

Social (network) psychology: How networks shape performance, persistence, and
access to information

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ABSTRACT

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Social psychologists have long been interested in understanding behavior as a function of both individuals and the social structures in which they are embedded. However, since the cognitive revolution of the 1960s, processes internal to individuals have received greater attention than structural influences. This dissertation examines how networks may shape important real-world outcomes beyond intrapsychic phenomena across three studies in varied contexts. In doing so, this work suggests that the networks to which people belong—whether networks of social ties or networks of information—provide both affordances and constraints that affect behavior and outcomes. Chapter I provides a brief introduction to social network analysis as a set of theoretical, methodological, and analytical tools. Chapter II examines the gender gap in negotiation performance. Findings suggest that disparities between male and female MBA students in class social network positions predict this gap more strongly than intrapsychic mechanisms more commonly studied, such as apprehension about negotiating and stereotype threat. Chapter III examines how students' social networks promote persistence over time in a high-stress science, technology, engineering, and math (STEM) setting. This chapter pulls social network analysis into an experimental context by examining the effects of a randomly assigned social psychological intervention on students' social networks and subsequent persistence in the biosciences. Chapter IV approaches networks from a different angle, examining how online news media are organized into network structures that may contribute to selective exposure to homogenous information. Finally, Chapter V discusses implications of

these three studies. Specifically, I discuss implications for education research, intervention science, and the growing area of social network psychology.

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Dedication

To my social network

I. Introduction¹

“We live in a highly individualistic society. Its ethos is that of the lone, self-reliant, enterprising individual who has escaped from the restraints of an oppressive community so as to be free to pursue his or her destiny in an environment that offers ever expanding opportunity to those who are fittest. I think this image has influenced much of American social psychology, which has been too focused on what goes on in the isolated head of the subject, with a corresponding neglect of the social reality in which the subject is participating... [I] hope that future social psychologists will be more concerned than we have been with characterizing the socially relevant properties of individuals and the psychologically relevant attributes of social structures.” (Deutsch, 1999, p. 29)

To understand how and why people think, feel, and behave the way they do, psychological research prioritizes processes internal to individuals (Oishi, 2014). Even social psychologists—who historically have cared deeply about the role of social structures—have, in practice, focused primarily on the ways individuals internally process social stimuli since the 1960s (Oishi & Graham, 2010; Steiner, 1974). Examinations of perceptions, beliefs, attitudes, mindsets, intentions, and attributions have proved fruitful, providing key insight into how the ways people make sense of the world and of themselves shape behavior and important real-world outcomes (Walton & Wilson, 2018).

Recently, however, social psychology has seen a revival of interest in moving outside the “isolated head of the subject” to examine the role of social environments and groups in the behavior and real-world outcomes of individuals. For example, pioneers of cultural psychology have endeavored to break down the barrier between the study of individual psychological processes and the study of social systems, showing that understanding sociocultural context is

¹ This chapter includes content previously published in Turetsky, K. M. & Riddle, T. A. (2018). Porous chambers, echoes of valence and stereotypes: A network analysis of online news coverage interconnectedness following a nationally polarizing race-related event. *Social Psychological and Personality Science*, 9(2), 163-175, and content contained in Turetsky, K. M. & Zee, K. S. (in preparation). Toward an integrated, multilevel perspective on the social effects of stress.

critical to understanding how individuals think, feel, and behave (Markus & Hamedani, 2007). Socioecological psychology—the study of how physical, societal, and interpersonal environments (social ecology) shape and are shaped by mind and behavior—is also gaining traction (Oishi, 2014). These perspectives reflect a more generalized contemporary intellectual trend of moving from individualist and atomistic views of human behavior to more contextual and systemic explanations (Borgatti & Foster, 2003). In many ways, these perspectives represent a return to the Lewinian roots of social psychology, including the rich study of group dynamics and the conceptualization of behavior as a function of both the individual and their social environment (Lewin, 1939b, 1947). They also serve to reinstate social psychology as a hub science, integrating the focus of traditional psychology and biology on individual and internal processes with the focus of sociology, anthropology, and political science on larger social systems (Steiner, 1974).

This dissertation explores how social environments and group dynamics shape individual outcomes through the lens of social network analysis. Social networks delineate relational ties between groups of individuals. As opposed to methods that rely on individuals' general perceptions of their social worlds (e.g., their sense of belonging) or relationships to a specific single individual (e.g., their romantic partner), social networks provide information about individuals' broader social systems. They capture the multitude of others to whom an individual is socially connected, the quality or strength of these relationships, and the structural context of these ties. Social network analysis is both a set of methods and analytical tools for quantifying these systems of relationships, and a theoretical framework for understanding the connections that hold individuals and groups together, the structure of those connections, and how these structures shape and are shaped by social behavior, attitudes, and beliefs (Prell, 2011).

Specifically, I examine the role of networks in the context of three social problems: gender disparities in negotiation (Chapter II), loss of needed talent in the sciences (Chapter III), and growing societal division and polarization in information exposure (Chapter IV). In doing so, the central thesis of this work is that the networks to which people belong—whether networks of social ties or networks of information—provide both affordances and constraints that affect behavior and outcomes.

In the remainder of this introduction, I briefly introduce key concepts for social network research, including outlining different types of network data and levels of network analysis. I then give a more comprehensive introduction to one of the most common concepts in social network analysis, network centrality. Finally, I provide a brief overview of the remaining chapters of this dissertation.

Key Concepts for Social Network Research

“I am persuaded that there exists a social space which has all the essential properties of a real empirical space and deserves as much attention by students of geometry and mathematics as the physical space, although it is not a physical one... It is a commonplace that the behavior of individuals as well as groups depends upon their situation and their peculiar position in it.” (Lewin, 1939a)

Types of Network Data

Social networks can be collected in a variety of ways (Knoke & Yang, 2008; Wasserman & Faust, 1994). A basic distinction is between *egocentric networks* and *complete networks*. Egocentric networks, sometimes called personal networks, are centered on individuals; each participant provides information on their relationships (e.g., friends, people from whom they seek support, people with whom they spend time or communicate). Participants in egocentric networks need not be related in any way to one another, and the individuals whom participants identify as members of their networks need not be part of the study. In contrast, complete

networks are centered on a particular bounded context or group, such as a workplace, school, family, neighborhood, or meeting. Members of this group are the participants, and each provides information on their relationships within the group, allowing researchers to extrapolate a single, interconnected social network for that context or group (e.g., a social network of all friendships between students in a particular school; Moody, 2001). Figure 1.1 visually illustrates the conceptual distinction between egocentric and complete networks. Each of the three studies presented in Chapters II-IV represent relationships between units using complete networks.

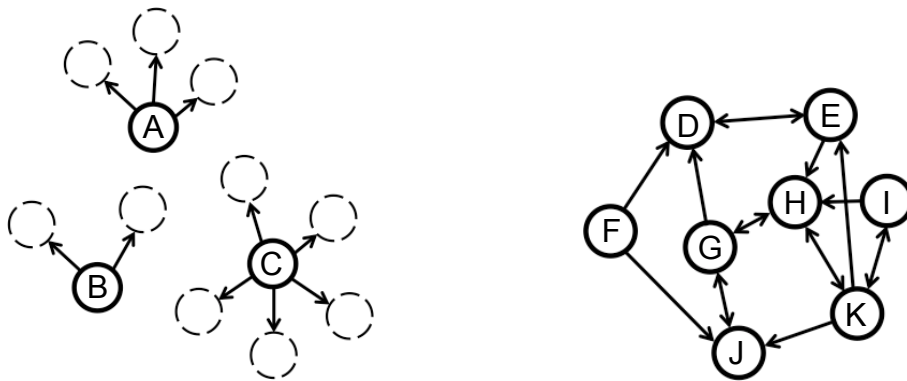


Figure 1.1. Egocentric versus complete networks

Egocentric networks (left) versus complete network (right). Each circle represents a single individual (with hypothetical participants providing data pictured with bold outlines). Each arrow line represents a relational tie between two individuals. These ties could represent liking, support-seeking, friendship, or other relationship dimensions. In the egocentric network example, participants A, B, and C have identified individuals with whom they share relationships; A, B, and C need not be connected to one another, and the ties they name may span multiple relational contexts (e.g., if they were naming support providers, they could name family members, friends, coworkers, and anyone else who provided them with support). In the complete network example, participants D–K all exist within the same bounded context (e.g., a workplace or classroom) and may only name others within that context. This allows for information on the full social network of that particular context, including information about both sides of a dyad (e.g., both one-sided and mutual relationships can be identified, as depicted by the arrows in the visualization).

Importantly, networks do not have to represent interpersonal relationships between people. Networks can represent any type of relation between any class of units. Social scientists tend to study people as these units—also called *nodes*, *vertices*, or *actors*. However, units can also be more abstract entities such as organizations, nation-states, servers, words, or news media sources. Similarly, relations between units—also called *ties* or *edges*—can be quite variable, such as friendships between people, grooming between animals, movement of resources between nation-states, transfer of information between servers, or co-occurrence of words in sentences. In Chapters II and III, we examine friendships between people—MBA students (Chapter II) and premedical students (Chapter III)—as is traditional in social network analysis in social psychology. In Chapter IV, we take a different approach, examining hyperlinks between online news media sources, to examine the structure of the online news media environment within which news consumers seek information.

Once a researcher has decided on who or what the units are and the type of relation given ties represent, there are two further distinctions in the way ties can be collected and represented. First, ties can be *directed* or *undirected*. Directed ties include information on who initiated the tie and to whom—demarcating the sender and receiver of the tie. In contrast, undirected ties do not include this directional information, instead simply indicating whether a tie exists between units. In the context of friendship, a directed tie indicates who nominated whom as a friend, whereas an undirected tie indicates that there is a friendship regardless of who reported it. The network depicted in Figure 1.1 has directed ties, represented by the arrows. For example, one can determine that G nominated D as a friend, but not vice versa, whereas G and H each nominated one another as friends (a reciprocal tie). Directed ties provide a richer form of data, and can

always be converted to undirected ties for certain procedures that require undirected data.

Chapters II-IV all use directed ties.

Second, ties can be *unweighted* (also called *binary*) or *weighted* (also called *valued*).

Unweighted ties simply indicate whether a tie is present or absent, represented by 1 (present) or 0 (absent). For example, an unweighted friendship tie would indicate that a friendship exists between two individuals. In contrast, weighted ties indicate whether a tie is present or absent and also, if the tie is present, the strength of that tie. In this case, ties are represented using a continuous scale, such as 0 (absent) or 1 and above depending on the strength of the tie. For example, a weighted friendship tie would indicate not only that a friendship exists, but also the strength of this friendship. Weights depend on the manner in which data is collected. For example, if the strength of a friendship is defined by interpersonal closeness ratings provided by participants, 1 might represent the weakest possible friendship, whereas a 5 might represent a strong friendship; in contrast, if objective data is available on the number of text messages friends sent each other, weights might be defined as the number of text messages sent. Similar to the directed versus undirected distinction, weighted ties provide richer data and can always be converted to unweighted ties by binarizing relationships as either present or absent. Chapters II-IV use weighted ties.

Analyzing Complete Network Data

Complete networks provide a route for analysis of inherently interdependent units, unlike traditional forms of statistical analysis that require independence of observations. These networks can be analyzed at different levels. For example, researchers can answer questions at the level of individual units (e.g., which unit is the most connected, or holds the most central position, in the network?), network subgroups (e.g., do some units connect more to one another

and not others, forming meaningful subgroups?), or at the whole network (e.g., how densely connected is the network?). Additionally, individual-level variables (called *attributes*), such as gender, political orientation, and, in the case of experiments, experimental condition, can be overlaid onto network structures, allowing researchers to examine patterns of connection by these variables (e.g., does gender predict position in a network?).

Across the three studies presented in Chapters II-IV, we ask and answer questions at each of these levels. In Chapters II-III, we examine questions at the level of individual units—specifically, how gender (Chapter II) and experimental condition (Chapter III) shape individuals' positions in social networks, and in turn how those positions shape performance and persistence. In Chapter IV, we examine questions at the subgroup and whole network level, examining patterns by which online news media sources link together through embedded hyperlinks.

Below I provide an overview of the most common individual-level concept in social network analysis, *network centrality* (Prell, 2011), because this concept is used in both Chapters II and III. Chapter IV introduces the subgroup level concept of *communities*, cohesive subgroups that can be identified within an overall network using varied algorithms. Chapter IV also introduces the whole network concept of *assortativity*, a measure of the tendency of an overall network to be segregated along a particular dimension, such that units are selectively connected to other similar units and less connected to dissimilar units.

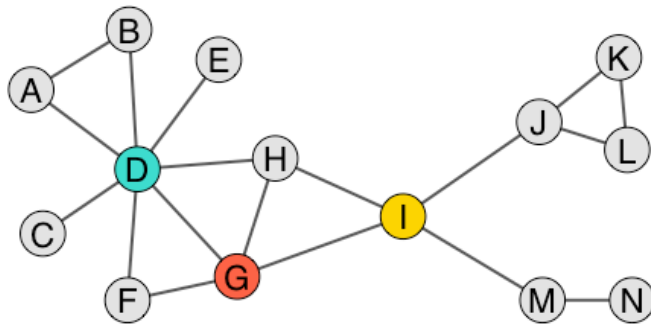
Network Centrality

Network centrality measures quantify how well-connected and prominent individuals are within a network; central individuals are those who tend to know and be known by more people, whereas individuals low in centrality occupy more peripheral roles in the network (Wasserman & Faust, 1994, p. 169). The idea of network centrality was originally rooted in social

psychology: Alex Bavelas, a student of Kurt Lewin, is credited as the originator of network centrality as a concept and method, with contributions by Leon Festinger and mathematician Duncan Luce (Prell, 2011). However, sociologist Linton Freeman (e.g., Freeman, 1978) is largely responsible for the modern conceptualization of network centrality. Although there are many measures of centrality, the three measures defined by Freeman (1978)—*closeness*, *betweenness*, and *degree* centrality—remain the three measures most widely used, and are used in both Chapters II and III of this dissertation. These measures are explained below and illustrated in Figures 1.2 and 1.3.

Closeness and betweenness centrality reflect an individual's position relative to the entire network. Closeness centrality is a measure of the number of intermediaries required for an individual to connect with others in the network. Individuals high in closeness centrality are widely connected to others in the network, both directly and indirectly, and so can reach others without going through too many other people. For example, in a research setting, a lab manager might have the highest closeness centrality because she can reach all research assistants, graduate students, post-doctoral researchers, and primary investigators (PIs) directly, plus all of the lab's collaborators by going through only one intermediary (e.g., the PI working on the collaboration). Betweenness centrality, on the other hand, is a measure of how often individuals connect others together that would not otherwise be connected or would be connected less directly. Individuals high in betweenness centrality serve as a bridge between many other individuals. In the research setting example, the person highest in betweenness centrality might be the PI, as she can connect members of her lab to many other researchers in the field, whom they might not otherwise know or be able to reach. Individuals who are high in closeness or betweenness centrality, or both, are

often considered advantageously positioned within the network, with greater access to and control over key resources (Freeman, 1978).



Student	Closeness	Betweenness	Degree
A	0.342	0.000	2
B	0.342	0.000	2
C	0.333	0.000	1
D	0.481	0.532	7
E	0.333	0.000	1
F	0.406	0.000	2
G	0.520	0.276	4
H	0.500	0.192	3
I	0.500	0.590	4
J	0.382	0.282	3
K	0.289	0.000	2
L	0.289	0.000	2
M	0.361	0.154	2
N	0.271	0.000	1

Figure 1.2. First example of network centrality measures

Here, three different students have the highest closeness, betweenness, and degree centralities. **G** has the highest closeness centrality because she requires the fewest intermediaries on average to reach each of the other students in the network (i.e., she is the *closest* on average to all other students in the network). **I** has the highest betweenness centrality because he is positioned on the most direct path *between* the greatest number of his peers. **D** has the highest degree centrality because she has the most direct friendships (seven) out of any student in the network. Note that ties in this network are undirected and unweighted for simplicity of illustration.

Finally, degree centrality, considered the most intuitive of the three measures (Prell, 2011), represents simply the number of direct ties an individual has within the network. In an undirected friendship network (as in Figures 1.2 and 1.3), for example, degree centrality is simply the number of friends an individual has. In directed friendship networks, degree centrality is equal to the number of others nominated by the individual as friends (*out-degree*) and the number of others who nominated the individual as a friend (*in-degree*). Degree centrality does not take into account the strength of ties in a weighted network, so researchers often complement degree centrality with an indication of overall tie strength. For example, *strength centrality* (used

in Chapter II) is essentially a weighted form of degree centrality, representing the total strength of ties an individual has in a network (Opsahl, Agneessens, & Skvoretz, 2010). Alternatively, *average strength* (used in Chapter III) is a way of measuring average relationship strength or quality; it is not influenced by degree and represents the average strength of a participants' ties overall.

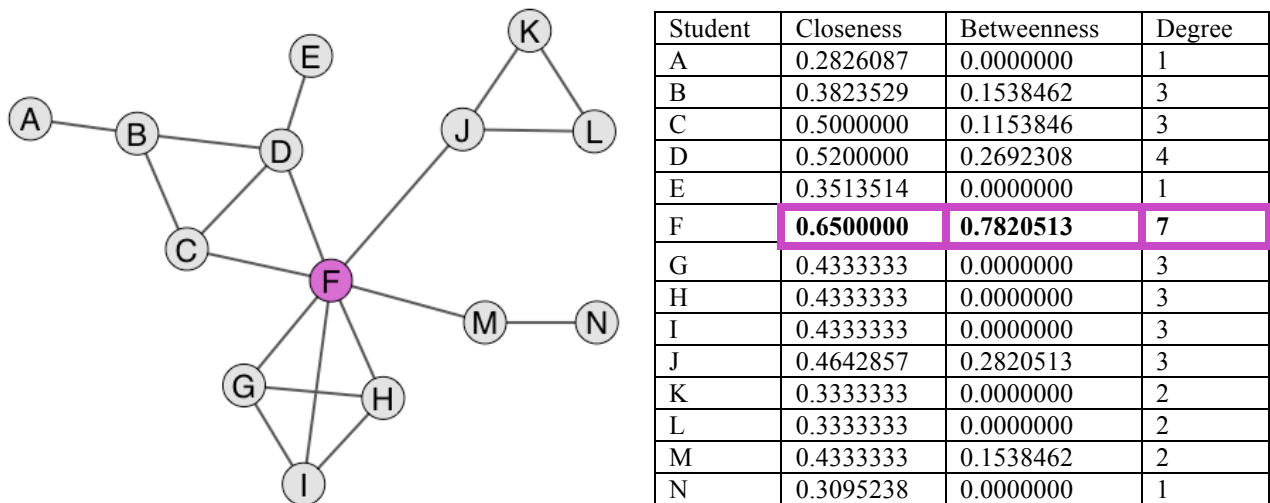


Figure 1.3. Second example of network centrality measures
 Here, one student, **F**, has the highest closeness, betweenness, and degree centrality. **F** requires the fewest intermediaries on average to reach each of the other students in the network, is positioned on the most direct path between the most other students, and has the most direct friendships out of everyone else in the network. Again, for illustrative purposes, the network depicts undirected and unweighted ties.

Overview of the Current Research

This dissertation examines how networks may shape important real-world outcomes in the context of three social problems: gender disparities in negotiation (Chapter II), loss of needed talent in the sciences (Chapter III), and growing societal division and selective exposure in the media (Chapter IV). Psychologists have traditionally centered on intrapsychic phenomena as explanations when studying these issues. This dissertation illuminates that a social network

approach can both deepen understanding of the ways in which intrapsychic phenomena may influence behavior and outcomes, as well as provide compelling alternate structural explanations. Specifically, this research suggests that the social structures in which people are embedded offer both affordances and constraints that drive human behavior. Ultimately, I suggest that both social psychology and social network science would benefit from greater adoption of social network theories, methods, and analysis by social psychologists (Chapter V).

Chapter II examines the gender gap in negotiation performance, which is thought to contribute to gender inequality in the workplace and beyond. Researchers have suggested many explanations for this disparity. In this chapter, we compare four potential mediators of this disparity. Three of the examined mediators reflect intrapsychic processes—apprehension about negotiating (Babcock & Laschever, 2009), stereotype threat (Kray, Thompson, & Galinsky, 2001), and mindset about negotiation-related stress (based on work by Crum, Salovey, & Achor, 2013). For the fourth, we moved outside the minds of participants to examine a potential structural mechanism for gender gaps in negotiation performance, negotiators' position in social networks. Although prior literature suggests that there are often gender differences in connection in workplace networks, and that being highly connected may offer a strategic benefit for negotiating through several routes, social networks have received little attention in the negotiation literature as a possible mechanism of the gender gap in negotiations. In this chapter, I review the literature related to each of these four potential mechanisms. I then describe a study conducted with MBA students in a managerial negotiations class, in which MBA students reported on their apprehension, stereotype threat concerns, stress mindset, and social networks in the class at the beginning of the term and then participated in a series of one-on-one negotiations with classmates. Results suggest that social networks may not only be a possible mechanism of

the gender gap in negotiations, but also that this social-structural explanation may in some cases explain this disparity better than the intrapsychic mechanisms often studied in the negotiations literature.

Chapter III examines how students' social networks promote persistence over time in a high-stress science, technology, engineering, and math (STEM) setting, a critical issue as the U.S. is facing a shortage of STEM graduates. This chapter focuses on strengthening students' social networks to help them persevere, drawing on work suggesting that strong social networks can act as "sticky webs" that encourage individuals to persist in challenging environments. This chapter describes a study that pulls social networks into an experimental context by examining the effects of a social psychological intervention on students' social networks and subsequent persistence in STEM. Specifically, this research examines the effects of a values affirmation intervention, which prior work suggests may have positive social effects. Results suggest that affirmation led students to have more friends and more central positions in a high-stress undergraduate biology course, demonstrating that psychological interventions can be leveraged to alter the social structure of groups in addition to individual-level psychology. Further, these affirmation-induced social gains predicted subsequent persistence in the biosciences, identifying peer relationships as a potential driver of persistence in STEM. This chapter also suggests that students' social networks more strongly predict persistence than other intrapsychic constructs often studied as important to persistence in STEM, grit and theories of intelligence.

Chapter IV approaches networks from a different angle. In this chapter, I examine how online media networks may contribute to disconnect in users' understanding of race in America, potentially making it harder to find common ground. I describe a study leveraging a large naturalistic dataset of online news coverage of the 2014 shooting of Michael Brown, an unarmed

Black teenager, by a White police officer in Ferguson, MO. We chose this event for several reasons, including its importance to the recent national discussion of racial justice in America and polling suggesting that responses were highly polarized along social lines. This chapter examines the extent to which online news sources selectively linked to other like-minded news coverage in the wake of Brown’s death—forming an “echo chamber” network structure that could increase disconnect and polarization. We found that news sources linked to a variety of other sources, including those with dissimilar political leanings, potentially mitigating selective exposure. However, news sources also linked to coverage that was similar to their own in emotional valence and racially stereotypic descriptions of Brown (e.g., emphasizing criminality versus youth). This suggests that clicking on links may expose users to homogenous content that could exacerbate polarization in attitudes about race and events like Brown’s shooting. Moreover, although the selective exposure literature often focuses on choices made by individual news consumers—such as the choices of what news site to visit, what to click on, and who to friend—this chapter suggests that the ecology of news media may facilitate exposure to networks of like-minded information even for passive users, regardless of individual choice.

Finally, Chapter V discusses implications of these three empirical chapters. Specifically, I discuss implications for education research, intervention science, and the growing area of social network psychology.

II. Explaining the Gender Gap in Negotiations: Social Network Positions, Apprehension, Stereotype Threat, and Stress Mindset

Abstract

Disparate outcomes in negotiations are thought to contribute to gender inequality in the workplace and beyond. The current research examined gender gaps in negotiation performance and compared four potential mechanisms of these gaps. Seventy-seven MBA students in a managerial negotiations class responded to questionnaires assessing their apprehension about negotiating, stereotype threat in negotiations, mindset about stress related to negotiating, and social networks in the class. Students then participated in a series of one-on-one negotiations based on real-world scenarios (e.g., buying a car, determining a salary), from which overall rankings of negotiation performance were calculated. Findings indicated that men outperformed women in negotiations. Significant gender differences emerged in stereotype threat concerns, negotiation stress mindset, and social network centrality, and these three variables also significantly predicted negotiation performance. However, only social network centrality—specifically number and total interpersonal closeness of ties—significantly mediated the relationship between gender and negotiation performance. Position in informal social networks may be an important variable influencing negotiations, particularly those that take place in a shared social environment, such as the workplace. Generalizability to negotiations between individuals who exist in non-overlapping social networks is discussed.

Introduction

Negotiating is critical to professional and personal advancement. From determining salary, time off, the cost of a car or house, work assignments, promotions, allocation of resources, health coverage, accommodations for family and health demands, and retirement savings, negotiations can play an important role in shaping one's career and quality of life (Sturm, 2009). Yet, the bargaining table can also be a barrier to advancement for certain groups: Research suggests that women and members of underrepresented groups often fare worse in negotiations than their male and white counterparts. From negotiating salary to the price of a car, this work suggests that women and members of underrepresented groups receive fewer returns from negotiation, ultimately making less and paying more (Ayres, 1990; Gerhart & Rynes, 1991; Seidel, Polzer, & Stewart, 2000; Sturm, 2009). Over time, these differences in outcomes of individual negotiations can accumulate into substantial gaps in compensation, promotion, and opportunity, reinforcing inequality in the workplace and beyond (Bowles, Babcock, & McGinn, 2005; Gerhart & Rynes, 1991; Sturm, 2009).

Negotiation researchers have been interested in gender differences in negotiation outcomes for over 40 years (Rubin & Brown, 1975a). An early meta-analysis of studies comparing men and women on objective outcomes of negotiations (e.g., points or dollars gained through the negotiation) found a small but significant gender difference, such that men achieved greater payoffs through negotiations than women across studies (Stuhlmacher & Walters, 1999). A more recent meta-analysis similarly found that men achieved better outcomes than women on average in negotiations, with some variation across different negotiating contexts (Mazei et al., 2015). A qualitative review including a wider span of the literature (e.g., including archival analyses, surveys, and allocation tasks) also concluded that men often outperform women in

negotiations (Kray & Thompson, 2005). This gap is mirrored in subjective assessment of negotiation performance. Compared to women, men have reported feeling greater satisfaction with their negotiation performance, more power at the bargaining table, and more confident about their negotiation abilities (Kray et al., 2001; Stevens, Bavetta, & Gist, 1993; Watson & Hoffman, 1996).

Researchers have suggested many explanations for gender gaps in negotiation performance. In this research, we examine two psychological mechanisms that have gained traction in the literature: women's apprehension about asking for what they want (e.g., Babcock & Laschever, 2009) and stereotype threat in negotiations (e.g., Kray et al., 2001). We also examine two new potential mechanisms for gender gaps in negotiation performance. First, we examine men and women's mindset about stress related to negotiating, specifically beliefs about whether stress related to negotiating is helpful or harmful for performance (Crum et al., 2013). Second, we move outside of intra-individual explanations to examine a potential structural mechanism for gender gaps in negotiations: negotiators' positions in social networks. We briefly review the literature related to each of these four potential mechanisms below.

Apprehension About Negotiating

The idea that women ask for less in negotiations—or are less likely to ask at all—than men has gained both academic and popular traction. Research suggests that women are more apprehensive about negotiating than men (though some explanations are not based in affect, e.g., not recognizing that asking is possible; Babcock, Gelfand, Small, & Stayn, 2006). For example, in prior studies, women selected adjectives like “scary” and metaphors like “going to the dentist” to describe negotiating, whereas men were more likely to choose adjectives like “exciting” and “fun,” and metaphors like “wrestling match” or “winning a ballgame” (Babcock et al., 2006;

Babcock & Laschever, 2009; Gelfand & McCusker, 2004). Women have also reported greater anxiety, discomfort, and nervousness about negotiating (Babcock et al., 2006; Bowles et al., 2005; Guthrie, Magyar, Eggert, & Kain, 2009). In turn, many popular books have encouraged women to push past their apprehension to negotiate and ask for more at work (Babcock & Laschever, 2009; Frankel, 2014; Sandberg, 2013).

Women may be more apprehensive about negotiating for several reasons. For example, women may generally be more apprehensive about engaging in competition (especially with powerful others), be less confident in their ability to perform competitive tasks, and feel less self-efficacious about their negotiation ability specifically (Babcock et al., 2006). Other work suggests that women may be more apprehensive about negotiating because they tend to be more concerned than men about how negotiating will affect their relationships (Gelfand, Major, Raver, Nishii, & O'Brien, 2006; Greig, 2010; Kray & Gelfand, 2009). This greater concern for social outcomes of negotiation may in part be attributable to socialization, such that women are socialized to be more communal and relationally oriented than men (see e.g., Gelfand et al., 2006; Kray & Thompson, 2005; Rubin & Brown, 1975).

However, research also shows that women often pay a higher social cost of negotiating than men, providing a realistic foundation for concern about social outcomes. A woman negotiating assertively can violate gender role expectations that women should be kind, gentle, and communal, leading to backlash against female negotiators (Amanatullah & Morris, 2010; Bowles, Babcock, & Lai, 2007; Eagly & Karau, 2002; Rudman & Glick, 2001). For example, a series of experiments showed that evaluators penalized female job candidates who negotiated for higher compensation (Bowles et al., 2007). These evaluators reported less willingness to work with women who negotiated and perceived that they were less nice and more demanding than

women who did not negotiate. These same evaluators showed no difference in their evaluations of men who did or did not negotiate. Women's awareness that they may face backlash for asserting themselves in negotiations may lead them to be more concerned about the social consequences of negotiating than men, and more apprehensive about negotiating in general (Amanatullah & Morris, 2010).

Stereotype Threat

Women are stereotyped as less effective at negotiating than men (Kray et al., 2001). Gender stereotypes associate women with being weak, submissive, accommodating, and emotional—characteristics that are also associated with being an *ineffective* negotiator. In contrast, gender stereotypes associate men with being strong, dominant, assertive, and rational—characteristics that are associated with being an *effective* negotiator. Past research theorizes that this overlap between gender stereotypes and traits that are valued in negotiation creates an implicit link whereby women are viewed as less effective negotiators than men (the "Gender Stereotype-Negotiation Link"; Kray & Thompson, 2005). Indeed, when asked about beliefs about whether men or women are generally more likely to perform better in negotiations, research participants have been more likely to believe that men would come out ahead (Kray et al., 2001). When asked why they thought men would perform better than women in negotiations, participants relied on gender stereotypes: They cited men's greater assertiveness, strength, and firmness, compared to women's tendency to be more emotional, accommodating, and relationship-oriented.

A large body of research suggests that negative stereotypes of a social group can undermine the performance of that group on stereotype-relevant tasks. Steele's theory of *stereotype threat* suggests that members of negatively stereotyped groups may worry that they

could inadvertently confirm or be judged through the lens of the negative stereotype about their group in the minds of others (Steele, 1997). In turn, these worries can increase stress, deplete cognitive resources, and, in doing so, impair performance (Beilock, Jellison, Rydell, McConnell, & Carr, 2006; Beilock, Rydell, & McConnell, 2007; Croizet et al., 2004; Johns, Inzlicht, & Schmader, 2008; Schmader & Johns, 2003; Steele, 1997). For example, negative stereotypes about the intellectual ability of Black individuals and the mathematical ability of women can have negative effects on the academic performance of Black and female students when they believe that a task is diagnostic of their intellectual or mathematical ability (for meta-analyses, see Nguyen & Ryan, 2008; Walton & Spencer, 2009).

Research suggests that stereotype threat can affect performance on a broad range of tasks, not just academic performance. For example, women have performed worse on driving tests after activation of stereotypes that women are worse than men at driving (Yeung & von Hippel, 2008). White men have performed worse in athletic tasks when the tasks were framed as a test of natural athletic ability (Stone, Lynch, Sjomeling, & Darley, 1999). Older individuals have performed worse on memory tasks when the tasks were framed as diagnostic of memory capacity (Mazerolle, Régner, Morisset, Rigalleau, & Huguet, 2012).

Negotiation research suggests that female negotiators similarly contend with stereotype threat. For example, women performed worse (i.e., gained less profit in dollars) than men in a negotiation when told that performance was diagnostic of their negotiating skills, but not when the negotiation was framed as non-diagnostic (Kray et al., 2001). Similarly, when gender stereotypes were explicitly linked to negotiation performance, such as by telling participants that negotiators who are rational and assertive perform better than negotiators who are accommodating or emotional, or when existing gender stereotypes of negotiating ability were not

explicitly negated, women also performed worse than men (Kray, Galinsky, & Thompson, 2002; Kray et al., 2001). This work suggests that stereotype threat at the bargaining table may at least in part explain gender gaps in negotiation performance (Kray & Thompson, 2005).

Stress Mindset

Many negotiators, regardless of gender, experience “nerves,” or heightened physiological arousal, before and during negotiations (Brooks & Schweitzer, 2011; Brown & Curhan, 2013). This arousal can have different effects on negotiation performance depending on how it is interpreted by the negotiator. For example, research has shown that when negotiators felt negatively about negotiating, they were more likely to interpret their pounding hearts and sweating palms as negative affect (e.g., dread, nervousness); in contrast, when negotiators felt positively about negotiating, they were more likely to interpret their arousal as positive affect (e.g., excitement, enthusiasm; Brown & Curhan, 2013). In turn, these attributions about arousal predicted negotiation outcomes. Negotiators who interpreted their arousal positively gained more objective and subjective value in negotiations than those who interpreted their arousal negatively. Similarly, negotiators who appraised stress about an upcoming negotiation as threatening reached lower quality deals than those who appraised the same upcoming negotiation as a challenge (O’Connor, Arnold, & Maurizio, 2010). When negotiators were told that experiencing anxiety while negotiating could be beneficial to their performance, cortisol increases during the negotiation were positively associated with negotiation performance (Akinola, Fridman, Mor, Morris, & Crum, 2016). In contrast, cortisol increases were negatively associated with performance among negotiators who did not receive the positive anxiety appraisal information.

This research highlights how negotiators' beliefs about the stress and anxiety they experience related to negotiating may influence their stress response and, in turn, their performance. Prior research on *stress mindset* indicates that when people believe that stress enhances performance, productivity, and growth (a “stress-is-enhancing” mindset), they are more likely to experience positive cognitive outcomes, affect, and performance under stress than when they believe that stress is debilitating (a “stress-is-debilitating” mindset; Crum et al., 2013). For example, in workplace settings, employees who have “stress-is-enhancing” mindsets (either naturally or via experimental manipulation) show better task performance and greater engagement, focus, vigor, and generation of new ideas (Casper, Sonnentag, & Tremmel, 2017; Crum, 2011).

