# How stable is the core discussion network?

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## ABSTRACT

Researchers have paid increasing attention to the core discussion network, the set of people we turn to when discussing important matters. Because the core discussion network is theorized to be composed of people's closest ties, not fleeting acquaintances, it is expected to be largely stable, evolving slowly over the span of people's lives. However, recent studies have shown that networks are strongly affected by the contexts in which people interact with others, and as people experience life course transitions, they also often enter new contexts – school, college, work, marriage, and retirement. We ask whether, as actors enter new social contexts, the core discussion network remains stable or changes rapidly. Based on original, longitudinal, qualitative and quantitative data on the experience of first-year graduate students in three academic departments in a large university, we examine the stability of the core discussion network over the first 6 and 12 months in this new context. We test four competing hypotheses that focus on strength of ties, new opportunities, obligations, and routine activity and predict, respectively, stasis, expansion, shedding, and substitution. We find that the core discussion network changes remarkably quickly, with little or no lag, and that it appears to do so because both the obligations that people face and the routine activities they engage in are transformed by new institutional environments. Findings suggest that core discussion network may be less a "core" network than a highly contextual support network in which people are added and dropped as actors shift from environment to environment.

## 1. Introduction

One of the most important networks studied in recent years has been the core discussion network, the set of people an individual regularly turns to when he or she has important matters to discuss (Marsden, 1987; McPherson et al., 2006; McPherson, 2009; Fischer, 2009; Brashears, 2011; Paik and Sanchagrin, 2012; Small, 2013). The core discussion network is theorized to be a major source of support over the span of a person's life, and it represents one of the most important ways that social networks are said to benefit everyday well-being (Fischer, 1982a,b; Marsden, 1987). When social scientists have sought to understand changes in the social networks of Americans over the past several decades, they have focused on changes in the core discussion network (McPherson et al., 2006; McPherson, 2009). And when they have sought to understand large-scale patterns in the nature of social support or the prevalence of isolation both in the U.S. and in other countries,

they have turned to the core discussion network as well (Marsden, 1987; Ruan, 1998; Völker and Flap, 2002; Suzman, 2009; Brashears, 2011).

As all networks are, the core discussion network is dynamic. Yet while several studies have focused on how the core discussion network has changed over a generation in American society (McPherson et al., 2006; McPherson, 2009; Fischer, 2009), few have examined how the core discussion network changes over the life of an individual. For example, we know that the core discussion network tends to be slightly smaller in the later years (see Cornwell et al., 2008; see also McDonald and Mair, 2010; Kalmijn, 2012). Yet we know little about its stability in size or composition at other stages in life, such as when people enter school, begin their first jobs, or marry. As a result, we know surprisingly little about how dynamic or stable this important form of social support is.

The extent to which the core discussion network remains stable in life transitions becomes an especially intriguing question when we consider the many recent studies suggesting that personal networks are sensitive to social contexts (Hsung et al., 2009; Small, 2009; Conti and Doreian, 2010; Doreian and Conti, 2012; Mollenhorst et al., 2014). A number of classic and recent studies have shown that the physical and institutional contexts of social

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interaction matter. For example Festinger et al. (1950) showed that among college students at MIT, proximity of living quarters was a strong determinant of friendship formation. More recently, Kossinets and Watts (2006) found evidence in a large university email dataset that students who attend the same courses are more likely to form social ties than those who do not, even taking into account confounding factors such as homophily and network closure. In a series of studies at a police academy, Conti and Doreian found that contextual features such as co-membership in squads and even physical proximity of assigned seating strongly shaped the network structure of cadets (Conti and Doreian, 2010; Doreian and Conti, 2012). In a study of mothers and their children's daycare centers, Small (2009) found that whether parents formed networks depended on how the centers structured opportunities for interaction, through drop-off and pick-up hours, fieldtrips, and meetings.

The accumulating evidence on the importance of context is notable because changes over the life course are often experienced as changes in the contexts of regular social interaction. Common life transitions involve entering school, college, the workforce, marriage, divorce, parenthood, and retirement. Several of these transitions have been shown to be associated with changes in personal networks (Kalmijn, 2012). Studies have shown, for example, that the general networks of men and women change after divorce (see Milardo, 1987 for a review). Many of these transitions, particularly to school, college, and the workforce, necessarily involve changes in institutional environments. Others, such as parenthood and retirement, often involve either partial or wholesale changes in institutional environments, such as when new parents enroll their children in daycare and enter a new network of parent acquaintances, or when elderly retirees join retirement homes and enter a new retiree community (Small, 2009; Knight et al., 2010). In fact, for many people, the transformation in personal networks experienced over their lifetime is the cumulative effect of discrete changes ensuing from alterations in personal status or institutional environments.[1]

Nevertheless, the core discussion network is not just any personal network. By definition, it is intimate and small, expected to constitute not an array of acquaintances that shift from context to context but a person's closest friends and family (McCallister and Fischer, 1978; Burt, 1984; Marsden, 1987; McPherson et al., 2006, 2008; but see Small, 2013). An important foundation for the recent controversy over whether the core discussion networks of Americans had declined between the 1980s and the 2000s was that these ties were not those to fleeting acquaintances, but those theorized to be close, stable, and strong. As McPherson et al. (2006: 353) stated in their important and controversial study, "[T]here are some things that we discuss only with people who are very close to us"; only these people, the authors argued, constitute the core discussion network. Indeed, the core discussion network has been used repeatedly in surveys across the world precisely because it is expected to tap more directly into the truly significant members of a person's network (Ruan, 1998; Völker and Flap, 2002; Suzman, 2009; Mollenhorst et al., 2011). Because these scholars theorize that the core discussion network is composed of strong ties, they would expect the core discussion network to exhibit a high level of stability.

The present paper, therefore, asks a question that recent lines of research have not settled: Does the core discussion remain stable or change rapidly in response to new social contexts?

We focus specifically on whether the core discussion network changes over 6 months and 12 months as a result of the changes in social context associated with a life-course transition. For reasons we discuss below, our case is a study of changes in the size and composition of the core discussion network among a cohort of adults over the course of their first year in graduate school. We derive four hypotheses about the expected changes from the literature and test them against original qualitative and quantitative data. To anticipate our results, we find that respondents' core discussion networks changed remarkably quickly, with little or no lag, in the new context, and that the networks appeared to do so because both the obligations respondents faced and the routine activities they engaged in were quickly transformed. Findings suggest that the obligations that strong ties impose and the everyday interactions of actors are more important to people's discussion network than previous studies have accounted for. We begin by discussing our orienting framework.

## 2. Literature and hypotheses

### 2.1. Orienting framework

We first clarify our scope and focus. We hope to understand the extent to which the core discussion network of a cohort of individuals changes in a new environment, a question that presumes both agency and context play a role. Our perspective is actor-based, aimed at understanding the actor's (ego) network, and founded on the notion that changes in that network result from decisions the actor makes given the new environment.

We focus on the two most basic processes through which an actor may change her or his network. When entering a new environment, an actor may either add or not add new ties to her core discussion network and either drop or not drop old ones. Focusing on these two processes is consistent with recent models of evolution in both ego-centric and socio-centric networks (Feld et al., 2007; McPherson, 2009; Snijders et al., 2010). For example, McPherson (2009) focuses on the evolution of the networks of individuals, and specifies a simple probability model of network evolution in which actors add and drop ties according to a mixture of Poisson processes. In his model, people have different networks if they either add or drop alters at different rates. Snijders et al. (2010) focus on the evolution of whole networks, such as all members of an organization, based on the decisions of their constitutive actors. The authors assume that actors make these two decisions – adding or dropping ties – in response to a myopically optimized utility function. For the authors, actors decide to add and drop ties based on the characteristics of the ego (actor), the alters (discussion partners), and characteristics shared by the pair. Our approach is to examine how the decisions of actors to either add or not add and either drop or not drop ties affect the composition of the actors' core discussion network.

