may demand co-authorship. Such behavior sends a stark signal: the provision of ideas and material come with the expectation of formal credit. The latter behavior and the associated expectation of direct exchange can shape the outlook of the various parties involved in the collaboration. Individuals in such environments are likely to learn that collaborations are short-term or one-shot arrangements. Each contribution—whether ideas, materials, critique, or effort—is accounted for in the assignment of authorship (Shibayama, Walsh and Baba, 2012).

In contrast, helpfulness without expectation of direct exchange lies at the other end of this spectrum. Such helpfulness, akin more to generalized exchange than to direct, consist of activities where the helper neither expects nor receives something in return from the receiver for their help (Takahashi, 2000; Shibayama, Walsh and Baba, 2012). A third party who lies at this end of the spectrum can engage in various, generally observable, behaviors that may vary in how costly they are to her. Perhaps the lowest cost activity is providing comments and feedback on research ideas, grants, and drafts. Critiques of this sort are low-cost and require little time commitment from the third. In addition to providing critiques, a third can provide much more costly forms of support. For instance, a third may possess rare specimens, cell-lines, data, or knowledge of a test or procedure that she shares with others without expecting co-authorship (Oettl, 2012). This material support is costly to the third because she could have used the materials herself or traded the material for formal credit. A third party's helpfulness, in contrast to self-interest, is likely to cause the different norms to emerge and thus shape collaborative activity and endurance. If the third party behaves in a self-interested manner, her peers are more likely to interpret their collaborations with the third as isolated transactions and thus are likely to face greater frictions when renegotiating the terms of the collaboration at each instance (Uzzi, 1997). On the other hand, if the third is helpful, her peers are likely to emphasize sharing and the longer-term nature of a collaboration with deficits of effort and material provision balancing out in the long term. For these reasons, each individual who has collaborated with the third should also become more helpful through her experience interacting with the helpful third.

We therefore predict:

Hypothesis 2: *A person who collaborates with a helpful third will also become more helpful.*

By aiding her collaborators in developing cooperative norms, a helpful third is likely to affect the character of the dyadic collaboration, independent of her own presence in two important ways. First, shared normative understandings lead to greater feeling of community, of belonging together, than mere structural interactions or even homophily (Vaisey, 2007). That is, the participants begin to view and interpret the relationships not as consisting of individuals and the connections between them, but rather as a distinct collective entity. Furthermore, helpfulness is fundamentally affirming of the other party, an investment into the person as they are, strengthening further commitment to the group or collectivity (Saks, Uggerslev and Fassina, 2007). When relationships are not seen as the primary entities but rather forming a group of affiliations to which one is committed, these relationships are seen as long-term investments with tolerance for asymmetry and conflict (Uzzi, 1996, 1997).

Second, such shifts in how a collaboration is perceived should also fundamentally change the nature and strength of dyadic ties. Collaborative norms are likely to make a tie both stronger as well as multiplex (Krackhardt, 1992). Iindividuals in such strong and multiplex relationships will interact more intensely, and in both professional and social capacities. Second, individuals will have greater affection for each other, independent of instrumental reasons for interaction. Finally, the emergent strong ties are likely to be characterized by greater motivation to help, support, and resolve any problems that do arise in the relationship. These behavioral changes to the interaction strengthen each individual tie, but also strengthening the commitment to the overall group.

On the other hand, collaborators of non-helpful thirds are unlikely to facilitate norms of long-term cooperation and therefore are likely to view a collaboration as an isolated event that requires repeated renegotiating. Therefore, one approach to examining whether third parties facilitate cooperative norms is by examining whether dyads that possess a helpful third relative to a non-helpful one are more likely to persist, even when the third is not present. Because helpful thirds are better able to encourage the adoption of cooperative norms, we hypothesize:

Hypothesis 3: *Dyads that lose a helpful third party will have a higher rate of future collaboration than dyads that lose a non-helpful third party.*

Methods

Data and Sample

A desirable empirical context in which to study collaboration patterns should be one in which 1) collaboration is a common characteristic; 2) a proxy for helpful behavior is readily available in a systematic fashion; and 3) the field is large enough to identify unexpected deaths of third parties. One such setting is the field of academic immunology. In terms of research, immunology is a large and important discipline. Its organization is very similar to other medical and biological sciences and most of the funding also comes from the National Institutes of Health, specifically the National Institute of Allergy and Infectious Diseases (NIAID).