Collectively, this work suggests that negotiators' mindset about the stress they experience related to negotiating may influence their performance. Further, men and women may differ in the degree to which they view stress related to negotiating as enhancing or debilitating on average. For example, some researchers have noted that men may be more likely to interpret physiological arousal they experience before negotiations as excitement, whereas women may be more likely to interpret this arousal as anxiety (Brooks & Schweitzer, 2011).

Social Network Position

Social networks represent the social connections among members of a group. Research suggests that an individual's position in a group's social network—such as whether they are highly connected or “central” within the network, or whether they are less connected and more peripheral—provides both opportunities and constraints that affect behavior and outcomes (Kilduff & Brass, 2010). Much research has found that holding central positions in informal social networks is advantageous, independent of formal position (e.g., formal position in a

workplace hierarchy). For example, central individuals tend to perform better than more peripheral individuals on a variety of metrics, including general performance (e.g., job performance: Mehra, Kilduff, & Brass, 2001; Sparrowe, Liden, Wayne, & Kraimer, 2001; grades in college and business school: Baldwin, Bedell, & Johnson, 1997; Stadtfeld, Vörös, Elmer, Boda, & Raabe, 2019), as well as leadership (Moolenaar, Daly, & Slegers, 2010), innovation (Obstfeld, 2005), and creativity (Perry-Smith, 2006).

Though there are several potential mechanisms through which network centrality may influence performance (generally and in negotiations specifically), we highlight three that may be especially relevant to negotiation. First, network centrality is often considered a proxy for social capital: Central individuals are thought to have greater access to and control over resources important for success, such as information and support, because of their greater connectedness (Borgatti & Foster, 2003; Haythornthwaite, 1996). Given that having maximal information is critical to achieving the best result in negotiations (both practical information and social information, e.g., norms and values), greater access to information through social ties may be advantageous in negotiating (Rubin & Brown, 1975b; Thompson, Peterson, & Kray, 1995).

Second, aside from actual advantages their positions may afford them, people who hold central positions in networks are often *perceived* as more influential, powerful, and competent (Brass, 1984; Brass & Burkhardt, 1993; Kilduff & Krackhardt, 1994). This greater perceived power could give them an advantage in negotiations with individuals who are aware of their social position (P. H. Kim, Pinkley, & Fragale, 2005). For example, a negotiation about a promotion between a boss and an employee might tilt more toward the employee if they hold a central informal position in the company network than if they hold a more peripheral position.

Finally, having many connections is thought to reduce an individuals' dependency on any one relationship, giving central individuals greater freedom to act assertively with less concern about how that assertion will affect a particular relationship (Brass & Burkhardt, 1993). Even if a central individual experiences backlash that damages one relationship, they have other connections that they can still rely on. Recent research shows that this affordance provided by network centrality may reduce central individuals' sense of professional and social risk, as well as encourage more assertive behavior (e.g., confronting sexism; Brands & Rattan, under review). Similarly, network centrality could reduce concern about social consequences in negotiation, affording more assertive negotiating tactics.

Research on gender differences in network centrality suggests that women often hold less central positions in workplace social networks than men (Ibarra, 1992; McGuire, 2000, 2002; Mehra, Kilduff, & Brass, 1998; Singh, Hansen, & Podolny, 2010). In turn, researchers have suggested that gender disparities in social network positions may in part explain gender gaps in negotiation performance, largely focusing on differential access to resources and social capital as mechanisms (Babcock & Laschever, 2009; Belliveau, 2005; Kolb, 2009; D. A. Small, Gelfand, Babcock, & Gettman, 2007). Although this idea has not been explicitly tested to our knowledge, one study showed that racial disparities in salary negotiations were largely explained by racial minority group members' fewer social ties to the organization relative to majority group members (Seidel et al., 2000).

Overview of Current Study

In the current study, we compared the negotiation performance of men and women in an executive MBA program. Participants completed a series of one-on-one negotiations based on real-world scenarios (e.g., buying a car, determining a starting salary), allowing for overall

performance rankings to be calculated across multiple negotiations and match ups. Our goals were threefold. First, we examined the negotiation performance of men and women. We expected to replicate prior findings suggesting that women underperform relative to men. Second, we examined the effects of gender on apprehension about negotiating, stereotype threat, negotiation stress mindset, and social network centrality. Prior work suggested that, compared to men, women would report greater apprehension about negotiating and greater concern about being perceived in line with gender stereotypes in negotiation. We also expected that women would believe that negotiating stress was more debilitating (vs. enhancing) and hold less central positions in the MBA class social network relative to men. Finally, we examined whether apprehension about negotiating, stereotype threat, negotiation stress mindset, and social network centrality predicted negotiation performance. We further examined whether these variables explained the gender gap in negotiation performance, if a gap emerged. We expected that apprehension about negotiating and stereotype threat would be negatively associated with negotiation performance, while negotiation stress-is-enhancing mindsets and social network centrality would be positively related to performance. We also examined whether social network centrality predicted negotiation performance over and above general sociality personality traits, given that a more social orientation (e.g., greater extraversion) could influence both social network centrality and negotiation performance. We then examined each of the four constructs as a mediator of the relationship between gender and performance in separate mediation analyses, and then entered all four as simultaneous mediators to compare their explanatory value.

Methods

Participants

Out of 80 students enrolled in a business school managerial negotiations course, 77 volunteered to participate (96.3% participation; aged 23-37, $M_{age} = 28.53$ years; 32 women, 45 men; 16 Asian, 12 Latinx, 45 White, 4 multiracial).

Procedure

The present research was integrated into existing course procedures. As a standard part of the course, students completed four questionnaires during the 12-week class term: one shortly before the course began (Q1), one during the first week of the course (Q2), one during the fifth week of the course (Q3), and one during the penultimate week of the course (Q4). These questionnaires included a variety of measures pertinent to the course, such as conflict styles and approach to negotiating, the results of which were shared with students and used as educational tools in the class. Measures relevant to the present research, described below, were added to the first, second, and third questionnaires.

In addition to completing questionnaires, students participated in five one-on-one negotiations with a fellow student in the first half of the course. For each negotiation, members of each pair were randomly assigned to negotiate one side of the deal. For example, students took on the roles of the buyer vs. seller to negotiate the price of a car, the owner of a small business vs. the account manager of an advertising agency to negotiate the price of an advertising campaign, and the hiring manager vs. prospective employee of a company to negotiate a hiring package. Each member of the pair received private instructions detailing their sides' finances and goals, such as the highest price they could afford to pay as a buyer and the lowest price they could afford to accept as a seller.

Based on the information provided to each member of the pair, each negotiation had a "zone of possible agreement," or bargaining range, within which both negotiators could agree

upon a price. For example, if the highest price the car buyer knew they were willing to pay was \$13,500 and the lowest price the car seller knew they were willing to accept was \$12,500, the zone of possible agreement was between \$12,500 and \$13,500—a range of \$1000 dollars that could be negotiated. This range was unknown to students, because each received only their own instructions.

Using this zone of possible agreement and the final price negotiators agreed to, the winner of each negotiation was determined based on the share of the zone of possible agreement claimed by each negotiator in the pair. For example, if the car buyer and seller agreed to a price of \$13,000, the negotiation was a tie because both sides claimed \$500 of the zone of possible agreement. If instead, the decided price was \$13,100, the buyer won because they claimed \$600 of the zone of possible agreement, whereas the seller claimed only \$400. The results of each of the five negotiations were determined using this procedure.

Measures

Negotiation performance. Using the recorded information about wins, losses, and ties in each paired negotiation, we calculated rankings of overall negotiation performance using David's scores (David, 1987; Gammell, de Vries, Jennings, Carlin, & Hayden, 2003). In this context, David's scores reflect the overall success of a particular student at winning a negotiation relative to the success of other students. Scores are calculated by first determining the dyadic proportion of wins for each student i in negotiations with another student j . Each student's wins (P_{ij}) and losses (P_{ji}) are then summed and weighted by the proportion of wins and losses of their competitors. Through this procedure, David's scores take into account the strength of the negotiation partner when calculating rankings of negotiation performance (e.g., losing a negotiation to a partner who has won 90% of negotiations damages a student's ranking less than

if they lose to a partner who has won only 20% of negotiations). By using this ranking procedure as opposed to, for example, pure value claimed, we were able to account for differences across the multiple negotiations (e.g., some negotiations had a much larger zone of possible agreement and therefore more potential value to claim than others), as well as interdependencies in negotiation outcomes (e.g., in the car buying example above, if one partner claims \$400, the other necessarily claims \$600). We calculated David's scores using the 'compete 0.1' package in R (Curley, 2016).

Apprehension about negotiating. Right before the course began (Q1), we measured apprehension about negotiating using the Apprehension subscale of the Propensity to Initiate Negotiations scale (Babcock et al., 2006). Participants responded to five items such as "I feel anxious when I have to ask for something I want," "I feel nervous when I am in situations in which I have to persuade others to give me things that I want," and "It always feels so unpleasant to have to ask for things for myself" on a scale from 1 = *Strongly Disagree* to 7 = *Strongly Agree*. Internal consistency of these items was excellent ($\alpha = .93$).

Stereotype threat. Given prior research suggesting that women contend with stereotype threat in negotiations—specifically, that their behavior at the bargaining table will be interpreted in light of stereotypes about women as less effective negotiators (Kray et al., 2002, 2001)—we created two measures to assess potential indicators of negotiation stereotype threat. Our primary stereotype threat measure was *gendered threat concerns* in negotiations, which we measured with three items: "I worry that I will not be taken seriously in negotiations," "I worry that people will not see me as an effective negotiator," and "I worry that I will be perceived as too nice or meek in negotiations."² These items aimed to assess the extent to which participants were

² A fourth item sought to assess concerns about backlash for behaving incongruently with stereotypes of women in negotiations: "I worry that I will be perceived as too aggressive or demanding in negotiations"

worried about others perceiving them in line with stereotypes of women at the bargaining table and had good internal consistency ($\alpha = .83$). Because research suggests that perceiving a task as diagnostic of ability can heighten stereotype threat, both in women in negotiations specifically, as well as in stereotype threat research more generally (Kray et al., 2001; Steele & Aronson, 1995), we also measured the extent to which participants felt the in-class negotiations were diagnostic of their negotiation ability as a secondary measure. We measured *perceived diagnosticity* with two items: “How well I negotiate in this course is diagnostic of my managerial negotiation abilities” and “How well I negotiate in this course is a reflection of how well I will negotiate in future business settings.” These items also had good internal consistency ($\rho = .79$). Participants responded to both measures on a scale from 1 = *Strongly Disagree* to 7 = *Strongly Agree*. Both measures were assessed during the first week of the course (Q2).

Negotiation stress mindset. We measured the extent to which participants felt that experiencing stress related to negotiating was enhancing or debilitating using the Stress Mindset Measure – Specific (Crum et al., 2013). First, participants were asked in a single item to indicate the degree to which they found negotiating stressful (1 = *Not at all stressful*, 7 = *Extremely stressful*). Next, participants were asked to indicate agreement with eight statements about their beliefs that this stress was either enhancing (four items, e.g., “experiencing this stress enhances my performance and productivity”) or debilitating (four items, e.g., “experiencing this stress debilitates my performance and productivity”). Participants responded on a scale from 1 = *Strongly Disagree* to 5 = *Strongly Agree*). The four items reflecting a “stress-is-debilitating” mindset were reverse-coded, such that higher values of stress mindset indicated greater belief that stress related to negotiating was enhancing. Internal consistency was good ($\alpha = .88$).

(Amanatullah & Morris, 2010; Eagly & Karau, 2002; Rudman & Glick, 2001). This item was dropped due to failure to load at ± 0.40 .

Social network centrality. To assess students' friendship networks in the managerial negotiations course, students responded to two items in the first week of the term (Q2): 1) a fixed choice free recall name generator, in which participants listed the full names of up to ten students in the class whom they considered to be their friends, followed by (2) a name interpreter, in which participants provided a rating of how close they felt to each friend listed (from 1 = *Not very close* to 5 = *Very close*). Students' responses to these questions allowed for the generation of a valued, directed friendship network at the start of the term. We then calculated the centrality of each participant's position in the course friendship network, quantifying how well-connected and prominent each participant was within the network at the beginning of the semester (Wasserman & Faust, 1994, p. 169; see Chapter I).

We calculated four measures of centrality: closeness, betweenness, degree, and strength. *Closeness centrality* is a measure of distance between each participant and all others in the network (Freeman, 1978). We used a variant of closeness centrality adapted for use in disconnected networks, calculated by summing the inverse of the shortest path lengths between the participant and all others (i.e., harmonic closeness centrality: Dekker, 2005; see also Marchiori & Latora, 2000; Opsahl, Agneessens, & Skvoretz, 2010; Rochat, 2009). Higher values indicate less distance from the participant to others in the network. *Betweenness centrality* is a measure of how often each participant rests on the shortest path linking two others in the network together (Freeman, 1978). Higher betweenness centrality indicates that the participant connects more pairs of students in the network. *Degree centrality* is the number of direct ties each participant has in the network (Freeman, 1978). Degree centrality is the total number of friendship nominations an individual made and received in the network (i.e., the sum of the number of peers a participant nominated as friends plus the number of peers who nominated the

participant). We also examined *strength centrality*, which is essentially a weighted version of degree centrality, taking into account not only the number of ties but also the strength of those ties (Barrat, Barthélemy, Pastor-Satorras, & Vespignani, 2004). Here, the strength of ties is operationalized as the interpersonal closeness ratings participants gave to each friend they nominated. Strength centrality is thus the total sum of the interpersonal closeness ratings of friendship nominations individuals made and received in the network (i.e., the sum of interpersonal closeness ratings that a participant made of all friends they nominated plus the sum of interpersonal closeness ratings that others made of the participant when nominating that individual as a friend). Higher strength indicates greater total interpersonal closeness of friendships.

We calculated closeness centrality using the ‘CINNA 1.1.51’ package in R (Ashtiani, Mirzaie, & Jafari, 2018), and betweenness centrality, degree centrality, and strength using the ‘igraph 1.2.2’ package in R (Csardi & Nepusz, 2006).

Sociality. We measured extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience during the first week of the term (Q2) using the Ten-Item Personality Inventory (Gosling, Rentfrow, & Swann, 2003). Participants rated themselves on two opposing items for each of the five facets (e.g., extraversion: “I see myself as extraverted, enthusiastic” and “I see myself as reserved, quiet”) using a 1 (*disagree strongly*) to 7 (*agree strongly*) Likert scale. Inter-item reliabilities were largely acceptable (extraversion: Spearman-Brown $\rho = .84$; agreeableness: $\rho = .44$; conscientiousness: $\rho = .62$; emotional stability: $\rho = .79$; openness: $\rho = .58$). We were particularly interested in extraversion and agreeableness as indicators of general sociality, given prior work showing consistent associations between these dimensions and social orientations and outcomes (e.g., Selfhout et al., 2010).

Results

We first conducted a series of linear regression analyses to determine the effects of gender on negotiation performance, apprehension about negotiating, stereotype threat, negotiation stress mindset, and network centrality. Next, we examined whether gender differences in apprehension about negotiating, stereotype threat, stress mindset, and network centrality could explain the effects of gender on negotiation performance. To do so, we conducted an additional set of linear regression analyses examining the effects of these four measures on negotiation performance. We then conducted separate mediation analyses to examine the indirect effects of gender on negotiation performance through apprehension about negotiating, stereotype threat, stress mindset, and network centrality. Finally, we entered apprehension about negotiating, stereotype threat, stress mindset, and network centrality as simultaneous mediators of the relationship between gender and negotiation performance to compare the relative strength of these constructs as mediators.

We used nonparametric permutation tests to assess statistical significance in regression models containing network centrality measures as either the predictor or dependent variable because individual-level network observations are non-independent (Hanneman & Riddle, 2005; Farine, 2017). In these models, the likelihood of the observed effects occurring by chance (reported p_{perm} -values) were calculated by comparing the intervention coefficient from the linear models fitted to the observed data to the coefficients from models fitted to 20,000 permutations of the network (see Appendix A for a detailed explanation of the permutation test methodology). The negotiations class friendship network and network statistics are shown in Figure 2.1.

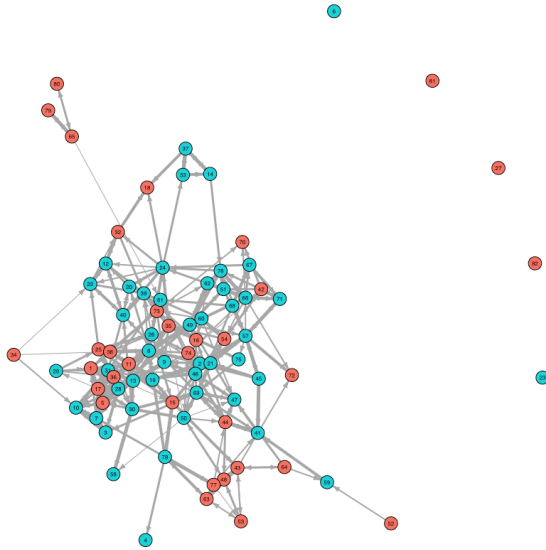


Figure 2.1. MBA student friendship network

Directed, weighted friendship network of 80 MBA students in managerial negotiations course, with 329 ties between them (graph density = 0.05). Network data was provided by 77 participants, but all 80 students are included in the network because the three students who did not complete the study were nominated by participants. Color denotes gender; red circles represent women and blue circles represent men. Arrow weight represents interpersonal closeness ratings of each tie (1 to 5), with wider arrows representing closer friendships.

Gender Effects

Negotiation performance. Gender significantly predicted performance in in-class negotiations ($b = 1.67$, $SE = 0.69$, $95\% CI = [0.28, 3.05]$, $p = 0.02$, $f^2 = .08$).³ Men outranked women in negotiation performance, indicating that they performed better overall (i.e., claimed more value than their opponent) than did women (see Figure 2.2).

Apprehension about negotiating. Although men reported slightly less apprehension about negotiating, gender did not significantly predict apprehension about negotiating ($b = -0.67$, $SE = 1.80$, $95\% CI = [-4.26, 2.93]$, $p = 0.71$; see Figure 2.3),⁴ contrary to prior findings.

³ One participant dropped the course before completing enough negotiations to be ranked and was omitted from analyses of negotiation performance.

⁴ Four participants did not complete this measure and was omitted from analyses of apprehension about negotiating.

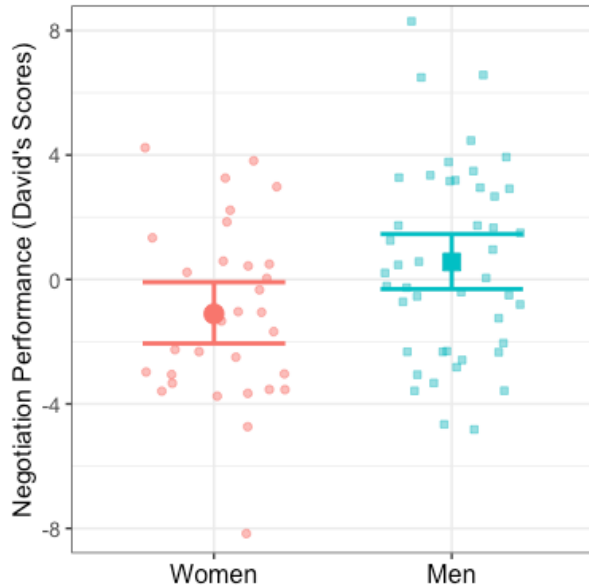


Figure 2.2. Gender difference in negotiation performance

Overall negotiation performance rankings of men and women across five negotiations, showing that women underperformed relative to men. Error bars represent 95% confidence interval of the mean.

Stereotype threat. We next examined whether gender predicted gendered threat concerns in negotiations and perceived diagnosticity of negotiation ability as indicators of stereotype threat.⁵ Gender significantly predicted threat concerns ($b = -0.88$, $SE = 0.32$, $95\% CI = [-1.52, -0.23]$, $p = .008$, $f^2 = .10$), indicating that women were more likely than men to report concern that they would not be taken seriously and would be perceived as ineffective and meek in negotiations (see Figure 2.3). Men and women did not differ significantly in the extent to which they believed their performance in in-class negotiations was diagnostic of their negotiation ability ($b = -0.10$, $SE = 0.25$, $95\% CI = [-0.60, 0.40]$, $p = .68$).

Negotiation stress mindset. Men and women did not differ significantly in the extent to which they found negotiating stressful ($b = -0.30$, $SE = 0.21$, $95\% CI = [-0.73, 0.13]$, $p = .17$).⁶

⁵ One participant did not complete these measures and was omitted from analyses of stereotype threat.

⁶ 17 participants did not complete these measures and were omitted from analyses of stress mindset.

However, gender significantly predicted negotiation stress mindset ($b = 0.42$, $SE = 0.17$, $95\% CI = [0.08, 0.75]$, $p = .02$, $f^2 = .11$), indicating that men were more likely to believe that their stress related to negotiating was enhancing (vs. debilitating) compared to women (see Figure 2.3).

Network centrality. Gender did not significantly predict closeness centrality ($b = 0.01$, $SE = 0.01$, $95\% CI [-0.01, 0.04]$, $p_{perm} = .35$) nor betweenness centrality ($b = 0.001$, $SE = 0.008$, $95\% CI [-0.01, 0.02]$, $p_{perm} = .89$) in the negotiations course friendship network at the beginning of the semester. However, gender significantly predicted degree centrality, the total number of friendship nominations students made and received ($b = 2.35$, $SE = 1.09$, $95\% CI [0.17, 4.52]$, $p_{perm} = .03$, $f^2 = .06$), indicating that men began the course with significantly more friends in the class than women (see Figure 2.3). Gender also significantly predicted strength centrality, the summed total of interpersonal closeness ratings of friendship nominations ($b = 9.59$, $SE = 3.64$, $95\% CI [2.33, 16.85]$, $p_{perm} = .01$, $f^2 = .09$), indicating that men also came into the course with greater total interpersonal closeness of friendships than women (see Figure 2.3).

Explanations of Gender Gap in Performance

Apprehension about negotiating. First, we examined whether apprehension about negotiating predicted negotiation performance (see Figure 2.4). Apprehension about negotiating did not significantly predict negotiation performance ($b = -0.03$, $SE = 0.05$, $95\% CI [-0.13, 0.06]$, $p = .50$), indicating that being more or less apprehensive was not associated with performance. Given that gender did not significantly predict apprehension about negotiating and apprehension about negotiating did not significantly predict negotiation performance, we did not examine apprehension about negotiating as a mediator of the relationship between gender and negotiation performance.

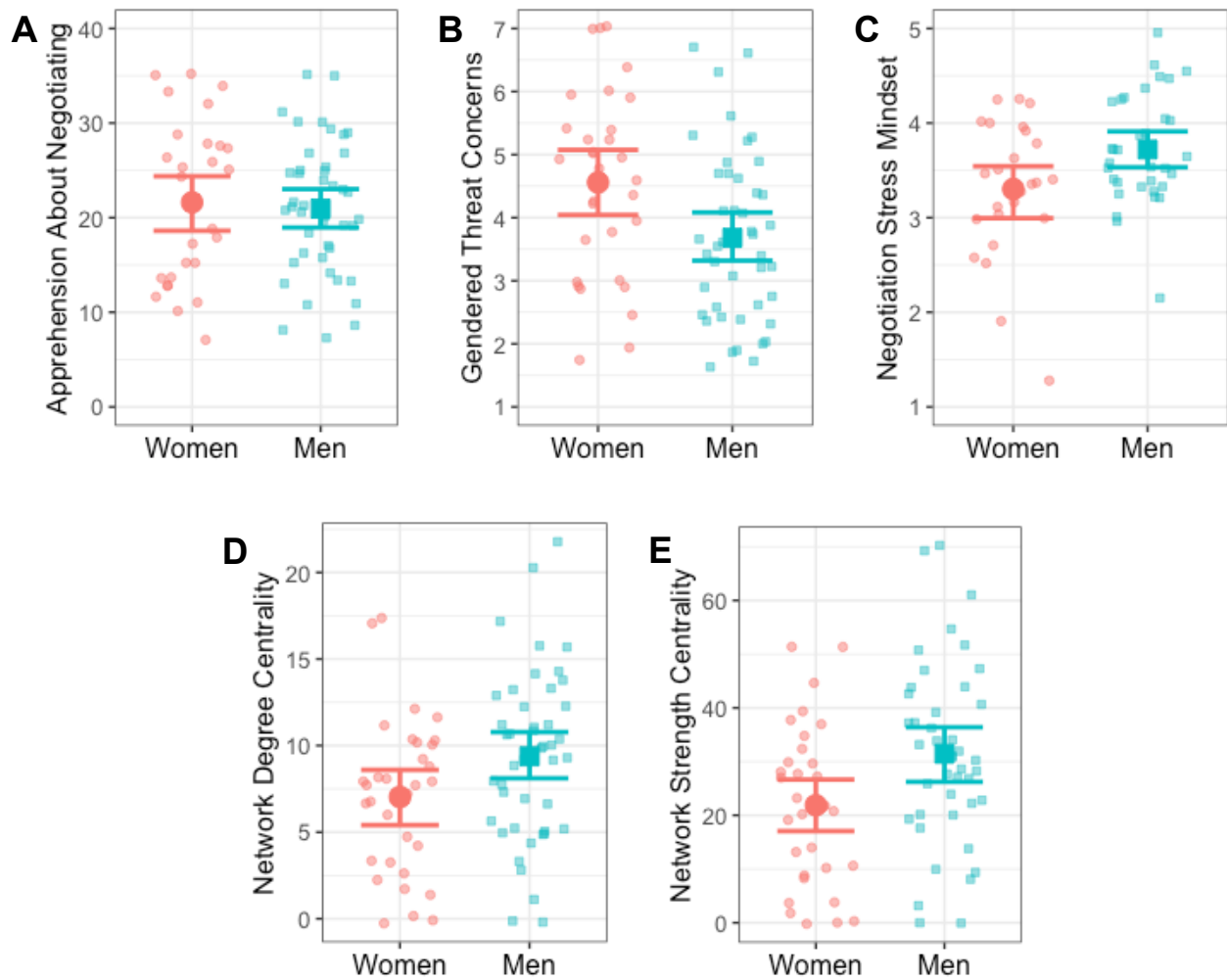


Figure 2.3. Gender differences in psychological variables

Gender differences in (A) apprehension about negotiating, (B) stereotype threat concerns, (C) negotiation stress mindset (higher values indicate more “stress-is-enhancing” mindset), (D) friendship network degree centrality, and (E) friendship network strength centrality. Significant differences emerged between men and women on all displayed variables except for apprehension about negotiating. Error bars represent 95% confidence intervals.

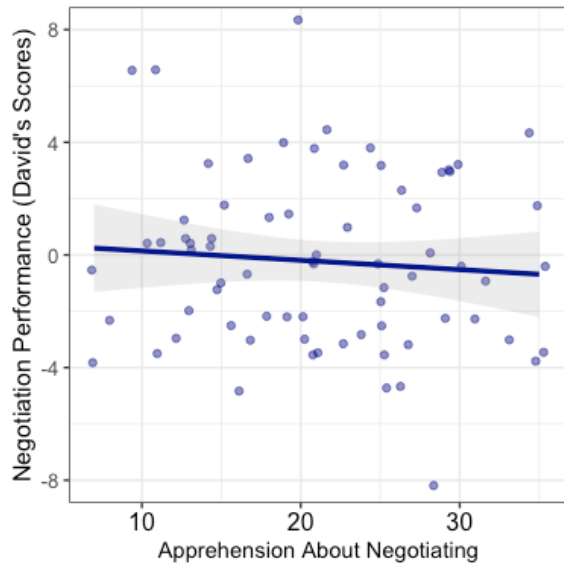


Figure 2.4. Apprehension and negotiation performance
 Apprehension did not significantly predict performance. Shaded band represents 95% confidence interval of the regression line.

Stereotype threat. Next, we examined whether indicators of stereotype threat predicted negotiation performance (see Figure 2.5). Gendered threat concerns in negotiations significantly predicted negotiation performance ($b = -0.57$, $SE = 0.24$, $95\% CI [-1.05, -0.09]$, $p = .02$, $f^2 = .08$). The more concerns participants had about being taken seriously and being perceived as ineffective and meek, the worse they performed in negotiations overall. Perceived diagnosticity of negotiation ability did not significantly predict performance ($b = -0.25$, $SE = 0.33$, $95\% CI [-0.92, 0.41]$, $p = .45$).

Given that gender significantly predicted negotiation gendered threat concerns, and in turn, these threat concerns significantly predicted negotiation performance, we examined whether threat concerns mediated the relationship between gender and performance. Threat concerns did not significantly mediate the relationship between gender and negotiation performance, although the indirect effect trended in the expected direction (estimated indirect

effect (ab) = 0.40, 95% CI [-0.10, 0.95], $p = .11$; estimated direct effect (c') = 1.27, 95% CI [-0.04, 2.62], $p = .06$; estimated 24.0% mediated).

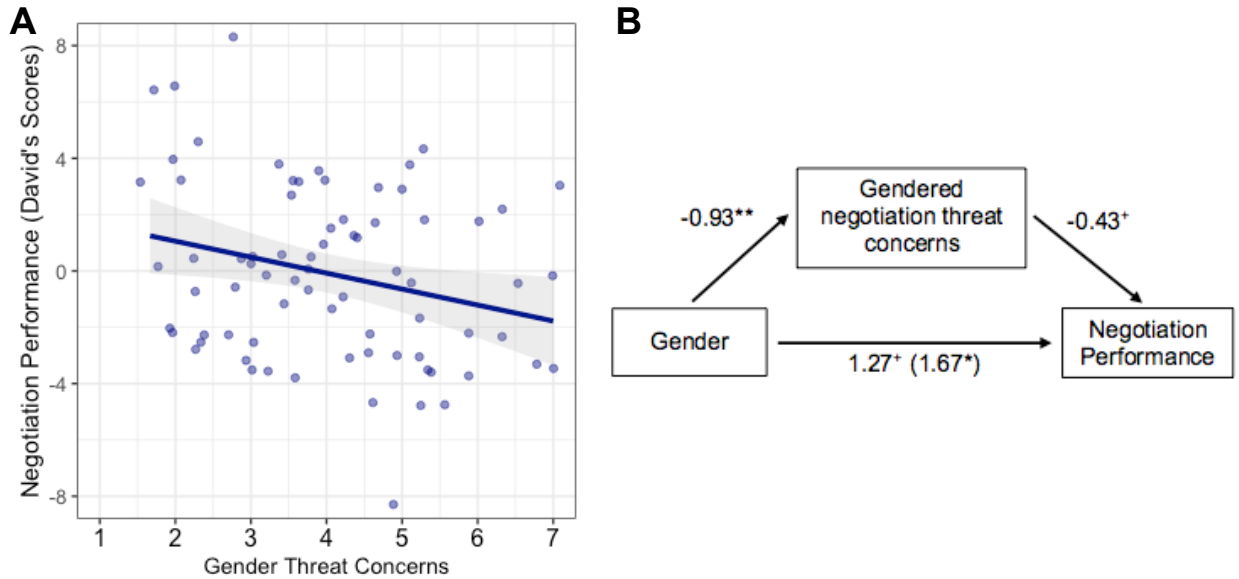


Figure 2.5. Stereotype threat concerns and negotiation performance

(A) Gendered stereotype threat concerns had a significant negative association with negotiation performance. Shaded band represents 95% confidence interval. (B) These threat concerns did not significantly mediate the relationship between gender and negotiation performance, although the indirect effect trended in the expected direction.

Negotiation stress mindset. We next examined whether mindsets about negotiation stress predicted negotiation performance (see Figure 2.6). The degree to which participants found negotiating stressful did not significantly predict negotiation performance ($b = -0.12$, $SE = 0.49$, 95% CI [-1.10, 0.86], $p = .81$). However, participants' mindset about stress related to negotiating significantly predicted negotiation performance ($b = 1.30$, $SE = 0.58$, 95% CI [0.14, 2.47], $p = .03$, $f^2 = .09$). The more participants believed their stress related to negotiating was enhancing (vs. debilitating), the better they performed in negotiations.

Again, given that gender significantly predicted negotiation stress mindset and negotiation stress mindset significantly predicted negotiation performance, we examined whether stress mindset mediated the relationship between gender and performance. Negotiation stress mindset did not significantly mediate the relationship between gender and negotiation performance, although the indirect effect trended in the expected direction ($ab = 0.43$, 95% CI [-0.09, 1.15], $p = .11$; $c' = 1.20$, 95% CI [-0.21, 2.59], $p = .09$; estimated 26.3% mediated).

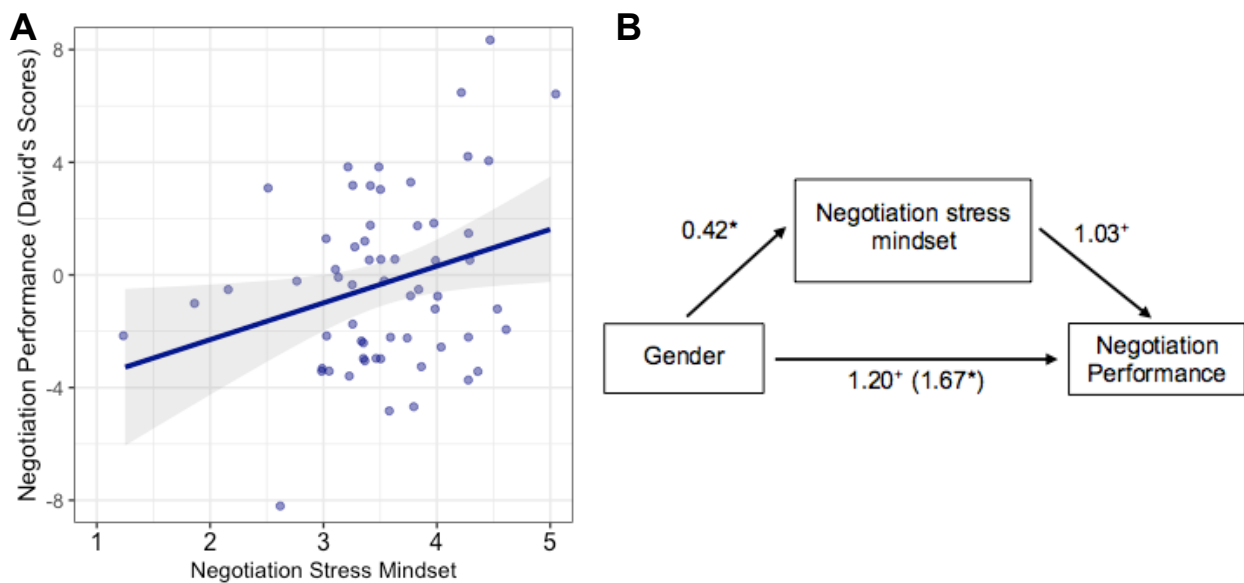


Figure 2.6. Stress mindset and negotiation performance

(A) Negotiation stress mindset had a significant positive association with negotiation performance. Shaded band represents 95% confidence interval. (B) Stress mindset did not significantly mediate the relationship between gender and negotiation performance, although the indirect effect trended in the expected direction.