Consistent with McPherson's (2009) model, our perspective is ego-centric in its focus on changes from the actor's perspective, an approach necessary because the core discussion network is an ego network. At the same time, as we discuss later, our data constitute entire cohorts of entering students, the kind of network data for which socio-centric models such as Snijders et al. (2010) would be appropriate. However, those models are forced to assume that all network ties occur within the boundaries of the cohort, and we know that people's core discussion networks involve many others who are not part of the cohort. In the modeling section, we discuss the benefits and limitations of our approach.[2]

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[1] We note that many other transitions common only within segments of the population also involve changes in institutional environment, most notably entering prison and the military (Western, 2006; Sampson et al., 2005; Moskos, 1977). For a life course perspective on social capital, see McDonald and Mair (2010). Of course, many changes in context can occur outside of changes in life stage.

[2] Note that while studying the actions of ego is necessary to understand change in the ego-network, other factors that likely play a role must necessarily be ignored

**Table 1**
Six possible outcomes in the evolution of ego's network.

|  | Without replacement | With replacement |
| --- | --- | --- |
| No change in size | Stasis | Substitution |
| Decrease | Shedding | Refinement |
| Increase | Expansion | Transformation |

How do an actor's decisions affect the evolution of the core discussion network? Since an actor may either add or not add and either drop or not drop ties, her network may change in *size* (increase, decrease, or remain the same) and *composition* (experience replacement or no replacement). These two processes, the extent of growth and the extent of replacement, lead to one of six possible outcomes, represented in Table 1.

Consider the first column, which describes the possible outcomes in cases where there is no replacement. If an actor neither adds nor drops core discussion members over 6 or 12 months, the network is perfectly stable, experiencing stasis. If she drops ties without adding any, we refer to the network as experiencing shedding; if she adds without dropping ties, there is again no replacement, and we refer to the outcome as expansion. The three conditions are consistent with stability in the network, as would be expected in a network of strong ties (Granovetter, 1973, 1983). The replacement column indicates, again, what the network experiences without necessarily implying something about motivation, and focuses on any situation in which actors *both* add new ties and drop existing ones. If the network does not change in size because equal numbers of alters were dropped and added, we refer to it as experiencing *substitution*. If an actor both adds and drops alters, but does the latter more than the former, we describe the network as experiencing *refinement*. If she does both but adds more than she drops, we describe the network as experiencing *transformation*.

### 2.2. Theoretical predictions

Which of the six outcomes is more prevalent after 6 months, and after 12 months, in a new institutional environment? We derive three predictions based on the existing theoretical literature that focus on the role of tie strength, opportunity, and obligation, respectively. We propose a fourth that focuses on routine activity.

The first perspective emphasizes the special characteristics of *strong ties.* The standard interpretation of the core discussion network is that it represents ego's strong ties. For example, Burt (1984) argued that the General Social Survey question used to produce the core discussion network would generate the names of alters with whom respondents are especially intimate, contrasting these with weak or short-lived ties. These intimates would represent the "primary ties through which interpersonal socialization operates" (Burt, 1984: 317; cf Fischer, 1982a,b). Marsden (1987: 123) argued that the question would elicit "intimate, comparatively strong ties." According to McPherson et al. (2006: 356), alters in the core discussion network "represent an important interpersonal environment for the transmission of information, influence, and support," the "set of close, routinely contacted people who make up our respondents' immediate social circle." Mollenhorst et al. (2008) put it similarly: "While people can have many network members and even many friends, they do not tend to discuss important personal matters with every one of them, but only with those they really

trust. We therefore use the word 'confidant' to indicate these core discussion network members. . ." (2008: 938).[3] Strong ties have several important characteristics. First, strong tie networks tend to be dense – the alters to which ego is strongly tied tend to be strongly tied to one another (Granovetter, 1973). Second, because of this density, the relationships tend to be the mutually reinforcing, such that the relations A has to B and to C tend to be reinforced by the relationship between B and C. As a result, strong ties are expected to be stable and not particularly susceptible to short-term changes in context (by contrast, see Mollenhorst et al., 2014, who report on changes in the core discussion network after a seven-year period). For example, sisters who are close tend to remain close even if one of them moves away from the family's home town.

Thus, our first hypothesis derives from the assumption that the core discussion network is composed of people's strong ties. While new environments may change the constitution of a network of strong ties eventually, this perspective would not expect a change over the short span of 6 or 12 months, given the inherent stability of those ties. On this basis, we generate a hypothesis, *H1* (*strength of ties*): *over the course of the first 6 and 12 months in a new institutional environment, the core discussion network should experience stasis.* Since the perspective draws its predictions from the strengths of existing ties, expansion would still be consistent with the perspective (even though expansion would not be the main prediction). However, both shedding and replacement of any kind would be contrary to the expectations of the perspective – strong ties will tend to maintain one another, making it unlikely that actors will choose to drop members in a short time frame.

A second perspective focuses on the *new opportunities* that entering a context provides for actors to expand their networks. This model also proposes that the discussion network is composed of strong, and thus resilient, ties. However, it builds on the first perspective by adding that people, if given the chance, respond to new opportunities to add others to their social support network by expanding it. A number of studies of network formation have focused on opportunities. Huckfeldt (1983) proposed a two-stage model of tie formation, requiring that a pair of actors first encounter one another in a friendly context before a closer relationship is even possible (see also the "meeting vs. mating" early literature on friendship formation; Verbrugge, 1977). Völker et al. (2009) argued that an individual's social network depends on the social contexts in which they live, as the social context creates the opportunity structure for meeting potential friends (see also Mollenhorst et al., 2014). Feld (1981) took the opportunity perspective further, arguing that it is focused interaction that makes the difference – actors develop ties to the extent their joint interaction is centered on a given activity.

This perspective would lead to a somewhat different prediction. While it agrees that strong ties are likely to be resilient, it notes that new environments provide new opportunities to interact with others, and that actors respond to these opportunities. In the absence of change, the core discussion network should remain stable; the change to a new environment will create new opportunities for ego to add members. While these opportunities may lead to new ties through several mechanisms – such as attraction by similarity (Lazarsfeld and Merton, 1954; McPherson et al., 2006) or triadic balance (Newcomb, 1961) – the core expectation is that the

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for the sake of analytical coherence. Change occurs because of the decisions of ego but also due to decisions by the alters; characteristics of each ego-alter dyad; characteristics of the ego network as a whole; characteristics of the ego networks of the alters; and characteristics of the institutional contexts of ego, the alters, or the ego-alter interactions (for some of these other perspectives, see McPherson et al., 1992; Mollenhorst et al., 2014).

[3] As we discuss below, the question asks respondents to name the people with whom they discuss "important matters." Small (2013) argues that the question does not necessarily capture strong ties. Indeed, the GSS question is a revision of a question originally developed by Fischer (1982a,b) to capture whom respondents talked to about "personal matters" (see Burt, 1984). Fischer's question, in conjunction with others in his survey, was arguably intended to capture strong ties. The revision of the question and the shift to "important matters" might have changed the nature of the elicited network.

network should expand. Thus, we hypothesize: *H2 (opportunity): over the course of the first 6 and 12 months in a new institutional environment, the core discussion network should experience expansion.* Since the prediction focuses on new opportunities, transformation (wherein a small number of existing ties are dropped but a larger number of new ties are added) would still be consistent with the model, though not the main prediction. Nevertheless, neither the decrease in the size of the network nor the absence of change would be expected.

A third perspective also begins with the notion that the core discussion network is composed of strong ties. However, it focuses on the *obligations* that strong ties imply. Much of this work arises in the context of either exchange theory or general models of reciprocity (Mauss, 1954; Homans, 1958; Ekeh, 1974; Bearman, 1997). The core theme across all such models is the notion that actions from one actor to another are typically accompanied by an expected reaction in kind. Blau ([1964] 1986) specifically argued that a basic process in association is reciprocity, wherein receiving support is accompanied by the expectation of providing it in return. Similarly, in her classic ethnographic study, Stack (1975) found that the supports low-income mothers received from others were accompanied by the obligation to support others. For current purposes, the most important issue is that while social ties bring benefits, they also carry costs – obligations commensurate with their benefits.