Our sample dataset is constructs from multiple data sources. We measure collaboration activity, tie formation, scientist productivity, and scientist location using data from the ISI Web of Science. For this we collect bibliometric data on the 639,439 articles published in the 136 ISI Journal Citation Reports-defined immunology journals between the years of 1910 and 2010.

Helpfulness data are constructed using acknowledgment counts from *The Journal of Immunology (JI)* (the preeminent journal within the field of immunology) as in Oettl (2012). We examined the 50,541 articles published in JI between 1950 and 2007 and applied name matching algorithms to identify the authors acknowledged in each article. There were on average 3.04 acknowledgments per article.

We collect data on immunologist deaths from two sources: the titles of articles within the set of 639,439 immunology articles (such as: "Berenice Kindred 1928–1985") and the "In Memoriam" column of the bi-monthly American Association of Immunology newsletter. While we identify 360 immunologists that die between 1978 and 2008, we restrict the sample to scientists with uncommon names (to avoid Type II errors) and that had a career age of less than 50 at the time of their death (were still research active). While we do make efforts to exclude authors who were likely to have died of natural causes, there is still a chance that some coauthors may have anticipated some of the deaths. However, any remaining anticipated deaths are likely to bias our results towards zero. After these considerations, we are left with 138 immunologists who passed away during our sample period. We call these the treatment group or the treated k's and the year of death we call the treatment year.

We construct a set of control immunologists to match these treated immunologists. An ideal control immunologist would match a treated immunologists in terms of the relevant criteria, such as productivity, helpfulness, and age, but differ in terms of the death year. For each of the treated immunologists, we look for similar immunologists in terms of following: year of first publication, number of coauthors by the treatment year, number of publications by the treatment year, number of citations received by 2010 for papers written prior to the treatment year, and the number of acknowledgements received by the treatment year. For each treated immunologists, we then randomly select a control immunologists that is similar along these characteristics and does not die in the same year.

Identifying Authors

Since our study relies on collaboration patterns, it is paramount to be able to directly identify which immunologists are collaborating with each other. One limitation of the ISI Web of Science data is that during our period of study, the data on authors listed only the first initial, a middle initial (if present), and the last name for each author of a paper. Since our empirical objective is to identify rates of collaboration, it is first necessary to disambiguate authors (that is, to distinguish B Jones from BL Jones). We rely on heuristics developed by Tang and Walsh (2010) to disambiguate between authors who share the same name. The heuristic considers backward citations of two focal papers. If two papers reference similar papers (weighted by how many times the paper has been cited, i.e., how obscure or popular it is), then the likelihood of the papers belonging to the same author increases, and we link the two papers to the same author. We repeat this process for all papers with authors who have the same first initial and last name. We exclude scientists who do not have more than two publications linked to their name.

Identifying Triads and Dyads

We construct a set of triadic collaborations using the focal 138 authors that die in our sample and find all sets of three authors appearing on the same paper where one of the focal authors was a member. That is, we find all pairs of i's and j's where i and j appeared together on the same paper with a focal author k. This pair of i and j we call the dyad l and follow its subsequent level of collaboration conditional on what happens to k and characteristics of k. We keep all dyads l in the sample until either i or j has gone three years without publishing a paper, even if that scientist later publishes a paper. We consider these dyads to be at risk of collaborating. Keeping dyads that are not at risk of collaborating in the sample adds a lot of zeros and thus produces attenuation bias in the results. However, we do confirm that our results are robust to relaxing this assumption. We further limit the sample to those dyads who were at risk of collaboration, based on this criteria, at the treatment time, i.e., the time of the death of k for the treated k's. Relaxing this assumption and keeping in the sample dyads that had stopped being at risk of collaboration before the treatment time had very little effect on the results.

Carrying out this procedure results in 11,084 dyads or approximately 80 dyads per k (which is approximately equivalent to 13 coauthors per k that collaborate with each other[1]).