Network centrality. Next, we examined whether friendship network centrality at the start of the course predicted performance in in-class negotiations (see Figure 2.7). Closeness centrality did not significantly predict negotiation performance ($b = 9.22$, $SE = 7.13$, 95% CI = [-4.99, 23.44], $p_{perm} = .18$). Betweenness centrality marginally predicted negotiation performance

($b = 20.43$, $SE = 10.30$, $95\% CI = [-0.09, 40.96]$, $p_{perm} = .06$, $f^2 = .05$), such that students who linked together more students in the network performed marginally better in negotiations. Degree centrality significantly predicted negotiation performance ($b = 0.24$, $SE = 0.07$, $95\% CI = [0.11, 0.38]$, $p_{perm} = .0007$, $f^2 = .17$), as did total strength of friendships ($b = 0.07$, $SE = 0.02$, $95\% CI = [0.03, 0.11]$, $p_{perm} = .0005$, $f^2 = .18$), indicating that students who had more friends and greater total interpersonal closeness with friends in the course performed significantly better in negotiations.

One possibility is that more sociable individuals are more likely both to be central in social networks and to perform well in negotiations. In that case, the relationship between network centrality and negotiation performance could be explained by sociability as a third variable. We thus repeated the analyses controlling for extraversion and agreeableness. Controlling for extraversion and agreeableness, closeness centrality marginally predicted negotiation performance ($b = 12.36$, $SE = 7.06$, $95\% CI = [-1.71, 26.43]$, $p_{perm} = .06$), and betweenness, degree, and strength centrality significantly predicted negotiation performance (betweenness: $b = 24.07$, $SE = 9.74$, $95\% CI = [4.66, 43.48]$, $p_{perm} = .02$; degree: $b = 0.25$, $SE = 0.07$, $95\% CI = [0.12, 0.38]$, $p_{perm} = .0004$; strength: $b = 0.07$, $SE = 0.02$, $95\% CI [0.03, 0.11]$, $p_{perm} = .0003$). These results suggest that network centrality predicts negotiation performance over and above personality traits related to general sociability.⁷

Given that gender significantly predicted degree and strength centrality, and in turn, degree and strength centrality significantly predicted negotiation performance, we next examined whether degree centrality and strength mediated the relationship between gender and

⁷ These results also hold when controlling for all Big Five personality facets. Controlling for extraversion, agreeableness, conscientiousness, openness, and emotional stability, all four network centrality measures significantly predict negotiation performance (closeness: $b = 14.43$, $SE = 6.93$, $95\% CI [0.61, 28.26]$, $p_{perm} = .03$; betweenness: $b = 21.70$, $SE = 9.75$, $95\% CI [2.25, 41.16]$, $p_{perm} = .03$; degree: $b = 0.25$, $SE = 0.07$, $95\% CI [0.12, 0.38]$, $p_{perm} = .0003$; strength: $b = 0.07$, $SE = 0.02$, $95\% CI [0.03, 0.11]$, $p_{perm} = .0003$)

performance. Degree centrality significantly mediated the effect of gender on negotiation performance ($ab = 0.46$, 95% CI [0.01, 1.11], $p = .047$; $c' = 1.21$, 95% CI [-0.03, 2.44], $p = .06$; estimated 27.6% mediated). Strength centrality also significantly mediated the effect of gender on negotiation performance ($ab = 0.58$, 95% CI [0.07, 1.28], $p = .01$; $c' = 1.09$, 95% CI [-0.18, 2.45], $p = .09$; estimated 34.7% mediated). Again, we ran these analyses a second time controlling for extraversion and agreeableness to determine whether general sociality explained these effects; with these covariates, both indirect effects of degree and strength network centrality were significant (degree: $ab = 0.55$, 95% CI [0.06, 1.10], $p = .03$; $c' = 1.14$, 95% CI [-0.16, 2.56], $p = .08$, estimated 32.4% mediated; strength: $ab = 0.62$, 95% CI [0.10, 1.21], $p = .01$; $c' = 1.07$, 95% CI [-0.27, 2.57], $p = .12$, estimated 36.6% mediated).⁸ These results suggest that network centrality—in particular, total number and strength of friendship ties in the network—at least partially explain the gender gap in negotiation performance, over and above any potential effect of general trait sociality.

⁸ Effects were also comparable when controlling for all of the Big Five personality facets (degree: $ab = 0.52$, 95% CI [0, 1.08], $p = .05$; $c' = 1.39$, 95% CI [0.05, 2.82], $p = .04$, estimated 27.2% mediated; strength: $ab = 0.59$, 95% CI [0.05, 1.21], $p = .03$; $c' = 1.31$, 95% CI [-0.11, 2.75], $p = .07$, estimated 31.1% mediated).

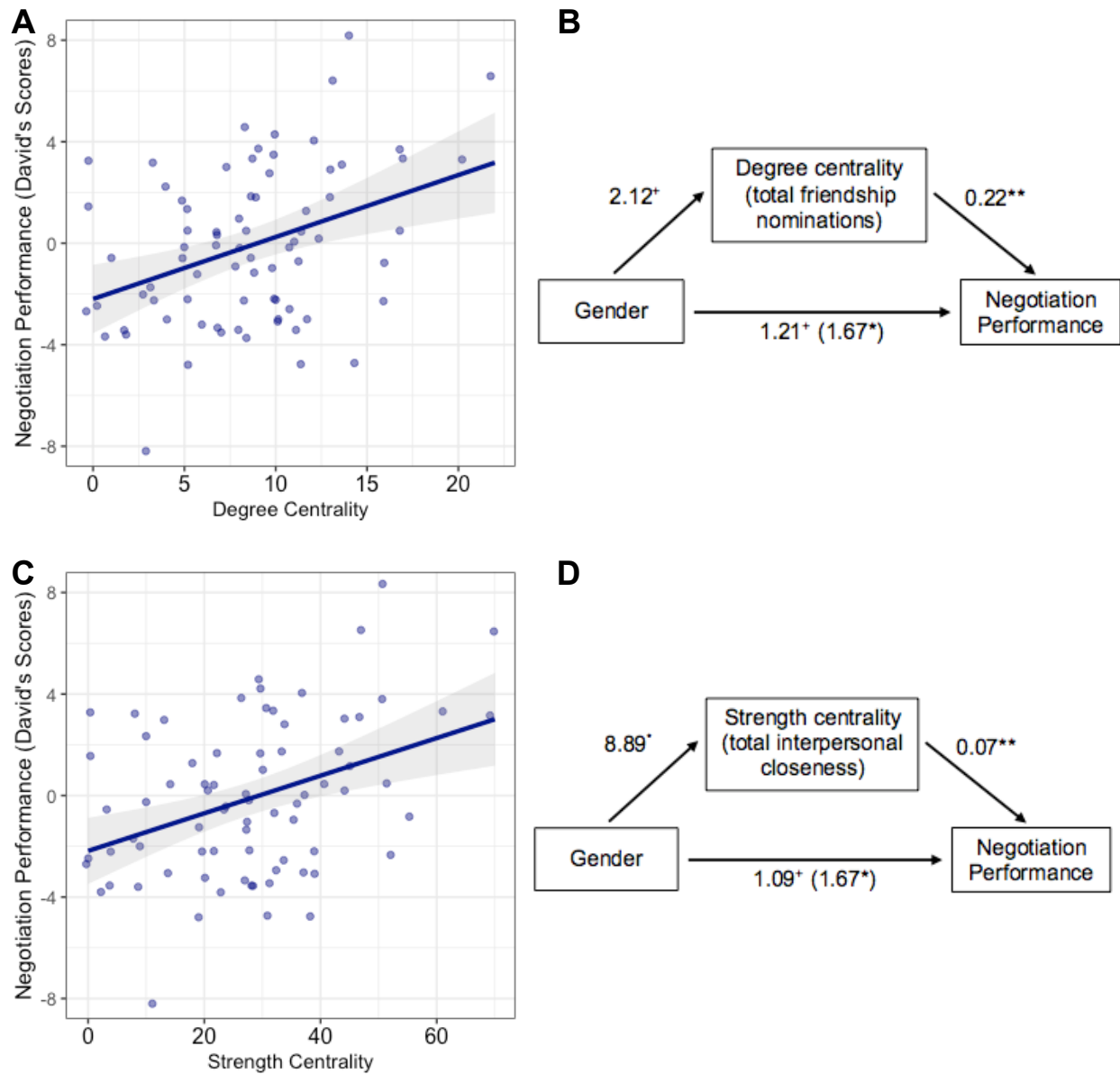


Figure 2.7. Network centrality and negotiation performance

(A) Degree centrality (total number of friendship nominations) had a significant positive association with negotiation performance. Shaded band represents 95% confidence interval. (B) Degree centrality marginally mediated the relationship between gender and negotiation performance (significantly when controlling for extraversion and agreeableness). (C) Strength centrality (total interpersonal closeness) had a significant positive association with negotiation performance. Shaded band represents 95% confidence interval. (D) Strength centrality significantly mediated the relationship between gender and negotiation performance (remained significant when controlling for extraversion and agreeableness).

Multiple mediators. Finally, we entered apprehension about negotiating, stereotype threat, stress mindset, and network centrality as simultaneous mediators of the relationship between gender and negotiation performance. When apprehension about negotiating, stereotype threat, stress mindset, and degree centrality were entered as simultaneous mediators, degree centrality emerged as the strongest mediator, and the only indirect effect that did not include 0 in the 95% confidence interval (see Figure 2.8; degree: $ab = 0.44$, 95% CI [0.01, 1.05]; threat concerns: $ab = 0.39$, 95% CI [-0.46, 1.02]; stress mindset: $ab = 0.22$, 95% CI [-0.43, 0.95]; apprehension: $ab = -0.03$, 95% CI [-0.28, 0.25]). Using strength centrality in place of degree centrality, strength was also the strongest mediator, and the 95% confidence interval did not include 0 (see Figure 2.9; strength: $ab = 0.53$, 95% CI [0.07, 1.19]; threat concerns: $ab = 0.33$, 95% CI [-0.50, 0.95]; stress mindset: $ab = 0.24$, 95% CI [-0.39, 1.02]; apprehension: $ab = -0.02$, 95% CI [-0.28, 0.25]). These results suggest that network centrality explained gender gaps in negotiation performance more than the intrapsychic measures of apprehension about negotiating, stereotype threat, and stress mindset.

Discussion

In this research, we sought to examine the gender gap in negotiation performance and possible explanations for this gap. In line with past research, we found that men outperformed women in a series of negotiations mimicking real-world scenarios, such as buying a car, determining the price of an advertising campaign, and arranging a hiring package. We next examined two mechanisms of this gender gap that have garnered attention in previous research, apprehension about negotiating and stereotype threat, as well as two new mechanisms, mindset about stress related to negotiating and position in social networks.

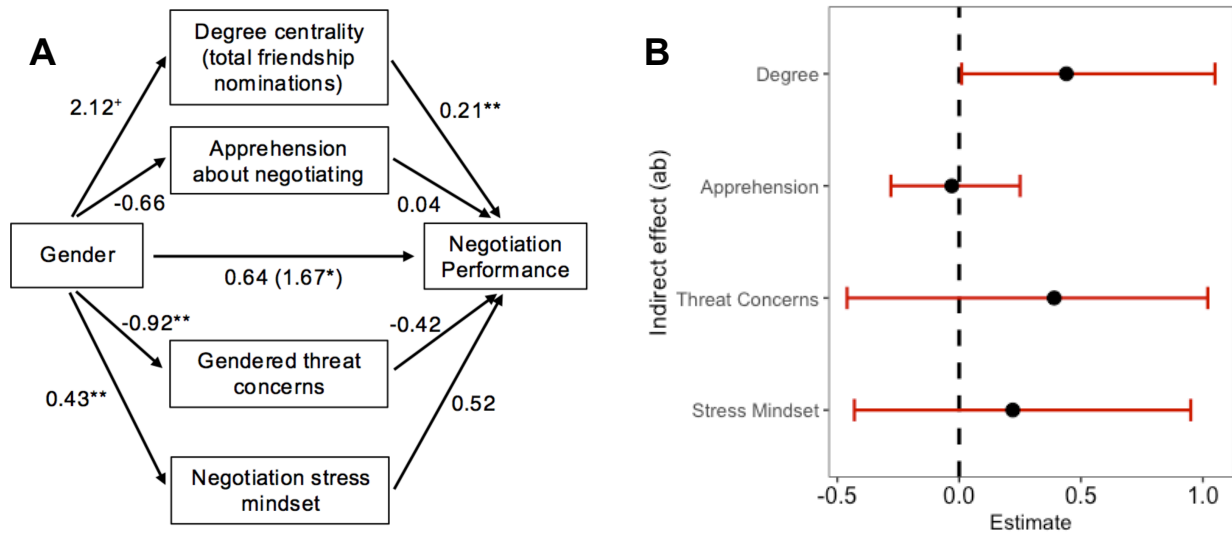


Figure 2.8. Multiple mediation analysis (degree centrality) Effect of gender on negotiation performance with degree centrality, apprehension about negotiating, gendered stereotype threat concerns, and negotiation stress mindset entered as simultaneous mediators. (A) Path diagram of multiple mediation analysis. ⁺.1 > *p* > .05, * .05 > *p* > .01, ** .01 > *p* > .001. (B) Coefficient plot of indirect effect (*ab*) for each of the four mediators. Error bars represent 95% confidence intervals.

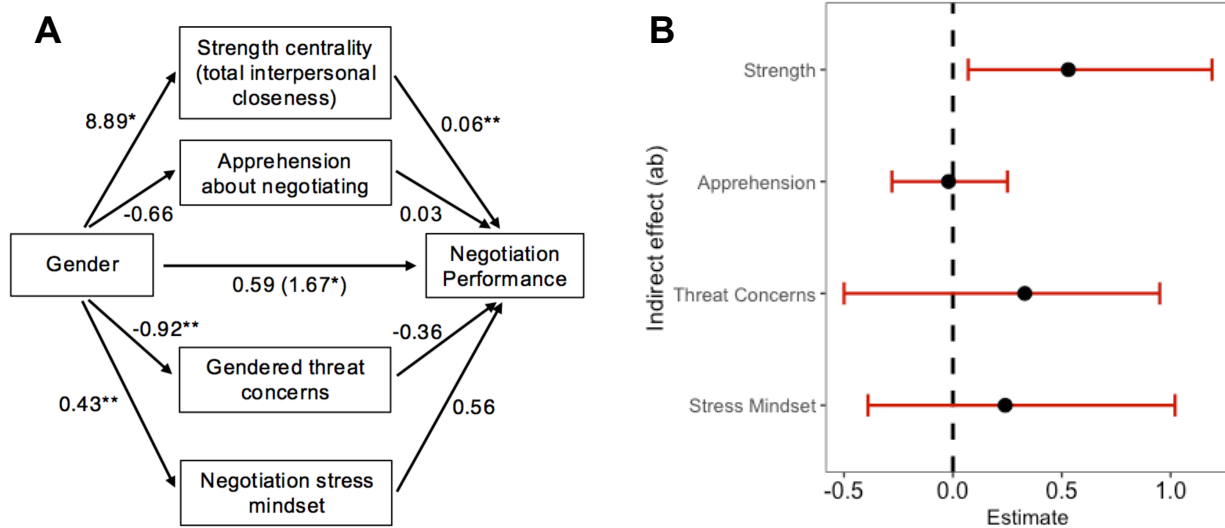


Figure 2.9. Multiple mediation analysis (strength centrality) Effect of gender on negotiation performance with strength centrality, apprehension about negotiating, gendered stereotype threat concerns, and negotiation stress mindset entered as simultaneous mediators. (A) Path diagram of multiple mediation analysis. ⁺.1 > *p* > .05, * .05 > *p* > .01, ** .01 > *p* > .001. (B) Coefficient plot of indirect effect (*ab*) for each of the four mediators. Error bars represent 95% confidence intervals.

Contrary to prior research, we did not find gender differences in apprehension about negotiating, nor did apprehension predict performance in subsequent negotiations. However, significant gender differences did emerge in stereotype threat, negotiation stress mindset, and social network positions. Specifically, women felt more concerned than men that their negotiation partners would perceive them as ineffective and meek, and that they would not be taken seriously—in line with stereotypes of women in negotiations. Additionally, although men and women reported comparable levels of stress related to negotiating, women were more likely than men to view this stress as debilitating to their performance and growth, whereas men were more likely to view this stress as enhancing. Finally, women held less central positions than men in the MBA course social network according to degree and strength centrality; in other words, women entered the class with fewer friends and lower total interpersonal closeness with their fellow classmates than men. In turn, stereotype threat, negotiation stress mindset, and social network centrality all predicted subsequent performance on negotiations. However, only social network centrality—number of friends and total interpersonal closeness—emerged as a significant mediator of the gender gap in negotiation performance, over and above any general tendency toward sociality.

This research is unique in empirically comparing multiple possible explanations of the gender gap in negotiation performance, and in particular for exploring both intrapsychic and social ecological mechanisms. Although correlational, the findings support recent research highlighting the importance of the social environment, and in particular, one's position in shared social networks, for performance (e.g., Stadtfeld et al., 2019). Similar to the findings presented in the next study (Chapter III), the current research suggests that individuals' integration into social

networks in a particular domain may in some cases be more important for performance in that domain than the intrapsychic mechanisms that are more commonly the subject of research.

The contrast between the current study's finding of no gender difference in general apprehension about negotiating and those of prior research (Babcock et al., 2006; Bowles et al., 2007) may reflect a difference in sample; perhaps MBA students, particularly those taking a negotiations class as an elective, are already inclined to negotiate and are therefore less apprehensive in general. However, this seems unlikely given that negotiation apprehension was approximately normally distributed across the full range of the scale for both men and women. The discrepancy in findings could reflect social changes in the last 10 years, such as the potential efficacy of popular media focused on empowering women to negotiate (Babcock & Laschever, 2009; Frankel, 2014; Sandberg, 2013). Alternatively, when considered along with the current findings on stress mindset, as well as other findings of no gender differences in apprehension about negotiating (Brooks & Schweitzer, 2011), these results could suggest that it is not the amount of nervousness, anxiety, and stress that separates men and women at the bargaining table, but rather the way in which these feelings are interpreted. For example, men may interpret their stress as excitement, or as helpful to attain the best result in negotiating, whereas women may interpret their stress more negatively. In that case, a key lever for increasing women's performance in negotiations may be mindset, rather than anxiety reduction per se; although stress mindset did not mediate the gender gap in negotiation performance in the current research, it tied strength centrality as the strongest predictor of performance (a small-to-medium effect size of $f^2 = .09$), a finding worthy of future research.

One question pertains to the generalizability of these results to negotiations in everyday life. A strength of the current research was assessing negotiation performance across multiple

negotiations that, while still role-play, simulated real-world negotiations (compared to prisoner's dilemma and other game theory paradigms that are common in negotiation research). However, other aspects of the design raise interesting questions about generalizability. For example, in the current research, individuals negotiated with others within a closed social network. In some cases, real-world negotiations mirror these conditions. For example, in negotiations with colleagues and bosses about work assignments, allocation of resources, directions to go in for a particular project, promotions, and other decisions in the workplace, individuals negotiate with others within the network of the organization or work team. In these cases, based on the current findings, we might hypothesize that employees who hold more central positions in their workplace social networks will be better able to achieve desirable outcomes in negotiations with others in their organization. Moreover, if there are disparities in social connection in the workplace between men and women, between members of different races, or along other social lines, we might also expect to see that more connected groups are more likely to advance and influence the direction of the organization. However, in other cases, such as negotiations between strangers (e.g., purchasing a car, negotiating a start up package with a hiring manager one has just met), the implications of the present findings are less clear, and raise a variety of questions for future research.

For example, might the benefits of network centrality in one domain “carry over,” continuing to provide advantages in a new domain in which an individual is negotiating? The answer may depend on the mechanism by which network centrality influences performance. If centrality largely benefits negotiators through the perception of others—by making highly connected individuals seem more powerful and influential (Brass, 1984; Brass & Burkhardt, 1993; Kilduff & Krackhardt, 1994)—this benefit would be unlikely to carry over to a new

context with a negotiation partner who was unaware of the negotiator's connectedness. However, if network centrality benefits negotiators by providing access to key information and resources, a central individual could continue to reap advantage from this information in a new context. For example, a study of women's starting salaries suggested that, in the absence of information about men's pay, women who graduated from women's colleges negotiated lower salaries than women who had social ties to men and therefore greater access to information about men's salaries—an example of how the information accessed through networks in one context can affect negotiation outcomes in a different context (Belliveau, 2005).

Similarly, someone who is better connected generally may have more opportunities to learn strategic information (e.g., how much others paid for a car, how much others make in salary, what a client values), which could benefit them even in a new context. Finally, if network centrality benefits negotiators through the affordances of existing ties, such that being more connected offers the opportunity to be more assertive and ask for more, with lower social risk, these benefits may also carry over in a new context. For example, an individual central in one context may be less worried about a deal or relationship souring if they have ties to many others who can connect them to other possible deal opportunities, and who they can fall back on socially.

Future research can shed light on these potential mechanisms. As a first step, videotaping negotiations would allow researchers to code the behavior of negotiators high and low in centrality, as well as the behavior of their negotiation partners (either for the entirety of the negotiation or in thin slices; Curhan & Pentland, 2007). If network centrality benefits negotiators through the affordances of their existing ties—that central individuals feel greater freedom to act assertively and take risks because they have many other connections they can rely on—we might

hypothesize that central individuals would use more assertive or riskier negotiation strategies than more peripheral individuals. For example, if they perceive lower social and professional risk than less central individuals (Brands & Rattan, under review), central negotiators might make higher demands, offer fewer concessions, speak more firmly, and express more anger—strategies that can be associated with greater reward, but can also increase the chance of impasse or social consequences (Larrick, Heath, & Wu, 2009; Overbeck, Neale, & Govan, 2010; Weingart, Hyder, & Prietula, 1996). If instead (or in addition) network centrality benefits negotiators through access to more information and resources, we might expect that more central negotiators will reference more insider information (e.g., knowledge of pay standards, comparable deals made by others, the finances or values of the negotiation partner or their competitors) or display more technical or financial knowledge. Alternatively, if network centrality benefits negotiators by boosting their negotiation partners' perception of their power and influence, we would expect that the primary differences in negotiations undertaken by individuals high versus low in centrality will be in the behavior of their negotiation partners. For example, the negotiation partners of central negotiators may behave in ways characteristic of having lower relative power, such as using more ingratiation and impression management tactics, responding more reactively than proactively, and making more concessions (De Dreu & Van Kleef, 2004; P. H. Kim et al., 2005; Overbeck et al., 2010).

Another possibility is that social network centrality helps to counteract bias and discrimination in negotiation. Though we compared multiple mechanisms of the gender gap in negotiations, one important mechanism that we did not examine is bias. Although much research focuses on differences between the negotiation attitudes and behavior of men and women, there is evidence that bias plays a role in disparate negotiation outcomes. For example, in audits of

new car purchase negotiations, car dealers made higher initial and final offers to female and black buyers compared to white men, even when the negotiation script was controlled, all auditors were trained to use the exact same negotiating strategies, and qualities like attire, attractiveness, occupation, and home addresses were controlled (Ayres, 1990, 1995; Ayres & Siegelman, 1995). In other types of negotiations, such as raising capital for entrepreneurial ventures, a pitch delivered by a male voice was more likely to garner investments than an identical pitch delivered by a female voice (Brooks, Huang, Kearney, & Murray, 2014), and women were asked more questions about what could go wrong in their ventures, which lowered the amount of investment they received (Kanze, Huang, Conley, & Higgins, 2018). Some research suggests that strong social ties may especially benefit women in negotiations because these connections can offset the disadvantages they face due to gender bias. For example, having a strong relationship with a potential investor can reduce uncertainty about female negotiators' competence and capabilities, whereas, due to gender bias, men's competence is often assumed without further evidence (Tinkler, Bunker Whittington, Ku, & Davies, 2015). Holding central network positions—and thereby having a web of potential references and resources—may generally give women credibility that they are otherwise assumed to lack, counteracting gender bias and discrimination in negotiations. We also note that none of the variables considered here fully explained the relationship between gender and negotiation performance, leaving open the possibility that bias and other mechanisms were still at play.

We join other researchers in urging resistance to interpreting these results through a “fix the woman” lens, which puts responsibility for change and remedying disadvantage on women (Kolb, 2009). Our findings that intrapsychic mechanisms did not explain gender gaps in negotiations as much as the structural explanation we examined, position in social networks,

should underscore that negotiation disparities are not wholly—nor primarily—caused by deficiencies in women’s negotiation attitudes and behaviors. Although recognizing the importance of social networks may help women take proactive steps to foster social connections in professional spheres, we believe our results should flag opportunities for structural changes that promote gender parity in social networks. When networks are left to form only through informal social processes, women are often subject to exclusion; “boy’s clubs” are still prominent features of workplaces and business schools (e.g., Johnson, 2009; Kinsey & Fisher, 2014). In turn, these features of informal social networks can influence positions in the formal authority hierarchy of organizations. Organizations and schools can take proactive steps to democratize social connection and capital, such as arranging formal opportunities for women to build important social ties, such as instituting formal mentoring and creating or supporting a women’s group; increasing representation of women toward 50%, especially in leadership positions; and regularly evaluating workplace or school climate and addressing cultural barriers to women’s social integration (Ibarra, 1993b; McCarthy, 2004; Srivastava, 2015).

III. A Psychological Intervention Strengthens Students' Social Networks And Promotes Persistence In STEM

Abstract

Retaining students in science, technology, engineering, and math (STEM) is a national priority as the need for STEM graduates outpaces those earning STEM degrees. Whereas most approaches to improve persistence target individuals' intrapsychic knowledge, skills, and resources, this experiment focused on strengthening students' social networks to help them persevere. Drawing on theoretical and empirical work suggesting that strong social networks can act as "sticky webs" that encourage individuals to persist in challenging environments, this research tested the effects of a brief psychological intervention on students' social networks and persistence in STEM. Early in the semester, 226 introductory biology students provided information about their friendship networks within the class. Next, students were randomly assigned to complete a control or values affirmation writing exercise, an intervention that has reduced socially defensive behavior and bolstered positive other-directed feelings, belonging, and other prosocial outcomes in prior work. Friendship networks were assessed again at the end of the semester. By the end of the term, affirmed students were estimated to have one more friend on average than students in the control condition, an approximately 29% increase. Affirmation also led to structural changes in students' network positions, such that affirmed students became more central in the overall course friendship network. These differing social trajectories predicted persistence in the biology track: Affirmed students were 11.7 percentage points more likely than unaffirmed students to take the next course in the bioscience sequence, an effect that was statistically mediated by students' end-of-semester friendship networks.

Introduction

Science, technology, engineering, and math (STEM) fields face high rates of attrition among students. National estimates suggest that fewer than 40% of undergraduate students in the United States who enter college intending to major in STEM actually graduate with a STEM degree (Olson & Riordan, 2012). At the same time, the need for STEM professionals outpaces those earning STEM degrees: Economic forecasts predict that, for economic and societal wellbeing, the U.S. will need approximately one million more college graduates in STEM fields by 2022 than current rates will produce (Chen, 2013; Olson & Riordan, 2012). Retaining more students who begin college intending to major in STEM fields is the lowest-cost and most efficient way to meet this need, as increasing retention by ten percentage points (from 40 to 50%) over a decade would alone generate three-quarters of the needed pool of STEM graduates (Olson & Riordan, 2012). Policy experts have thus identified increasing STEM persistence in college as a national priority.

Most psychological research has conceptualized persistence as an individual endeavor, focusing on the intrapsychic causes and correlates of persistence in interventions to help students persevere. For example, researchers have targeted individuals' mindsets about the nature of intelligence, showing that encouraging beliefs that intellectual abilities are malleable as opposed to static can increase persistence in academic settings (Paunesku et al., 2015). Other intervention approaches to promote persistence have focused on building "character skills" such as self-control and grit (A. Duckworth, Peterson, Matthews, & Kelly, 2007; Heckman & Kautz, 2013), helping students to see course material as relevant to their lives (Hulleman & Harackiewicz, 2009), and reducing anxiety about belonging in college (Yeager et al., 2016).

In the present research, we examine the possibility of intervening on socioecological mechanisms of persistence—here, students’ embeddedness in the social networks of challenging STEM classes—as both a theoretical and practical complement to interventions that focus on bolstering intrapsychic knowledge, skills, and resources to help students persevere (Oishi, 2014). In doing so, we conceptualize students’ choices to persist or leave STEM as not wholly determined by individual internal processes, but also uniquely influenced by the set of relationships in which they are embedded (Granovetter, 1985). Specifically, we use social network analysis, a method of quantifying the system of interpersonal relationships in which individuals are enmeshed, to examine whether a randomly assigned low-cost psychological intervention can strengthen students’ positions in social networks and, in turn, promote persistence in STEM.

Research across disciplines suggests that social networks may be a powerful force driving perseverance in challenging environments, functioning as “sticky webs” (Moynihan & Pandey, 2008) that encourage individuals to persist when they might otherwise drop out. Research in organizational settings has shown that employees who are more socially connected to friends within their workplace are less likely to quit or change jobs (Ducharme, Knudsen, & Roman, 2007; Mossholder, Settoon, & Henagan, 2005; Moynihan & Pandey, 2008; Riordan, 2013). Similarly, cross-sectional analyses of college students’ social ties have shown that students were less likely to leave school when they were more integrated into campus social networks (e.g., had more interconnected webs of friendships with peers in their class year, were identified as friends by more peers, knew more classmates, or spent more time with other students in class, sports, and student organizations) (Eckles & Stradley, 2012; Thomas, 2000). In STEM fields in particular, a recent study showed that students who were more centrally positioned in the

classroom social network of their introductory physics course were more likely to take a subsequent physics course the following semester, regardless of their performance (Zwolak, Dou, Williams, & Brewé, 2017).

Embeddedness in social networks within a particular environment may support persistence in that environment through several mechanisms. These include providing access to both emotional and informational support needed to overcome challenges, adding pressure (conscious or not) to persist due to normative influence and role fulfillment demands, strengthening institutional and goal commitment by increasing satisfying and enjoyable social interactions, heightening sense of fit, belonging, and identification, amplifying the stakes of leaving because leaving would require not only giving up the field but also the social ties, increasing alignment with core communal goals, reducing stress, and increasing self-efficacy (Bean, 1983; Boucher, Fuesting, Diekman, & Murphy, 2017; Granovetter, 1985; Karp, 2011; Morrison, 2002; Riordan, 2013; Robbins et al., 2004; Thomas, 2000; Tinto, 1975; William Lee, Burch, & Mitchell, 2014). In other words, enmeshment in social networks may promote persistence both through uniquely relational mechanisms, as well as by strengthening many of the intrapsychic resources researchers and practitioners often target when trying to increase persistence.

Despite this work suggesting that social networks may be critical to persistence, methods of experimentally intervening to strengthen social networks, especially in cost effective ways, have largely not yet been explored. In network science, much attention has been devoted to examining the effects of proximity on network formation and maintenance (Rivera, Soderstrom, & Uzzi, 2010), finding that individuals who are spatially proximate due to shared activities have more opportunities to interact, and are thus more likely to develop social ties. This work would

suggest that STEM students should develop strong social networks over time simply by nature of spending time in classes together. However, psychological research suggests proximity is unlikely to breed intimacy in all circumstances, with some research suggesting that stressful or psychologically threatening contexts trigger defensive social responses such as relationally destructive behavior and social withdrawal (Lewandowski, Mattingly, & Pedreiro, 2014; Randall & Bodenmann, 2017; Repetti & Wood, 1997; Turetsky & Zee, in prep). These findings are mostly limited to dyadic romantic or familial relationships, but may suggest that certain environments—such as competitive STEM classrooms—could in fact lead to network erosion, despite proximity. This pattern could be particularly detrimental to persistence as disruption in relationships can reduce perceived self-efficacy, potentially increasing stress further and causing additional defensive social behavior in a vicious cycle (Caldwell, Rudolph, Troop-Gordon, & Kim, 2004). In this case, an intervention to lessen social defensiveness may be one route to strengthening social networks.

To address this possibility, we examined the effects of values affirmation on students' social networks (Steele, 1988). Values affirmation interventions aim to minimize psychological threat in stressful environments by refocusing individuals on an alternative source of self-worth: their core values (Cohen & Sherman, 2014). In these interventions, individuals complete a 10-15 minute exercise that prompts them to write about their most important personal values (e.g., *friends and family* or *religious values*) before an upcoming stressor. Affirmation theory suggests that by doing so, participants in these interventions can better put stressors in perspective, allowing them to shift from self-protective, defensive, and avoidant modes of processing to more open and approach-based orientations (Cohen & Sherman, 2014). Prior work has documented that affirmation can lessen social defensiveness and promote positive social behavior and

attitudes in particular, making this intervention a promising means to instigate change in students' social networks. For example, in laboratory studies, chronically insecure individuals who were affirmed (vs. unaffirmed) reported decreased intention to defensively distance from a romantic partner and behaved less tensely with an experimenter following a relational threat manipulation (Jaremka, Bunyan, Collins, & Sherman, 2011; Stinson, Logel, Shepherd, & Zanna, 2011). Affirmed individuals have also reported more positive feelings toward others such as love and empathy (Crocker, Niiya, & Mischkowski, 2008; Thomaes, Bushman, de Castro, & Reijntjes, 2012) and a heightened sense of belonging (Cook, Purdie-Vaughns, Garcia, & Cohen, 2012) under threat compared to their unaffirmed peers. Moreover, affirmation interventions have increased prosocial intent and behaviors, including willingness to help and actual helping (S. Kim & McGill, 2017; Lindsay & Creswell, 2014; Thomaes et al., 2012). This work suggests that affirmation may interrupt defensive social responses to stressful environments and foster positive interpersonal interactions and perceptions, and could thus strengthen students' social networks in STEM.