New institutional environments create obligations both social and institutional in nature (Powell and DiMaggio, 1991). Actors must not only negotiate relations with a new set of acquaintances, but also master new skills, take on new responsibilities, and fulfill new obligations. Notably, many of the obligations that accompany a change in institutional environment are in fact institutional, rather than social, in nature. In the case of graduate school, which we discuss later, obligations such as passing exams, developing a research agenda, or reading for class are not inherently social in nature (though of course they may be fulfilled in conjunction with others); they are simply responsibilities associated with the new institutional membership. As Meyer and Rowan (1977) have argued, institutions may be conceived as expectations of behavior with either formal or informal sanctions for noncompliance. Since an actor's time and attention are limited, these obligations compete with the obligations to provide reciprocal support that are inherent in the existing core discussion network. As the demands of the new environment raise the burden of reciprocating the old ties, actors are likely to drop the weakest of those ties.[4]

On this basis, we generate a third hypothesis, *H3 (obligations): over the course of the first 6 and 12 months in a new institutional environment, the core discussion network should experience shedding.* While shedding is the primary expectation, at least two alternatives would also be generally consistent. It is possible that actors fulfill new obligations by replacing an old tie with a new one more conducive to fulfilling the new obligations, such as replacing an old soccer friend with a new study partner. Thus, refinement or substitution would be consistent with the model. However, neither the absence of change (stasis) nor overall growth of any kind (which would imply greater obligations) would be expected by the perspective.

A fourth perspective differs from the first three in its belief that the core discussion network is not necessarily composed of strong ties. This belief was supported in a recent survey by Small (2013)

that found, contrary to common expectations, that 45% of the core discussion network was composed of people respondents were not close to. Instead, the perspective assumes that whom people regularly turn to when discussing important matters depends less on whom they are close to than on whom they regularly interact with; it shifts attention from the emotional tie between actors to the frequency of their interaction. Thus, the perspective would focus on the new *routines* that arise in new environments.

Several sociological traditions have focused on the consequences of regular interaction for trust (Homans, 1961; Lawler et al., 2008; Yamagishi and Cook, 1993). The more people interact regularly, the more likely they should be to discuss important matters. Several ethnographic studies have found supportive evidence. Furman (1997) uncovered that elderly women who encountered each other repeatedly while going for regular treatments at a hair salon began sharing deeply personal topics, such as their experience with cancer treatments, in conversation. Small (2009) found that the regular interaction among mothers whose children are enrolled in the same daycare center led to the discussion of personal family topics. Often, these regular interactions do create strong bonds, as Duneier (1992) found among men who frequented the same neighborhood restaurants (see also Martin and Yeung, 2006). The perspective would argue, however, that regular interaction is the primary factor. By extension, if two strongly tied actors fail to maintain routine interaction (e.g., because of physical distance), they should be less likely to continue discussing important matters on a regular basis, even if they remain strongly tied. Consistent with this idea, Mollenhorst et al. (2014: 72) recently found in a study of Dutch networks over seven years that "52.9 percent of the relationships [they studied] were discontinued because of a lack of meeting opportunities."[5]

When actors enter new institutional environments, their daily routines are affected, reducing regular contact with many of their prior alters and creating repeated contacts with new ones. To the extent that regular interaction is a foundation of the core discussion network, sudden changes in routine environments should alter the network rather quickly. Thus, we derive a fourth hypothesis, *H4 (routine): over the course of the first 6 and 12 months in a new institutional environment, the core discussion network should experience substitution.* This perspective implies replacement. Thus, while substitution is the primary prediction, both transformation and refinement would be consistent with the model as well. However, none of the non-replacement conditions would be expected.

## 3. Methods and data

### 3.1. Our case

Our test of these hypotheses focuses on how the core discussion network evolves over the course of a specific life transition, entering a graduate program. Our case is ideal for several reasons. First, contrary to other similar kinds of institutional changes, such

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[4] A reviewer has suggested that, from a social capital perspective, people may drop the least useful, rather than weakest, ties. If so, the perspective would be consistent with H3. At the same time, however, social capital study would theorize the set of issues in this paper differently, beginning with the notion that people form ties to others in the interest of securing resources (Bourdieu, 1986; Coleman, 1988; Lin, 2001).

[5] Readers will note that Mollenhorst et al. (2014) is cited in the discussions of H2 and H4. That paper is consistent with both hypotheses because it does not take into account Small (2013), which shows that the core discussion network is not composed only of strong ties. For example, the authors write that the core discussion network is composed of strong ties: "As a consequence, this study is restricted to this small, but important part of people's personal networks. The core discussion network question was selected for this procedure, because this question delineates the inner core of one's personal network, which consists of the most intimate ties" (Mollenhorst et al., 2014: 68). In this respect, the paper is theoretically consistent with H2. However, in another part of the paper, they argue that people gain core discussion members from the contexts in which they interact with others routinely: "This suggests that people draw about half of their new confidants and practical helpers from contexts they newly entered" (Mollenhorst et al., 2014: 73–74). In this respect, the paper is theoretically consistent with H4.

as entering high school or college (Harris and Udry, 2013), our population consists entirely of fully mature adults. Studies of networks in institutional environments involving children raise concerns of applicability beyond childhood. Second, in contrast to people at earlier stages of their lives, those entering graduate school have both a fully formed personal network and a low probability of having previously known alters in the new environment. That is, they typically have both an established core discussion network and a near complete fresh start. Our case is based in a large university where most entering graduate students lived in other cities prior to enrollment. Third, while people beginning graduate programs are experiencing a discrete change in the kind of environment they face, this change, unlike similarly stark transitions in other institutional contexts – such as children in school, adults in prison, and the elderly in retirement homes – results from a freely made decision. Since adding or dropping ties involves a fundamental exercise of agency, the ability to point to a freely made transition is key (Emirbayer and Mische, 1998).

### 3.2. Data and approach

In a large university, we interviewed all entering students in the graduate cohorts in three academic departments in the arts and sciences – one in a laboratory science, one in a social science, and one in a humanities field. Interviews were conducted three times, 6 months apart. The first was conducted within a month of the start of the first semester. We interviewed 37 respondents in all three waves (93% of the entire set of three cohorts). Almost all interviews were audio recorded and lasted from 50 to 90 minutes. None of the students dropped out of graduate school over the course of the first year.[6] (Please also note that, to comply with IRB confidentiality requirements, we are unable to describe the university or departments in great detail.)

We conducted semi-structured interviews with both survey questions common to all and open-ended questions that were conversational in nature. The core variable in the quantitative portion of our analysis is the respondent's core discussion network. To obtain this network, we followed standard practice and employed the question wording of the General Social Survey (Marsden, 1987; Fischer, 2009; McPherson et al., 2006). We asked: "From time to time, most people discuss important matters with other people. Looking back over the last six months – who are the people with whom you discussed matters important to you?" The number of answers was left to respondents. After the last name, we asked "any others?" and also recorded these names if provided. A "name interpreter" section asked respondents the gender, age, and race of the alter, and if the alter was currently in graduate school. Researchers have shown that the name generator is sensitive to question ordering effects (Fischer, 2012). Thus, the bank of questions involving the core discussion network took place at the very start of our interview.

The qualitative analysis is based on the subsequent, open-ended portion of the interviews. This portion began with structured

prompts geared at understanding the main issues respondents worried about within and outside graduate school, and whom they talked to about these worries. Respondents were asked to think of the last time they talked about a given worry, whom they spoke to, why, and under what circumstances. Further questions regarding the confidants named probed deeper into the nature of the respondents' relations. Our open-ended questions and subsequent conversations formed the basis for understanding the mechanisms behind the formation and maintenance of their social networks.[7]

We employ what mixed-methods researchers refer to as a qualitative-quantitative complementary approach (Onwuegbuzie and Collins, 2007; Small, 2011). Our approach is "complementary" in the sense that the qualitative and quantitative data are used to assess different elements of the same hypotheses. The qualitative data serve two purposes. First, the qualitative data provide evidence for the mechanisms underlying the hypotheses. Each of the four hypotheses predicts a network *outcome* (e.g., stasis, shedding, etc.) on the basis of a *mechanism* (e.g., strength of ties, obligations, etc.) affecting the decisions of individuals. While our quantitative data can be used to assess which outcome is most likely, they do not allow us to test whether the outcomes result from the particular mechanisms proposed in the respective theories. Our qualitative data do allow us to observe the proposed mechanisms. The qualitative data identify how respondents perceived their new environment, how they maintained strong ties, whether they encountered opportunities to make new ties, whether they experienced obligations in their relationships, and if their new routines impacted how they maintained relationships. Thus, the qualitative data make evident the processes behind changes in respondent's networks.