Variables

Collaboration: We created a dummy variable $Collab_{lt}$ to indicate whether a paper was published in the year t that included both members i and j of the dyad l as coauthors. This is our main dependent variable and we use it to assess the persistence of collaboration in the dyad.

Death of k: To estimate the effect on the dyad caused by the death of k, we code the variable D_{lt} to indicate the years after the passing of k on the dyad l where k was the third member. Thus, for the dyads involved with the treated k's, this variable is zero up to and including the year of k's passing and then one for the subsequent years. For the dyads involved with the control k's, this variable is always zero.

Helpfulness of k: Following Oettl (2012), we consider acknowledgments in papers as a sign that the scientist acknowledged for contributing to the paper without receiving formal coauthorship was helpful. Hence, we measure the helpfulness of the treated and control authors by the number of acknowledgements they received by the treatment time. We further classify authors as being helpful if they were above the median on this count and as non-helpful if they were below the median.

[1]The number of dyads from a set coauthors can be calculated by the formula $\frac{N*N-1}{2}$ so that $\frac{13*12}{2} = 78$.

Productivity of k: We consider the number of papers published by the treated and control authors by the treatment time as a measure of their productivity. We further classify the k's as being productive if they are above the median on this count and as non-productive of they are below median.

Dyad Fixed Effects: We control for the stable features of each dyad using dyad fixed effects. These stable features include the stable characteristics of all the three parties, i, j, and k, including their cohorts as well as the main effects of the productivity and helpfulness of k.

Calendar Year Fixed Effects: Prior studies have shown that there are general trends in the likelihood of collaboration over time (e.g., Wuchty, Jones and Uzzi, 2007; Guimera et al., 2005). One may be concerned that these trends might be confounded with the effect of the passing of k. Hence, we include as controls a full set of dummy variables for the calendar years. This is the most flexible and conservative way to control for overall trends in collaboration. Including both dyad and calendar year fixed effects means that any additional control variables need to be dyad-specific and time-varying.

Collaboration Age Fixed Effects: Since collaborations have a natural decay over time that might be confounded with the passing of k, we control for the collaboration age with a full set of dummy variables indicating the years since the first paper on which all of i, j, and k appeared. This is the most flexible and conservative way to control for the age of collaboration.

Colocation of i & j: Since being located at the same institution is likely to increase the propensity to collaborate, we use a dummy variable indicating whether i and j, the members of the dyad l, where at the same institution at the time t. There is a number of scientists for whom we were not able to establish their locations and hence all dyads where one of these scientists is a member have a missing value for this variable. In our main regressions we assume that these dyads were not at the same location, but the results are robust both to assuming that they were at the same location and to dropping these dyads entirely from the sample.

Papers Published by i & j: Since the passing of a coauthor might affect the productivity of a scientist (Azoulay, Graff Zivin and Wang, 2010; Oettl, 2012), there is a worry that we may confound a drop in overall productivity as reduced collaboration. We control for this possibility using a time-varying count of the total number of papers that i and j, the members of the dyad l, published in the year t.

Helpfulness of i and j: If helpful k's select to work with helpful i's and j's and those collaborations then are likely to last longer, we may confound the causal effect of the helpfulness of k on the dyad with the care with which the helpful k's select their partners. This possibility is in principle controlled for by the dyad fixed effects, but we further add as a control the interaction of the number of acknowledgments i and j had received prior to the beginning of the triadic collaboration with the passing of k. We use the minimum of the acknowledgments that i and j as individuals had received, but the results are similar if we use the maximum or the average.

Matching

Even though the treatment and control k's were carefully matched, there is no reason *a priori* to expect the triads where the k's were members to be fully balanced across the treatment and control groups. We address this concern using the coarsened exact matching (CEM) algorithm (Blackwell et al., 2009; Iacus, King and Porro, 2012). This allows us to find treated dyads for which a similar control dyad can be found and assign weights to each dyad to obtain a balanced sample. We match dyads at the treatment time, i.e., the time of k's passing for the treatment group and the matched time for the control group, and then apply these weights for the entire life of the dyad. We match dyads on (1) whether the members of the dyad were at the same institution at the treatment time, (2) the rate of their collaboration in the prior three years, (3) the number of papers they individually published in the prior three years, (4) the years since the triadic collaboration began, (5) the treatment year, (6) the dummy indicating whether k was helpful, and (7) the dummy indicating whether k was productive. Table 2 presents the test of balance at the treatment time. The treatment and control groups appear well balanced with no difference statistically significant. Table 3 then presents summary statistics for the matched sample. We confirm also that our results are robust to using the full, unmatched sample.