Affirmation theory also suggests that values affirmation interventions should be most effective for those individuals facing the greatest psychological threat in a given environment (Cohen & Sherman, 2014). The STEM context may be particularly threatening for students from social groups who have been historically marginalized in STEM, such as women, students from underrepresented racial/ethnic minority groups, and first-generation students. Indeed, values affirmation studies in academic settings have often found that students from these groups experience a boost in academic outcomes following affirmation, whereas students from groups that are not stereotyped are unaffected (Cohen, Garcia, Apfel, & Master, 2006; Harackiewicz et al., 2014; Miyake et al., 2010). In the current study, it was unclear whether we should expect

similar subgroup patterns in social outcomes, such as students' friendship networks. Some prior work has found main effects whereby people who were affirmed showed more prosocial or positive relational outcomes (e.g., Crocker et al., 2008, Study 1; Lindsay & Creswell, 2014). One study examined the social effects of values affirmation among marginalized versus non-marginalized group members, finding that affirmation specifically insulated African American students' sense of belonging during middle school (Cook et al., 2012). However, most findings related to social outcomes focus on groups facing other types of threat that are not academically driven, such as relational threat in individuals with low self-esteem (Jaremka et al., 2011; Stinson et al., 2011) or threat from being confronted with information about others' suffering (S. Kim & McGill, 2017) or about the perils of smoking (Crocker et al., 2008, Study 2). Nevertheless, we examined whether the effects of values affirmation on social outcomes and performance would differ by gender and racial subgroups.

We examined the effect of values affirmation on social network trajectories and persistence in a challenging academic STEM environment: a gateway biology course. This course, the first semester of introductory molecular and cellular biology, is the required "weed-out" gateway course for all premedical and bioscience majors at the university. It thus represents a particular inflection point for students who begin college intending to pursue careers in those fields, and may be perceived as a make-or-break moment for their fundamental aspirations. Prior work suggests that improving students' social experiences in gateway introductory science courses may be key to reducing overall STEM attrition (Gainen, 1995; Zwolak et al., 2017), making this high-stakes introductory course an ideal target for intervention.

We assessed students' course friendship networks at the beginning and end of a semester⁹, both before and 2.5 months after they completed a values affirmation or control exercise in their weekly course section during the third week of the term. Embeddedness in friendship networks is important because friendships provide access to key social support and information, as well as convey a sense of belonging, shared identity, and attachment to the shared domain (Feeley, Moon, Kozey, & Slowe, 2010; Morrison, 2002; Vardaman, Taylor, Allen, Gondo, & Amis, 2015). The individuals who are best able to access these benefits of friendship networks are those who are socially enmeshed, or "central," in two ways. First, they are advantageously positioned relative to others across the whole network, such that they are connected both directly and indirectly to more individuals, providing broad access to both social resources and information. Second, they have strong personal relationships with individuals within the broader network. We examined the effects of the intervention on each of these two forms of social embeddedness in the current study.

To address the first type of social embeddedness, advantageous positioning, we measured students' *closeness* and *betweenness centrality* (Freeman, 1978; see Figures 1.2 and 1.3 for a visual illustration of these measures). These measures are often considered proxies for social capital and access to information. Closeness centrality is a measure of the number of intermediaries required for an individual to connect with others in the network. Individuals high in closeness centrality are widely connected to others in the network, both directly and indirectly, and so can reach others without going through too many other people. For example, in a classroom, a student high in closeness centrality would be broadly connected, able to reach many

⁹We also measured students' study partner and support provider networks in order to assess different types of academic relationships, but there was extremely high overlap between these two networks and the friendship network: Across time points, 95-99% of classmates nominated as study partners or support providers in the course were also named as friends. Study and support network methods and results are reported in Appendix B.

other students in the class directly or through friends of friends. Betweenness centrality, on the other hand, is a measure of how often individuals connect others together that would not otherwise be connected or would be connected less directly. Individuals high in betweenness centrality serve as a bridge between many other individuals, having connections with individuals who would otherwise be unconnected or more distantly connected. In a classroom, a student high in betweenness centrality would have friendships with different groups of students who were otherwise largely unconnected. Those who are central to the network in either closeness or betweenness centrality, or both, are thought to be advantageously positioned within the broader network, with the greatest access to and control over key resources compared to those who are more peripheral (Freeman, 1978).

To address the second type of social embeddedness, strong personal relationships, we measured students' *degree centrality*. Degree centrality is the number of direct ties each individual in a network has (Freeman, 1978), and is equal to the sum of *out-degree*, the number of others nominated by the individual as friends, and *in-degree*, the number of others who nominate the individual as a friend. For example, if a student nominates three friends in the class (out-degree of 3) and two students nominate her back (in-degree of 2), she has a total degree of 5. We also measured the strength of these incoming and outgoing ties through students' reports of how interpersonally close they felt to each friend. Finally, collecting network data over the course of the semester allowed us to examine whether changes in degree centrality from the beginning to end of the term were due to maintaining friendships or forming new ones, in addition to providing a baseline against which to compare the effect of affirmation on end-of-semester networks.

The primary research questions we addressed in the present research were, first, does affirmation have positive social effects, such that affirmed students become more embedded into the classroom social network over time compared to students in the control condition? Second, given prior work associating stronger social networks with increased persistence in difficult environments (Ducharme et al., 2007; Eckles & Stradley, 2012; Moynihan & Pandey, 2008; Thomas, 2000), are intervention effects on students' social network positions associated with persistence in the biology course sequence? We also examined whether these effects differed by race or gender, given prior affirmation work suggesting that the intervention has stronger effects for those who are negatively stereotyped in STEM.

Methods

Participants

All undergraduate and post-baccalaureate students in a gateway biology course were invited to participate in the study. Following online and in-person recruitment, 328 students initially consented to participate. Of these participants, 290 (88%; 145 affirmed, 145 control) were present in class the week that the intervention was administered and thus completed the intervention, and 226 (69%; 118 affirmed, 108 control) completed both the baseline and end-of-semester measures in addition to the intervention.¹⁰ All 226 participants who completed the study were included in the present analyses (aged 18-44, $M_{age} = 20.6$ years, $SD = 3.4$; 151 women, 72 men, 3 gender-fluid or other; 72 Asian, 15 Black, 25 Latino, 2 Native American, 70 White, 37 multiracial, 5 other or declined to report).

¹⁰ Condition did not predict attrition. See Appendix B for analyses comparing participants who completed all aspects of the study to participants who did not.

Procedure

The data presented in this paper were collected as part of a larger study; relevant portions of the procedure and measures are discussed here (for a diagram of the procedure, see Figure 3.1; for additional details, see Appendix B). First, all participants completed an online start-of-semester (baseline) questionnaire assessing demographics, social networks, and a set of psychological measures during the first two weeks of the semester. Participants were then randomly assigned to complete either a values affirmation or control writing exercise. The writing exercise was distributed by teaching assistants in students' weekly sections during the third week of the course, following procedures described in previous research (Cohen et al., 2006). In both conditions, participants first ranked a list of 11 values (e.g., creativity, relationships with friends or family, religious values) from most-to-least personally important and then wrote a short essay for fifteen minutes. In the affirmation condition, participants wrote about the value they had ranked as most important. In the control condition, participants wrote about why the value they ranked as ninth most important might be important to someone else. As such, students in both conditions wrote about why a particular value was important, but the exercise was only self-relevant for students in the affirmation condition. Envelopes concealed the existence of multiple conditions for students, and teaching assistants and instructors were unaware of students' condition assignments.

In the last week of the course, participants were sent an end-of-semester online questionnaire similar to the baseline assessment, including social network items. Participants completed the end-of-semester questionnaire by the end of finals period.

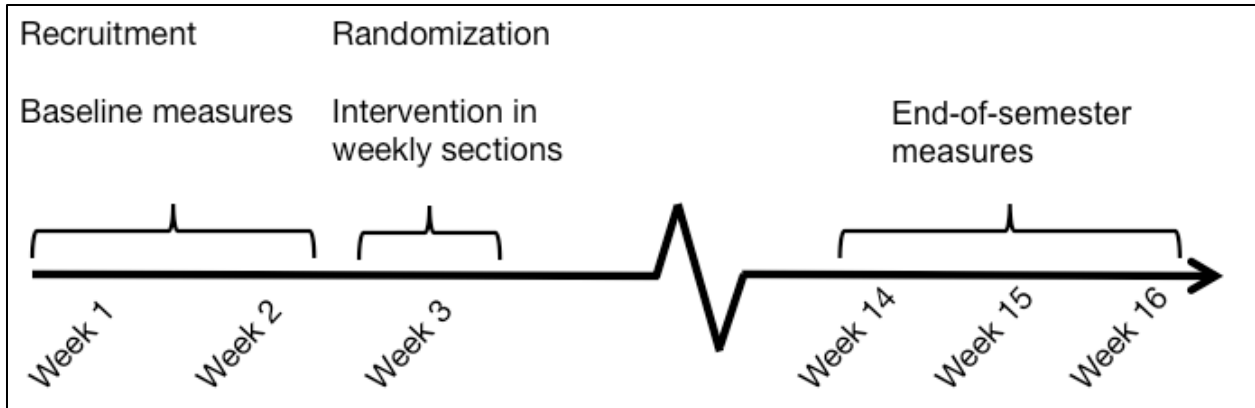


Figure 3.1. Diagram of study timeline and procedure

Measures

Friendship network. We administered two items to assess students' friendship networks, consistent with established social network methods (Clifton & Webster, 2017a; Wasserman & Faust, 1994, pp. 46–47): (1) a fixed choice free recall name generator, in which participants listed the full names of up to six students from the class whom they considered to be their friends, followed by (2) a name interpreter, in which participants provided a rating of how close they felt to each friend listed (from 1 = *Not very close* to 5 = *Very close*). Participants answered these questions at both the beginning and end of the semester, yielding valued, directed social network data for each time point. Responses to these questions allowed for the calculation of the following measures:

Centrality measures. Network centrality measures quantify how well-connected, important, or prominent each individual is within their social network (Wasserman & Faust, 1994, p. 169). *Closeness centrality* is a measure of distance between each participant and all others in the network (Freeman, 1978). We used a variant of closeness centrality adapted for use in disconnected networks, calculated by summing the inverse of the shortest path lengths between the participant and all others (harmonic centrality; Rochat, 2009; see also Dekker, 2005;

Marchiori & Latora, 2000; Opsahl, Agneessens, & Skvoretz, 2010). Higher values indicate less distance from the participant to others in the network. We calculated total harmonic closeness centrality based on the weighted network using the ‘CINNA 1.1.51’ package in R (Ashtiani et al., 2018), and normalized it to account for differences in network size across time points by dividing by $N - 1$ (N = number of nodes in the network; Csardi & Nepusz, 2006). Calculating total harmonic closeness centrality disregards direction of ties.

Betweenness centrality is a measure of how often each participant rests on the shortest path linking two others in the network together (Freeman, 1978). Higher betweenness centrality indicates that the participant connects more pairs of students in the network. We calculated normalized betweenness centrality based on the weighted, directed network using the ‘igraph 1.2.2’ package in R (Csardi & Nepusz, 2006). Betweenness centrality was also normalized to account for differences in network size across time points (Csardi & Nepusz, 2006).

Degree centrality is the number of direct ties each participant has in the network (Freeman, 1978). Degree centrality is the sum of two components: *out-degree*, the number of peers a participant nominated as friends, plus *in-degree*, the number of peers who nominated the participant. We calculated total degree centrality, and its components in-degree and out-degree, using the ‘igraph 1.2.2’ package in R (Csardi & Nepusz, 2006).

Average strength of friendships. Strength of friendships was measured by participants’ interpersonal closeness ratings for each friend. These ratings were averaged both for incoming ties (mean of ratings of felt closeness to the participant reported by all peers who nominated that participant as a friend) and outgoing ties (mean of felt closeness ratings to all friends reported by the participant). Higher tie strength indicates greater interpersonal closeness. We calculated average total strength, average in-strength, and average out-strength of ties, by calculating total,

in-, and out-strength using the ‘igraph 1.2.2’ package in R (Csardi & Nepusz, 2006), and then dividing by total, in-, and out-degree respectively.

Number and proportion of old and new friends. Old friends were defined as friends who were nominated at the end of the semester who were also nominated at the beginning of the semester. New friends were defined as friends who were nominated at the end of the semester who were *not* nominated at the beginning of the semester, suggesting that the friendship developed between time points.

Biology track persistence. The biology course under study in this experiment was the first half of a two-semester course. Next-semester persistence in the biosciences was measured by whether students enrolled or did not enroll in the second semester of the course, according to the course roster the following semester.

Alternative explanations of persistence. We examined three alternative explanations of persistence. First, we examined *course performance*. Course performance was operationalized as students’ final point total for the course, on which the professors based the letter grades they awarded, calculated from the curved scores students received on the four class exams. Next, we examined two measures commonly used in psychology as predictors of persistence, *grit* and *theories of intelligence*. To measure grit, we used the Short Grit Scale (A. L. Duckworth & Quinn, 2009), which includes eight items assessing participants’ grit, defined as “the tendency to sustain interest in and effort toward very long-term goals.” A high composite score indicates high grit. To measure theories of intelligence, we used the three-item implicit theories of intelligence questionnaire (Dweck, Chiu, & Hong, 1995). A high composite score indicates agreement with an entity theory of intelligence (i.e., intelligence is fixed), whereas a low composite score indicates agreement with an incremental theory (i.e., intelligence is malleable).

Results

To test intervention effects, all end-of-semester (Time 2) dependent variables were submitted to a series of multiple regression analyses with intervention condition as the critical predictor. Two covariates were also entered into each model: students' course section and, where applicable, the homologous baseline (Time 1) measurement of the dependent variable. Because individual-level network observations are non-independent, we used nonparametric permutation tests to assess the statistical significance of the effects of intervention condition on network measures (Hanneman & Riddle, 2005; Farine, 2017). The likelihood of the observed effects occurring by chance (reported p -values) were calculated by comparing the intervention coefficient from the multiple linear models fitted to the observed data to the coefficients from models fitted to 20,000 permutations of the network (see Appendix A for details on this procedure). See Appendix B for confidence intervals and means and SEs for all dependent variables. Students' friendship networks at the beginning and end of the semester are shown in Figure 3.2.

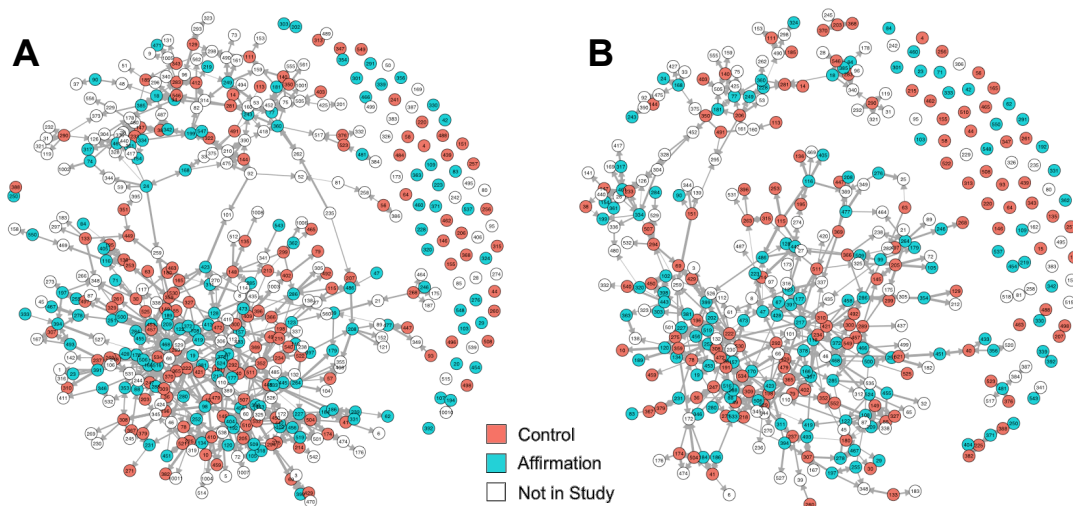


Figure 3.2. Friendship network over time
Course friendship networks at the (A) start of the semester (460 students, 855 ties), and (B) end of the semester (394 students, 629 ties).

Classroom Network Embeddedness

Closeness and betweenness centrality. At the beginning of the semester, before the intervention, students' closeness centrality did not differ by condition. After the intervention, students' positions in the course friendship network diverged: Affirmed students had significantly higher closeness centrality by the end of the semester than their unaffirmed counterparts, indicating that they required fewer intermediaries to reach other students in the network ($b = 0.009$, $SE = 0.003$, $p = .007$). As an indication of effect size, a student who began the semester at the mean level of closeness centrality could expect an increase of 58.5% in closeness centrality if they were in the intervention condition compared to the control, based on model estimates.¹¹ Similarly, betweenness centrality did not differ by condition at the beginning of the semester. By the end of the semester, there was a trend such that affirmed students were higher in betweenness centrality than unaffirmed students, indicating that they bridged together others in the network more often, but not significantly ($b = 0.001$, $SE = 0.001$, $p = .10$). As seen in Figure 3.3, results indicated that affirmed students held more structurally central positions in the course network by the end of the term, particularly as measured by closeness centrality, potentially allowing them greater access to resources, information, and support in the course.

Degree centrality and strength of ties. At the beginning of the semester, there was no significant difference between conditions in degree centrality, or participants' total number of friends (i.e., the number of individuals they nominated as friends plus the number of individuals who nominated them; $b = 0.47$; $SE = 0.49$, $p = .29$). However, by the end of the semester, affirmed students had significantly higher degree centrality than unaffirmed students ($b = 0.99$, $SE = 0.30$, $p = .01$). These results suggest that values affirmation led students to have approximately one more friend in the course on average by the end of the semester than students

¹¹ Or an increase of 16.6% based on raw means

in the control condition. As seen in Figure 3.3, in the absence of intervention, students' friendships eroded; despite spending time in close proximity to classmates during the semester, unaffirmed students lost overall course friends over time. In contrast, values affirmation buffered students against this network erosion, allowing affirmed students to maintain their net number of friendships over the course of the semester.

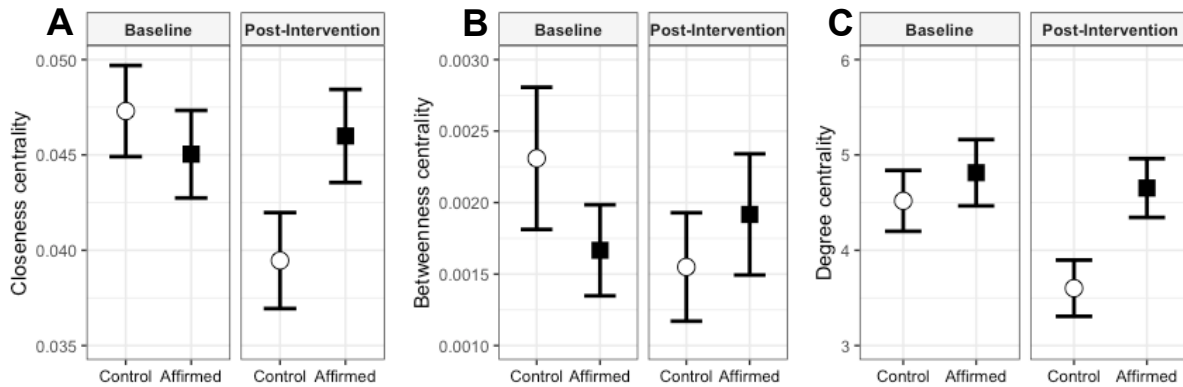


Figure 3.3. Effects of the intervention on students' friendship network centrality

There were no significant differences by condition in network centrality at the beginning of the semester (baseline). By the end of the semester (post-intervention), however, affirmed students had (A) significantly higher closeness centrality, (B) slightly but not significantly higher betweenness centrality and (C) significantly higher degree centrality. Error bars represent ± 1 SE of the mean.

Additional analyses examined the direction and strength of students' friendship ties.

These analyses indicated that affirmed students' higher degree centrality was primarily driven by the ties they nominated. Other students in the class nominated affirmed students more often and reported feeling closer to affirmed students compared to unaffirmed students, but these differences were not significant (in-degree centrality: $b = 0.24$, $SE = 0.15$, $p = .23$; strength of incoming ties: $b = 0.18$, $SE = 0.19$, $p = .45$). In contrast, affirmed students nominated significantly more friends than their unaffirmed counterparts by the end of the term (i.e., had higher out-degree centrality; $b = 0.78$, $SE = 0.23$, $p = .007$). Affirmed students also reported

feeling marginally closer to those whom they listed as friends compared to unaffirmed students ($b = 0.43, SE = 0.21, p = .08$).¹²

Maintaining Existing Versus Forming New Friendships

Next, we examined whether values affirmation helped students maintain relationships with the friends they had at the start of the term or helped students form new friendships that replenished lost ties over the course of the semester. To address this question, we examined the extent to which students nominated friends at the end of the semester whom they also nominated at the beginning of the semester (i.e., maintained old friendships) versus nominated friends at the end of the semester whom they did not nominate at the beginning of the semester (i.e., formed new friendships). These analyses¹³ revealed that affirmed participants both maintained more old friendships (kept about half an old friend more on average; $b = 0.48, SE = 0.21, p = .02$) and formed marginally more new friendships (made about a third of a new friend on average; $b = 0.33, SE = 0.18, p = .07$) than unaffirmed participants over the course of the semester. The proportion of old vs. new friends did not differ by condition among those who identified any friends in the class ($N = 167; b = 0.03, SE = 0.06, p = .57$); students in both conditions had old and new friends in approximately a 3:2 ratio at the end of the semester. In short, values affirmation did not seem to tip the scales in favor of forming new friends over maintaining old friends, or vice versa, but rather led affirmed students to broadly engage more in both friendship maintenance and formation than unaffirmed students during the semester.

¹² For a discussion of potential alternative explanations of these effects, see Appendix B. Neither of the examined alternatives—a difference in mere perception of friendships or attention paid to recalling friends in the course—were consistent with the data.

¹³ Because these analyses related only to the ties each participant nominated, independent of the ties any other participant nominated, we report standard p -values from multiple linear regression analyses in this section.

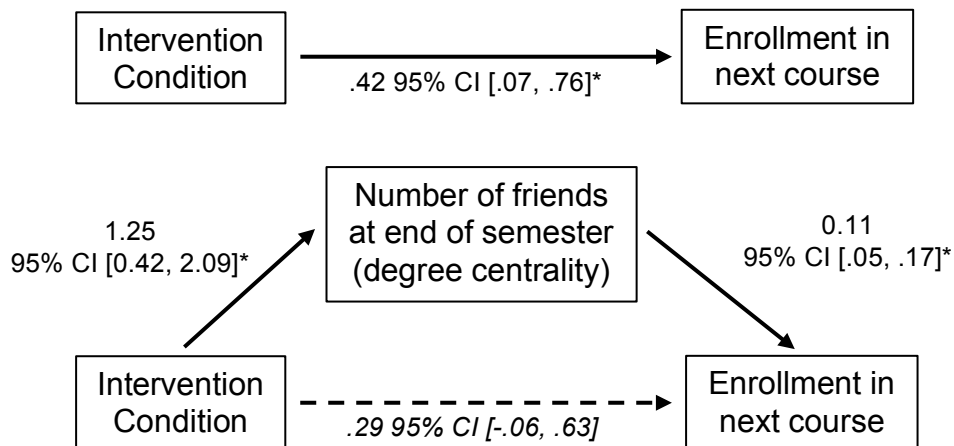


Figure 3.4. Indirect effect of degree centrality on course enrollment

Path diagram with point estimates (posterior means) of effect parameters and associated 95% credible intervals. (I) The total effect of intervention condition on enrollment in the next course was .42, $SE = .18$, 95% CI [.07, .76], $p_{positive-effect} = .009$. (II) The effect of intervention condition on total number of friends (degree centrality) at the end of the course was 1.25, 95% CI [.42, 2.09], $p_{positive-effect} = .001$, in line with the previously reported results. Total number of friends at the end of the semester predicted enrollment in the next course, with an estimated effect of .11, 95% CI [.05, .17], $p_{positive-effect} < .001$. With both intervention condition and total number of friends at the end of the semester in the mediation model, there was an indirect effect of intervention condition on enrollment in the next course through number of friends at the end of the semester (estimated effect of .13, 95% CI [.03, .28], $p_{positive-effect} = .001$), while the 95% credible interval for the direct effect dropped to include 0 (estimated effect of .29, 95% CI [-.06, .63], $p_{positive-effect} = .05$). This suggests that the greater likelihood of affirmed students taking the next biology course was in part explained by affirmation-induced increases in total number of friends at the end of the semester: Students' end-of-semester degree centrality explained 31% of the variance in the effect of intervention condition on enrollment in the next course.

Mediation of Biology Track Persistence

Finally, we examined whether the observed effects of affirmation on students' social network ties had downstream consequences for persistence. Specifically, we tested whether students' end-of-semester social networks mediated the relationship between affirmation and persistence in the biology academic track using Bayesian mediation models. Results are shown in Figure 3.4, with additional details in Appendix B. Affirmed students were significantly more

likely to enroll in the next semester of the biology course than unaffirmed students (83.4% of affirmed students enrolled in the next course in the following semester vs. 71.7% of unaffirmed students). Students' closeness and degree centrality at the end of the first semester of the course, both mediated this effect, explaining 31% and 40% of the variance in the effect of the intervention on next-semester enrollment, respectively. The number and strength of the friendships participants nominated (out-degree and out-tie strength) also significantly mediated this effect, while betweenness, number and strength of times nominated by others (in-degree and in-tie strength), and total tie strength did not (see Appendix B). This is evidence that the positive effects of affirmation on students' friendship networks may confer additional downstream benefits for persistence in STEM.

Race and Gender Subgroup Effects

We next examined whether these observed effects of affirmation on social outcomes and academic persistence were moderated by gender or by race and ethnicity.¹⁴ No significant interactions between intervention condition and gender (see Table 3.1), nor between intervention condition and race (see Table 3.2), emerged for either social outcomes or persistence. There was one marginal interactions in the gender analyses suggesting that the values affirmation intervention may have led to slightly but not significantly bigger gains in incoming tie strength for women compared to men in the class. Otherwise, the results suggested that neither gender nor race moderated the effects of the intervention.

¹⁴ First generation status has also moderated values affirmation effects on academic persistence (Harackiewicz et al., 2014), but we did not run subgroup analyses here for first versus continuing generation students because there were few first generation students in the class ($n = 39$ total across both conditions).

Table 3.1. Gender x intervention interactions

Means and standard errors for women and men in the affirmation and control conditions, plus the p -value derived from permutation tests indicating significance of the gender x condition interaction.

Dependent variable	Affirmed		Control		Gender x Condition p_{perm}
	Women (N=79)	Men (N=37)	Women (N=72)	Men (N=35)	
Closeness	0.05 (0.003)	0.04 (0.005)	0.04 (0.003)	0.04 (0.004)	0.16
Betweenness	0.0018 (0.0005)	0.0022 (0.0009)	0.0014 (0.0005)	0.0019 (0.0007)	0.63
Total degree	4.85 (0.35)	4.35 (0.62)	3.64 (0.36)	3.63 (0.54)	0.33
Outdegree	3.08 (0.24)	2.70 (0.39)	2.35 (0.25)	2.14 (0.36)	0.49
Indegree	1.77 (0.18)	1.65 (0.31)	1.29 (0.16)	1.49 (0.24)	0.42
Total tie strength	2.95 (0.14)	2.52 (0.28)	2.62 (0.19)	2.80 (0.26)	0.19
Out-tie strength	2.78 (0.17)	2.35 (0.32)	2.32 (0.20)	2.18 (0.30)	0.49
In-tie strength	2.47 (0.20)	1.91 (0.30)	2.18 (0.23)	2.40 (0.30)	0.07
Next-semester persistence	0.84 (0.04)	0.86 (0.06)	0.76 (0.05)	0.74 (0.07)	0.63 ^a

^a p -value from standard binomial regression model as next-semester persistence does not violate assumption of independence of observations

Table 3.2. Race x intervention interactions

Means and standard errors for students belonging to racial/ethnic groups marginalized in STEM (Black, Latinx, and Native American students) and students belonging to racial/ethnic groups not marginalized in STEM (White, Asian) in the affirmation and control conditions, plus the p -value derived from permutation tests indicating significance of the race group (marginalized/non-marginalized) x condition interaction.

Dependent variable	Affirmed		Control		Race group x Condition p_{perm}
	Marginalized (N=33)	Non-marginalized (N=85)	Marginalized (N=32)	Non-marginalized (N=76)	
Closeness	0.04 (0.005)	0.05 (0.003)	0.04 (0.005)	0.04 (0.003)	0.58
Betweenness	0.0018 (0.0008)	0.0020 (0.0005)	0.0009 (0.0003)	0.0018 (0.0005)	0.79
Total degree	3.79 (0.52)	4.99 (0.37)	3.25 (0.43)	3.75 (0.38)	0.48
Outdegree	2.58 (0.36)	3.08 (0.24)	2.06 (0.33)	2.34 (0.26)	0.81
Indegree	1.21 (0.23)	1.91 (0.19)	1.19 (0.20)	1.41 (0.17)	0.27
Total tie strength	2.58 (0.26)	2.93 (0.15)	2.67 (0.29)	2.65 (0.19)	0.86
Out-tie strength	2.34 (0.27)	2.79 (0.18)	2.32 (0.30)	2.34 (0.27)	0.63
In-tie strength	2.05 (0.32)	2.37 (0.19)	2.15 (0.33)	2.26 (0.22)	0.76
Next-semester persistence	0.67 (0.08)	0.91 (0.03)	0.66 (0.09)	0.80 (0.05)	0.27 ^a

^a p -value from standard binomial regression model as next-semester persistence does not violate assumption of independence of observations

Alternative Explanations of Persistence

First, we examined the alternative possibility that course performance, rather than or in addition to social network variables, mediated the effect of affirmation on persistence in the biosciences. Predictably, course performance predicted persistence ($b = .06$, $SE = .01$, 95% CI [.04, .08], $p < .001$). However, intervention condition did not significantly predict course performance ($b = .13$, $SE = 7.16$, 95% CI [-13.99, 14.25], $p = .99$), suggesting that the effect of the values affirmation intervention on persistence in the biosciences was not mediated by performance in the first semester of the course. There were also no significant interactions between intervention condition and gender or race predicting course performance (gender x intervention: $b = -5.04$, $SE = 14.99$, 95% CI [-34.60, 24.53], $p = .74$; race x intervention: $b = 8.15$, $SE = 14.99$, 95% CI [-21.40, 37.69], $p = .59$).

Next, we examined the alternative possibility that perhaps students high in trait grit were more likely to both maintain strong personal relationships and continue in the biology track. However, intervention condition did not significantly predict grit ($b = 0.06$, $SE = 0.09$, 95% CI [-0.11, 0.23], $p = 0.49$), grit and network measures were not significantly correlated (see Table 3.3), and grit did not predict taking the subsequent biology class (see Table 3.4). We also examined theories of intelligence as a possible explanation of persistence. Again, intervention condition did not significantly predict theories of intelligence ($b = -0.01$, $SE = 0.17$, 95% CI [-0.36, 0.33], $p = 0.93$), theories of intelligence and network measures were not significantly correlated (see Table 3.3), and theories of intelligence did not predict taking the subsequent biology class (see Table 3.4).

Table 3.3. Correlations between grit, theories of intelligence, and network measures

	Correlations with grit ^a		Theories of intelligence ^a	
	<i>r</i>	<i>p</i> ^b	<i>r</i>	<i>p</i> ^b
Closeness	.08	.26	.01	.92
Betweenness	.06	.38	.03	.66
Total degree	.06	.34	-.02	.77
Outdegree	.12	.08	-.02	.81
Indegree	-.03	.69	-.02	.79
Total tie strength	.02	.76	.10	.13
Out-tie strength	.03	.61	.09	.19
In-tie strength	.00	.96	.09	.20

^aVariables measured at end of semester

^bUnadjusted *p*-values; with Holms' method of adjustment for multiple comparisons, all *ps* = 1, except for *p*_{grit-outdegree} = .68.

Table 3.4. Grit and theories of intelligence do not predict persistence

Models predicting persistence in the bioscience sequence with grit and/or theories of intelligence as predictors, along with three primary network centrality DVs

Variable ^a	Model 1	Model 2	Model 3	Model 4	Model 5
Grit	0.004 (0.044)		-0.013 (0.045)	0.003 (0.044)	-0.007 (0.043)
Theories of intelligence		0.022 (0.022)	0.026 (0.021)	0.026 (0.021)	0.025 (0.021)
Closeness centrality			122.763* (57.487)		
Betweenness centrality				5.077 (6.769)	
Degree centrality					0.030*** (0.008)
N	224 ^b	226	224	224	224
R ²	0.064	0.056	0.091	0.073	0.127
Adjusted R ²	-0.008	-0.016	0.012	-0.008	0.050

Note. Table reports *b* (*SE*), with **p* < 0.05, ***p* < 0.01, ****p* < 0.001. Analyses controlled for course weekly section (as in all other analyses in this paper), but results are equivalent when not controlling for weekly section.

^aAll variables measured at end of semester (but results are equivalent when using grit and theories of intelligence variables measured at the beginning of the semester).

^bTwo participants did not complete the grit scale.

Discussion

This research had three primary objectives. First, we sought to examine whether social networks were responsive to a brief psychological intervention. Specifically, we examined

whether a values affirmation intervention could experimentally strengthen students' academic network positions and ties in a challenging "weed-out" gateway biology course. We found that, in contrast to untreated students, who socially withdrew from the classroom friendship network over time, affirmed students preserved the friendships they had at the start of the term and formed new friendships over the course of the semester. In terms of effect size, affirmation increased number of friends in the course by an estimated 1 friend ($b = .99$), or an increase of approximately 29%, compared to the control condition. Additionally, the intervention led to structural changes in students' network positions, such that they became more central in the overall course network, potentially giving them greater access to social and informational resources important for success (Ibarra, 1993a).

Second, we examined how these differing social trajectories predicted persistence. Affirmed students' gains in the course social network in turn shaped their persistence in the biology track: Affirmed students were 11.7 percentage points more likely than unaffirmed students to take the next course in the biosciences/biomedical sequence, an effect that was statistically mediated by students' end-of-semester social networks. To put this work into perspective, economic projections suggest that increasing the retention of college students intending to major in STEM by 10 percentage points (from 40 to 50%) over a decade is the most efficient way to meet the United States' increasing demand for college graduates in STEM fields (Olson & Riordan, 2012). Interventions to help students build and maintain social connections in introductory STEM classes may thus be one promising route forward to aid students in meeting their personal goals while also helping to alleviate the larger societal shortage of STEM graduates.