Second, the qualitative data serves a "proof of concept." The qualitative findings will serve to test for the presence of the four hypothesized mechanisms in the decision-making of the respondents. That is, they will assess whether there is any basis in the interviews that each of the four mechanisms identified – strength of ties, obligations, opportunity, and routine activity – is, in fact, at play among our respondents (Hedström and Swedberg, 1998; Hedström and Ylikoski, 2010). For example, H3 predicts shedding (network outcome) because of the obligations (mechanism) imposed by the new environment and required by the old ties. If the qualitative data did not produce evidence that obligations affect actors' decisions as theoretically described, we would have little reason to expect that shedding is a likely outcome, undermining the third theoretical perspective. In this sense, uncovering evidence of the presence of the mechanisms is the first evidentiary bar against which we assess the theoretical perspectives.

The quantitative findings will then adjudicate among the hypotheses by testing which of the four different primary outcomes they predict – stasis, expansion, shedding, and substitutions – is most statistically likely. For example, it is possible that the qualitative evidence shows clearly that actors are making decisions based both on the opportunities presented (H2 theoretical mechanism) and the obligations they face (H3 theoretical mechanism). Only the quantitative tests will tell us whether, in the end, actors' decisions were more likely to lead to expansion (H2 network outcome) or to shedding (H3 network outcome). Our empirical strategy for adjudicating among the hypotheses is informed by Bayesian inference,

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[6] A reviewer asked for a discussion of the implications of sample size. Studies with few respondents have always been a part of social network analysis, given the researcher's ability to probe deeply into relationships (e.g., Breiger, 1974; Krackhardt, 1987). In addition, note that, because of its small sample size, our study constitutes a conservative test. Generally, the larger the sample, the more likely results are to be statistically significant. Finally, we should be clear that, as with many small-*n* studies, our study is aimed at conceptual, not statistical, generalizability. Our aim is to propose a way of understanding changes in the core discussion network, and to assess whether we have reason to suspect that new contexts affect actors' behavior with respect to discussing important matters, rather than to propose that all graduate students in large universities will have the precise rates of change reported in our study.

[7] Each interview was transcribed and then coded to identify instances relevant to the addition or dropping of ties. We coded for respondents remaining close with prior alters, obligations associated with maintenance of current ties, the presence of new opportunities to make ties, and routines that impact ties. These codes generated a list of quotes that served as the base for our qualitative evidence.

and is discussed in detail in the section on quantitative findings. We begin with the qualitative findings.

## 4. Qualitative findings

Our first hypothesis was based on the idea that core discussion network ties would be *strong ties* to close, intimate friends and family. These kinds of ties would resist change over short periods. (This strength is the reason our first hypothesis predicted stasis.) Our in-depth interviews found evidence to support that many core discussion ties were strong in nature (and thus likely to lead to stasis).

When Ethan enrolled in his graduate program, he moved away from his hometown and group of close friends.[8] After six months of his graduate program, Ethan had not formed close relationships with his new peers, though he was not especially concerned:

I have something between friendship and acquaintances with a lot of the [new] students, but no particular close friends, which I don't really feel honestly is all that much of a problem, because I keep in contact with friends back home, both on the phone and Skype. . .. [S]o I feel like I get enough social activity to a certain extent.

His group of friends consisted of four "core members" (himself included) who gathered online each week to play an interactive game. They had done so consistently for the past six years. When these friends asked if Ethan was going to find another group to play with, "I basically told them, why do I need to? . . .I have you guys over Skype." He continued playing with these friends throughout his first two years of graduate school, keeping his strong ties throughout his transition.

Ethan's experience was not unique. Many other respondents maintained the strong ties they had before enrolling in graduate school, often because a spouse or romantic partner joined them on their move to graduate school. Irita explained that her partner, Ali, "up and left [their home town] to live here with me." Although graduate school demanded Irita's time, she purposefully adjusted her schedule to make sure she was active in their relationship:

I feel like I have a responsibility to not be like really terrible and just be working all the time. As far as I know, and we do talk about it, we try to keep in touch with each other about it, at least like once every week and a half or two weeks we check in. . . about how much time I'm spending. I think, at least as far as I know, based on our little check-ins, like we're okay. But it's still something that I try to like manage.

In addition to "check-ins" on their relationship, Irita and Ali discussed her graduate school and personal worries. When asked why she talks about such matters with her partner, Irita explained: "I just talk about everything with Ali. . . you know, like yeah, at the end of the day, like, 'How was your day?'" In fact, Ali had met many of Irita's colleagues and was also friends with Irita's graduate-school friends. For respondents like Irita, who moved into time-demanding new environments with a close partner, strong ties remained strong, and, thus, the core discussion network did not change.

The second hypothesis was based on the idea that actors respond actively to *new opportunities*, and that starting a graduate program provides access to a new set of potential discussion partners. (Hence, the hypothesis predicted expansion.) Our interviews provided substantial evidence that the students not only encountered numerous opportunities for new interactions, but also that they took advantage of these opportunities. They met new people in

classes, study groups, academic events, and extra-curricular activities, and these new relations often led to friendships.

Not surprisingly, courses provided among the most common opportunities to interact with others, as graduate students talked to others before and after a shared class. They sometimes joined other graduate students for lunch or coffee around their class times, taking advantage of opportunities to develop relationships with others. Theo described how "glad" he was about opportunities to have lunch with his colleagues:

I go out to lunch with a lot of the people in my cohort, not a lot, but a number of people in my cohort, every time we have classes. Since I'm in, I think all my classes are around from nine to twelve. And the Ph.D. students that are in them that are in my cohort, we normally tend to converge. Or to go somewhere else, whenever we need to eat.

Theo added: "I expect that [during] the Ph.D., my cohort will develop very close. . . and I hope that our friendships will last for many years to come." Indeed, Theo did develop new strong ties. Six months into his graduate program, he explained that he had formed friendships with four other graduate students. He described them as "a close group of friends that I constantly go out with to watch movies and just talk and go to events that they host."

As Theo did, Kaylee formed a study group with two other graduate students and met them at the library a few times per week. They initially began studying together because of their common classwork, but the relationship soon developed into a closer friendship. Kaylee described her study group as "helpful" and her two friends as "very supportive" of her: "So what we do is we take these breaks in between [studying] where we sort of go out to the hallway and talk about these things, just life and academics and all that." The time spent studying and talking together, in turn, strengthened their relationships, so that the three became "really sort of tight with each other." In fact, she was considering rooming with one of her new study group friends the following year.

The third hypothesis derived from the notion that core discussion partners not only provided support, but also implied *obligations*. For an alter to serve as ego's confidant, ego must be available when the alter needs a confidant as well. Furthermore, new environments involve new obligations – in this case, courses, exams, event attendance, and others – that would likely undermine the ability to maintain past obligations. Given this burden, the perspective expected the loss of the weakest of the ties in the core discussion network.

We found evidence that obligations affected students' decision-making. Owen moved from overseas for his graduate program, leaving behind two good friends with whom he had often discussed academic life. When asked if he had talked with them recently, Owen replied:

Well, [I did] when I was living [abroad], but not that much anymore. I mean, I haven't, I've emailed him. I emailed both of them. Um, and I spoke, I Skyped with Dennis like two weeks ago and that's about it, unfortunately. I would love to talk more often to them but it's just – I don't have time.

Similarly, Michelle discussed the challenges she faced when trying to keep relationships going with her longtime friends, given the new demands on her time: "I do worry that my social life is like, my network has just become so tiny." She explained that she was too busy with graduate school work to maintain relations with her old friends, because the work demands of her new schedule did not allow her the time to interact with them: "I actually don't see [my old friends] as much as I should. Yeah, sort of what I'm complaining about is that I just don't have the energy anymore to reach out to people unless they just happen to be living right next to me." Michelle contrasted this experience with her college years, when

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[8] All names are pseudonyms.

she formed many of these ties: "Whereas, you know, I feel like in college there was a lot more, you know, diversity in terms of like who you hung out with. But because of my schedule and I'm tired all the time, and I have a boyfriend. So, you know, I feel like everything is a much smaller community now." Michelle and Owen's discussion networks, and those of others in similar circumstances, bear evidence to the obligations that come with maintaining close ties.

The final hypothesis was grounded on the notion that the maintenance of networks depends primarily on *routine activity*, such that as students changed what they did on a regular basis, their core discussion network would also change. (It is for this reason that the perspective predicted substitution.) We found evidence consistent with the idea that graduate students' new routines altered the people with whom they spent much of their time, replacing old discussion partners with new ones.