Estimation

In our main regressions, we estimate the following model:

$$Collab_{lt} = \alpha + \beta D_{lt} + \sum_{m} \gamma_{ltm} X_{ltm} + \phi_l + \eta_t + \theta_{lt} + \epsilon_{lt}, \tag{1}$$

where $Collab_{lt}$ is a dummy variable indicating whether the dyad l published a paper together in year t, D_{lt} is a dummy indicating whether the third party in the dyad l had passed away by time t, X_{ltm} is a series of control variables, ϕ_l is the fixed effect for the dyad l, η_t is a fixed effect for the calendar time t, θ_{lt} is the fixed effect for the age of the collaboration, and ϵ_{lt} is the error term. We also add interactions of the variable D_{lt} with characteristics of the third party k. A statistically significant value for the parameter β indicates that the death of k had an effect on the rate of collaboration in the dyad l. We use robust standard errors clustered by the third party k to make inference. Our preferred estimation method is the linear probability model, i.e., ordinary least squares (OLS), as it allows for a natural interpretation of interactions, on which we rely heavily. We confirm that the results are robust to using the logit estimator.

Results

Table 4 presents the basic results using the Equation 1. This is a linear probability model estimation of the likelihood of a dyad collaborating on a paper in a given year and includes fixed effects for the dyad itself, the calendar year as well as the age of the triadic collaboration. The sample in Model 1 includes all of the third parties in the dataset and the result suggests a weak negative effect on collaboration within the dyad from the death of the third party. The negative coefficient is consistent with with Hypothesis 1a, but the statistical insignificance does not allow us to rule out the opposite Hypothesis 1b.

In Models 2 and 3 we then present subsamples consisting of first all dyads involved with those third parties who are considered non-helpful, being below median in terms of the number of acknowledgments they had received by the treatment time, and then those third parties who are considered helpful, being above the median. The results show a striking difference based on the type of the third party. The dyads where the third party was non-helpful show a considerable 13 %-point drop in their probability of collaboration following the passing of the third party. In contrast, the dyads where the third party was helpful show an actual increase in the rate of their collaboration, roughly 3.6 %-points, following the passing of the third party. These results are consistent with Hypothesis 3 and thus allow us in these subsamples to find evidence consistent with both Hypotheses 1a and 1b.

Table 5 then adds a consideration for the productivity of the third party, given that productive third parties are also more likely to receive acknowledgements as a function of their position in the field. The productive third parties are also more likely to be in position to offer help to others. We use the same estimation model as in the previous table and add two control variables. First, we include a control for the logarithm of the number of papers i and j, the members of the dyad l, published in total in the given year. This alleviates any concern that passing of k may have affected the productivity of i and j individually (Azoulay, Graff Zivin and Wang, 2010; Oettl, 2012), and thus the likelihood of collaboration, and also alleviates any concern regarding the matching of the dyads on this measure. Second, we add a dummy variable indicating whether i and j, the members of the dyad l, were in the same institution at the time t. This alleviates any concern regarding our matching on this variable and also any potential concern that the dyad's colocation may have been affected by the passing of k and thus indirectly also their collaboration.

Model 1 of Table 5 presents then the main effect of the passing of k. The coefficient is negative but not statistically significant, suggesting a potential weak effect. The magnitude of the coefficient is very similar to the result in Table 4 Model 1 and thus the concerns that the control variables are alleviating do not seem to have been very important. Model 2 then adds an interaction of the passing of k with the dummy indicating whether k was considered helpful. The main effect of the passing of k now turns negative and highly significant with the magnitude of the effect quite close to the effect estimated in Table 4 Model 2. The coefficient of the interaction on the other hand is positive and very significant. The magnitude of the total effect, the main effect plus the interaction, is a 4.7 %-point increase in the probability of collaboration when a helpful k passes away, and thus also quite close to the effect estimated in Table 4 Model 3.