In addition to its implications for practitioners working to increase persistence in STEM, this research makes key theoretical contributions to two distinct literatures: the field of intervention science and research on network change and relationships. Most psychological interventions designed to increase persistence have aimed to build individual psychological resources. This study demonstrated that psychological interventions can be leveraged to alter not only individual-level psychology, but also broader social structure—in this case, student’s social networks—and that these structural shifts may play a key role in shaping downstream persistence. In this case, social networks were more predictive of persistence than some intrapsychic variables often considered to influence persistence, grit and theory of intelligence; these variables did not predict taking the subsequent biology course. Our findings dovetail with other recent experimental work showing that individual-level psychological interventions can trigger ecological shifts in the social systems of treated individuals, which can promote lasting positive change (Paluck, 2011; Powers et al., 2016). Moreover, our work suggests that changes in the social networks of treated individuals could be an important understudied mechanism by which the effects of affirmation and potentially other interventions in educational settings propagate over time.

This work also makes an important theoretical contribution to research on the social ecology of network change and relationships. Prior research on social networks has suggested that a group of individuals within a shared environment will become more connected over time as people spend time together in the same space (Rivera et al., 2010). Research on people’s tendency toward homophily suggests this should be particularly true among individuals who are similar to one another (McPherson, Smith-Lovin, & Cook, 2001), as the students in the current study were along age, education, interests, and goals. However, we observed that students in the

control condition seemed to become less connected in the classroom friendship network over time, despite spending time in close proximity to classmates during the course of the semester. These untreated students lost friends on average over time, even to the point where more of these students were completely friendless at the end of the semester than at the beginning (15.7% had zero friends at the beginning of the semester vs. 22.2% at the end of the semester, whereas the percentage of affirmed students with zero friends decreased from 16.9% to 13.6% over the course of the semester).

These findings highlight the importance of considering psychological climate in future research on how social networks change over time. Whereas in some environments, spending time together may lead group members to strengthen existing relationships and form new ties, our research suggests that certain environments may undermine social connection, even between individuals who might otherwise gravitate together due to their similarities. This idea is supported by recent research finding that when companies transitioned from traditional office spaces to open floorplans in an attempt to increase collaboration, employees paradoxically engaged in *less* face-to-face social interaction (Bernstein & Turban, 2018). This work, conducted in high pressure Fortune 500 work environments, underscores that simply creating more opportunities for people to be together can backfire without careful consideration of psychological climate. Although some types of stressors may promote affiliation (Schachter, 1959), perhaps psychologically threatening or competitive environments inhibit positive social ties with others.

The intervention's effects on students' social networks and persistence were not moderated by gender or race, despite prior affirmation literature suggesting that values affirmation interventions are more effective for those experiencing greater threat in academic

settings. There were also no significant effects of the intervention on course performance, nor significant interactions with gender or race. One possibility was that the course examined in the current research differed qualitatively from those studied in past research; for example, perhaps students were more uniform in their perceptions of psychological threat in the course, as opposed to only members of particular social groups experiencing threat.¹⁵ Alternatively, perhaps the nature of affirmation effects are generally more heterogeneous than currently understood (Hanselman, Rozek, Grigg, & Borman, 2017). For whom affirmation leads to positive social and persistence effects, and under what conditions, are important questions for future research.

Interpretations of this work should keep in mind that, although we aimed to maximize external validity by conducting this work in a real STEM setting with high stakes for students, replication studies are needed to determine the robustness and generalizability of the observed social network effects. Additionally, we were interested only in students' social ties within the biology course, and so the effects of such environments on relationships outside this context remain an open question. For example, perhaps unaffirmed students did not show erosion in their social networks outside of the course or even grew closer to roommates, romantic partners, families, or others who support them in times of stress. Prior work suggests that relationships outside the challenging environment may not lead to the same “sticky web” benefits for persistence as relationships within that environment (Lee, Mitchell, Sablynski, Burton, & Holtom, 2004; Moynihan & Pandey, 2008; Ost, 2010), but these relationships may confer other benefits that help individuals thrive, and merit future research.

¹⁵ Although this idea is largely speculative based on anecdotes provided by students who had taken the class in the past and participated in focus groups before the current research, some data from this experiment supports this idea as well. For example, we collected salivary cortisol from participants in class as part of the larger experiment in which this social network study was embedded, and analyses of this cortisol showed no significant differences between men and women, or between students of marginalized or non-marginalized racial and ethnic backgrounds (Park et al., manuscript in preparation).

Future work could also extend the current approach by leveraging proximity sensor technologies such as sociometric badges (T. Kim, McFee, Olguin, Waber, & Pentland, 2012), accessing digital traces of social contact such as text messages and emails, or videotaping student interactions. Such data would allow for insight into the specific changes in social behavior between treated and untreated students that accompany changes in reported friendships. In addition, future research should examine the specific characteristics of environments, and the people in them, that may strengthen versus undermine social networks over time. A better theoretical understanding of the multilevel factors shaping social behavior and ties could allow for the development of more effective nested intervention approaches targeted at both the individual-level, to encourage network members to engage in positive social behavior, and at the network-level, to foster a communal climate. Testing the social effects of existing intervention approaches, as well as new interventions specifically designed to build social network integration, is a rich area for future work.

IV. A Network Analysis of Echo Chambers in Online News Coverage of a Nationally Polarizing Race-Related Event¹⁶

Abstract

Selective exposure to one-sided news coverage, especially of controversial geopolitical events, may contribute to growing social polarization. Existing research on “echo chambers”—fragmented information environments that amplify homogeneous perspectives—focuses on the degree to which individuals and social media platforms shape informational segregation. Here, we explore whether news organizations directly contribute to echo chambers through the hyperlinks they embed in online articles. Using network and text analysis, we examined coverage of the 2014 shooting of Michael Brown in Ferguson, Mo., and found that online news media exhibited weak community structure and high connectivity across news outlets. However, analyses also indicated that media sources were more likely to link to coverage that was similar to their own in terms of emotional valence and stereotype-relevant aspects of the events. While hyperlinking to diverse news sources may ameliorate fragmented information environments, selectively linking to similar coverage may contribute to growing polarization.

¹⁶ This chapter has been previously published in Turetsky, K. M. & Riddle, T. A. (2018). Porous chambers, echoes of valence and stereotypes: A network analysis of online news coverage interconnectedness following a nationally polarizing race-related event. *Social Psychological and Personality Science*, 9(2), 163-175.

Introduction

Social psychologists have long studied the phenomenon of selective exposure to information consistent with individuals' pre-existing attitudes (for a review, see Smith, Fabrigar, & Norris, 2008). While recent work has focused on the role of individual preferences and motivations in seeking ideologically consistent information and avoiding exposure to contradicting information (e.g., Frimer, Skitka, & Motyl, 2017; Galdi, Gawronski, Arcuri, & Friese, 2012; Sawicki et al., 2013), social psychologists have also played a key role in illuminating situational factors of the information environment that increase exposure to like-minded perspectives beyond individual choice (Fischer, Schulz-Hardt, & Frey, 2008; Freedman & Sears, 1965; Johnston, 1996; Smith, Fabrigar, Powell, & Estrada, 2007). For example, in early work, Freedman and Sears (1965; 1967) stressed that it is not individual consumers alone who shape their exposure, but also that people tend to be exposed to more attitude-congruent information simply by nature of how this information is marketed and communicated (i.e., *de facto selective exposure*, such as political advertisements targeting neighborhoods already more likely to support the advertised candidate). In this paper, we aim to update the field's understanding of how the organization of the modern news environment may shape *de facto* selective exposure beyond consumers' choices and preferences, particularly in response to polarizing geopolitical events.

Recent research and the popular press suggest that selective exposure to like-minded news coverage is growing, with national news media consumption becoming increasingly polarized (Pariser, 2011; Pew Research Center, 2014a). In particular, researchers and journalists have suggested that individuals increasingly operate within online "echo chambers," fragmented information environments that promote selective access to one-sided news coverage aligned with

users' pre-existing attitudes and beliefs (e.g., Iyengar & Hahn, 2009). Given that continued exposure to like-minded perspectives in echo chamber-like environments can reinforce individuals' attitudes and make them more extreme in their views (DiFonzo et al., 2013), the proliferation of such media environments could exacerbate growing social and political polarization in America and across the world (Moody & Mucha, 2013; Westfall, Van Boven, Chambers, & Judd, 2015). The consequences of fragmented information environments for social polarization may be particularly severe in the context of charged geopolitical events where there are multiple interpretations of what happened. In these cases, selective exposure to one-sided media may not only strengthen users' attitudes, but also result in a different understanding of the basic facts of the event (Shapiro & Bloch-Elkon, 2008).

Despite increased attention to the potential effects of echo chambers, the degree to which information fragmentation in news media actually exists is unclear. Much of the work in this area has focused on social media platforms and users (Aiello & Barbieri, 2017; Bakshy, Messing, & Adamic, 2015; Barberá et al., 2015; Sharma, Hofman, & Watts, 2015), finding mixed results as to whether social media has increased or decreased exposure to cross-cutting content. However, researchers have yet to examine whether online news outlets directly contribute to the formation of segregated information environments—in other words, whether these news sources promote *de facto* selective exposure (Freedman & Sears, 1965; Sears & Freedman, 1967).

We propose that one way in which news media sources could reinforce or mitigate echo chambers is through hypertextuality: hyperlinks embedded within the text of online news articles that allow users to click through to another article or website (Deuze, 2003). Hypertextuality is a prominent feature of online news media (Deuze, 2003). Users not only notice and use hyperlinks to access additional information in online news articles, but the presence of hyperlinks even

affects the way individuals cognitively process online news, increasing attention, memory, and information-seeking (Borah, 2014; Wise, Bolls, & Schaefer, 2008). Informed by previous research on political blogs (Adamic & Glance, 2005), we suggest two routes by which news media organizations could directly contribute to echo chambers through the hyperlinks they choose to embed. First, media outlets may habitually link to articles from a limited and consistent set of other sources, and rarely link to content from sources outside this set. If this were the case, a user clicking on links to access additional information would be passively confined to articles from a narrow segment of the news media—the “chamber.” Second, media organizations may specifically link to like-minded sources that cover news events in a similar manner. In this case, the link-clicking user would not only be corralled within the chamber, but would also be consistently exposed to thematically homogenous editorial takes and presentations of underlying facts—the “echo.” Alternatively, news outlets could mitigate information fragmentation by linking to a wide variety of sources with diverse perspectives.

The question of how online news media are organized, absent social media or individual intervention, is important for several reasons. Digital news will soon be the dominant platform for information seeking, already overtaking television as the primary news source among adults under 50 (Mitchell et al., 2014), and research suggests that the majority of online news consumption occurs through direct browsing (as opposed to social media newsfeed or news aggregator recommendations; Flaxman, Goel, & Rao, 2016). Prior work in social psychology suggests that people’s selective exposure—and thus perhaps their resulting polarization—is driven by the interaction of their information environments and individual motivations (Freedman & Sears, 1965; Smith et al., 2007). Yet, despite the growing prominence of direct-browse online news media in people’s daily lives, very little is understood about its organization

and role in promoting or mitigating selective exposure through information fragmentation. A full understanding of the causes and effects of selective exposure requires knowledge of the situational factors that could affect individuals' information-seeking behavior and the information to which they are exposed. In addition, research indicates that users take advantage of hyperlinking in online news articles most frequently in times of unusual (rather than routine) political occurrences, and are particularly likely to click on content related to crime, death, and violence (Boczkowski & Mitchelstein, 2012; Tenenboim & Cohen, 2015). This research suggests that the choices news media organizations make that influence consumer browsing—such as when and how to embed hyperlinks—may be particularly important to understand in the context of acute geopolitical events involving violence.

To this end, we focused our analysis on news media coverage of the widely publicized shooting of Michael Brown (an unarmed black teenager) by Darren Wilson (a white police officer) in Ferguson, Mo., and subsequent protests, in August, 2014. This event was followed by high attitudinal polarization regarding underlying causes and implications of the shooting (particularly concerning the role of race), as well as the basic facts of how and why Michael Brown was shot (Pew Research Center, 2014b). Using a combination of network and text analytical approaches, we conducted a pre-registered analysis to determine whether a collection of top online news media outlets exhibited echo chamber-like tendencies (i.e., organization into distinct groups of sources presenting like-minded perspectives) in their coverage of the Ferguson shooting. We operationalized like-minded perspective as similarity across psychologically and politically meaningful dimensions, specifically political leaning of sources, linguistic sentiment, and language related to race. Prior work has found that political orientation and sentiment shape how individuals consume and share news (e.g., Brady, Wills, Jost, Tucker, & Van Bavel, 2017;

Frimer et al., 2017; Himmelboim et al., 2016). Our goal in examining these measures was thus to understand whether online news sources contribute to political and affective information segregation by linking to other sources with similar ideological and affective bents.

We chose to examine linguistic framing of race in coverage because there was high polarization in the degree to which individuals believed race played a role in Wilson shooting Brown (Pew Research Center, 2014b). If news organizations directed readers to sources with thematically similar perspectives on race through hyperlinks, this could contribute to the observed polarization. We identified three aspects of linguistic framing theoretically related to racial attitudes in prior research. First, we examined sources' *focus on race* (i.e., used race-related words). Prior work suggests that avoiding the discussion of race is correlated with colorblind ideology on an individual level (Norton, Sommers, Apfelbaum, Pura, & Ariely, 2006). More recent work suggests that exposure to colorblind news coverage of prior shootings of Black Americans (e.g., Trayvon Martin) predicts a lower likelihood of believing race was a factor compared to coverage that discusses race (Lawrence, 2014), suggesting that news media could be a key contributor to attitudinal polarization about the role of race. Second, we examined evidence for sources clustering by *linguistic intergroup bias*—the use of abstract language to discuss negative characteristics and concrete language to discuss positive characteristics of racial out-group members (Maass et al., 1989)—in articles. This linguistic pattern is associated with implicit bias and perpetuation of racial stereotypes (e.g., Gorham, 2006; Von Hippel, Sekaquaptewa, & Vargas, 1997). Finally, we examined whether sources linked to other outlets that used similar *language related to stereotypes*. Specifically, we examined the extent to which sources focused on (a) Michael Brown's youth when he was killed, or (b) the petty crime he was reported to have committed prior to the shooting (i.e., stealing cigarillos from a local store). Prior

work shows that people often perceive Black boys as older, bigger, and less innocent than White children, in line with stereotypes about Black males as threatening (Goff, Jackson, Di Leone, Culotta, & DiTomasso, 2014). Other work shows that news media often focuses on the crimes of Black subjects (e.g., Sommers, Apfelbaum, Dukes, Toosi, & Wang, 2006), which propagates the stereotype of Blacks as criminals among media audiences (e.g., Dixon, 2007; Dixon & Maddox, 2005). Thus, we suggest that increased focus on Brown's youth would be consistent with counterstereotypic coverage, whereas increased focus on the cigarillo theft would be consistent with stereotypic coverage. Selective hyperlinking along these concepts would be consistent with the idea that news media organizations may themselves contribute to polarization in attitudes and beliefs, specifically those about race (Pew Research Center, 2014b), via de facto selective exposure.

Methods

This research is part of a larger ongoing project exploring how news media covered the 2014 shooting of Michael Brown in Ferguson, Mo. We registered a pre-analysis plan detailing this work on the Open Science Framework. Departures from this plan and additional methodological details are discussed in Appendix C.

Data Collection

Articles about the Ferguson shooting were collected from the top overall 51 online media sources and top 18 online African American-oriented media sources, identified by Pew Research Center (2015) based on number of unique visitors in January, 2015. Using the search engines of sources' websites and Google search functions, we obtained all articles containing the keyword "Ferguson" published by these sources from the day Michael Brown was shot, August 9th, to August 19th, 2014. This date range was strategically selected to correspond with the initial

period of protest in Ferguson. All search results were screened by research assistants to ensure that the article referred to the correct “Ferguson.” The research team extracted the contents of each article that met this criterion. After accounting for overlap in these sources and sites without any relevant articles, our final sample included 3,284 articles from 66 online news sources.

Hyperlink Network

During data collection, we manually annotated each article to record all hyperlinks embedded in the text. All but two sources, Boston Globe and MSN, included hyperlinks in the text of collected articles. A total of 13,516 hyperlinks were identified (see Table 4.1 for breakdown by source). Of these, 7,928 (2,701 external and 5,227 internal) were between two sources in our sample and thus were included in the network.

As in similar hyperlink analyses (Adamic & Glance, 2005; Leskovec et al., 2007; Meusel et al., 2014), we constructed a network representing each source in our sample as a single node and hyperlinks between sources as connections between these nodes (i.e., edges; for an introduction to network analysis for social-personality psychologists, see Clifton & Webster, 2017). The result (Figure 4.1) is a directed, weighted hyperlink network. Edge weights correspond to the number of times articles of the originating source linked to articles of the target source.

Table 4.1. Number of articles and hyperlinks of sources in final sample

Source	Category	Articles	External Links	Internal Links
ABC	Top Overall	36	21	135
AL	Top Overall	40	55	47
BBC	Top Overall	49	49	9
BET	Top African American	26	80	85
BlackAmericaWeb	Top African American	22	19	7
BlackEnterprise	Top African American	10	24	25
BleacherReport	Top Overall	2	4	0
Bossip	Top African American	40	29	59
Boston	Top Overall	10	19	13

Source	Category	Articles	External Links	Internal Links
BostonGlobe	Top Overall	14	0	0
BusinessInsider	Top Overall	83	247	146
Buzzfeed	Top Overall	45	111	52
CBS	Top Overall	71	57	423
ChicagoTribune	Top Overall	44	28	74
Chron	Top Overall	31	76	50
ClutchMag	Top African American	11	24	0
CNET	Top Overall	7	19	14
CNN	Top Overall	89	120	119
DailyBeast	Top Overall	51	60	19
DailyMail	Top Overall	161	105	0
DallasMorningNews	Top Overall	28	11	6
DetroitFreePress	Top Overall	34	12	10
Ebony	Top African American	18	196	3
EliteDaily	Top Overall	3	23	6
Engadget	Top Overall	1	11	0
Essence	Top African American	12	19	2
EurWeb	Top African American	43	36	30
Examiner	Top Overall	68	255	189
FoxNews	Top Overall	95	48	24
Gawker	Top Overall	61	227	83
Grio	Top African American	18	34	33
Guardian	Top Overall	89	386	621
HelloBeautiful	Top African American	9	97	25
HuffPost	Top Overall	240	1208	439
Independent	Top Overall	42	24	32
LATimes	Top Overall	103	75	177
MadameNoire	Top African American	18	56	10
Mashable	Top Overall	42	199	57
Mic	Top Overall	23	201	34
Mirror	Top Overall	14	2	23
Mlive	Top Overall	9	7	6
MSN	Top Overall	3	0	0
NBC	Top Overall	108	97	279
NewsOne	Top African American	35	74	11
NJ	Top Overall	2	1	3
NPR	Top Overall	71	132	57
NYDailyNews	Top Overall	54	27	9
NYPost	Top Overall	47	14	41
NYTimes	Top Overall	80	292	192
Salon	Top Overall	74	402	34
SFGate	Top Overall	5	0	6
Slate	Top Overall	41	175	39
TechCrunch	Top Overall	2	14	2
Telegraph	Top Overall	43	9	20
TheAtlantic	Top Overall	27	164	20
TheBlaze	Top Overall	73	111	79
TheRoot	Top African American	58	221	50
Time	Top Overall	92	244	132
Upworthy	Top Overall	8	19	0
USAToday	Top Overall	155	227	153
USNews	Top Overall	30	128	26
Vice	Top Overall	33	195	65
Vox	Top Overall	44	117	129
WashingtonPost	Top Overall	269	1045	749

Source	Category	Articles	External Links	Internal Links
Yahoo	Top Overall	111	281	36
YBF	Top African American	7	26	8
Total		3284	8289	5227

Note. Number of articles and total count of external hyperlinks (linking to an article from a different source) and internal hyperlinks (linking to an article from the same source) embedded in articles of 66 online news media sources in final sample ($n = 52$ top overall outlets; $n = 14$ top African American-oriented outlets).

Methods of Analysis

Community Detection. We used the Spinglass community detection algorithm (Reichardt & Bornholdt, 2006) to examine network structure, per established guidelines for detecting communities in networks containing fewer than 1,000 nodes (Yang, Algesheimer, & Tessone, 2016). In the context of this study, the presence of robust communities would indicate that online news media is segregated into defined clusters of sources that link to one another frequently, and more rarely link to sources outside their cluster (a “chamber”-like structure; Adamic & Glance, 2005). To determine whether news sources were partitioned into defined communities based on their hyperlinks, we bootstrapped our original network 10,000 times with replacement, reassessing community membership in each bootstrap replicate while recording the number of times each pair of sources was assigned to the same community (“comembership”). We obtained final community assignments by running the Spinglass algorithm on the comembership matrix (Lusseau, Whitehead, & Gero, 2009).

We assessed the overall robustness of these communities by calculating the community assortativity coefficient, r_{com} , which represents the degree of overlap between the communities of the observed network and those derived from the 10,000 bootstrap replicates (Shizuka & Farine, 2016). The authors of this method suggest that an r_{com} value greater than 0.5 provides evidence for robust community structure, with values approaching 1 indicating higher confidence in the reliability of identified communities (Shizuka & Farine, 2016, p. 241). Finally, we

estimated network modularity (Q_{est}), a measure of the strength of network division into distinct groups (Newman & Girvan, 2004), by calculating the mean of modularity coefficients derived from 10,000 iterations of Spinglass community detection on the original data.

Assortativity. We examined assortativity (Newman, 2003), a network-level metric that, in this context, reflects the tendency of sources to selectively link to other similar sources. Assortativity coefficient (r) values range from -1, indicating a perfectly disassortative network (in this context, for example, where the political leanings of each pair of sources connected via hyperlink are perfectly negatively correlated), to 0, indicating a non-assortative network (the political leanings of each pair of sources connected via hyperlink are not correlated), to 1, indicating a perfectly assortative network (the political leanings of each pair of sources connected via hyperlink are perfectly positively correlated; Noldus & Van Mieghem, 2015; Newman, 2003). To examine whether the Ferguson news hyperlink network was significantly more or less assortative than what would be expected under a null model, we used a two-tailed node permutation test with 10,000 randomizations of the network, where exact p -values are calculated as the proportion of times assortativity coefficients generated from random networks were greater than the absolute value of the observed assortativity coefficient (e.g., Williamson, Franks, & Curley, 2016; Farine & Whitehead, 2015).

Similarity Measures

We first examined the degree to which sources selectively linked to other sources with a similar political leaning. To examine selective linking to thematically similar content, we extracted two categories of measures of articles' textual content: sentiment and framing of race.

Political leaning. Political leaning of sources was operationalized as the political orientation of their audiences, as in previous research (e.g., Gentzkow & Shapiro, 2011). To

estimate political leaning, we used data collected in another study in which 1,556 participants reported their political orientation and how much they trusted news information from online media sources (see Appendix C). Data was available for 64 of 66 sources in our sample.

Sentiment. Sentiment analysis is a way to measure the positivity, negativity, or general emotionality of text. We calculated *emotionality*—the overall sentiment expressed regardless of positive or negative valence—by computing the proportion of words in articles that appeared in either the LIWC positive or negative emotion dictionaries (Pennebaker, Booth, & Francis, 2007). Higher values of this metric indicate that the text contains a higher proportion of emotion-laden terms generally (Godbole, Srinivasaiah, & Skiena, 2007).

Next, we calculated two metrics of *valence*, or the direction of emotionality expressed in articles (positive or negative). For the first, we used LIWC to calculate the proportion of positive emotion words out of total emotion words. To calculate the second, we used VADER, a more sophisticated context-aware sentiment analysis tool that takes into account contextual factors such as intensifying words and negations (Hutto & Gilbert, 2014). For both of these metrics, higher values indicate positive sentiment and lower values reflect negative sentiment.

Linguistic framing of race. We investigated three linguistic components of Ferguson coverage related to past research on framing of race and race-related issues: focus on race, linguistic intergroup bias, and stereotype-relevant language.

Focus on race. Each source's focus on race was measured using Word2Vec latent word embeddings in dictionary-like methods (Garten et al., 2017). This method relies on distributed word representations that emerged from neural networks (Mikolov et al., 2013). We represented the concept of race as the average of the word vectors for “black,” “white,” “race,” “ethnicity,” and “diversity.”

Linguistic intergroup bias. A source’s linguistic intergroup bias (Maass, Salvi, Arcuri, & Semin, 1989) was operationalized as the correlation between concreteness and emotional valence of language (calculation described above) used in each of that source’s articles. The concreteness for a given article was computed by averaging concreteness ratings for all words in the article that appeared in a lexicon of approximately 40k English words scored from concrete to abstract via crowd-sourcing (Brysbaert, Warriner, & Kuperman, 2014). A positive correlation indicated that articles tended to use concrete and positive language together, and abstract and negative language together—a pattern consistent with conceptualizations of linguistic intergroup bias. This correlation was computed for all sources containing more than two articles about Ferguson ($n = 62$).

Stereotype-relevant language. We used Word2Vec to measure the extent to which news media depicted Michael Brown in a stereotypic (focus on criminality, i.e., his theft of cigarillos) versus counterstereotypic (youth at time of shooting) way. We used the seed words “cigarillo,” “cigar,” and “cigarette” to measure focus on crime, and “youth,” “young,” “child,” “teenager,” “graduation,” and “school” for focus on youth.

Source-level estimation. Whenever source-level estimates of a metric were needed, we fit a multilevel Bayesian model in which each estimated source-specific intercept were so-called “random effects,” in order to account for the nested data structure (see Appendix C). We used the mean of the posterior distribution for each source as the source-level estimate.

Results

Community Structure

Using the previously described bootstrapping approach, we detected four distinct communities of news sources based on hyperlink connectivity, reported in Table 4.2 and pictured

in Figure 4.1. This approach yielded modest evidence that these communities were robust ($r_{com} = .55$, just over the .5 threshold). However, modularity was low ($Q_{est} = .022$). This suggests that while there were four statistically reliable clusters of interconnected sources in this network, segregation was generally weak, and there were still many links across group divisions. In fact, excluding internal links, 23.1% of hyperlinks were between sources of the same community, while 76.9% of hyperlinks cut across community divisions.

Table 4.2. Community membership results

Community 1	Community 2	Community 3	Community 4
AL	ABC	BlackAmericaWeb	BET
BBC	BleacherReport	BlackEnterprise	BostonGlobe
Bossip	DallasMorningNews	ChicagoTribune	BusinessInsider
Boston	Time	Chron	ClutchMag
Buzzfeed	Vice	EliteDaily	CNET
CBS	WashingtonPost	Engadget	CNN
DailyMail		Guardian	DailyBeast
DetroitFreePress		HelloBeautiful	Essence
Ebony		Mic	EurWeb
Gawker		Mirror	Examiner
Grio		NewsOne	FoxNews
HuffPost		NYDailyNews	LATimes
Independent		Salon	NJ
MadameNoire		TheAtlantic	NPR
Mashable		Upworthy	Slate
Mlive		USAToday	TechCrunch
MSN		Yahoo	Telegraph
NBC		YBF	
NYPost			
NYTimes			
SFGate			
TheBlaze			
TheRoot			
USNews			
Vox			
$n = 25$	$n = 6$	$n = 18$	$n = 17$

Note. Membership results derived from hyperlink connectivity using bootstrapping method with Spinglass community detection algorithm.

$n_{links} = 7,826$; see Figure 4.2), we find that the network was assortative by political leaning ($r_{lean} = .12$), but assortativity was not greater than would be expected under the null ($p = .98$). In other words, while the 64 sources were more likely to link to other sources with similar rather than dissimilar political leanings, the observed correlation between political leanings of sources connected by hyperlinks did not exceed the correlation expected by chance.

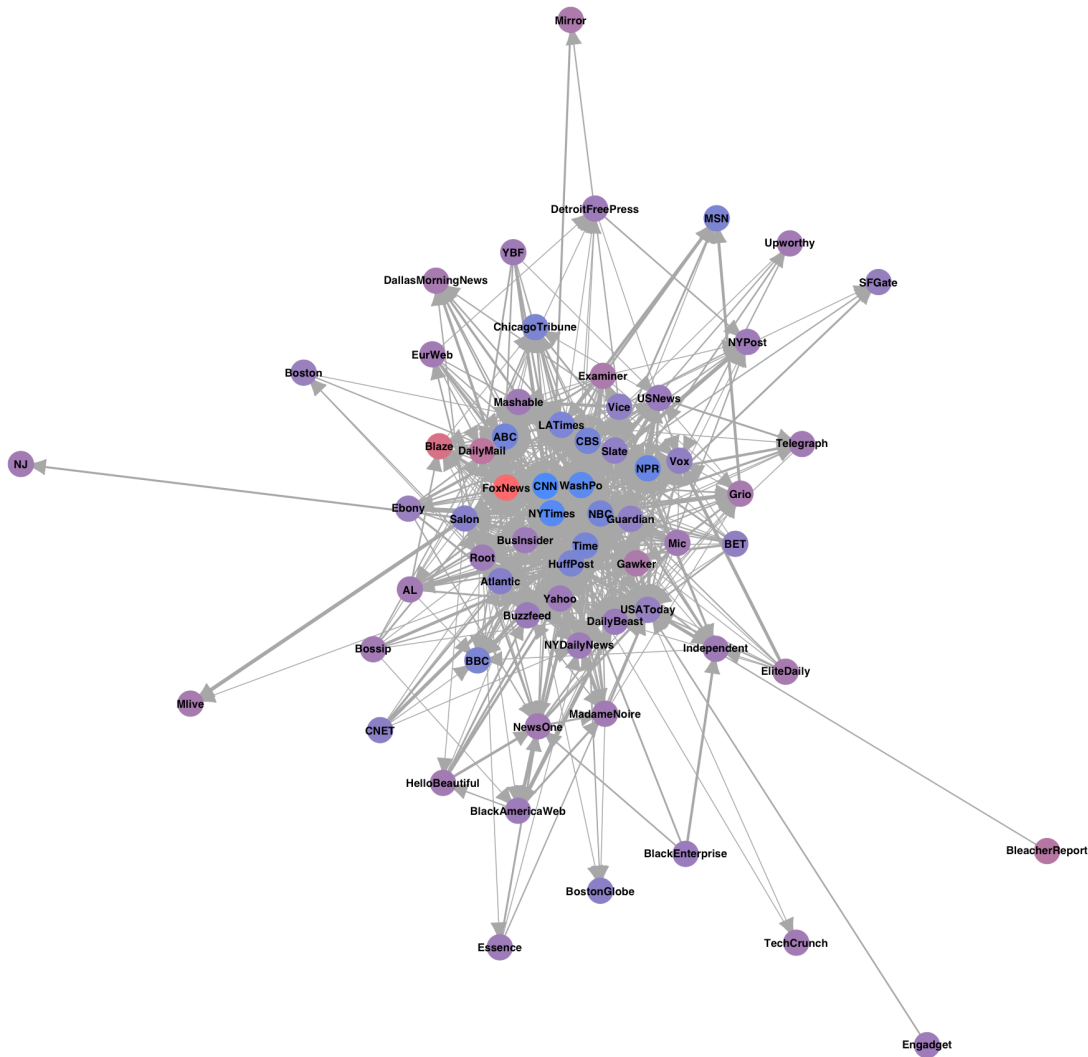


Figure 4.2. News hyperlink network with source political leaning

The sub-network of 64 sources for which political leaning data was available, colored by proportion of conservative users from red (highest proportion of conservative users) to blue (lowest proportion of conservative users). Internal hyperlinks (an article linking to another article from the same source) are not pictured, nor are hyperlinks from or to sources outside the 64-source subset.

We next turned to assortativity analyses based on the linguistic metrics calculated for each of the sources. Figure 4.3 displays the correlations between the linguistic measures used in our analyses, plus source political leanings. To determine whether the network showed evidence of assortativity by sentiment, we first examined emotionality. Assortativity by emotionality would indicate that sources that used emotional language—whether positively or negatively valenced—in their coverage of the Ferguson shooting tended to link to other sources that also used emotional language. Analyses did not reveal significant assortativity by emotionality ($r_{emo} = .15$, $p = .23$). However, analyses of assortativity by valence revealed that the network was significantly more assortative by valence than would be expected by chance using both the LIWC method ($r_{val-L} = .19$, $p = .04$), and the context-aware VADER method ($r_{val-V} = .19$, $p = .01$). These results indicate that sources tended to link to other sources that covered the shooting with a similar valence (i.e., *either* positively *or* negatively).

Analyses on linguistic framing of race revealed no significant assortativity by sources' use of race-related words in articles about the events in Ferguson ($r_{race} = .14$, $p = .39$) or by our operational measure of linguistic intergroup bias—the correlation between article text concreteness and valence—using either valence measure (LIWC: $r_{LIB-L} = .15$, $p = .28$, VADER: $r_{LIB-V} = .17$, $p = .09$). However, the network was significantly more assortative by focus on both Brown's criminality (i.e., stealing cigarillos; $r_{crime} = .21$, $p = .01$) and his youth ($r_{youth} = .18$, $p = .03$) than would be expected by chance. These results indicate that news sources tended to link to other sources that had similarly stereotypic or counterstereotypic coverage.