Graduate students expressed difficulty in maintaining their old networks as they transitioned to the routines of graduate school. Camille explained that she "definitely missed" her old college friends, indicating why she was now less close to them: ". . .[My two close friends] are still down in [the college town]. . . . So, it's like, they're not as, I don't know, they're not as accessible. And I miss. . . having that." At the same time, she was quickly finding herself in regular contact with new sets of people in graduate school: "I am making, like, I am making new friends here. Like, I have a little group that I hang out with." Camille met two people in class, and, after seeing one another after class, in the office, and at social events, they "just kind of like clicked." She also developed an important confidant in her student office. When Camille had worries about her research, she often found herself talking to her office mate Dennis. "I share an office with him," she explained. "So I talk to him about [research concerns] a lot." Camille believed that she and Dennis had a good "rapport," and together they had "a bunch of ideas going" that they talked about frequently. Indeed, they became so close that Dennis "helped. . . design the original study" for one of her projects. Interestingly, Camille shared a great deal with Dennis, without necessarily considering Dennis a close friend.

Other students had similar experiences. Demetrius found his new work schedule made it particularly difficult for him to maintain relationships with his old friends:

> I think just the time commitments of the program and communicating even to people that I went to undergrad with, that now are working at non-academic jobs – they're not grad students or anything. But I think they don't recognize, now that they're on a different schedule, what my schedule's like or what their schedule used to be like. So the idea of, you know, "[I]t's 5 o'clock. I'm done . . . let's go out." "You know, I have a paper to do. I got to go to a workshop." . . . And on the flip side, going to bed earlier for them, and I'm still in student mode, so I'm still up in the night. Our schedules are different, and I think that's just something personally that I have to work out more, just balancing [my] personal schedule.

Demetrius' new routines were simply not compatible with those of his longstanding friends – their schedules were different and they saw each other less frequently. He worried about losing touch with them: "I think that's [my] general concern, just having enough time for seeing friends and maintaining these solid friendships beyond like a Facebook thing, or chat or Skype or something." He "would be happier if I had more time to spend with [my old] friends." At the same time, he did not find having less time for friends to be of an "immediate concern." We asked why. "I'm building new friendships in the department. So I now have people I work with that happen to be my friends, and I have plenty of time for them."

Demetrius's case is consistent with the idea that where and how students routinely spend their time matters. Several of our

**Table 2**
Size and number of within-cohort members, core discussion network, by wave.

| Wave | Mean | S.D. | Within-cohort mean |
|------|------|------|--------------------|
| 1 | 5.24 | 1.85 | 0.14 |
| 2 | 4.92 | 1.83 | 0.76 |
| 3 | 5.27 | 1.71 | 0.70 |

respondents were quick to replace old discussion partners with new ones, responding to their changing routines.

## 5. Quantitative findings

The qualitative findings have given us reason to believe that each of the four mechanisms underlying the hypotheses adequately describes the decision-making of at least some of our respondents. That is, none of the hypotheses are "straw-man" models. Only a quantitative test, however, can tell us whether in the balance of strong relations, new potential partners, heavy obligations, and changing routines, our respondents' core discussion networks will remain static, expand, shed members, or instead substitute them in the first year in this new context. Before discussing our approach to the tests, we begin with descriptive statistics.

### 5.1. Descriptive statistics

We know the members of each of our respondents' core discussion network at three time points. Table 2 summarizes the distribution of network size over the three time periods, as well as the average number of members that were within the respondent's cohort. Except for a small increase in within-cohort discussion partners, the aggregated numbers do not present any obvious trend. Our respondents had a core discussion network with a mean size of 5.24, 4.92, and 5.27, in each of three waves, respectively.[9] The increase in average number of within-cohort members (from just 0.14 in the first wave to 0.76 and 0.70 in the second and third waves, respectively) is consistent with hypothesis H4 (and to some extent H2). That this increase is not larger reflects the fact that the respondents are still interacting with many people not in their cohort. These aggregated numbers describe networks that do not change much in size, but that have a potentially significant change in composition.

To address compositional questions, we begin by considering how many of the alters who were present at time 1 were present also at time 2 and time 3. Fig. 1 exhibits the answer. It shows the evolution of the core discussion network for respondents in each of the three departments. The core discussion networks for all of the respondents in a department are pooled. Thus, each horizontal line represents a unique pair of respondent and alter (not a unique respondent) in the network.

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[9] Our study produced a core discussion network larger than that reported in the General Social Survey, as a result of several factors. First, our interviews were conducted in person, rather than over the phone, which created an intimate environment that encouraged openness. By contrast, while most of the GSS interviews are conducted face-to-face, about 24% in the 2010 GSS were conducted over the phone (Paik and Sanchagrin, 2012). In addition, a recent reanalysis of the GSS data suggested that interviewer effects made a large difference. Paik and Sanchagrin (2012) found that strong interviewers elicited over two more discussion partners per respondent than poor interviewers. In our study, almost all interviews across all waves were conducted by only two interviewers, one highly experienced and one highly trained (both are co-authors of the present study). Finally, our interview protocol required asking, "Is there anyone else?" after the last alter was named, a process that elicited at least one additional alter more than half the time. This combination of in-person interviews, strong interviewers, and supplementary elicitation is sufficient to account for size difference between our and the GSS reports on the size of the core discussion network. Also, adults in their twenties and thirties will have slightly larger networks than much older adults (Marsden, 1987).
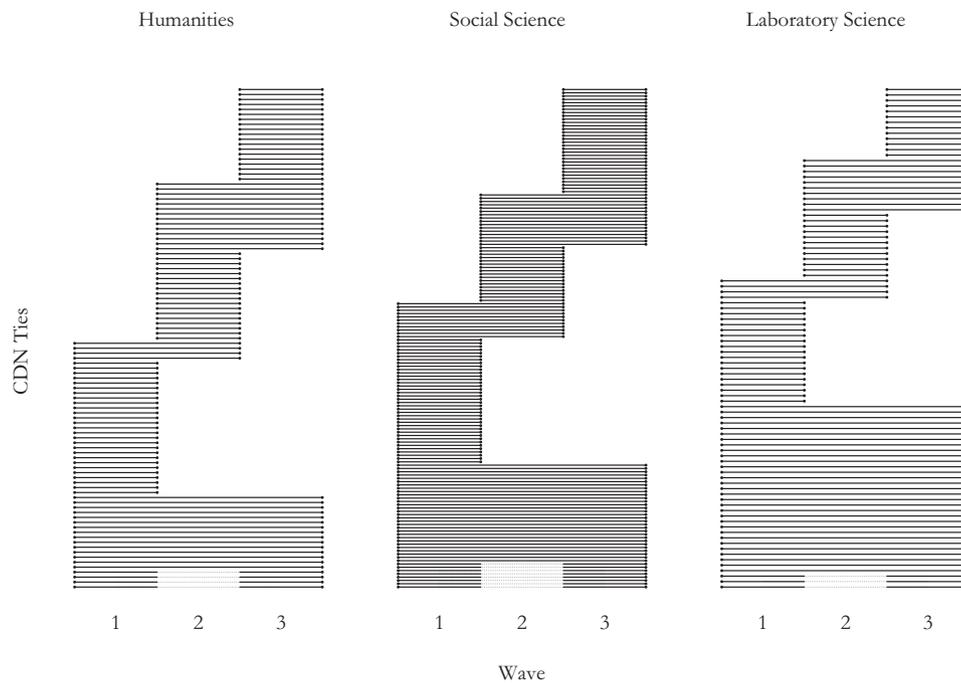
**Fig. 1.** Cohort core discussion network composition. Each horizontal bar represents a unique tie between a respondent and an alter. The length of the bar indicates the number of waves the tie lasted. Most ties lasted only one wave. If a tie from wave 1 disappeared in wave 2 and reappeared in wave 3, the wave 2 portion is denoted with a dotted line.