In Models 3 and 4 of Table 5 we the consider the interaction of helpfulness and productivity. First in Model 3, we add the interaction of the passing of k with the dummy whether k was productive, i.e., above median in the number papers published at the time. The results indicate that dyads involving productive k's were very likely to persist as well and that a part of the effect of helpful k's was due to the correlation of helpfulness and productivity. In Model 4, we then add the three-way interaction of passing of k, the dummy for helpful k, and the dummy for productive k. The results suggest a negative interaction between helpfulness and productivity in terms of the durability of ties. That is, helpfulness and productivity seem to be substitutes for each other. For the non-productive k's, the total effect is a 2.5 %-point increase (= -0.179 + 0.204) in the probability of collaboration when a helpful k passes away. For the productive k's, the total effect is a 4.5 %-point increase (= -0.179 + 0.204 + 0.176 - 0.156) in the probability of collaboration when a helpful k passes away. The effect estimated in Table 4 Model 3, a 3.6 %-point increase, falls in the middle of this narrow range. These results increase our confidence that the data support Hypotheses 1 and 3.

There are a number of other concerns, however, that we need to consider. First, one may be concerned that the effect of k's helpfulness is really about selection: helpful k's like to work with people who themselves are helpful and whose collaborations tend to persist. In Model 1 of Table 6, we replicate the Model 4 of Table 5 with a further control variable: the logarithm of the number of acknowledgements i and j, the members of the dyad l, received prior to the triadic collaboration.[2] The results suggest that indeed collaboration involving helpful people tends to persist, but that does not affect the main results. Second, one maybe concerned that the interaction with productivity does not fully capture the effects and in Model 2 we replicate Model 1 using only the productive k's as the sample. The interactions involving productive k's now cannot be estimated as all k's are productive in the sample. The main effect of the passing of k weakens considerably and turns insignificant. The interaction with helpful k dummy also weakens but remains significant. However, the total effect, i.e., the main effect plus the interaction, at a 3.2 %-point increase is very similar in this regression as in Model 3 of 4 as well as Models 2 and 4 of Table 5. Hence, we conclude that helpfulness has an effect even when fully controlling for productivity.

Third, one maybe concerned that our sample is creating a bias in our estimations.

[2] We used the minimum of the two individual values. We also tried the average and the maximum. The results were similar with the minimum giving the most conservative test of the Hypotheses 1 and 3. Due to zeros, we added 1 to the count of acknowledgements prior to taking the logarithm.

Recall that we dropped any dyad from the sample when one member of the dyad had gone three years without publishing a paper. We considered these dropped dyads as having zero or very low risk of collaboration and thus potentially causing attenuation bias in our estimates. In Models 3, 4, and 5 of Table 6 we test this. In Model 3, we keep all dyads until one member has gone five years without publishing a paper. The results are similar to prior results, though overall attenuated. However, the total effect of helpfulness remains at very similar levels as before. In Model 4, we keep all dyads until one member has gone seven years without publishing a paper. The results are again very similar, in particular the total effect of helpfulness. In Model 5, we keep all dyads in the sample until the end of our time period. As in the previous two models, the results are similar though again all coefficients move towards zero as we are adding a very large number of zero observations, a classic case of attenuation bias. We can thus be confident that our results were not due to the sample selection.

Fourth, there is a concern that the linear probability model, i.e., OLS estimation, may bias the results and that a logit estimation would give a more accurate picture. In Model 6, we repeat the prior models with the main sample but using the logit estimator. The relative magnitudes and significance levels of the coefficients are very similar to the prior results, strongly suggesting that our results are not simply due to our choice of estimator. Hence, we present the linear probability model results as the interpretation of the interactions is more straightforward. Fifth, one maybe concerned that the matching employed is driving the results. In Model 7, we present results using the full sample and find that the estimates are very similar, though somewhat attenuated. Again though, the total effect of helpfulness is quite inline with the prior estimates. Sixth, one maybe concerned that the way we imputed locations when we were not sure may have biased the results. So in Model 8 we drop all observations that used the imputed locations and get results that are again very similar. One further concern may be that the way we dichotomized helpfulness and productivity at the median could lead to a wrong interpretation of the results. To be sure, in Model 9 we use the counts of acknowledgements and papers that k had at the time of death. The results are very consistent with the dichotomized results, which we prefer due to the ease of interpretation.