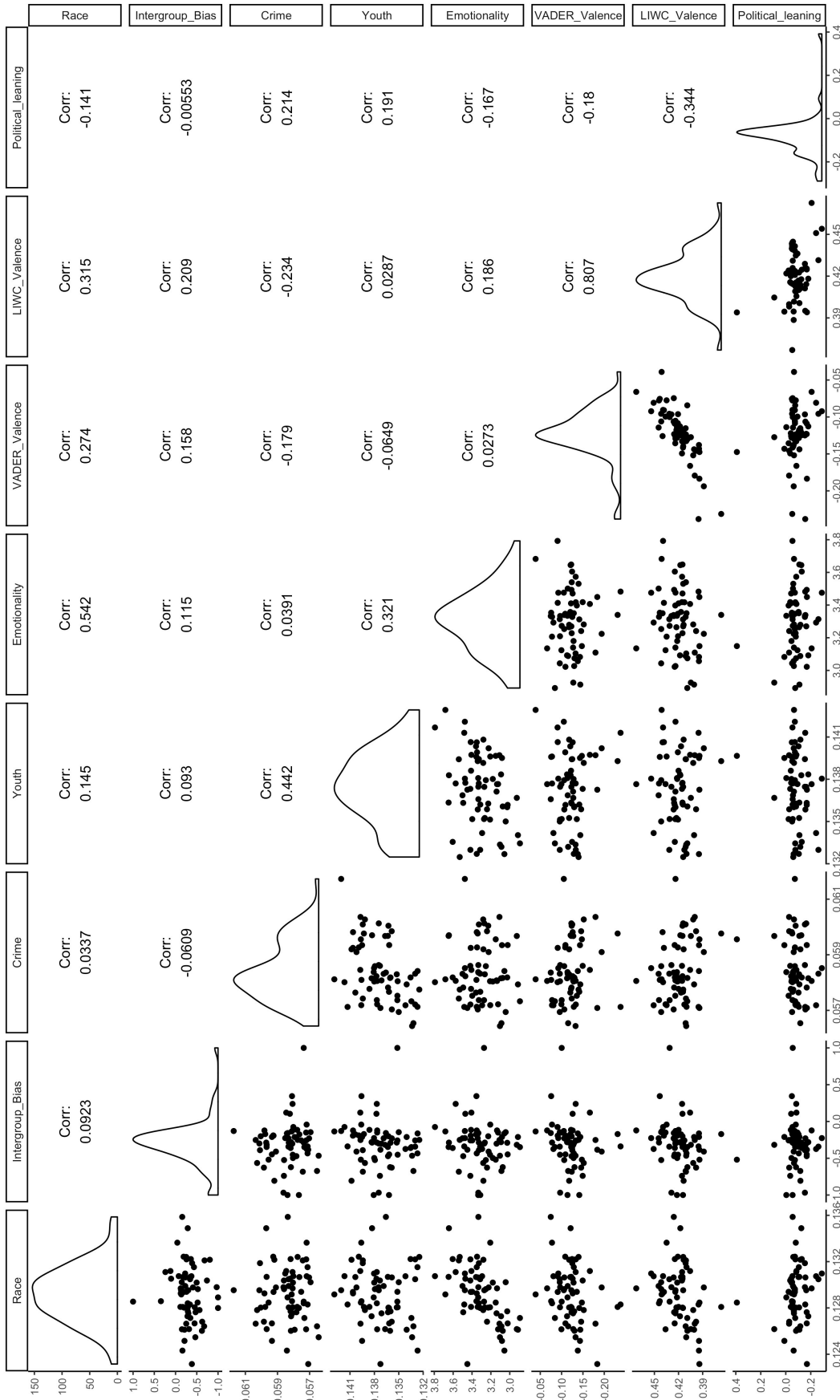


Figure 4.3. Correlation matrix of linguistic metrics measured at the source level
 “Intergroup Bias” refers to the correlation between concreteness and valence (VADER measure).

Discussion

In this research, we sought to illuminate modern situational factors contributing to selective exposure by documenting the ways in which online news media may directly shape and segment the information to which individuals are exposed. Specifically, we examined a hyperlink network of news articles about the 2014 shooting of Michael Brown in Ferguson to determine whether media organizations contribute to potential “echo chambers” by (1) selectively embedding links to a finite set of other sources, limiting the potential for users to click through to sources outside the “chamber,” and, further, (2) selectively embedding links to sources that cover national—especially nationally polarizing—events in thematically similar ways (the “echo”). Results indicated, first, that although the network divided into statistically reliable subgroups of interconnected sources, the overall division of the network into distinct, segregated groups was low, and sources frequently linked to other news outlets outside of their own communities. Second, we found that sources tended to link to other sources that covered the Ferguson events with a similar valence (i.e., positive or negative emotionality), and with similar emphasis on Brown’s criminality and youth. We did not find selective linking between sources that had similar political leanings, use of race-related words, or language consistent with linguistic intergroup bias.

Our finding that news sources linked to other sources that covered the Ferguson events with a similar emotional valence is consistent with previous work that found assortativity by valence in political dialogue among Twitter users (Himmelboim et al., 2016). Our work demonstrates that this “valence sorting” extends to hyperlink decisions made by media organizations, creating a digital structure that may support and reinforce the tendency to engage with others who have the same emotional take on political events. In particular, given that

individuals tend to seek out affective information that matches their own beliefs (Swann et al., 1992), selective hyperlinking by valence similarity may ensure that consumers are exposed to information matching their particular affective attitude toward a given event from both the first news source they visit and from subsequent articles to which they are directed. This repeated exposure may strengthen their attitudes and beliefs about the event, heightening affective polarization (Petty, Haugtvedt, & Smith, 1995). This could translate to increased ideological polarization, given work suggesting that political and moral judgments are frequently driven by affective response (Graham, Meindl, & Beall, 2012; Valdesolo & DeSteno, 2006). As such, valence assortativity in hyperlinking could provide one explanation for growing ideological polarization (Moody & Mucha, 2013; Pew Research Center, 2014a).

Further, this research suggests that news media may facilitate selective exposure to racial stereotypes through hyperlinking decisions. Sources emphasizing Brown's theft of cigarillos—consistent with the stereotype of Black Americans as criminals (Dixon & Maddox, 2005)—were more likely to link to other sources that also emphasized this aspect of the narrative. Similar sorting emerged in emphasis on Brown's youth, a focus counter to the stereotype-driven tendency to regard Black boys as older and less innocent than they are (Goff et al., 2014). This suggests that, depending on where individuals enter a news cycle, they may be differentially exposed to pockets of stereotypic or counterstereotypic coverage. This could have profound implications for endorsement of racial stereotypes, and societal movement toward improved race relations and equality more broadly. Exposure to stereotypic information perpetuates stereotypes (Hilton & von Hippel, 1996), and stereotypes in the media specifically can strengthen real-world stereotype endorsement and prejudice, and decrease support for policies that may help the stereotyped group (Ramasubramanian, 2007). Exposure to such information in echo chamber-

like environments may strengthen these effects (DiFonzo et al., 2013), increasing societal polarization in racial stereotype endorsement depending on where one gets one's news.

This work paves the way for future research examining how structural factors shaping access to thematically different information interact with individuals' motivations to confirm pre-existing attitudes and avoid inconsistent information (Smith et al., 2008). Previous work suggests that attitudinal polarization is partly driven by biased assimilation, where individuals perceive attitude-confirming information as more convincing than attitude-disconfirming information (Lord, Ross, & Lepper, 1979). For example, individuals with negative attitudes toward a social group are more likely to believe stereotype-consistent information than counterstereotypic information about that group, strengthening their original attitudes (Munro & Ditto, 1997). Our work suggests that the organization of online news media, in promoting selective exposure (for example, to stereotypic versus counterstereotypic news coverage), may facilitate attitude polarization, exacerbating the effects of individual attitudinal and information-seeking processes. Directly examining how the themes and organization of coverage observed here affect individual attitudes and selective exposure is a critical next step.

This research also suggests a need for future work on the motivations behind and consequences of journalistic decisions to link to other sources. Although we have focused on implications for news consumers—i.e., de facto selective exposure—there are also people behind online news hyperlinking decisions, and the psychology of these individuals is important to understand considering the potential influence (however unintentional) of their decisions on selective exposure and attitude polarization. A greater understanding of these decisions could also shed light on how “chambers” emerge in online news media. While results of this analysis suggested that there were reliable groups of sources that tended to link to one another, these

communities were relatively weak, and we detected no obvious source characteristics that could be driving the observed divisions. Future work could illuminate presently unobserved variables that explain these groupings, such as timing (i.e., media sources that publish first influence what other sources decide to cover, and the themes they use in their coverage; Golan, 2006) or corporate partnerships (e.g., NBC and MSN may have incentive to link to one another because of their corporate relationship). Linking decisions could also be dependent on the type of news being covered. For example, perhaps hyperlink decisions in coverage of a presidential campaign depend more on ideological alignment (potentially leading to more ideological segregation in the news network) given that news sources may actively endorse candidates, whereas linking decisions in coverage of an unexpected geopolitical event such as Brown's shooting rely more on timing, regardless of ideological compatibility (leading to weaker segregation). This is also an important consideration for generalizability of the findings described here, as a hyperlink network of coverage of a different event could have revealed different findings.

In sum, using the "echo chamber" framework, our work shows that there is relatively weak evidence for the existence of "chambers" in the hyperlinking behavior of news organizations on the web. However, there is robust evidence that the hyperlinks embedded in online news articles promote valence and stereotype "echoes" by connecting coverage with similar affect and content related to racial stereotypes. This work highlights the importance of examining structural factors shaping access to certain types of information, particularly in the context of prominent geopolitical events like the Ferguson shooting. This is an increasingly pressing research topic in the context of high social polarization and the constantly connected nature of modern society.

V. Conclusions¹⁷

Three studies leveraged network theory and methods to advance understanding of three distinct phenomena: gender disparities in negotiation outcomes, student persistence in the sciences, and selective exposure to like-minded information. Across these three studies, this dissertation demonstrates that the social systems in which people are embedded affect real-world outcomes, sometimes over and above intrapsychic processes that often receive more attention in psychological research. A person's position within a network may provide both affordances and constraints. For example, Chapters II and III demonstrated the potential affordances of holding central positions in social networks: Greater centrality in class networks predicted improved negotiation performance and greater persistence in the sciences. Yet, Chapter IV demonstrated that network structures can also impart constraints, suggesting that where a person enters a given news cycle—which source or article he or she initially reads—may shape exposure to different strands of thematically consistent information, a structural form of selective exposure. Below, I discuss implications of this dissertation research for three areas of research: education, intervention science, and the growing area of social network psychology.

Implications for Education Research

Helping students persist in the face of academic challenges and succeed in attaining their scholastic goals is a primary aim of higher education (U.S. Department of Education, 2015). Classic theories of student attrition have long suggested that that students' social integration into campus life is critical to their persistence and achievement (Bean, 1982; Tinto, 1975). Yet, the vast majority of education research investigating strategies to increase student persistence and success has focused on individual intrapsychic knowledge, skills, and psychological resources.

¹⁷ This chapter includes some content from Turetsky, K. M. & Zee, K. S. (in preparation). Toward an integrated, multilevel perspective on the social effects of stress.

For example, researchers and practitioners frequently concentrate on cognitive and noncognitive skills, from abstract thinking and study strategies to personality and character skills like self-control and grit (e.g., Duckworth, Peterson, Matthews, & Kelly, 2007; Dunlosky et al., 2013; Gutman & Schoon, 2013). Surprisingly little work, especially in psychology, has empirically investigated methods of building students' extrapsychic social resources as a means of helping them persevere and thrive in academic settings.

This work joins other recent research (e.g., Stadtfeld, Vörös, Elmer, Boda, & Raabe, 2019; Zwolak, Dou, Williams, & Brewé, 2017) in suggesting that students' integration into school social networks is often important for their persistence and success. Further, this work—in particular, Chapter III—goes beyond prior work to highlight the value of psychological interventions in education settings to help students build and maintain strong, positive social networks over time. Developing effective strategies to strengthen students' networks over time benefit their long-term scholastic outcomes.

This work could be extended by examining strategies to increase connection among students at different levels. For example, in many cases, changing course design to provide opportunities for connection, such as instituting formal study groups or incorporating collaborative learning opportunities (e.g., jigsaw classrooms; Aronson, 1978), may provide the most direct route to building students' networks and facilitating their success. In contrast, in cases when teachers are unwilling to implement changes, or when the course context does not allow for such changes, interventions aimed to lower social defenses and increase social approach behavior in individual students (as in Chapter III) may be effective.

Attending to students' social networks may be particularly important in stressful or psychologically threatening educational contexts. For example, in science, technology,

engineering and math (STEM) disciplines, ideas and messages that performance reflects innate intellectual ability, rather than effort and potential, are prevalent in STEM (Dweck, 2006; Leslie, Cimpian, Meyer, & Freeland, 2015). Many instructors and departments view introductory courses in STEM as important mechanisms to “weed out” students who are not cut out for science and math, promoting a belief that class performance is diagnostic of underlying ability, and that some students have this ability and some do not (Frazier, Howard, Shaw, & Ticknor, 2017). Much research has shown that this type of messaging can undermine self-esteem, performance, and motivation (Dweck, 2000; Leslie et al., 2015; Shapiro & Sax, 2011). This may be further exacerbated by perceptions of STEM departmental climates as “chilly” and isolating, with little personalized attention, expressions of interest in students’ advancement, or faculty and peer support (Burke & Mattis, 2007).

Consistent with findings in Chapter III, research suggests that these types of psychological stressors can erode individuals’ social relationships (Aquino & Douglas, 2003; Lewandowski et al., 2014; Turetsky & Zee, in prep). Stress frequently inhibits positive relationship maintenance behaviors and leads to social withdrawal and other behavior that is destructive to relationships (Lewandowski et al., 2014). In other words, the stress of STEM courses (especially introductory “weed-out” courses) may not only undermine students’ performance, motivation, and wellbeing, but also lead to deterioration of their social relationships—potentially dealing further damage to students’ persistence and performance. In contrast, efforts to protect and build students’ social networks in STEM and other similarly stressful courses may help these students persist and succeed. These efforts are particularly important given the larger societal problem of the STEM graduate shortage.

Attending more closely to students' social integration, and potential disparities in integration, may also be important in graduate and professional education. For example, greater connectedness in business school may not only affect negotiation performance, as seen in Chapter II, but may also roll over into better post-graduate outcomes. Recent research suggests that business students are recruited for leadership positions directly out of MBA programs, and that network centrality in business school predicts better job placement (Yang, Chawla, & Uzzi, 2019). This work also suggests that having a predominantly female inner circle is associated with better job placement for women, as these connections provide greater access to gender-related tacit information. Chapter II is thus consistent with other research suggesting that it is important for education settings to attend to and value students' social networks, and also offer opportunities for connection among those who may be disadvantaged in a particular educational context by creating or supporting affinity groups.

Implications for Intervention Science

In addition to its specific implications for strengthening connection in educational settings, this work also makes key theoretical contributions to the field of intervention science. The vast majority of social psychological intervention research focuses on intrapsychic processes and individual outcomes (e.g., "wise" interventions; Walton, 2014; Walton & Wilson, 2018). However, the experiment described in Chapter III suggests that psychological interventions can be leveraged to alter the social structure of groups in addition to individual-level psychology. Such shifts could be an understudied mechanism by which psychological interventions affect change.

First, changes in individuals' local ecology could help to sustain the effects of an intervention over time. For example, prior work has shown that "wise" interventions can operate

recursively, such that they often have small initial effects that strengthen over time (Walton & Wilson, 2018). For example, the effects of a social belonging intervention aiming to normalize social adversity and concerns about belonging unfolded over nine years after treatment, such that treated African American students felt less concerned about belonging in college, received better grades through senior year, and later reported greater life and career satisfaction (Walton & Cohen, 2007, 2011; Walton & Wilson, 2018). Further, an affirmation intervention had increasingly strong effects over time, narrowing the racial achievement gap more as time since the intervention elapsed (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009).

Researchers have typically focused on intrapsychic mechanisms as the drivers of these processes, such as improved self-perception and less uncertainty about belonging. Indeed, these psychological changes are surely important in the lasting effects of these interventions. However, the present research suggests that changes in treated individuals' social ecology may also be one key factor in the propagation of positive intervention effects. If these interventions strengthen individuals' social ties and their positions in social networks, this could afford many other extrapsychic benefits to these individuals that could help to maintain and promote positive effects, such as social support and access to information and relationships important for success. Ongoing research by others supports this idea, with findings suggesting that students who received a social belonging intervention reported developing more mentor relationships in college and beyond, which in turn promoted their long term success (see description of manuscript in preparation, Walton & Wilson, 2018, p. 621).

Second, psychological interventions may also shift broader social ecology in ways that benefit untreated students as well. For example, although in Chapter III we did not have an appropriate comparison group to test this idea, it is possible that the greater connectedness of

affirmed students may afforded benefits to unaffirmed students as well, by way of creating a more connected network with and around unaffirmed students. Other research that has compared the effects of interventions at the class and school level support this idea. For example, one study found that the more African American students in a class who participated in a values affirmation intervention, the better the entire class performed (Powers et al., 2016). Another study found that schools in which some students were selected to participate in an anti-conflict intervention had fewer disciplinary reports of student conflict overall than schools in which there was no intervention (Paluck, Shepherd, & Aronow, 2016). This dissertation research thus joins a growing body of work suggesting that psychological interventions can affect change in both local and broad social ecologies, boosting outcomes for both treated individuals and others in the shared social environment.

On the other side of the coin, the present work also suggests that the effect of interventions at the individual level may be undermined if overarching social structure is not taken into account during intervention development. For example, negotiations literature suggesting that intrapsychic factors such as apprehension about negotiating and stereotype threat contribute to the gender gap in negotiations may identify these processes as a target for intervention. However, reducing women's apprehension about negotiating, for example, may not have a strong effect, or any effect at all, if women hold disadvantaged positions in the larger social structure. Indeed, in Chapter II, we found no gender difference in apprehension about negotiating, perhaps due to the selection bias inherent to selecting MBA students in a negotiations class for the study. Yet, the gender gap in negotiation outcomes persisted, and was most strongly explained by students' positions in social networks, rather than by any intrapsychic factor. Similarly, an intervention attempting to encourage individuals to diversify their

information exposure may be less successful if the broader social structures that subtly promote selective exposure to homogenous perspectives outside of individual choice are not addressed. Thus, networks may provide both opportunities to strengthen intervention effects as well as constraints on their effects if social structure is not considered. A greater understanding of both the existing social ecology in which one is intervening as well as the potential ecological effects of the target intervention is important to advance intervention science research.

Finally, this research highlights an opportunity for social psychological insight into interventions on social structure. Whereas social psychologists have focused more on interventions targeted at individuals, sociologists and political scientists have leveraged structural and ecological interventions as a cornerstone of their disciplines. Findings from this dissertation suggest that structural interventions typically advanced by other disciplines could benefit in important ways from taking the psychology of individuals into account. For example, research suggests that instituting formal mentoring can reduce the social network disadvantage of women in the workplace (Srivastava, 2015). However, this literature also points to challenges with formal mentoring, such as formal mentors being less motivated than informal mentors to develop a deep relationship because mentees have been assigned to them rather than personally chosen (Ragins & Cotton, 1999). As a result of this lower motivation, formal mentorship relationships can last for shorter periods, may provide fewer psychosocial benefits to mentees, and be more variable in quality compared to informal mentoring relationships (Ragins & Cotton, 1999; Ragins, Cotton, & Miller, 2000). On the mentee side, mentees may have unrealistic expectations about the benefits formal mentors will provide, and that these unmet expectations may increase the likelihood of turnover (Brief, 2008). This example illustrates the potential contributions social psychologists could make to developing effective structural interventions.

With expertise on motivation, expectations, and other intrapsychic processes, social psychologists could be in a unique position to implement multilevel interventions that carefully attend to the individual psychological processes that may make or break the success of broader structural changes.

Implications for Social Network Psychology

Research suggests that social network analysis is gaining exponentially in popularity in social and personality psychology (Clifton & Webster, 2017b). This analysis suggested that an average of 11% of articles published in two social psychology flagship journals, *Journal of Personality and Social Psychology* and *Personality and Social Psychology Bulletin*, mentioned social networks in the last five years. However, only 12 articles since 1990 collected network data, and only 9 of these used social network analysis. This suggests that social and personality psychologists are becoming more interested in social networks. However, there remains room to grow in actually using social network analysis in social psychological work.

There are two ways in which greater adoption of social network analysis in social psychology would be beneficial. First, social network analysis can shed light on many of the questions social psychologists are already interested in. As long as social psychologists are interested in relational processes—such as intergroup relations, close relationships, social support, social norms—social network analysis offers an opportunity to better understand these processes in context at multiple levels. Second, social psychologists can shed light on the psychological correlates, antecedents, and consequences of network processes. I discuss each of these in turn.

Social network analysis and classic social psychological phenomena. Social network analysis can reveal new insight into classic social psychological questions. Consider, for

example, one subfield of social psychology: social support (Turetsky & Zee, in prep). Although social support research has often focused primarily on support provided within close romantic relationships, research taking a network-based approach has begun to provide a fuller picture of the importance of receiving support from multiple sources, even for romantic relationship outcomes. Some early work showed that support from social networks predicts marital success above and beyond support within the couple (Bryant & Conger, 1999). More recent work suggests that the more people who name an individual as a friend, the lower his or her likelihood of divorce (McDermott, Fowler, & Christakis, 2013). Daily diary work has also revealed a link between day-to-day marital conflict and physiological stress (operationalized as cortisol responses) among partners who reported low quality support available outside of their romantic relationship; in contrast, partners experienced less physiological stress in response to marital conflict if they reported high quality support networks (Kaneski, Neff, & Loving, 2017). Additionally, recent research has revealed that individuals tend to turn to different network members for different emotional needs, and that people who diversify whom they seek out for regulating different emotions (e.g., people who turn to a sibling to rant when they are angry, versus a friend to help them cheer up when they are sad) tend to show increased wellbeing compared to those who rely on the same individuals for all of their emotion regulation needs (Cheung, Gardner, & Anderson, 2015). Further, recent work has begun to demonstrate the potential of studying how stress impacts social networks at large, beyond specific dyadic relationships. In a direct demonstration of the novel insight social network approaches can yield, one recent analysis examining who individuals seek out during difficult and stressful times found that individuals often confide in weak or distant ties, as opposed to close friends, romantic partners, or family members, as is often assumed in individual and dyadic research (M. L. Small,

2017). Importantly, these are types of patterns that individual and dyadic designs typically do not—or cannot—pick up on. These findings highlight the unique insights social network approaches can provide to topics that have traditionally interested social psychologists.

In addition to shedding light on relational processes, network analysis can provide a theoretical approach and set of tools to advance the study of any interconnected phenomena. For example, psychologists have used network analysis to advance a novel theory of personality as a system of interconnected affective, cognitive, and behavioral components (Cramer et al., 2012). Challenging conventional ideas of personality as defined by a small set of latent dimensions (e.g., extraversion, conscientiousness), this network model examines personality more holistically as an interdependent system of likes and dislikes, attitudes and cognition, and behavior that varies between individuals. Similarly, others have advocated for a model of psychopathology based on networks of symptoms as an alternative to defining psychopathology as a series of discrete mental disorders (Borsboom, 2017). Still others have used network analysis to define political belief systems, showing that symbolic beliefs (such as party identification) are more central to political belief networks than operational beliefs (such as positions on particular issues; Brandt, Sibley, & Osborne, 2019). Similar to how we used network analysis concepts and tools to examine echo chamber-like structures in online news media in Chapter IV, this work highlights the many possible creative uses of social network analysis for advancing social and personality psychology, including and beyond relational applications.

Social psychology and the psychology of network processes. The second benefit of incorporating social network analysis is that social psychologists can shed light on the psychological correlates, antecedents, and consequences of network processes. Currently in the

network literature, there are many psychological interpretations of social network concepts and processes. For example, that greater centrality in social networks provides greater access to information, resources, and support is considered common knowledge. Additionally, specific centrality measures are often cited as having particular social implications: *Betweenness centrality* is often seen as a measure of power or potential control over the flow of information in a network, *closeness centrality* is often seen as a measure of influence and ability to access information, *degree centrality* is often seen as a measure of overall involvement and activity in the network, and so on. Yet, in many cases, these commonplace interpretations are backed only by theoretical ideas of what certain network positions should entail (e.g., Freeman, 1978). Greater integration between social network science and social psychology thus has the potential to reveal much-needed empirically-based insight into the psychology of holding central network positions and other network constructs.

Such insight would greatly help to uncover mechanisms of network effects. For example, in Chapter II, I identified three potential mechanisms by which social network centrality may affect negotiation performance: access to information and resources, perceived power, and greater affordances to take social risks. These mechanisms are all empirically testable. For example, one could test the objective knowledge and perceived access to knowledge and resources of central versus noncentral individuals. One could present participants with individuals who ostensibly hold more or less central positions in social networks and ask participants to rate perceived power and status. Additionally, one could experimentally manipulate perceived social risk of undertaking a certain behavior (e.g., an assertive bargaining tactic in a negotiation, calling out a sexist remark) and evaluate whether more or less central individuals are more likely to take on social risk. Experimental approaches—the bread and butter

of social psychologists—would be particularly valuable for advancing understanding of the psychology of network processes and mechanisms.

Lastly, it is worth emphasizing that social network data collection can be easily integrated into traditional social psychological methods, such as questionnaires, interviews, and daily diaries (Clifton & Webster, 2017b). Collecting network data can be as simple as asking individuals to nominate people who fit a certain type of relationship of interest, such as friends, people they spend time with, and people from whom they receive support or advice in a questionnaire (e.g., Paluck, Shepherd, & Aronow, 2016). Data collection can also occur through daily diary or ecological momentary assessment surveys, such as asking individuals to note who they came into contact with on a particular day or who they are with at a particular moment (e.g., Pagel, Erdly, & Becker, 1987). Social networks can also be collected through more objective means, such as accessing email or text metadata or recording friends on social networking sites, which may also be feasible in particular applications. Further, social network analytical tools are more easily accessible now than ever: Whereas expensive dedicated programs were often the norm for social network analysis in the past, R packages like *igraph* (Csardi & Nepusz, 2006) and *statnet* (Handcock, Hunter, Butts, Goodreau, & Morris, 2008) now offer free and powerful solutions for social network analysis.

Conclusion

This dissertation sheds light on the potential influence of networks on important outcomes in the context of real-world social problems. Three studies suggested that network structure may influence performance in negotiations, persistence in the sciences, and selective exposure to homogenous information. These network structures can provide both affordances and constraints that affect individual behavior and outcomes. In particular, all three studies

suggest that these networks may in some cases affect outcomes over and above intrapsychic processes that tend to receive greater attention in social psychological research. These findings highlight one of the original premises of social psychology: that to understand behavior, one must understand both individuals and the social structures in which they operate. As Ivan Steiner commented in 1974 when wondering what happened to the study of groups in social psychology: “Seeing individuals, but not the social system, is like seeing the trees but not the forest.”

References

- Akinola, M., Fridman, I., Mor, S., Morris, M. W., & Crum, A. J. (2016). Adaptive Appraisals of Anxiety Moderate the Association between Cortisol Reactivity and Performance in Salary Negotiations. *PLOS ONE*, *11*(12), e0167977. doi:10.1371/journal.pone.0167977
- Almaatouq, A., Radaelli, L., Pentland, A., & Shmueli, E. (2016). Are You Your Friends' Friend? Poor Perception of Friendship Ties Limits the Ability to Promote Behavioral Change. *PLOS ONE*, *11*(3), e0151588. doi:10.1371/journal.pone.0151588
- Amanatullah, E. T., & Morris, M. W. (2010). Negotiating gender roles: Gender differences in assertive negotiating are mediated by women's fear of backlash and attenuated when negotiating on behalf of others. *Journal of Personality and Social Psychology*, *98*(2), 256–267. doi:10.1037/a0017094
- Aquino, K., & Douglas, S. (2003). Identity threat and antisocial behavior in organizations: The moderating effects of individual differences, aggressive modeling, and hierarchical status. *Organizational Behavior and Human Decision Processes*, *90*(1), 195–208. doi:10.1016/S0749-5978(02)00517-4
- Aronson, E. (1978). *The jigsaw classroom*. Oxford, England: Sage.
- Ashtiani, M., Mirzaie, M., & Jafari, M. (2018). CINNA: An R/CRAN package to decipher Central Informative Nodes in Network Analysis. *BioRxiv*, 168757. doi:10.1101/168757
- Ayres, I. (1990). Fair Driving: Gender and Race Discrimination in Retail Car Negotiations. *Harvard Law Review*, *104*, 817.
- Ayres, I. (1995). Further Evidence of Discrimination in New Car Negotiations and Estimates of Its Cause. *Michigan Law Review*, *94*(1), 109–147. doi:10.2307/1289861

- Ayres, I., & Siegelman, P. (1995). Race and Gender Discrimination in Bargaining for a New Car. *The American Economic Review*, 85(3), 304–321.
- Babcock, L., Gelfand, M., Small, D., & Stayn, H. (2006). Gender differences in the propensity to initiate negotiations. In D. D. Cremer, M. Zeelenberg, & J. K. Murnighan (Eds.), *Social psychology and economics* (pp. 239–259). Mahwah, NJ: Lawrence Erlbaum.
- Babcock, L., & Laschever, S. (2009). *Women Don't Ask: Negotiation and the Gender Divide*. Princeton University Press.
- Baldwin, T. T., Bedell, M. D., & Johnson, J. L. (1997). The Social Fabric of a Team-Based M.B.A. Program: Network Effects on Student Satisfaction and Performance. *The Academy of Management Journal*, 40(6), 1369–1397. doi:10.2307/257037
- Barrat, A., Barthélemy, M., Pastor-Satorras, R., & Vespignani, A. (2004). The architecture of complex weighted networks. *Proceedings of the National Academy of Sciences of the United States of America*, 101(11), 3747–3752. doi:10.1073/pnas.0400087101
- Bean, J. P. (1982). Conceptual models of student attrition: How theory can help the institutional researcher. *New Directions for Institutional Research*, 1982(36), 17–33. doi:10.1002/ir.37019823604
- Bean, J. P. (1983). The Application of a Model of Turnover in Work Organizations to the Student Attrition Process. *The Review of Higher Education*, 6(2), 129–148. doi:10.1353/rhe.1983.0026
- Beilock, S. L., Jellison, W. A., Rydell, R. J., McConnell, A. R., & Carr, T. H. (2006). On the Causal Mechanisms of Stereotype Threat: Can Skills That Don't Rely Heavily on Working Memory Still Be Threatened? *Personality and Social Psychology Bulletin*, 32(8), 1059–1071. doi:10.1177/0146167206288489

- Beilock, S. L., Rydell, R. J., & McConnell, A. R. (2007). Stereotype threat and working memory: Mechanisms, alleviation, and spillover. *Journal of Experimental Psychology: General*, *136*(2), 256–276. doi:10.1037/0096-3445.136.2.256
- Belliveau, M. A. (2005). Blind Ambition? The Effects of Social Networks and Institutional Sex Composition on the Job Search Outcomes of Elite Coeducational and Women’s College Graduates. *Organization Science*, *16*(2), 134–150.
- Bernstein, E. S., & Turban, S. (2018). The impact of the ‘open’ workspace on human collaboration. *Phil. Trans. R. Soc. B*, *373*(1753), 20170239. doi:10.1098/rstb.2017.0239
- Boogert, N. J., Farine, D. R., & Spencer, K. A. (2014). Developmental stress predicts social network position. *Biology Letters*, *10*(10), 20140561–20140561. doi:10.1098/rsbl.2014.0561
- Borah, P. (2014). The Hyperlinked World: A Look at How the Interactions of News Frames and Hyperlinks Influence News Credibility and Willingness to Seek Information. *Journal of Computer-Mediated Communication*, *19*(3), 576–590. doi:10.1111/jcc4.12060
- Borgatti, S. P., & Foster, P. C. (2003). The Network Paradigm in Organizational Research: A Review and Typology. *Journal of Management*, *29*(6), 991–1013. doi:10.1016/S0149-2063(03)00087-4
- Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry*, *16*(1), 5–13. doi:10.1002/wps.20375
- Boucher, K. L., Fuesting, M. A., Diekman, A. B., & Murphy, M. C. (2017). Can I Work with and Help Others in This Field? How Communal Goals Influence Interest and Participation in STEM Fields. *Frontiers in Psychology*, *8*. doi:10.3389/fpsyg.2017.00901

- Bowles, H. R., Babcock, L., & Lai, L. (2007). Social incentives for gender differences in the propensity to initiate negotiations: Sometimes it does hurt to ask. *Organizational Behavior and Human Decision Processes*, *103*(1), 84–103.
doi:10.1016/j.obhdp.2006.09.001
- Bowles, H. R., Babcock, L., & McGinn, K. L. (2005). Constraints and triggers: Situational mechanics of gender in negotiation. *Journal of Personality and Social Psychology*, *89*(6), 951–965. doi:10.1037/0022-3514.89.6.951
- Brady, W. J., Wills, J. A., Jost, J. T., Tucker, J. A., & Van Bavel, J. J. (2017). Emotion shapes the diffusion of moralized content in social networks. *Proceedings of the National Academy of Sciences*, 201618923. doi:10.1073/pnas.1618923114
- Brands, R., & Rattan, A. (under review). A cognitive social network account of women's interpersonal responses to prejudice in the workplace.
- Brandt, M. J., Sibley, C. G., & Osborne, D. (2019). What Is Central to Political Belief System Networks? *Personality and Social Psychology Bulletin*, 0146167218824354.
doi:10.1177/0146167218824354
- Brass, D. J. (1984). Being in the Right Place: A Structural Analysis of Individual Influence in an Organization. *Administrative Science Quarterly*, *29*(4), 518–539. doi:10.2307/2392937
- Brass, D. J., & Burkhardt, M. E. (1993). Potential Power and Power Use: An Investigation of Structure and Behavior. *Academy of Management Journal*, *36*(3), 441–470.
doi:10.5465/256588
- Brief, A. P. (2008). *Diversity at Work*. Cambridge University Press.