Several aspects of the network's evolution are clear. First, all three departments experience a fair amount of change. Less than 50% of the alters in any department remain in the network through all three waves. The transition between waves one and two in particular exhibits a high turnover of ties, indicating a great deal of change within the first 6 months. At a glance, this pattern seems to be incompatible with H1, while giving some support to H2, H3 and in particular H4. If such a large proportion of the ties in the pooled network are being replaced each 6 months, then it is unlikely that *stasis* is the predominant pattern within the individual respondent's networks. Second, the overall size of the pooled discussion networks does not change substantially across the different waves, a pattern consistent with the *routine* hypothesis of network substitution. It is also worth noting that the laboratory science department seems to exhibit a more stable network with less replacement and more consistency than either the humanities or social science departments.

While this summary yields some intuition about the dynamics of change in the network, an ego-centric approach is necessary to explicitly test our competing hypotheses. For each respondent, we compute change in size (the net difference in the number of reported discussion partners between interviews) and the presence or absence of replacement (present if at least one discussion partner was dropped and one new partner was added between waves). Using these two statistics, we can place each respondent in one of six outcomes (from Table 1) for each pair of waves. A respondent's network can experience no replacement between the waves (the first column) or some replacement (the second column); he or she can experience no change in the size (top row), a decrease in size (center row), or an increase in size (bottom row). Every respondent must fall into one of these six outcomes.

Table 3 lists the number of respondents in each category. The differences are computed between waves one and two (6 months) and between waves one and three (12 months). A few patterns are evident. First, respondents' core discussion networks experience some replacement much more frequently than no replacement. Over 12 months, 31 out of 37 respondents replaced at least one member of their core discussion network. Furthermore, we notice that *stasis* – the outcome with no change in size and without replacement – is virtually absent from the data. Only one respondent (in the social science department), experienced a fully static network, and even then only over the first 6 months. (We later assess the possibility that stasis might be underestimated due to reporting error.) The descriptive data suggests considerable turnover in core discussion partners, which we test formally with a mathematical model of network change.

### 5.2. Model

To model the student outcomes quantitatively, we considered several approaches. Popular models of network dynamics, such as exponential random graph models (Robins et al., 2007; Snijders et al., 2006) or actor-oriented models (Snijders et al., 2007), might be appealing; however, they are ultimately inappropriate for the type of core discussion networks we utilize. Core discussion network data are collected as ego-centric responses, such that actors may be tied to out-of-sample alters. In addition, ties between out-of-sample alters are unknown. With the exception of the few discussion partners who were also respondents in our sample, we have no way of knowing which of a respondent's core discussion partners would list another respondent's discussion partner as a partner as well.[10] This condition makes standard models implausible. While one might in theory be able to treat these unseen ties as missing data, this approach would mean that the large majority of the dyadic data would be missing, making estimation problematic and inferences suspect.

Instead, we opted for a multinomial model treating respondent outcomes as straightforward categorical random variables, and adopted a Bayesian approach to estimation. Under our model, each respondent experienced one of the six possible outcomes according

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[10] Twenty of the 322 core discussion partners listed by respondents were themselves in our sample.

**Table 3**
Outcome frequencies across all respondents, by duration.

| | Waves 1–2 (6 months) | | Waves 1–3 (12 months) | |
|---|---|---|---|---|
| | Without replacement | With replacement | Without replacement | With replacement |
| No change in size | 1 (3%) | 8 (22%) | 0 (0%) | 11 (30%) |
| Decrease | 5 (14%) | 8 (22%) | 2 (5%) | 11 (30%) |
| Increase | 3 (8%) | 12 (32%) | 4 (11%) | 9 (24%) |

to a fixed but unknown set of probabilities. As we will show below, this modeling approach allows us to test against null hypotheses of no difference in outcomes and to rigorously compare our four hypotheses. Suppose that, between interviews, each of the six outcomes (shedding, stasis, expansion, substitution, refinement, and transformation) has a distinct probability $p_i$ associated with it. Each student has probability $p_{shedding}$ of experiencing shedding, probability $p_{stasis}$ of experiencing stasis, and so on. Because each student must end up in exactly one of these outcomes, the probabilities sum to one: $\sum p_i = 1$. Under this model, the frequencies reported in the tables above are an observation from a multinomial distribution over six categories with a number of trials equal to the number of respondents in the cohort. Numbering the outcomes 1,..., 6 we have the formal model,

$$(f_1, \ldots, f_6) \sim \text{Multinomial}((p_1, \ldots, p_6), N)$$

where $f_i$ is the frequency of students experiencing outcome $i$, and $N$ is the total number of respondents in the cohort.

### 5.3. Estimation

As a first pass, we test the null hypothesis that no outcome is more likely than any other:

$$H_0: \quad p_1 = p_2 = \ldots = p_6 = \frac{1}{6}$$

We test this null hypothesis using an exact multinomial test of goodness-of-fit.[11] This yields a $p$-value of 0.0186 for the first 6 months of the study, and 0.0004 for the full 12 months. We can therefore soundly reject the null hypothesis of equal probability: some outcomes are clearly more probable than others.

To compare the relative likelihood of our four hypotheses, we examine the probabilities of the various outcomes predicted by each. For example, the "strength of ties" hypothesis (H1) primarily predicts that a student entering the graduate program will experience *stasis*, although *expansion* is also a compatible outcome. The "routine" hypothesis (H4), in contrast, makes a primary prediction that respondents will experience *substitution*, but allows *refinement* and *transformation* as consistent as well. Each of the four hypotheses makes a strict prediction of a *primary* outcome, and a looser prediction of *compatible* outcomes.

We adopt a Bayesian approach to the estimation of the outcome probabilities, an approach we find most appropriate for the current questions.[12] Rather than focusing on best-guess point estimates of the outcome probabilities, we represent the uncertainty of our estimates as probability distributions. Thus, we can talk about the likelihood that a respondent has at least a 50% chance of experiencing *refinement*. While this language can seem counter-intuitive outside of a Bayesian framework, the general approach facilitates simultaneous evaluation of all four hypotheses and explicit comparisons between those hypotheses. Furthermore, because the mechanisms on which they are based allow for both primary and non-primary but compatible outcomes, our hypotheses have some degree of overlapping predictions (e.g., both H3 and H4 consider *refinement* to be a compatible outcome). Calculating posterior distributions of the parameters $p_1$ through $p_6$ allows simple comparisons of these overlapping hypotheses, a complicated if not impossible task using traditional frequentist estimation.

Given a hypothesis of interest, we estimate the probability that a respondent will experience an outcome compatible with that hypothesis. We do this by constructing a posterior probability of the joint probabilities of the outcomes:

$$(p_1, \ldots, p_6) \sim \text{Dirichlet}((f_1 + \alpha, \ldots, f_6 + \alpha))$$

Here again, $p_i$ is the probability of a respondent experiencing outcome $i$, $f_i$ is the frequency (count) of respondents observed with that outcome, and $\alpha$ is the concentration parameter for a non-informative Dirichlet prior, which is the conjugate prior of a multinomial distribution. We use $\alpha = 0.5$ as a conservative value.[13] With these posterior likelihoods, we can construct the probability that a respondent's outcome is compatible with H1 as a marginal distribution of the full posterior (in practice, this reduces the Dirichlet distribution to a Beta distribution). Intuitively, we let $\text{Pr}(H1) = p_2 + p_3$, or the probability of *stasis* plus the probability of *expansion*.

Fig. 2 summarizes the probability distributions for each of the hypotheses. The vertical axis represents the estimated probability of a respondent falling into a category, while the boxes and whiskers represent the statistical uncertainty of that estimation. Hypotheses can be compared by contrasting their relative heights in the figures. Looking at the left panel, we see a clear ordering of the four hypotheses, with H3 (*shedding*) and H4 (*routine*) appearing much more likely than H1 (*stasis*) or H2 (*expansion*). The median probability that a respondent will be compatible with the *routine* hypothesis (H4) is nearly 80%. In contrast, the median probability of outcomes compatible with H1 is less than 15%. The right panel of the figure shows that even if we limit our analysis to the strictest predictions made by the hypotheses – that is, even if we eliminate compatible but keep primary predictions – strong contrasts remain: while the difference between H2 and H3 disappears, we still see strong evidence in support of H4 and against H1.