To summarize, in Table 6 we have considered a range of potential concerns and found that the results are robust in all cases. Hence, we are confident that the data support Hypothesis 3 and within the subsample of helpful third parties we find evidence for Hypothesis 1b and in the remaining subsample for Hypothesis 1a.

Let us turn then to Hypothesis 2. In Table 7, we consider how the measure of a scientist's helpfulness changes when they collaborate with a helpful coauthor. The observations here are i-k interactions where we limit ourselves to the k's who pass away. The dependent variable here is the logarithm of the number of acknowledgements i had received by the time of k's death and we control for a range of factors that may have lead k to start collaborating with i. First, we include full sets of dummies for the number of acknowledgements i had received prior to the beginning of the collaboration, for i's career age (i.e., years since first paper) at the time the collaboration began, and for the calendar year in which the collaboration began. Second, we control for number of papers i had published prior to the collaboration, the impact-factor weighted number of papers, as well as the citations i had. We use OLS to estimate and use robust standard errors.

Model 1 shows that working with a helpful coauthor is associated with an increase in the focal scientist's measure of helpfulness. Model 2 and 3 then adds a consideration for the duration of the interaction, the exposure of i to k. That is, the time from the first paper published by i and k together to k's passing. This time period is exogenous to the interaction and thus gives us more confidence that the results are causal, i.e, working with a helpful coauthor is leading to an increase in the focal scientist's helpfulness. In particular, the results in Model 3 show that the longer i worked with a helpful

k, the more helpful i was likely to become. The main effect of exposure of i to k captures the fact that any longer interaction is more to be associated with increased acknowledgements than a shorter interaction. However, there is a real effect coming from being exposed to a helpful coauthor.[3] One major concern here is that helpful k's simply select more helpful i's for collaboration. While this is could be the case, we control for it as much as possible by including in a very flexible specification of the helpfulness of i prior to collaborating with k and by considering how the increase in i's measured helpfulness correlates with the exogenously determined period of time of collaboration with k. Hence, these results support Hypothesis 2.

Conclusions

Social capital has long been central to understanding the process of innovation. In this article we examine how one form of social capital—the helpfulness of third parties—affects the collaborative dynamics of dyads, the building blocks of larger networks and communities. We theorized about two mechanisms through which third parties can affect whether dyadic collaborations endure. We argue that third parties play both active and passive roles—helping resolve emergent conflict as well as creating and instantiating collaborative norms. In our context of scientific collaborations among research immunologists, we find that when a pair of collaborating immunologists lose a third collaborator through an unexpected death two things happen. When the lost third party is non-helpful, the dyadic collaborations among the surviving scientists decays rapidly, providing support for the active role of the third. On the other hand, when the lost third is helpful, the surviving dyad persists and continues to collaborate into the future. We argue that this persistence is due to the helpful third instilling collaborative norms as evidenced by the increase in their surviving collaborators' level of helpfulness.

[3] The results are robust to controlling for the exposure time also with a full set of dummy variables.

An important conclusion of our study is that third parties—by facilitating helpful norms—can have an enduring effect on collaborative endurance. Our finding, we think, is an important recasting of the role of thirds in the dynamics of social structure. While prior research has long acknowledged that third parties are important, and that triads are more stable than solitary dyads due to group norms, the research has primarily viewed thirds as agents of both stability and instability. When thirds are present they stabilize; when absent, they destabilize. Our results provide strong evidence that the characteristics of third parties strongly moderate their stabilizing role. In this study we show that "helpfulness" is one such moderating trait. However, we think there is likely to be other "relational" work that third parties to which can matter in the long-term, even in their absence.