- Brooks, A. W., Huang, L., Kearney, S. W., & Murray, F. E. (2014). Investors prefer entrepreneurial ventures pitched by attractive men. *Proceedings of the National Academy of Sciences*, *111*(12), 4427–4431. doi:10.1073/pnas.1321202111
- Brooks, A. W., & Schweitzer, M. E. (2011). Can Nervous Nelly negotiate? How anxiety causes negotiators to make low first offers, exit early, and earn less profit. *Organizational Behavior and Human Decision Processes*, *115*(1), 43–54.
doi:10.1016/j.obhdp.2011.01.008
- Brown, A. D., & Curhan, J. R. (2013). The Polarizing Effect of Arousal on Negotiation. *Psychological Science*, *24*(10), 1928–1935. doi:10.1177/0956797613480796
- Burke, R. J., & Mattis, M. C. (2007). *Women and Minorities in Science, Technology, Engineering, and Mathematics: Upping the Numbers*. Edward Elgar Publishing.
- Caldwell, M. S., Rudolph, K. D., Troop-Gordon, W., & Kim, D.-Y. (2004). Reciprocal Influences Among Relational Self-Views, Social Disengagement, and Peer Stress During Early Adolescence. *Child Development*, *75*(4), 1140–1154. doi:10.1111/j.1467-8624.2004.00730.x
- Casper, A., Sonnentag, S., & Tremmel, S. (2017). Mindset matters: the role of employees' stress mindset for day-specific reactions to workload anticipation. *European Journal of Work and Organizational Psychology*, *26*(6), 798–810. doi:10.1080/1359432X.2017.1374947
- Chen, X. (2013). *STEM Attrition: College Students' Paths into and out of STEM Fields*. *Statistical Analysis Report. NCES 2014-001*. National Center for Education Statistics.
Retrieved from <http://eric.ed.gov/?id=ED544470>

- Cheung, E. O., Gardner, W. L., & Anderson, J. F. (2015). Emotionships: Examining People's Emotion-Regulation Relationships and Their Consequences for Well-Being. *Social Psychological and Personality Science*, 6(4), 407–414. doi:10.1177/1948550614564223
- Clifton, A., & Webster, G. D. (2017a). An Introduction to Social Network Analysis for Personality and Social Psychologists. *Social Psychological and Personality Science*, 8(4), 442–453. doi:10.1177/1948550617709114
- Clifton, A., & Webster, G. D. (2017b). An Introduction to Social Network Analysis for Personality and Social Psychologists. *Social Psychological and Personality Science*, 8(4), 442–453. doi:10.1177/1948550617709114
- Cohen, G. L., & Garcia, J. (2005). 'I am us': Negative stereotypes as collective threats. *Journal of Personality and Social Psychology*, 89(4), 566–582. doi:10.1037/0022-3514.89.4.566
- Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the Racial Achievement Gap: A Social-Psychological Intervention. *Science*, 313(5791), 1307–1310. doi:10.1126/science.1128317
- Cohen, G. L., Garcia, J., Purdie-Vaughns, V., Apfel, N., & Brzustoski, P. (2009). Recursive processes in self-affirmation: Intervening to close the minority achievement gap. *Science*, 324(5925), 400–403. doi:10.1126/science.1170769
- Cohen, G. L., & Sherman, D. K. (2014). The Psychology of Change: Self-Affirmation and Social Psychological Intervention. *Annual Review of Psychology*, 65(1), 333–371. doi:10.1146/annurev-psych-010213-115137
- Cook, J. E., Purdie-Vaughns, V., Garcia, J., & Cohen, G. L. (2012). Chronic threat and contingent belonging: Protective benefits of values affirmation on identity development. *Journal of Personality and Social Psychology*, 102(3), 479–496. doi:10.1037/a0026312

- Cramer, A. O. J., Sluis, S. van der, Noordhof, A., Wichers, M., Geschwind, N., Aggen, S. H., ... Borsboom, D. (2012). Dimensions of Normal Personality as Networks in Search of Equilibrium: You Can't Like Parties if You Don't Like People. *European Journal of Personality*, 26(4), 414–431. doi:10.1002/per.1866
- Crocker, J., Niiya, Y., & Mischkowski, D. (2008). Why Does Writing About Important Values Reduce Defensiveness? Self-Affirmation and the Role of Positive Other-Directed Feelings. *Psychological Science*, 19(7), 740–747. doi:10.1111/j.1467-9280.2008.02150.x
- Croft, D. P., Madden, J. R., Franks, D. W., & James, R. (2011). Hypothesis testing in animal social networks. *Trends in Ecology & Evolution*, 26(10), 502–507. doi:10.1016/j.tree.2011.05.012
- Croizet, J.-C., Després, G., Gauzins, M.-E., Huguet, P., Leyens, J.-P., & Méot, A. (2004). Stereotype Threat Undermines Intellectual Performance by Triggering a Disruptive Mental Load. *Personality and Social Psychology Bulletin*, 30(6), 721–731. doi:10.1177/0146167204263961
- Crum, A. J. (2011). Evaluating a mindset training program to unleash the enhancing nature of stress. *Academy of Management Proceedings*, 2011(1), 1–6. doi:10.5465/ambpp.2011.65870502
- Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*, 104(4), 716–733.
- Csardi, G., & Nepusz, T. (2006). The igraph software package for complex network research. *InterJournal, Complex Systems*, 1695.

- Curhan, J. R., & Pentland, A. (2007). Thin slices of negotiation: Predicting outcomes from conversational dynamics within the first 5 minutes. *Journal of Applied Psychology, 92*(3), 802–811. doi:10.1037/0021-9010.92.3.802
- Curley, J. P. (2016). compete: Analyzing competitive interaction data (Version 0.1) [R]. Retrieved from <https://rdrr.io/cran/compete/>
- David, H. A. (1987). Ranking from unbalanced paired-comparison data. *Biometrika, 74*(2), 432–436. doi:10.1093/biomet/74.2.432
- De Dreu, C. K. W., & Van Kleef, G. A. (2004). The influence of power on the information search, impression formation, and demands in negotiation. *Journal of Experimental Social Psychology, 40*(3), 303–319. doi:10.1016/j.jesp.2003.07.004
- Dekker, A. (2005). Conceptual Distance in Social Network Analysis. *Journal of Social Structure (JoSS), 6*. Retrieved from <http://www.cmu.edu/joss/content/articles/volume6/dekker/>
- Deutsch, M. (1999). A personal perspective on the development of social psychology in the twentieth century. In A. Rodriguez & R. V. Levine (Eds.), *Reflections on 100 Years of Experimental Social Psychology* (pp. 1–34). New York, NY: Basic Books.
- Deuze, Ma. (2003). The Web and its Journalisms: Considering the Consequences of Different Types of Newsmedia Online. *New Media & Society, 5*(2), 203–230. doi:10.1177/1461444803005002004
- DiFonzo, N., Bourgeois, M. J., Suls, J., Homan, C., Stupak, N., Brooks, B. P., ... Bordia, P. (2013). Rumor clustering, consensus, and polarization: Dynamic social impact and self-organization of hearsay. *Journal of Experimental Social Psychology, 49*(3), 378–399. doi:10.1016/j.jesp.2012.12.010

- Dixon, T. L. (2007). Black Criminals and White Officers: The Effects of Racially Misrepresenting Law Breakers and Law Defenders on Television News. *Media Psychology, 10*(2), 270–291. doi:10.1080/15213260701375660
- Dixon, T. L., & Maddox, K. B. (2005). Skin Tone, Crime News, and Social Reality Judgments: Priming the Stereotype of the Dark and Dangerous Black Criminal. *Journal of Applied Social Psychology, 35*(8), 1555–1570. doi:10.1111/j.1559-1816.2005.tb02184.x
- Ducharme, L. J., Knudsen, H. K., & Roman, P. M. (2007). Emotional Exhaustion and Turnover Intention in Human Service Occupations: The Protective Role of Coworker Support. *Sociological Spectrum, 28*(1), 81–104. doi:10.1080/02732170701675268
- Duckworth, A. L., & Quinn, P. D. (2009). Development and Validation of the Short Grit Scale (Grit-S). *Journal of Personality Assessment, 91*(2), 166–174.
doi:10.1080/00223890802634290
- Duckworth, A., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087–1101.
- Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychological Science in the Public Interest, 14*(1), 4–58. doi:10.1177/1529100612453266
- Dweck, C. S. (2000). *Self-theories: Their Role in Motivation, Personality, and Development* (1 edition). Philadelphia, PA: Psychology Press.
- Dweck, C. S. (2006). *Mindset: The New Psychology of Success*. Random House.

- Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit Theories and Their Role in Judgments and Reactions: A Word From Two Perspectives. *Psychological Inquiry*, 6(4), 267–285. doi:10.1207/s15327965pli0604_1
- Eagly, A. H., & Karau, S. J. (2002). Role congruity theory of prejudice toward female leaders. *Psychological Review*, 109(3), 573–598. doi:10.1037/0033-295X.109.3.573
- Eckles, J. E., & Stradley, E. G. (2012). A social network analysis of student retention using archival data. *Social Psychology of Education*, 15(2), 165–180. doi:10.1007/s11218-011-9173-z
- Farine, D. R. (2017). A guide to null models for animal social network analysis. *Methods in Ecology and Evolution*, 1–12. doi:10.1111/2041-210X.12772
- Feeley, T. H., Moon, S.-I., Kozey, R. S., & Slowe, A. S. (2010). An Erosion Model of Employee Turnover Based on Network Centrality. *Journal of Applied Communication Research*, 38(2), 167–188. doi:10.1080/00909881003639544
- Fischer, P., Schulz-Hardt, S., & Frey, D. (2008). Selective exposure and information quantity: how different information quantities moderate decision makers' preference for consistent and inconsistent information. *Journal of Personality and Social Psychology*, 94(2), 231–244. doi:10.1037/0022-3514.94.2.94.2.231
- Frankel, L. P. (2014). *Nice Girls Don't Get the Corner Office: Unconscious Mistakes Women Make That Sabotage Their Careers* (Revised ed. edition). New York: Business Plus.
- Frazier, A., Howard, T., Shaw, K., & Ticknor, C. (2017). Dismantling Deficit Thinking and Uprooting Fixed Mindsets Through Possible Selves: A Potential Theoretical Framework for Supporting Underrepresented Groups in STEM. *Interdisciplinary STEM Teaching &*

- Learning Conference*. Retrieved from
<http://digitalcommons.georgiasouthern.edu/stem/2017/2017/23>
- Freedman, J. L., & Sears, D. O. (1965). Selective Exposure. *Advances in Experimental Social Psychology*, 2, 57–97. doi:10.1016/S0065-2601(08)60103-3
- Freeman, L. C. (1978). Centrality in social networks: Conceptual clarification. *Social Networks*, 1(3), 215–239. doi:10.1016/0378-8733(78)90021-7
- Frimer, J. A., Skitka, L. J., & Motyl, M. (2017). Liberals and conservatives are similarly motivated to avoid exposure to one another's opinions. *Journal of Experimental Social Psychology*, 72, 1–12. doi:10.1016/j.jesp.2017.04.003
- Gainen, J. (1995). Barriers to success in quantitative gatekeeper courses. *New Directions for Teaching and Learning*, 1995(61), 5–14. doi:10.1002/tl.37219956104
- Galdi, S., Gawronski, B., Arcuri, L., & Friese, M. (2012). Selective Exposure in Decided and Undecided Individuals: Differential Relations to Automatic Associations and Conscious Beliefs. *Personality and Social Psychology Bulletin*, 38(5), 559–569.
doi:10.1177/0146167211435981
- Gammell, M. P., de Vries, H., Jennings, D. J., Carlin, C. M., & Hayden, T. J. (2003). David's score: A more appropriate dominance ranking method than Clutton-Brock et al.'s index. *Animal Behaviour*, 66(3), 601–605. doi:10.1006/anbe.2003.2226
- Gelfand, M. J., Major, V. S., Raver, J. L., Nishii, L. H., & O'Brien, K. (2006). Negotiating Relationally: The Dynamics of the Relational Self in Negotiations. *Academy of Management Review*, 31(2), 427–451. doi:10.5465/amr.2006.20208689

- Gelfand, M. J., & McCusker, C. (2004). Metaphor and the Cultural Construction of Negotiation: A Paradigm for Research and Practice. In *The Blackwell Handbook of Cross-Cultural Management* (pp. 292–314). John Wiley & Sons, Ltd. doi:10.1002/9781405164030.ch15
- Gerhart, B., & Rynes, S. (1991). Determinants and consequences of salary negotiations by male and female MBA graduates. *Journal of Applied Psychology, 76*(2), 256–262.
doi:10.1037/0021-9010.76.2.256
- Goff, P. A., Jackson, M. C., Di Leone, B. A. L., Culotta, C. M., & DiTomasso, N. A. (2014). The essence of innocence: Consequences of dehumanizing Black children. *Journal of Personality and Social Psychology, 106*(4), 526–545. doi:10.1037/a0035663
- Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*(6), 504–528.
doi:10.1016/S0092-6566(03)00046-1
- Granovetter, M. (1985). Economic Action and Social Structure: The Problem of Embeddedness. *American Journal of Sociology, 91*(3), 481–510. doi:10.1086/228311
- Greig, F. (2010). Gender and the social costs of claiming value: An experimental approach. *Journal of Economic Behavior & Organization, 76*(3), 549–562.
doi:10.1016/j.jebo.2010.08.002
- Guthrie, S. R., Magyar, T. M., Eggert, S., & Kain, C. (2009). Female Athletes Do Ask! An Exploratory Study of Gender Differences in the Propensity to Initiate Negotiation among Athletes. *Women in Sport and Physical Activity Journal, 18*(1), 90–101.
doi:10.1123/wspaj.18.1.90
- Gutman, L. M., & Schoon, I. (2013). *The impact of non-cognitive skills on outcomes for young people* (pp. 1–59). London, UK: Institute of Education, University of London.

- Haidt, J. (2013). *The Righteous Mind: Why Good People Are Divided by Politics and Religion* (Reprint edition). New York: Vintage.
- Handcock, M. S., Hunter, D. R., Butts, C. T., Goodreau, S. M., & Morris, M. (2008). statnet: Software Tools for the Representation, Visualization, Analysis and Simulation of Network Data. *Journal of Statistical Software*, *24*(1), 1548–7660.
- Hanneman, R., & Riddle, M. (2005). *Introduction to Social Network Methods*.
- Hanselman, P., Rozek, C. S., Grigg, J., & Borman, G. D. (2017). New evidence on self-affirmation effects and theorized sources of heterogeneity from large-scale replications. *Journal of Educational Psychology*, *109*(3), 405–424. doi:10.1037/edu0000141
- Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Giffen, C. J., Blair, S. S., Rouse, D. I., & Hyde, J. S. (2014). Closing the social class achievement gap for first-generation students in undergraduate biology. *Journal of Educational Psychology*, *106*(2), 375–389. doi:10.1037/a0034679
- Haythornthwaite, C. (1996). Social network analysis: An approach and technique for the study of information exchange. *Library & Information Science Research*, *18*(4), 323–342. doi:10.1016/S0740-8188(96)90003-1
- Heckman, J. J., & Kautz, T. (2013). *Fostering and Measuring Skills: Interventions That Improve Character and Cognition* (Working Paper No. 19656). National Bureau of Economic Research. Retrieved from <http://www.nber.org/papers/w19656>
- Hilton, J. L., & von Hippel, W. (1996). Stereotypes. *Annual Review of Psychology*, *47*(1), 237–271. doi:10.1146/annurev.psych.47.1.237
- Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting Interest and Performance in High School Science Classes. *Science*, *326*(5958), 1410–1412. doi:10.1126/science.1177067

- Ibarra, H. (1992). Homophily and Differential Returns: Sex Differences in Network Structure and Access in an Advertising Firm. *Administrative Science Quarterly*, 37(3), 422–447. doi:10.2307/2393451
- Ibarra, H. (1993a). Network Centrality, Power, and Innovation Involvement: Determinants of Technical and Administrative Roles. *Academy of Management Journal*, 36(3), 471–501. doi:10.2307/256589
- Ibarra, H. (1993b). Personal Networks of Women and Minorities in Management: A Conceptual Framework. *The Academy of Management Review*, 18(1), 56–87. doi:10.2307/258823
- Jaremka, L. M., Bunyan, D. P., Collins, N. L., & Sherman, D. K. (2011). Reducing defensive distancing: Self-affirmation and risk regulation in response to relationship threats. *Journal of Experimental Social Psychology*, 47(1), 264–268. doi:10.1016/j.jesp.2010.08.015
- Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General*, 137(4), 691–705. doi:10.1037/a0013834
- Johnson, A. J., Haigh, M. M., Craig, E. A., & Becker, J. a. H. (2009). Relational closeness: Comparing undergraduate college students' geographically close and long-distance friendships. *Personal Relationships*, 16(4), 631–646. doi:10.1111/j.1475-6811.2009.01243.x
- Johnson, M. (2009). *Cracking the Boy's Club Code: The Woman's Guide to Being Heard and Valued in the Workplace*. Morgan James Publishing.

- Johnston, L. (1996). Resisting change: information-seeking and stereotype change. *European Journal of Social Psychology*, 26(5), 799–825. doi:10.1002/(SICI)1099-0992(199609)26:5<799::AID-EJSP796>3.0.CO;2-O
- Kanze, D., Huang, L., Conley, M. A., & Higgins, E. T. (2018). We Ask Men to Win and Women Not to Lose: Closing the Gender Gap in Startup Funding. *Academy of Management Journal*, 61(2), 586–614. doi:10.5465/amj.2016.1215
- Karp, M. M. (2011). *Toward a New Understanding of Non-Academic Student Support: Four Mechanisms Encouraging Positive Student Outcomes in the Community College* (Working Paper No. 28). Community College Research Center. Retrieved from <https://ccrc.tc.columbia.edu/publications/non-academic-student-support-mechanisms.html>
- Kellstedt, P. M. (2000). Media Framing and the Dynamics of Racial Policy Preferences. *American Journal of Political Science*, 44(2), 245–260. doi:10.2307/2669308
- Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., & Hiripi, E. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry*, 60(2), 184–189. doi:10.1001/archpsyc.60.2.184
- Kilduff, M., & Brass, D. J. (2010). Organizational Social Network Research: Core Ideas and Key Debates. *The Academy of Management Annals*, 4(1), 317–357. doi:10.1080/19416520.2010.494827
- Kilduff, M., & Krackhardt, D. (1994). Bringing the Individual Back in: A Structural Analysis of the Internal Market for Reputation in Organizations. *Academy of Management Journal*, 37(1), 87–108. doi:10.5465/256771

- Kim, P. H., Pinkley, R. L., & Fragale, A. R. (2005). Power Dynamics In Negotiation. *Academy of Management Review*, 30(4), 799–822. doi:10.5465/amr.2005.18378879
- Kim, S., & McGill, A. L. (2017). Helping Others by First Affirming the Self: When Self-Affirmation Reduces Ego-Defensive Downplaying of Others' Misfortunes. *Personality and Social Psychology Bulletin*, 0146167217741311. doi:10.1177/0146167217741311
- Kim, T., McFee, E., Olguin, D. O., Waber, B., & Pentland, A. "Sandy". (2012). Sociometric badges: Using sensor technology to capture new forms of collaboration. *Journal of Organizational Behavior*, 33(3), 412–427. doi:10.1002/job.1776
- Kinsey, S., & Fisher, V. (2014). Behind closed doors! Homosocial desire and the academic boys club. *Gender in Management: An International Journal*, 29(1), 44–64. doi:10.1108/GM-10-2012-0080
- Knoke, D., & Yang, S. (2008). *Social Network Analysis*. SAGE.
- Kolb, D. M. (2009). Too Bad for the Women or Does It Have to Be? Gender and Negotiation Research over the Past Twenty-Five Years. *Negotiation Journal*, 25(4), 515–531. doi:10.1111/j.1571-9979.2009.00242.x
- Krackardt, D. (1987). QAP partialling as a test of spuriousness. *Social Networks*, 9(2), 171–186. doi:10.1016/0378-8733(87)90012-8
- Kray, L. J., Galinsky, A. D., & Thompson, L. (2002). Reversing the Gender Gap in Negotiations: An Exploration of Stereotype Regeneration. *Organizational Behavior and Human Decision Processes*, 87(2), 386–410. doi:10.1006/obhd.2001.2979
- Kray, L. J., & Gelfand, M. J. (2009). Relief Versus Regret: The Effect of Gender and Negotiating Norm Ambiguity on Reactions to Having One's First Offer Accepted. *Social Cognition*, 27(3), 418–436. doi:10.1521/soco.2009.27.3.418

- Kray, L. J., & Thompson, L. (2005). Gender stereotypes and negotiation performance: An examination of theory and research. *Research in Organizational Behavior*, 26, 103–182. doi:10.1016/S0191-3085(04)26004-X
- Kray, L. J., Thompson, L., & Galinsky, A. (2001). Battle of the sexes: Gender stereotype confirmation and reactance in negotiations. *Journal of Personality and Social Psychology*, 80(6), 942–958. doi:10.1037/0022-3514.80.6.942
- Larrick, R. P., Heath, C., & Wu, G. (2009). Goal-Induced Risk Taking in Negotiation and Decision Making. *Social Cognition*, 27(3), 342–364. doi:10.1521/soco.2009.27.3.342
- Lee, T. W., Mitchell, T. R., Sablinski, C. J., Burton, J. P., & Holtom, B. C. (2004). The Effects of Job Embeddedness on Organizational Citizenship, Job Performance, Volitional Absences, and Voluntary Turnover. *Academy of Management Journal*, 47(5), 711–722. doi:10.5465/20159613
- Leslie, S.-J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, 347(6219), 262–265. doi:10.1126/science.1261375
- Lewandowski, G. W., Mattingly, B. A., & Pedreiro, A. (2014). Under Pressure: The Effects of Stress on Positive and Negative Relationship Behaviors. *The Journal of Social Psychology*, 154(5), 463–473. doi:10.1080/00224545.2014.933162
- Lewin, K. (1939a). Experiments in social space. *Harvard Educational Review*, 9, 21–32.
- Lewin, K. (1939b). Field Theory and Experiment in Social Psychology: Concepts and Methods. *American Journal of Sociology*, 44(6), 868–896. doi:10.1086/218177

- Lewin, K. (1947). Frontiers in group dynamics: concept, method and reality in social science; social equilibria and social change. *Human Relations, 1*, 5–41.
doi:10.1177/001872674700100103
- Lindsay, E. K., & Creswell, J. D. (2014). Helping the self help others: self-affirmation increases self-compassion and pro-social behaviors. *Frontiers in Psychology, 5*.
doi:10.3389/fpsyg.2014.00421
- London, B., Downey, G., Romero-Canyas, R., Rattan, A., & Tyson, D. (2012). Gender-based rejection sensitivity and academic self-silencing in women. *Journal of Personality and Social Psychology, 102*(5), 961–979. doi:10.1037/a0026615
- Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37*(11), 2098–2109.
- Maass, A., Salvi, D., Arcuri, L., & Semin, G. R. (1989). Language use in intergroup contexts: The linguistic intergroup bias. *Journal of Personality and Social Psychology, 57*(6), 981–993. doi:10.1037/0022-3514.57.6.981
- Marchiori, M., & Latora, V. (2000). Harmony in the small-world. *Physica A: Statistical Mechanics and Its Applications, 285*(3), 539–546. doi:10.1016/S0378-4371(00)00311-3
- Markus, H. R., & Hamedani, M. G. (2007). Sociocultural psychology: The dynamic interdependence among self systems and social systems. In S. Kitayama & D. Cohen (Eds.), *Handbook of cultural psychology* (pp. 3–39). New York, NY, US: Guilford Press.
- Mazei, J., Hüffmeier, J., Freund, P. A., Stuhlmacher, A. F., Bilke, L., & Hertel, G. (2015). A meta-analysis on gender differences in negotiation outcomes and their moderators. *Psychological Bulletin, 141*(1), 85–104. doi:10.1037/a0038184

- Mazerolle, M., Régner, I., Morisset, P., Rigalleau, F., & Huguet, P. (2012). Stereotype Threat Strengthens Automatic Recall and Undermines Controlled Processes in Older Adults. *Psychological Science, 23*(7), 723–727. doi:10.1177/0956797612437607
- McCarthy, H. (2004). *Girlfriends in High Places: How Women's Networks are Changing the Workplace*. Demos.
- McGuire, G. M. (2000). Gender, Race, Ethnicity, and Networks: The Factors Affecting the Status of Employees' Network Members. *Work and Occupations, 27*(4), 501–524. doi:10.1177/0730888400027004004
- McGuire, G. M. (2002). Gender, Race, and the Shadow Structure: A Study of Informal Networks and Inequality in a Work Organization. *Gender & Society, 16*(3), 303–322. doi:10.1177/0891243202016003003
- McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a Feather: Homophily in Social Networks. *Annual Review of Sociology, 27*, 415–444.
- Mehra, A., Kilduff, M., & Brass, D. J. (1998). At the Margins: A Distinctiveness Approach to the Social Identity and Social Networks of Underrepresented Groups. *Academy of Management Journal, 41*(4), 441–452. doi:10.5465/257083
- Mehra, A., Kilduff, M., & Brass, D. J. (2001). The Social Networks of High and Low Self-Monitors: Implications for Workplace Performance. *Administrative Science Quarterly, 46*(1), 121–146. doi:10.2307/2667127
- Mendoza-Denton, R., Downey, G., Purdie, V. J., Davis, A., & Pietrzak, J. (2002). Sensitivity to status-based rejection: Implications for African American students' college experience. *Journal of Personality and Social Psychology, 83*(4), 896–918. doi:10.1037/0022-3514.83.4.896

- Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Cohen, G. L., & Ito, T. A. (2010). Reducing the Gender Achievement Gap in College Science: A Classroom Study of Values Affirmation. *Science*, *330*(6008), 1234–1237. doi:10.1126/science.1195996
- Moody, J. (2001). Race, School Integration, and Friendship Segregation in America. *American Journal of Sociology*, *107*(3), 679–716. doi:10.1086/338954
- Moolenaar, N. M., Daly, A. J., & Slegers, P. J. C. (2010). Occupying the Principal Position: Examining Relationships Between Transformational Leadership, Social Network Position, and Schools' Innovative Climate. *Educational Administration Quarterly*, *46*(5), 623–670. doi:10.1177/0013161X10378689
- Morrison, E. W. (2002). Newcomers' Relationships: The Role of Social Network Ties During Socialization. *Academy of Management Journal*, *45*(6), 1149–1160. doi:10.2307/3069430
- Mossholder, K. W., Settoon, R. P., & Henagan, S. C. (2005). A Relational Perspective on Turnover: Examining Structural, Attitudinal, and Behavioral Predictors. *Academy of Management Journal*, *48*(4), 607–618. doi:10.5465/AMJ.2005.17843941
- Moynihan, D. P., & Pandey, S. K. (2008). The Ties that Bind: Social Networks, Person-Organization Value Fit, and Turnover Intention. *Journal of Public Administration Research and Theory*, *18*(2), 205–227. doi:10.1093/jopart/mum013
- Munro, G. D., & Ditto, P. H. (1997). Biased Assimilation, Attitude Polarization, and Affect in Reactions to Stereotype-Relevant Scientific Information. *Personality and Social Psychology Bulletin*, *23*(6), 636–653. doi:10.1177/0146167297236007
- Nguyen, H.-H. D., & Ryan, A. M. (2008). Does stereotype threat affect test performance of minorities and women? A meta-analysis of experimental evidence. *Journal of Applied Psychology*, *93*(6), 1314–1334. doi:10.1037/a0012702

- Nieuwhof, M. G., Cate, O. T. ten, Oosterveld, P., & Soethout, M. B. (2009). Measuring Strength of Motivation for Medical School. *Medical Education Online, 9*.
doi:10.3402/meo.v9i.4355
- Norton, M. I., Sommers, S. R., Apfelbaum, E. P., Pura, N., & Ariely, D. (2006). Color Blindness and Interracial Interaction Playing the Political Correctness Game. *Psychological Science, 17*(11), 949–953. doi:10.1111/j.1467-9280.2006.01810.x
- Obstfeld, D. (2005). Social Networks, the Tertius Iungens Orientation, and Involvement in Innovation. *Administrative Science Quarterly, 50*(1), 100–130.
doi:10.2189/asqu.2005.50.1.100
- O'Connor, K. M., Arnold, J. A., & Maurizio, A. M. (2010). The prospect of negotiating: Stress, cognitive appraisal, and performance. *Journal of Experimental Social Psychology, 46*(5), 729–735. doi:10.1016/j.jesp.2010.04.007
- Oishi, S. (2014). Socioecological Psychology. *Annual Review of Psychology, 65*(1), 581–609.
doi:10.1146/annurev-psych-030413-152156
- Oishi, S., & Graham, J. (2010). Social Ecology: Lost and Found in Psychological Science. *Perspectives on Psychological Science, 5*(4), 356–377. doi:10.1177/1745691610374588
- Olson, S., & Riordan, D. G. (2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. Report to the President*. Executive Office of the President. Retrieved from <http://eric.ed.gov/?id=ED541511>
- Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks, 32*(3), 245–251.
doi:10.1016/j.socnet.2010.03.006

Ost, B. (2010). The role of peers and grades in determining major persistence in the sciences.

Economics of Education Review, 29(6), 923–934. doi:10.1016/j.econedurev.2010.06.011

Overbeck, J. R., Neale, M. A., & Govan, C. L. (2010). I feel, therefore you act: Intrapersonal and interpersonal effects of emotion on negotiation as a function of social power.

Organizational Behavior and Human Decision Processes, 112(2), 126–139.

doi:10.1016/j.obhdp.2010.02.004

Pagel, M. D., Erdly, W. W., & Becker, J. (1987). Social networks: We get by with (and in spite of) a little help from our friends. *Journal of Personality and Social Psychology*, 53(4),

793–804. doi:10.1037/0022-3514.53.4.793

Paluck, E. L. (2011). Peer pressure against prejudice: A high school field experiment examining social network change. *Journal of Experimental Social Psychology*, 47(2), 350–358.

doi:10.1016/j.jesp.2010.11.017

Paluck, E. L., Shepherd, H., & Aronow, P. M. (2016). Changing climates of conflict: A social network experiment in 56 schools. *Proceedings of the National Academy of Sciences*,

113(3), 566–571. doi:10.1073/pnas.1514483113

Park, H. J., Turetsky, K. M., Dahl, J., Pasek, M. H., Germano, A. L., Harper, J. O., ... Cook, J. E. (manuscript in preparation). The psychological meaning of cortisol assessed during a

challenging STEM college class.

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015).

Mind-Set Interventions Are a Scalable Treatment for Academic Underachievement.

Psychological Science, 26(6), 784–793. doi:10.1177/0956797615571017

- Perry-Smith, J. E. (2006). Social Yet Creative: The Role Of Social Relationships In Facilitating Individual Creativity. *Academy of Management Journal*, 49(1), 85–101.
doi:10.5465/amj.2006.20785503
- Powers, J. T., Cook, J. E., Purdie-Vaughns, V., Garcia, J., Apfel, N., & Cohen, G. L. (2016). Changing Environments by Changing Individuals: The Emergent Effects of Psychological Intervention. *Psychological Science*, 27(2), 150–160.
doi:10.1177/0956797615614591
- Prell, C. (2011). *Social Network Analysis: History, Theory and Methodology*. Los Angeles ; London: SAGE Publications Ltd.
- Ragins, B. R., & Cotton, J. L. (1999). Mentor functions and outcomes: A comparison of men and women in formal and informal mentoring relationships. *Journal of Applied Psychology*, 84(4), 529–550. doi:10.1037/0021-9010.84.4.529
- Ragins, B. R., Cotton, J. L., & Miller, J. S. (2000). Marginal Mentoring: The Effects Of Type Of Mentor, Quality Of Relationship, And Program Design On Work And Career Attitudes. *Academy of Management Journal*, 43(6), 1177–1194. doi:10.5465/1556344
- Ramasubramanian, S. (2007). Media-based Strategies to Reduce Racial Stereotypes Activated by News Stories. *Journalism & Mass Communication Quarterly*, 84(2), 249–264.
doi:10.1177/107769900708400204
- Rambaran, J. A., Hopmeyer, A., Schwartz, D., Steglich, C., Badaly, D., & Veenstra, R. (2017). Academic Functioning and Peer Influences: A Short-Term Longitudinal Study of Network–Behavior Dynamics in Middle Adolescence. *Child Development*, 88(2), 523–543. doi:10.1111/cdev.12611

- Rammstedt, B. (2007). The 10-item Big Five Inventory: Norm values and investigation of sociodemographic effects based on a German population representative sample. *European Journal of Psychological Assessment, 23*(3), 193–201. doi:10.1027/1015-5759.23.3.193
- Randall, A. K., & Bodenmann, G. (2017). Stress and its associations with relationship satisfaction. *Current Opinion in Psychology, 13*, 96–106. doi:10.1016/j.copsyc.2016.05.010
- Repetti, R., & Wood, J. (1997). Effects of daily stress at work on mothers' interactions with preschoolers. *Journal of Family Psychology, 11*(1), 90. doi:10.1037/0893-3200.11.1.90
- Riordan, C. M. (2013). We All Need Friends at Work. *Harvard Business Review*. Retrieved from <https://hbr.org/2013/07/we-all-need-friends-at-work>
- Rivera, M. T., Soderstrom, S. B., & Uzzi, B. (2010). Dynamics of Dyads in Social Networks: Assortative, Relational, and Proximity Mechanisms. *Annual Review of Sociology, 36*(1), 91–115. doi:10.1146/annurev.soc.34.040507.134743
- Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do Psychosocial and Study Skill Factors Predict College Outcomes? A Meta-Analysis. *Psychological Bulletin, 130*(2), 261–288. doi:10.1037/0033-2909.130.2.261
- Robins, R. W., Hendin, H. M., & Trzesniewski, K. H. (2001). Measuring Global Self-Esteem: Construct Validation of a Single-Item Measure and the Rosenberg Self-Esteem Scale. *Personality and Social Psychology Bulletin, 27*(2), 151–161. doi:10.1177/0146167201272002
- Rochat, Y. (2009). *Closeness centrality extended to unconnected graphs: The harmonic centrality index*. ASNA.