We test these comparisons explicitly by measuring the likelihood that any one hypothesis is more probable than another. Table 4 compares each pair of hypotheses in terms of its compatible and primary outcomes. If we adopt a threshold of 5% significance, the previously identified order of the compatible outcomes is strong: $\text{Pr}(H4) > \text{Pr}(H3) > \text{Pr}(H2) > \text{Pr}(H1)$. That is, H4 is most strongly supported; H1 is least so. The same order holds for

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[11] The exact multinomial test is a generalization of the two-tailed binomial test. To construct a $p$-value, the probability of the observed frequencies under the null hypothesis is first calculated. Then, the probabilities of all possible outcomes at least as unlikely as the observed frequencies are summed, giving a measure of the likelihood of observing an outcome at least as extreme as the one observed.

[12] See, e.g., Gelman et al. (2003) and Kruschke (2010) for an introduction to Bayesian inference.

[13] There is considerable discussion in the statistical literature about the most appropriate value for $\alpha$ (see, e.g., Kass and Wasserman, 1996). Following common practice, we use the Jeffreys prior $\alpha = 0.5$, which is also relatively conservative. The same analyses were run using other common values ($\alpha = 1$, $\alpha = 0$, $\alpha = 1/6$), yielding substantively identical results. The results of these analyses are available upon request.

Primary or Compatible
Outcomes

Primary
Outcomes
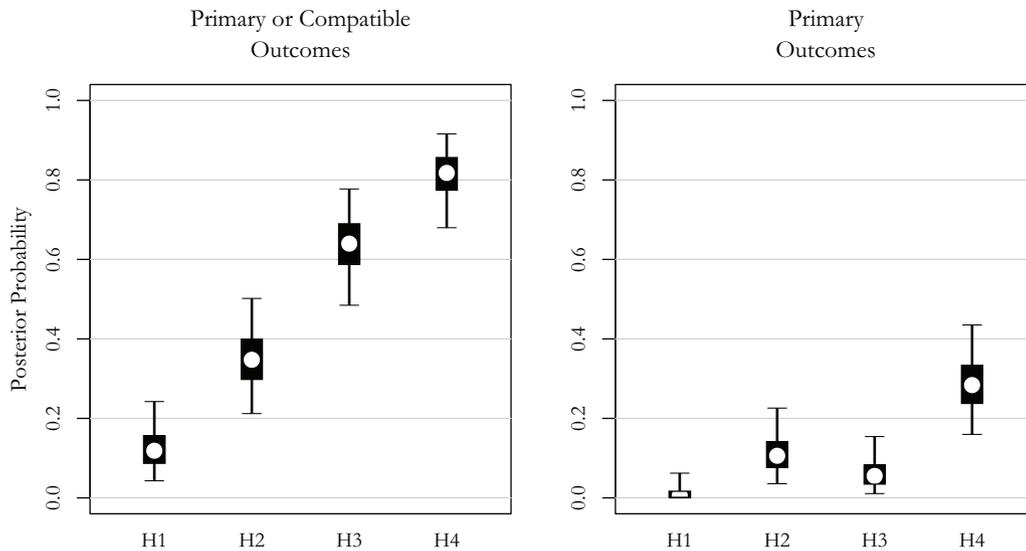


**Fig. 2.** Posterior probabilities for hypotheses 1 through 4. The left panel shows the median, 50% credible interval, and 95% credible interval for the outcomes compatible with each hypothesis. The right panel shows the same intervals for only the primary predicted outcome of each hypothesis.

**Table 4**
Adjudication among hypotheses.

|  | Compatible or primary outcomes | | |  | Primary outcomes only | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | H2 | H3 | H4 |  | H2 | H3 | H4 |
| H1 | 0.0003 | 0.0000 | 0.0000 | H1 | 0.0150 | 0.0755 | 0.0001 |
| H2 |  | 0.0312 | 0.0001 | H2 |  | 0.7909 | 0.0335 |
| H3 |  |  | 0.0149 | H3 |  |  | 0.0047 |

*Note*: Tables present the posterior likelihoods that the hypothesis in the labeled row is a more probable outcome than the hypothesis in the labeled column. For example in the compatible outcomes, there is a 3.12% chance that H2 is a more probable outcome than H3.

the primary outcomes, except that we have insufficient evidence to determine whether a respondent is more or less likely to experience *shedding* (H3) than *expansion* (H2). This statistical comparison confirms what is apparent in the right panel of Fig. 2, where H2 and H3 seem equally probable.

While these results do not assert that *stasis* is an impossible outcome for a student entering one of the graduate programs, they do suggest that it is the least likely of our hypothesized network trajectories. Our second and third hypotheses, *opportunity* and *shedding*, show more middling results. They are clearly more probable outcomes than *stasis*, but neither is the most likely pattern of change in the core discussion network. In particular, students seem likely to follow a trajectory compatible with H3 (*shedding*), although this is likely due to the overlapping predictions of H3 and H4. The fourth hypothesis, *routine*, is by far the most likely outcome, whether we focus on its direct prediction or only on its compatible outcomes.

### 5.4. Probing further

The quantitative analyses above assume that observations are independent. The multinomial model assumes that the outcome of one student is unrelated to the outcome of another, except through the probabilities $(p_1,\ldots,p_6)$ that we estimate. There are a few ways in which such an assumption could be violated, and it is important to validate our model against such violations.

First, the results could be biased by ignoring unobserved differences among academic departments. If outcome probabilities differed significantly depending on the respondent's department the results reported earlier could be spurious. To address this potential problem, we performed the same analysis as above separately for each of the three departments. Fig. 3 shows the posterior distributions of the probabilities for each hypothesis in

each department. While the spread of the estimates is necessarily wider than those using the full data set (see Fig. 2), the pattern of outcomes is largely unchanged, with strong support for H4 and H3, and little or no support for H1. The most noticeable difference is in the outcomes compatible with H4 in the laboratory science department. However even in this case there is virtual certainty that H4 is more probable than H1 or H2; only the difference between H3 and H4 is statistically uncertain. These results suggest that our findings are not the product of unobserved differences among departments

Another, less obvious source of non-independence comes from the existence of core discussion partners within the dataset itself. A central concern with many network analyses lies in the potentially complex interdependencies of relational data. If respondents Amy and Bob both list Carly as a core discussion partner, we cannot assume that these two data points are independent; they both share the characteristic that Carly is an alter. While specialized methods exist to account for this type of interdependence, our dataset precludes their use, because it lacks full information on whether the listed alters of separate respondents are connected to one another (see the discussion of exponential-random graph and actor-oriented models above). We can take some steps toward addressing this question by focusing on those particular alters in our respondents' core discussion networks who are themselves also our respondents (i.e., who are also in the cohort). We examine whether excluding core discussion partners who are within the dataset changes our findings. Although not all these respondent-alters are named by more than one person, they are all obvious *potential* core discussion partners.