We study the impact of third parties on collaboration using a research design that allows us to address many inferential concerns that are present in networks research. In particular, because the presence or absence of a third is credibly exogenous, arising from unexpected deaths, we are more confident that selection out of a third party situation is not as susceptible to unobserved heterogeneity. Further, our use of a rich suite of fixed-effects allows us to control for important sources of unobserved fixed characteristics of dyads. Thus, given our design we are confident that our estimated effects are credible. However, because we use archival data a key remaining worry is whether our measure of helpfulness captures the ability of the third to establish cooperative norms. We address this concern in three ways. First, we control for several measures of a thirds productivity which may be confounded with helpfulness. We find that the effect of helpfulness persists even when productivity is accounted for. Further, we find that helpfulness does not vary based on the seniority or status of the third-parties—first, middle, and last authors all have comparable levels of helpfulness. Finally, our qualitative analysis of the obituaries of the third parties indicate that those that were more helpful were acknowledged as such by their peers in their obituaries.

Nevertheless, we think future research can benefit our understanding by looking into the specific types of actions and activities of the third that make them so effective as "social glue."

Our results also have several implications for research and practice. First, our results suggest an important mechanism through which individuals, such as scientists and others whose work relies on durable collaborative relationships, can help create robust communities. By being helpful and instilling norms of helpfulness, individuals can facilitate long term collaborations that withstand perturbations in organizational structures, personnel changes, and even unexpected deaths of critical people. Second, we believe our results demonstrate the reinforcing and complementary roles of culture and structure. Culture—emergent norms—can help reinforce structure—concrete ties among individuals in a network. Conversely, network structure and the actions of individuals over that structure can reinforce culture. Finally, we think our results have implications for organizations that are designing teams and work groups. Our results suggest that durable and collaborative groups can be engineered through the strategic placement of helpful individuals.

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Table 1: Summary Statistics for Dying Ks

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Year of Death	2000.43	5.38	1983	2008
Career Age	29.30	11.15	5	50
Coauthors	22.91	26.44	1	169
Publications	46.97	44.43	4	256
Impact Factor-Weighted Publications	220.55	286.67	10.59	1913.09
Citations	2050.91	2986.34	35	20923
Acknowledgements	4.04	6.12	0	33
Helpful (0/1)	0.41	N/A	0	1
Productive (0/1)	0.33	N/A	0	1
Helpful & Productive (0/1)	0.23	N/A	0	1
N		138		

Table 2: Balance Test for Matched Dyads at the Time of k's Death

	(1)	(2)
Sample Average	Treated k's	Control k's
i & j at the same institution	0.0736	0.0736
Collaboration (3 yr sum)	0.311	0.311
Papers by i & j (3 yr sum)	4.189	4.700
Collaboration Age	3.424	2.842
Death Year of k	2000.2	2000.3
Helpful k	0.488	0.488
Productive k	0.564	0.564
Observations	11084	9236

No difference is statistically significant.

Table 3: Summary Statistics for Matched Dyads

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Papers by i & j at t	2.572	3.254	0	104
i & j at the same institution at t	0.154	0.361	0	1
Year	2001.158	4.584	1974	2010
Collaboration Age	4.841	4.485	0	36
Helpful k	0.394	0.489	0	1
Productive k	0.505	0.5	0	1
Acknowledgements for k	3.238	5.967	0	55
Papers by k	45.41	34.719	4	256
N		163179		

Table 4: Propensity of i & j to Collaborate

	(1) All k's	(2) non-helpful k's	(3) Helpful k's
Death of k	-0.0429	-0.131***	0.0359*
	(0.0544)	(0.0339)	(0.0144)
Dyad Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Collaboration Age Fixed Effects	Yes	Yes	Yes
R^2	0.161	0.339	0.060
Observations	156987	95440	61547

Robust standard errors in parentheses, clustered by k.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Propensity of i & j to Collaborate - Interaction with k's Productivity

	(1)	(2)	(3)	(4)
Papers by i & j at t (log)	0.107***	0.106***	0.106***	0.107***
	(0.0105)	(0.0112)	(0.0113)	(0.0113)
i & j at the same institution at t	0.182***	0.179***	0.179***	0.180***
	(0.0318)	(0.0312)	(0.0312)	(0.0312)
Death of k	-0.0531	-0.147***	-0.173***	-0.179***
	(0.0525)	(0.0317)	(0.0229)	(0.0217)
Death of k x Helpful k		0.194***	0.0775**	0.204***
		(0.0290)	(0.0243)	(0.0311)
Death of k x Productive k			0.145***	0.176***
			(0.0280)	(0.0327)
Death of k x Helpful k x Productive k				-0.156***
				(0.0446)
Dyad Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Collaboration Age Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.208	0.221	0.223	0.224
Observations	156987	156987	156987	156987