Approximately 10% of the named core discussion partners across the entire sample are also respondents. We repeated our prior analyses after removing these ties from the data, to detect whether their presence – and the implicit unobserved
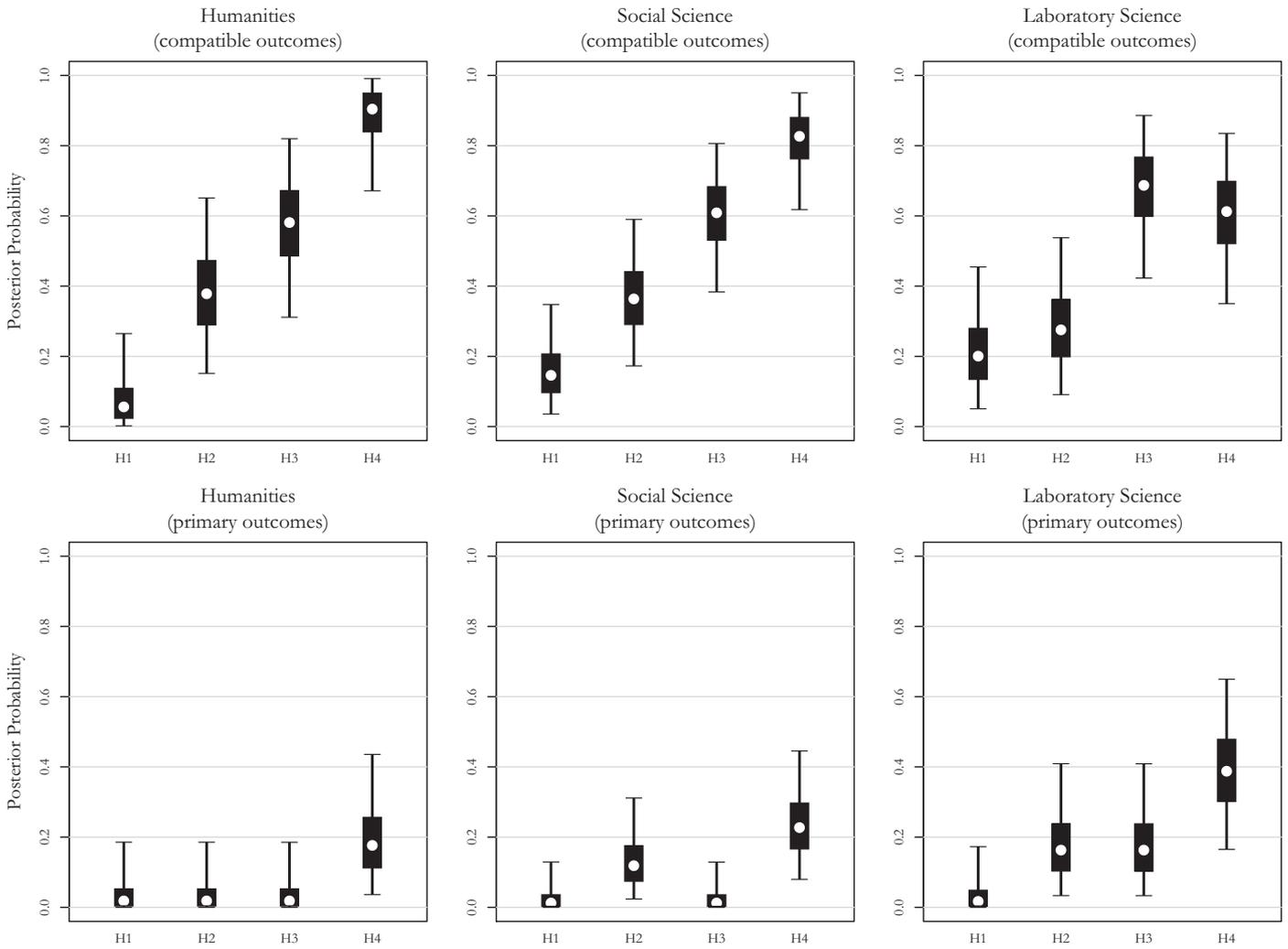
**Fig. 3.** Posterior summaries of outcome probabilities, by department and hypothesis type.

heterogeneity – was biasing our estimates Some of the results are presented in the left-hand panel of Table 5 Although the smaller sample size necessarily widens the posterior distributions, the main effect is that of weakening the distinction between H1 and H2, and the distinction between H3 and H4 Thus, the main results and ordering of the hypotheses described above remain

A final potential bias would stem from the possibility of over-reporting change. One way that our analysis could produce strong evidence for turnover in the networks is simple noise in the data. Respondents in general are prone to report different answers to the same question when asked at different time points, because of recall errors, incidental day-to-day occurrences, and a host of other mechanisms that add uncertainty to name generators (e.g., see Killworth and Bernard, 1976; Marin, 2004). For example,

respondents whose true core discussion network did not change from time 1 to time 2 might still report fewer ties at the second interview because they forgot about a person they had not seen regularly. If many respondents experienced similar biases, our results would find more change in the network than in fact, there is. This bias would result in the *stasis* perspective appearing less likely than it truly is.

To test for this possibility, we redefined the outcomes listed in Table 1 under much more conservative assumptions. We cat-egorized a core discussion network as having "no change in size" (i.e., experiencing *stasis* or *substitution*) if respondents listed the same number of alters, or one fewer alter, or one additional alter at time 2 and time 3. Furthermore, we categorized a network as "without replacement" (i.e., experiencing *substitution*, *refinement*,

**Table 5**
Two tests of model sensitivity.

| | Compatible or primary outcomes | | | | Compatible or primary outcomes | | |
|---|---|---|---|---|---|---|---|
| | **Non-cohort** | | | | **Weak stasis** | | |
| | H2 | H3 | H4 | | H2 | H3 | H4 |
| H1 | 0.0473 | 0.0000 | 0.0000 | H1 | 0.8167 | 0.0243 | 0.0120 |
| H2 | | 0.0003 | 0.0000 | H2 | | 0.0043 | 0.0003 |
| H3 | | | 0.3705 | H3 | | | 0.2089 |

*Note*: The left panel replicates the left panel of Table 4 with a dataset restricted to only out-of-cohort discussion partners. The right panel uses the weak definition of "stasis."

or *transformation*) if the respondent replaced fewer than two alter names between waves. This approach constitutes a substantial expansion of the outcomes associated with H1; it is, in essence, a much more generous test of the hypothesis. For example, someone who listed Amy, Bob, and Carly in one interview and listed Carly and David 6 months later would now be considered to have experienced *stasis* (rather than refinement) in their network. We conducted this revised analysis, and found that the previous results were substantively the same. The right-hand panel of Table 5 presents the results. Even with such a strict definition of change in an ego network, the outcomes associated with H3 and H4 are vastly more probable than those of H1 and H2.

## 6. Conclusions

Our study makes three contributions. First, we found that when actors enter new institutional environments, their core discussion network changes rather quickly. Our qualitative data made clear that the four perspectives were robust enough to find justification in the responses of many individuals. The quantitative data helped adjudicate among the four predictions. The data were most consistent with the idea that people's core discussion network responds to changing obligations (H3) and that, in new contexts, the routines that people develop over the course of their new experiences have an impact on whom they realize they find themselves turning to for support (H4).

Second, our study introduced a new framework to understand the evolution of core discussion networks, or other ego networks, that begins with the two basic processes – addition or subtraction and replacement or non-replacement – while allowing for the generation of perspectives with multiple and overlapping predictions. An important strength of our approach is that it did not require forcing network theories into mutually exclusive predictions. Theories about social behavior are complex enough to admit overlapping outcomes, and our approach not only allowed for such outcomes, but also showed that in some cases the room for overlap was necessary.

Third, our findings are consistent with the idea that the core discussion network may include people who are not close associates or intimates. Indeed, Small (2013) showed that 45% of the core discussion network in a sample of two thousand respondents was composed of people to whom respondents were not close. These findings suggest that, rather than conceiving of social supporters as necessarily our closest allies, they may be context-dependent relations that actors form in response to the changing environments associated with the natural transitions over the life course, or they may be strong ties within the particular context (Small, 2009).

It is important to place our findings, based on the analytically strategic case of entering graduate students, in their proper context within the larger literature.[14] Two issues are salient. One is our focus on institutional contexts. Our study explicitly focused on the stability of the core discussion network as actors enter new institutional contexts. In this respect, our qualitative findings on how actors respond to new obligations and changing routines implicitly add to the mounting evidence that context matters to the operation of social support, and other kinds of, networks (Mollenhorst et al., 2008, 2011; Small, 2009). At the same time, our findings do not explicitly speak to the stability of the core discussion network among actors who are institutionally stable. They also do not speak to how the prior context might have structured possibilities as

actors entered their new one.[15] The findings must be understood as part of a broader literature paying greater attention to institutional contexts and their changes as people move through life stages.

The other issue is longevity. Our findings of rapid change over the course of the first 6 months to a year do not speak to what happens after students have remained in their programs for many years. Indeed, if the obligations and routines perspectives are accurate, then in the third and fourth years the core discussion network should stabilize, provided the daily routines of the respondents do not change. At the same time, however, our findings call into question the notion that the core discussion network is composed of strong ties that resist change. In fact, our findings suggest that people respond rather quickly to changing circumstances and adapt in part, and often indirectly, by changing their discussion partners. This dynamism should form greater part of how scholarship on social networks understands social support.

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[14] The fact that the sample is strategic is important. As with other network studies of small groups, such as managers of firms and elites in Renaissance Florence, additional studies among new entrants in other kinds of contexts would need to be conducted to examine similar questions in other contexts.

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[15] Our study starts from the point at which respondents have entered the new context. Naturally, each respondent experienced a social process through which they entered that context in the first place, an issue which must be part of a broader understanding. For example, the literature on meeting opportunities (Mollenhorst et al., 2008; Kalmijn and Flap, 2001) has shown that the place and the institutional context of meeting plays a large role in the formation of ties and in the types of ties that form.

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