Robust standard errors in parentheses, clustered by k.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Propensity of i & j to Collaborate - Robustness Tests

	(1) Selection	(2) Productive k	(3) 5 yrs	(4) 7 yrs	(5) All yrs	(6) Logit	(7) Full sample	(8) Location	(9) Count
Papers by i & j at t (log)	0.115***	0.0814***	0.0855***	0.0766***	0.0614***	2.329***	0.134***	0.0937***	0.116***
	(0.0123)	(0.0108)	(0.00803)	(0.00686)	(0.00428)	(0.0785)	(0.0160)	(0.0112)	(0.0122)
i & j at the same institution at t	0.194***	0.143***	0.165***	0.153***	0.112***	1.748***	0.240***	0.194***	0.195***
	(0.0341)	(0.0151)	(0.0345)	(0.0333)	(0.0237)	(0.203)	(0.0415)	(0.0362)	(0.0342)
Death of k	-0.178***	-0.0226	-0.113***	-0.0838**	-0.0659**	-2.703***	-0.118***	-0.0890*	-0.667***
	(0.0251)	(0.0229)	(0.0275)	(0.0282)	(0.0245)	(0.506)	(0.0344)	(0.0349)	(0.123)
Death of k x Helpful k	0.202***	0.0549*	0.146***	0.118***	0.0806***	3.438***	0.142***	0.121**	
	(0.0281)	(0.0259)	(0.0232)	(0.0200)	(0.0219)	(0.773)	(0.0261)	(0.0394)	
Death of k x Productive k	0.166***		0.0946***	0.0664**	0.0639**	2.987***	0.107**	0.0995**	
	(0.0311)		(0.0220)	(0.0203)	(0.0200)	(0.693)	(0.0326)	(0.0370)	
Death of k x Helpful k x Productive k	-0.152***		-0.0773*	-0.0496	-0.0458^{+}	-2.959**	-0.0740^{+}	-0.0899^{+}	
	(0.0419)		(0.0340)	(0.0308)	(0.0272)	(0.928)	(0.0434)	(0.0461)	
Death of k x Prior Ack'ments of i & j (log)	0.0642**	-0.0174	0.0498*	0.0394*	0.0295^{+}	0.0498	0.0559^{+}	0.0344*	0.0598*
	(0.0242)	(0.0155)	(0.0203)	(0.0177)	(0.0159)	(0.508)	(0.0284)	(0.0164)	(0.0260)
Death of k x k's Acknowledgements (log)									0.281**
									(0.0940)
Death of k x Papers by k (log)									0.153***
									(0.0304)
Death of k x k's Ack'ments (log) x Papers by k (log)									-0.0590**
									(0.0213)
Dyad Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Collaboration Age Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.218	0.103	0.168	0.157	0.139		0.208	0.162	0.217
Observations	163179	82437	269622	341655	600962	78975	192897	116351	163179

Robust standard errors in parentheses, clustered by k.
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Change in i's helpfulness

	(1)	(2)	(3)
Prior Papers by i (log)	-0.0677	-0.0756^{+}	-0.0738
	(0.0456)	(0.0445)	(0.0447)
Prior IF-weighted papers by i (log)	0.133***	0.138***	0.134***
	(0.0286)	(0.0278)	(0.0277)
Prior Forward Cites to i (log)	0.0250^{+}	0.0240^{+}	0.0256^{+}
	(0.0148)	(0.0143)	(0.0141)
Acknowledgements of k (log)	0.0948***	0.0820**	0.0179
	(0.0224)	(0.0252)	(0.0285)
Exposure of i to k		0.0165**	0.0104*
		(0.00552)	(0.00526)
Exposure of i to k x Acknowledgements of k (log)			0.00425***
			(0.00126)
Prior Acknowledgements of i Dummies	Yes	Yes	Yes
i Career Age Dummies	Yes	Yes	Yes
Initial Co-Authoring Year Dummies	Yes	Yes	Yes
R^2	0.658	0.664	0.665
Observations	4073	4073	4073

Robust standard errors in parentheses, clustered by k.

$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$