- Rubin, J. Z., & Brown, B. R. (1975a). Bargainers as individuals. In *The Social Psychology of Bargaining and Negotiation* (pp. 158–197). Elsevier.
- Rubin, J. Z., & Brown, B. R. (1975b). The bargaining relationship. In *The Social Psychology of Bargaining and Negotiation* (pp. 6–18). Elsevier.
- Rudman, L. A., & Glick, P. (2001). Prescriptive Gender Stereotypes and Backlash Toward Agentic Women. *Journal of Social Issues*, 57(4), 743–762. doi:10.1111/0022-4537.00239
- Sandberg, S. (2013). *Lean In: Women, Work, and the Will to Lead* (1 edition). New York: Knopf.
- Sawicki, V., Wegener, D. T., Clark, J. K., Fabrigar, L. R., Smith, S. M., & Durso, G. R. O. (2013). Feeling Conflicted and Seeking Information: When Ambivalence Enhances and Diminishes Selective Exposure to Attitude-Consistent Information. *Personality and Social Psychology Bulletin*, 39(6), 735–747. doi:10.1177/0146167213481388
- Schachter, S. (1959). *The psychology of affiliation*. Stanford, CA: Stanford University Press.
- Schmader, T., & Johns, M. (2003). Converging Evidence That Stereotype Threat Reduces Working Memory Capacity. *Journal of Personality and Social Psychology*, 85(3), 440–452. doi:10.1037/0022-3514.85.3.440
- Sears, D. O., & Freedman, J. L. (1967). Selective Exposure to Information: A Critical Review. *The Public Opinion Quarterly*, 31(2), 194–213. doi:10.2307/2747198
- Seidel, M.-D. L., Polzer, J. T., & Stewart, K. J. (2000). Friends in High Places: The Effects of Social Networks on Discrimination in Salary Negotiations. *Administrative Science Quarterly*, 45(1), 1–24. doi:10.2307/2666977
- Selfhout, M., Burk, W., Branje, S., Denissen, J., Van Aken, M., & Meeus, W. (2010). Emerging Late Adolescent Friendship Networks and Big Five Personality Traits: A Social Network

- Approach. *Journal of Personality*, 78(2), 509–538. doi:10.1111/j.1467-6494.2010.00625.x
- Shapiro, C. A., & Sax, L. J. (2011). Major selection and persistence for women in STEM. *New Directions for Institutional Research*, 2011(152), 5–18. doi:10.1002/ir.404
- Singh, J., Hansen, M. T., & Podolny, J. M. (2010). The World Is Not Small for Everyone: Inequity in Searching for Knowledge in Organizations. *Management Science*, 56(9), 1415–1438. doi:10.1287/mnsc.1100.1201
- Small, D. A., Gelfand, M., Babcock, L., & Gettman, H. (2007). Who goes to the bargaining table? The influence of gender and framing on the initiation of negotiation. *Journal of Personality and Social Psychology*, 93(4), 600–613. doi:10.1037/0022-3514.93.4.600
- Small, M. L. (2017). *Someone To Talk To* (1 edition). New York, NY: Oxford University Press.
- Smith, S. M., Fabrigar, L. R., & Norris, M. E. (2008). Reflecting on Six Decades of Selective Exposure Research: Progress, Challenges, and Opportunities. *Social and Personality Psychology Compass*, 2(1), 464–493. doi:10.1111/j.1751-9004.2007.00060.x
- Smith, S. M., Fabrigar, L. R., Powell, D. M., & Estrada, M.-J. (2007). The Role of Information-Processing Capacity and Goals in Attitude-Congruent Selective Exposure Effects. *Personality and Social Psychology Bulletin*, 33(7), 948–960. doi:10.1177/0146167207301012
- Sommers, S. R., Apfelbaum, E. P., Dukes, K. N., Toosi, N., & Wang, E. J. (2006). Race and Media Coverage of Hurricane Katrina: Analysis, Implications, and Future Research Questions. *Analyses of Social Issues and Public Policy*, 6(1), 39–55. doi:10.1111/j.1530-2415.2006.00103.x

- Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. (2001). Social Networks and the Performance of Individuals and Groups. *Academy of Management Journal*, *44*(2), 316–325. doi:10.2307/3069458
- Srivastava, S. B. (2015). Network Intervention: Assessing the Effects of Formal Mentoring on Workplace Networks. *Social Forces*, *94*(1), 427–452. doi:10.1093/sf/sov041
- Stadtfeld, C., Vörös, A., Elmer, T., Boda, Z., & Raabe, I. J. (2019). Integration in emerging social networks explains academic failure and success. *Proceedings of the National Academy of Sciences*, *116*(3), 792–797. doi:10.1073/pnas.1811388115
- Steele, C. M. (1988). The Psychology of Self-Affirmation: Sustaining the Integrity of the Self. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 21, pp. 261–302). Academic Press. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0065260108602294>
- Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist*, *52*(6), 613–629. doi:10.1037/0003-066X.52.6.613
- Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*(5), 797–811. doi:10.1037/0022-3514.69.5.797
- Steiner, I. D. (1974). Whatever happened to the group in social psychology? *Journal of Experimental Social Psychology*, *10*(1), 94–108. doi:10.1016/0022-1031(74)90058-4
- Stevens, C. K., Bavetta, A. G., & Gist, M. E. (1993). Gender differences in the acquisition of salary negotiation skills: The role of goals, self-efficacy, and perceived control. *Journal of Applied Psychology*, *78*(5), 723–735. doi:10.1037/0021-9010.78.5.723

- Stinson, D. A., Logel, C., Shepherd, S., & Zanna, M. P. (2011). Rewriting the Self-Fulfilling Prophecy of Social Rejection Self-Affirmation Improves Relational Security and Social Behavior up to 2 Months Later. *Psychological Science, 22*(9), 1145–1149.
doi:10.1177/0956797611417725
- Stone, J., Lynch, C. I., Sjomeling, M., & Darley, J. M. (1999). Stereotype threat effects on Black and White athletic performance. *Journal of Personality and Social Psychology, 77*(6), 1213–1227. doi:10.1037/0022-3514.77.6.1213
- Stuhlmacher, A. F., & Walters, A. E. (1999). Gender Differences in Negotiation Outcome: A Meta-Analysis. *Personnel Psychology, 52*(3), 653–677. doi:10.1111/j.1744-6570.1999.tb00175.x
- Sturm, S. (2009). Negotiating Workplace Equality: A Systemic Approach. *Negotiation and Conflict Management Research, 2*(1), 92–106. doi:10.1111/j.1750-4716.2008.00030.x
- Thomaes, S., Bushman, B. J., de Castro, B. O., & Reijntjes, A. (2012). Arousing “gentle passions” in young adolescents: Sustained experimental effects of value affirmations on prosocial feelings and behaviors. *Developmental Psychology, 48*(1), 103–110.
doi:10.1037/a0025677
- Thomas, S. L. (2000). Ties that bind: A social network approach to understanding student integration and persistence. *The Journal of Higher Education, 71*(5), 591–615.
doi:10.1080/00221546.2000.11778854
- Thompson, L., Peterson, E., & Kray, L. (1995). Social context in negotiation: An information-processing perspective. In *Negotiation as a social process: New trends in theory and research* (pp. 5–36). Thousand Oaks, CA, US: Sage Publications, Inc.
doi:10.4135/9781483345369.n1

- Tinkler, J. E., Bunker Whittington, K., Ku, M. C., & Davies, A. R. (2015). Gender and venture capital decision-making: The effects of technical background and social capital on entrepreneurial evaluations. *Social Science Research, 51*, 1–16.
doi:10.1016/j.ssresearch.2014.12.008
- Tinto, V. (1975). Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research, 45*(1), 89–125. doi:10.3102/00346543045001089
- Turetsky, K. M., & Riddle, T. A. (2018). Porous Chambers, Echoes of Valence and Stereotypes: A Network Analysis of Online News Coverage Interconnectedness Following a Nationally Polarizing Race-Related Event. *Social Psychological and Personality Science, 9*(2), 163–175. doi:10.1177/1948550617733519
- Turetsky, K. M., & Zee, K. S. (in prep). Toward an integrated, multilevel perspective on the social effects of stress.
- U.S. Department of Education. (2015). *Fact Sheet: Focusing Higher Education on Student Success*. Washington, DC. Retrieved from <https://www.ed.gov/news/press-releases/fact-sheet-focusing-higher-education-student-success>
- Vaquera, E., & Kao, G. (2008). Do you like me as much as I like you? Friendship reciprocity and its effects on school outcomes among adolescents. *Social Science Research, 37*(1), 55–72. doi:10.1016/j.ssresearch.2006.11.002
- Vardaman, J. M., Taylor, S. G., Allen, D. G., Gondo, M. B., & Amis, J. M. (2015). Translating Intentions to Behavior: The Interaction of Network Structure and Behavioral Intentions in Understanding Employee Turnover. *Organization Science, 26*(4), 1177–1191.
doi:10.1287/orsc.2015.0982

- Walton, G. M. (2014). The New Science of Wise Psychological Interventions. *Current Directions in Psychological Science*, 23(1), 73–82. doi:10.1177/0963721413512856
- Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology*, 92(1), 82–96. doi:10.1037/0022-3514.92.1.82
- Walton, G. M., & Cohen, G. L. (2011). A Brief Social-Belonging Intervention Improves Academic and Health Outcomes of Minority Students. *Science*, 331(6023), 1447–1451. doi:10.1126/science.1198364
- Walton, G. M., & Spencer, S. J. (2009). Latent Ability Grades and Test Scores Systematically Underestimate the Intellectual Ability of Negatively Stereotyped Students. *Psychological Science*, 20(9), 1132–1139. doi:10.1111/j.1467-9280.2009.02417.x
- Walton, G. M., & Wilson, T. D. (2018). Wise interventions: Psychological remedies for social and personal problems. *Psychological Review*, 125(5), 617–655. doi:10.1037/rev0000115
- Wasserman, S. S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications*. Cambridge, UK: Cambridge University Press.
- Watson, C., & Hoffman, L. R. (1996). Managers as negotiators: A test of power versus gender as predictors of feelings, behavior, and outcomes. *The Leadership Quarterly*, 7(1), 63–85. doi:10.1016/S1048-9843(96)90035-1
- Weingart, L. R., Hyder, E. B., & Prietula, M. J. (1996). Knowledge matters: The effect of tactical descriptions on negotiation behavior and outcome. *Journal of Personality and Social Psychology*, 70(6), 1205–1217. doi:10.1037/0022-3514.70.6.1205

- Wethington, E., & Kessler, R. C. (1986). Perceived Support, Received Support, and Adjustment to Stressful Life Events. *Journal of Health and Social Behavior*, 27(1), 78–89.
doi:10.2307/2136504
- William Lee, T., Burch, T. C., & Mitchell, T. R. (2014). The Story of Why We Stay: A Review of Job Embeddedness. *Annual Review of Organizational Psychology and Organizational Behavior*, 1(1), 199–216. doi:10.1146/annurev-orgpsych-031413-091244
- Williams, D. R., Yan Yu, Jackson, J. S., & Anderson, N. B. (1997). Racial Differences in Physical and Mental Health: Socio-economic Status, Stress and Discrimination. *Journal of Health Psychology*, 2(3), 335–351. doi:10.1177/135910539700200305
- Wise, K., Bolls, P. D., & Schaefer, S. R. (2008). Choosing and Reading Online News: How Available Choice Affects Cognitive Processing. *Journal of Broadcasting & Electronic Media*, 52(1), 69–85. doi:10.1080/08838150701820858
- Yang, Y., Chawla, N. V., & Uzzi, B. (2019). A network's gender composition and communication pattern predict women's leadership success. *Proceedings of the National Academy of Sciences*, 116(6), 2033–2038. doi:10.1073/pnas.1721438116
- Yeager, D. S., Walton, G. M., Brady, S. T., Akcinar, E. N., Paunesku, D., Keane, L., ... Dweck, C. S. (2016). Teaching a lay theory before college narrows achievement gaps at scale. *Proceedings of the National Academy of Sciences*, 113(24), E3341–E3348.
doi:10.1073/pnas.1524360113
- Yeung, N. C. J., & von Hippel, C. (2008). Stereotype threat increases the likelihood that female drivers in a simulator run over jaywalkers. *Accident; Analysis and Prevention*, 40(2), 667–674. doi:10.1016/j.aap.2007.09.003

Zwolak, J. P., Dou, R., Williams, E. A., & Brewster, E. (2017). Students' network integration as a predictor of persistence in introductory physics courses. *Physical Review Physics Education Research*, 13(1), 010113. doi:10.1103/PhysRevPhysEducRes.13.010113

Appendix A: Permutation Test Methodology

Network data challenge the independence assumption required for parametric tests by reflecting relationships between participants. Because of this inherent non-independence of network variables, we used permutation tests with 20,000 randomizations of network nodes to assess the statistical significance of models that contained network variables as either independent or dependent variables in Chapters II and III. The goal of these permutation tests is to compare observed results to a null model based on randomization of the data.

When the network variable is the independent variable (such as in Chapter II, where we examined how network centrality predicted negotiation performance), the null hypothesis is that the observed effect of the network variable on the outcome variable does not differ from what we would expect to see by chance (e.g., if high and low negotiation performers were randomly distributed across the network). When the network variable is the dependent variable (such as in Chapter III, where we examined how intervention condition predicted network centrality), the null hypothesis is that the observed effect of the independent variable on the network outcome variable does not differ from what we would expect to see by chance (i.e., if individuals in each condition were randomly distributed across the network). For each hypothesis test, we thus constructed a null model by permuting individuals across nodes in the network 20,000 times—thus randomly distributing individuals (and their negotiation performance, intervention conditions, and other attributes) across the network.

On each of the permuted networks, we ran the same regression model and extracted the coefficient of interest. For example, in Chapter III, we estimated the model $y_1 = b_0 + b_1Z + b_2S + b_3y_0$, where y_1 was the posttreatment value of the dependent variable of interest (e.g., number of friends nominated at the end of the semester); b_0 was the intercept of the regression

equation; b_1 was the coefficient of Z , intervention condition; b_2 was the coefficient of covariate S , the students' course section; b_3 , where applicable, was the coefficient of Y_0 , the pretreatment (baseline) value of the dependent variable (e.g., number of friends nominated at the beginning of the semester). When we ran this model on the observed data, this yielded an observed b_1 (i.e., b_{1obs}), the observed coefficient of the effect of intervention condition. When we ran this same model on each of the 20,000 permutations of the network and extracted the b_1 coefficient of the effect of intervention condition from each of these regressions, this yielded a distribution of b_1 estimates under the null—in other words, the distribution of coefficients of the effect of intervention condition that we should expect to see by chance.

For each permutation test, a two-sided p -value was calculated as the proportion of the 20,000 network permutations where $|b_1| \geq |b_{1obs}|$. Thus, if b_{1obs} fell outside the middle 95% of the distribution of calculated b_1 for each of the 20,000 node permutations, we rejected the null hypothesis that there is no significant difference between conditions in the social network dependent variable; if b_{1obs} fell within the middle 95% of the distribution, we failed to reject the null (see Figure A1 below for an example).

A similar logic applies for when the network variable was the independent variable, as in models of network centrality predicting negotiation performance reported in Chapter II. In those cases, the observed coefficient of the effect of network centrality was compared to the distribution of coefficients of the effect of network centrality derived from 20,000 randomizations of the network.

See Farine, 2017, p. 2 for a succinct generalized overview of these steps, as well as Boogert, Farine, & Spencer, 2014; Croft, Madden, Franks, & James, 2011; and Hanneman & Riddle, 2005.

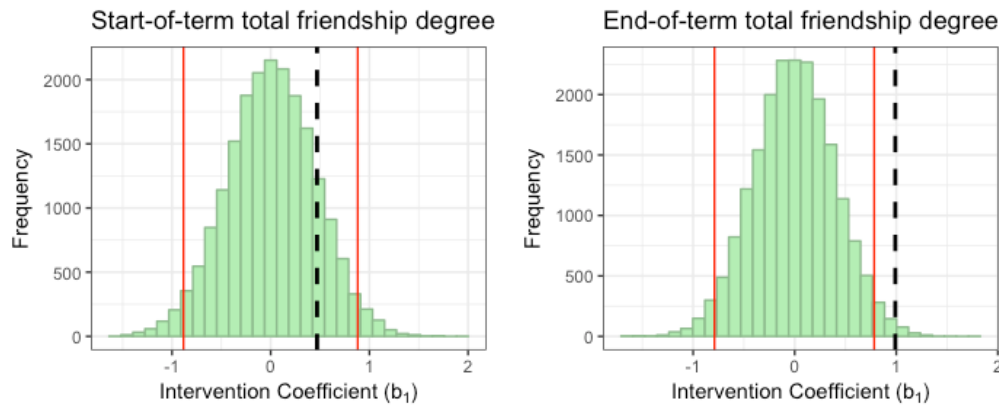


Figure A1. Permutation tests of significance.

The bars of the two histograms display the 20,000 calculated b_1 intervention coefficients from the linear models fitted to the random networks in Chapter III. The red vertical lines correspond to the 2.5 and 97.5 percentiles of the distribution of b_1 coefficients. The black dotted line corresponds to the intervention coefficient from the linear model fitted to the observed network (b_{1obs}). b_{1obs} were 0.47 (start-of-term, left) and 0.99 (end-of-term, right) and p_{perm} values ($|b_1| \geq |b_{1obs}|$) were .29 and .01 respectively.

Appendix B: Supplementary Information for Chapter III

This appendix contains supplementary information for Chapter III, *A Psychological Intervention Strengthens Students' Social Networks and Promotes Persistence in STEM*.

1. Methods and Materials

1a. Study Procedure

Participants were recruited by researchers both online and in person. Researchers emailed all students in the class with information about the study and a personalized link to the online consent form and baseline questionnaire during the first week of the semester. The next day (the second day of the course), researchers visited the biology course to make an announcement about the study at the beginning of class, distribute paper consent forms to all students, and answer any questions students had about participating at a table outside the classroom after class. During the following week, researchers again set up a table outside the classroom to recruit participants and answer any questions about the study before and after class, and also sent an additional recruitment email containing a personalized link to the online consent form and baseline questionnaire to all students who had not yet signed up to participate. Any students who consented in person using paper consent materials were emailed a link to complete the baseline questionnaire by the end of the day they consented. All students who consented to participate in the study during the first two weeks of the semester were included as participants in the study.

Participants were randomly assigned to the values affirmation or control condition before the third week of the course, and their assigned writing exercises were placed into envelopes labeled with their names. During students' weekly sections in the third week of the course, teaching assistants introduced the exercise and handed out these envelopes to the students in their sections (see section 1b below for teaching assistant script). The envelopes were designed to look

identical so that students would not know that there were different conditions. Students who did not consent to participate in the study received the control writing exercise inside their envelope, which was discarded immediately upon transfer to the research team.

After opening their envelopes, students in both conditions first ranked a list of 11 values (e.g., creativity, independence, relationships with friends or family, religious values) in order of personal importance. Next, participants were asked to write a short essay for fifteen minutes. In the affirmation condition, participants wrote this essay about the value they had ranked as most important. In the control condition, participants wrote about why the value they ranked as ninth most important might be important to someone else. To reinforce the manipulation, participants in both conditions then summarized the top two reasons the value they selected was important to them (affirmation) or someone else (control) and indicated their agreement with statements about the value's importance (e.g., affirmation: "This value has influenced my life," control: "This value has influenced some people").

Finally, participants were emailed an individualized link to the end-of-semester measures in the last week of the course (Week 14). Participants completed these measures by the end of finals period (by Week 16). During the subsequent semester, we obtained the enrollment status of each participant in the second semester of the biology course to determine next-semester biology track retention.

The social network study described in this paper was administered as one component of a larger study, which aimed to understand students' experiences in gateway STEM classes and the processes that underlie affirmation effects. Accordingly, the baseline and end-of-semester questionnaires included questions about psychological wellbeing, perceptions and experiences related to STEM and identity, and other individual difference measures that were not part of the

social network study. These measures are not described in detail here; however, we did examine whether participants who completed all aspects of the social network study differed on any collected measures from participants who were lost to attrition (including non-network measures), and we report those measures and results of the attrition analyses in section 2a below.

1b. Sample Intervention

Teaching Assistant Script

I am going to be reading some of the instructions for today's recitation to make sure that I say everything I need to.

Today in recitation, we're going to be starting off with a writing exercise.

As Professor ----- mentioned in lecture, one of the things that is important in biology and biology training is clear thinking.

Professors ----- and ----- have teamed up with some other researchers on campus to develop a writing exercise that will ask you to think about values that are important to people. As you know, thinking and writing clearly is valuable in science, and this exercise is intended to start that process in this course.

I am now going to pass out materials for the writing exercise. All of the instructions for the writing exercise are inside the envelope. You can start as soon as you get the envelope.

Please be QUIET as you do this. If you have any questions, please come and see me up front.

[Pass out envelopes. Look at provided stopwatch. Be sure to give students ~15 minutes to work on the exercise, even if some finish early. When they are done, after ~15 minutes, continue script below.]

Okay, please put your exercise back in the envelope and pass them to the front. It's OK if you did not complete the whole writing exercise.

[Collect envelopes. A member of the research team will take them once class is over. Please do not open envelopes to ensure privacy.]

Affirmation Condition

Biol. C2005/F2401 Handout 3G-01

WHAT ARE YOUR PERSONAL VALUES?

Below is a list of characteristics and values, some of them may be important to you; some may be unimportant to you. Please rank them from 1 to 11 according to how important they are to you ("1" being the most important item, "11" being the one that is least important to you). Use each number only once.

- _____ Being Good at Art
- _____ Physical Attractiveness
- _____ Creativity
- _____ Independence
- _____ Membership in a Social Group (such as your community, racial group, or school club)
- _____ Music
- _____ Politics
- _____ Relationships with Friends or Family
- _____ Religious Values
- _____ Sense of Humor
- _____ Sports Ability

Biol. C2005/F2401 Handout 3G-02

Directions

- 1) Look at the value you picked as most important to you (the value you ranked as #1 on the previous page).
- 2) Think about times when this value was or would be very important to you.
- 3) Describe why this value would be important to you.

Focus on your thoughts and feelings and don't worry about spelling, grammar, or how well written it is.

Again, look at the value you picked as **most** important. List the top two reasons why this value is important to you.

1. _____

2. _____

- | | | |
|---|-----|----|
| 1. This value has influenced my life. | Yes | No |
| 2. This value is an important part of who I am. | Yes | No |

Control Condition

WHAT ARE YOUR PERSONAL VALUES?

Below is a list of characteristics and values, some of them may be important to you; some may be unimportant to you. Please rank them from 1 to 11 according to how important they are to you ("1" being the most important item, "11" being the one that is least important to you). Use each number only once.

- _____ Being Good at Art
- _____ Physical Attractiveness
- _____ Creativity
- _____ Independence
- _____ Membership in a Social Group (such as your community, racial group, or school club)
- _____ Music
- _____ Politics
- _____ Relationships with Friends or Family
- _____ Religious Values
- _____ Sense of Humor
- _____ Sports Ability

Directions

- 1) Look at the value you ranked as #9 on the previous page.
- 2) Think about times when this value would be important to someone else (like another student or a person you've heard about).
- 3) Describe why this value would be important to someone else.

Focus on your thoughts and feelings and don't worry about spelling, grammar, or how well written it is.

Again, look at your #9 value. List the top two reasons why **someone else** would pick this as their most important value.

1. _____

2. _____

- | | | |
|---|-----|----|
| 1. This value has influenced some people. | Yes | No |
| 2. This value is important to some people. | Yes | No |

2. Results

2a. Attrition Analyses

Analyses were conducted to assess whether the sample of participants who completed all aspects of the study and are therefore included in the main analyses, “completers” ($n = 226$), differed from those who enrolled in the study but did not complete all parts, “non-completers” ($n = 102$). Completers and non-completers differed in age, whereby completers were significantly younger ($t(138.13) = -4.17, p < 0.001$; completers: $M = 20.60, SE = 0.22$ vs. non-completers: $M = 22.79, SE = 0.47$). This age difference is likely explained by the decreased proportion of postbaccalaureate students (i.e., “postbacs”), who are on average older ($t(90.49) = -13.32, p < 0.001$; postbacs: $M = 26.14, SE = 0.48$ vs. undergraduate students: $M = 19.60, SE = 0.12$), in the final sample of completers ($\chi^2(1) = 22.93, p < 0.001$; postbacs comprised 16.8% of completers but 42.2% of non-completers). This decrease in the proportion of postbac students in the final sample of completers resulted from the fact that attendance at course weekly sections—where the intervention was administered—was not required for postbac students. As such, relatively fewer postbacs were present in class the day that the intervention was administered, and therefore fewer of these students completed the intervention. In addition, completers had significantly more friends than non-completers ($t(212.91) = 2.30, p = 0.02$; completers: $M = 4.67, SE = 0.24$ vs. non-completers: $M = 3.75, SE = 0.32$) and were higher in collective threat than non-completers (Cohen & Garcia, 2005; $t(174.96) = 2.12, p = 0.04$; completers: $M = 2.77, SE = 0.05$ vs. non-completers: $M = 2.59, SE = 0.07$). The final sample of completers did not differ significantly from non-completers on any of the other demographic or baseline measures collected at the beginning of the semester, including intervention condition, gender, race, parents’ income, first vs. continuing college generation status, relationship status, strength of

friendships, number and strength of study and support ties, medical school motivation (Nieuwhof, Cate, Oosterveld, & Soethout, 2009), perceptions that the course was diagnostic of ability to get into and succeed in medical school (lab-created scale), theories of intelligence (Dweck et al., 1995), grit (A. L. Duckworth & Quinn, 2009), extraversion (Rammstedt, 2007), conscientiousness (Rammstedt, 2007), belonging at the university (Walton & Cohen, 2007), gender and race rejection sensitivity (London, Downey, Romero-Canyas, Rattan, & Tyson, 2012; Mendoza-Denton, Downey, Purdie, Davis, & Pietrzak, 2002), everyday discrimination (Williams, Yan Yu, Jackson, & Anderson, 1997), psychological distress (Kessler et al., 2003), and self-esteem (Robins, Hendin, & Trzesniewski, 2001).

We also assessed whether completers differed from those who completed the in-class intervention, but did not complete both of the questionnaires (“intervention-only”; $n = 64$). Because the in-class intervention writing exercise was presented as part of the course but the questionnaires were an optional online study, we were concerned that the 226 completers included in our analyses would not be representative of all participants who completed the intervention. Analyses comparing the completers to the intervention-only participants suggested that the two groups were fairly similar: Compared to the 64 participants who completed the intervention but did not complete the post-semester questionnaires, the final sample of 226 participants who completed all three parts were significantly higher in grit ($t(92.69) = 2.27, p = 0.03$; completers: $M = 3.49, SE = 0.04$ vs. intervention-only: $M = 3.29, SE = 0.08$; this difference is perhaps unsurprising considering that grit is a measure of persistence and follow-through), but did not differ significantly on any of the other demographic or baseline measures collected.

2b. Network Properties

Friendship Network

Full network. At the beginning of the semester, through the baseline questionnaire, a total of 239 participants nominated one or more friends. The remaining 82 participants who filled out the baseline questionnaire reported having no friends in the course. These responses produced a valued, directed start-of-semester friendship network of 460 students (all participants who completed the baseline network survey and the friends in the course whom they nominated), with 855 friendship ties between them.¹⁸ At the end of the semester, 181 of the 257 participants who completed the end-of-semester questionnaire nominated one or more friends, while the remaining 76 reported no friends in the course. These responses produced a valued, directed, end-of-semester friendship network of 394 students, with 629 ties between them. See Figure 2.1 in main text and Table B1 for additional information about the start- and end-of-semester friendship networks.

Completers only. Among the participants who completed all parts of the study and were thus included in the analyses ($n = 226$ “completers”), 172 nominated one or more friends at the beginning of the semester. The remaining 54 reported having no friends in the course. At the end of the semester, 167 of the 226 completers reporting having one or more friends, while the remaining 59 reported no friends in the course.

Study Partnership Network

Full network. At the beginning of the semester, through the baseline questionnaire, a total of 202 participants nominated one or more study partners. The remaining 126 participants

¹⁸ Many students began the course with friends because they decided to take the class at the same time as friends—in focus groups before the study, students revealed that this was a common strategy for coping with the difficulty of the course—and/or because they had met classmates in previous science and pre-medical courses.

who filled out the baseline questionnaire reported having no study partners in the course. These responses produced a valued, directed start-of-semester study network of 419 students (all participants who completed the baseline network survey and the study partners in the course whom they nominated), with 475 study partnership ties between them. At the end of the semester, 150 of the 257 participants who completed the end-of-semester questionnaire nominated one or more study partners, while the remaining 107 reported no study partners in the course. These responses produced a valued, directed, end-of-semester study network of 326 students, with 226 ties between them. See Figure B1 for study network visualizations and Table B1 for additional information about the start- and end-of-semester study partnership networks.

Completers only. Among the 226 participants who completed all parts of the study, 145 nominated one or more study partners at the start of the semester. The remaining 81 reported no study partners in the course. At the end of the semester, 100 participants reported having one or more study partners, while the remaining 126 reported no study partners in the course.

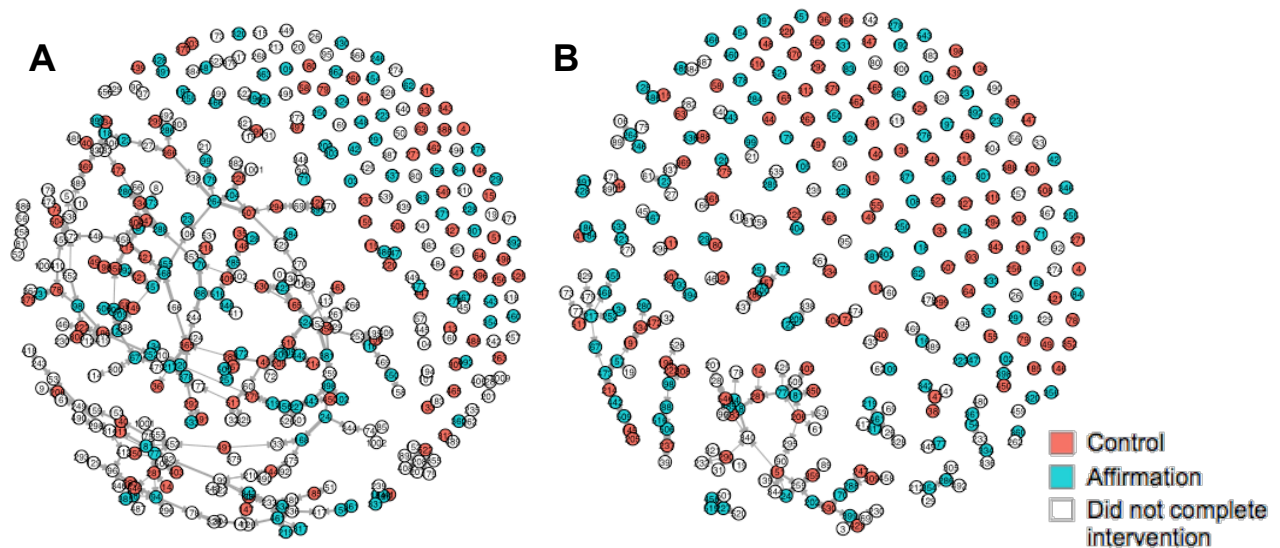


Figure B1. Study partnership networks
Weighted, directed study partnership network at (A) the start of the semester (Time 1) and (B) the end of the semester (Time 2)

Support Network

Full network. At the beginning of the semester, through the baseline questionnaire, a total of 176 participants nominated one or more support-providing peers in the course. The remaining 152 participants who filled out the baseline questionnaire reported having no support providers in the course. These responses produced a valued, directed start-of-semester support network of 392 students (all participants who completed the baseline network survey and the support providers in the course whom they nominated), with 350 support ties between them. At the end of the semester, 127 of the 257 participants who completed the end-of-semester questionnaire nominated one or more support providers, while the remaining 130 reported no support providers in the course. These responses produced a valued, directed, end-of-semester support network of 326 students, with 225 ties between them. See Figure B2 for support network visualizations and Table B1 for additional information about the start- and end-of-semester support networks.

Completers only. Among the 226 participants who completed all parts of the study, 130 nominated one or more support-providing peers at the beginning of the semester. The remaining 96 reported having no support providers in the course. At the end of the semester, 120 participants reported having one or more support providers, while the remaining 106 reported no support peers in the course.

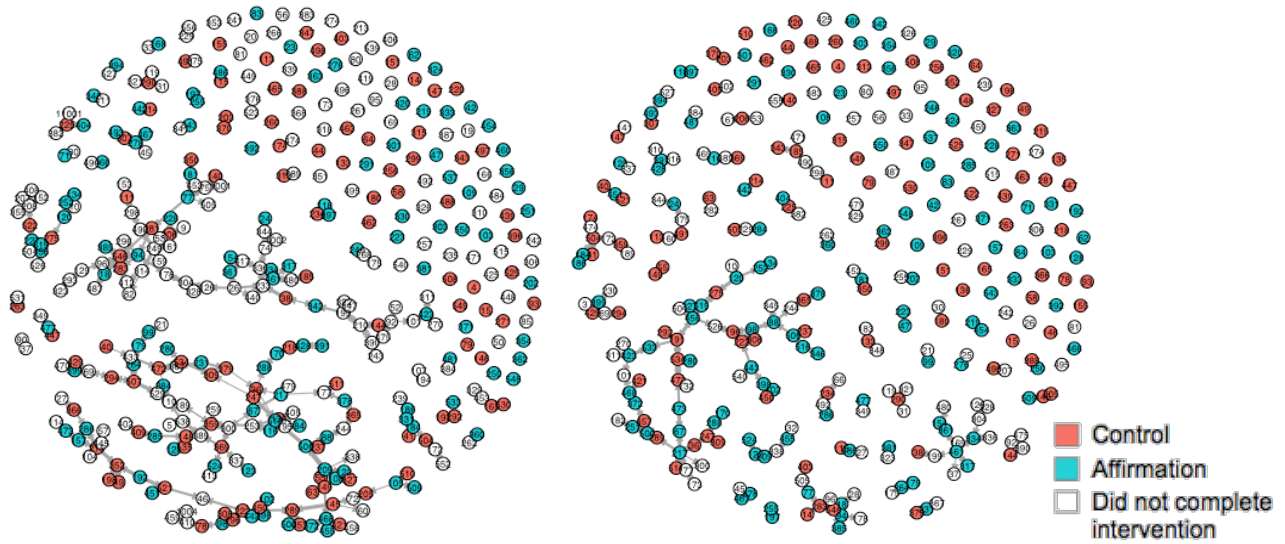


Figure B2. Support networks

Weighted, directed support network at (A) the start of the semester (Time 1) and (B) the end of the semester (Time 2)

Table B1. Network statistics by network type and time point

Network	<i>N</i>	<i>E</i>	<i>Iso</i>	<i>Deg</i>	<i>Weight</i>	<i>Den</i>	<i>Clust</i>	<i>Recip</i>	<i>Jaccard</i>
Friendship									
Time 1	460	855	60	3.72	.25	.004	.22	.40	.32
Time 2	394	629	53	3.19	.21	.004	.23	.35	
Study Partnership									
Time 1	419	475	90	2.27	.20	.003	.26	.38	.22
Time 2	326	226	122	1.39	.10	.002	.36	.32	
Support									
Time 1	392	350	112	1.79	.17	.002	.23	.33	.28
Time 2	326	225	103	1.38	.15	.002	.24	.25	

Note. Time 1 = start-of-semester (baseline/pre-treatment); Time 2 = end-of-semester (post-treatment); *N* = number of nodes in network; *E* = number of edges; *Iso* = number of isolates (nodes with no ingoing or outgoing ties); *Incl* = inclusiveness; *Deg* = average degree (number of others nominated + number of times nominated by others); *Weight* = average weight of ties (strength of relationships), scaled from 0 to 1 for comparison between network types; *Den* = graph density; *Clust* = global clustering coefficient (i.e., transitivity); *Recip* = reciprocity; *Jaccard* = Jaccard index of similarity between networks of same type at times 1 and 2

2c. Relationships Between Networks

As noted in the text, the study and support networks substantially overlapped with the friendship network. At the start of the semester (Time 1), 96.5% of study partners were also named as friends and 99.2% of support providers were also named as friends. At the end of the semester (Time 2), 95.3% of study partners were also named as friends and 96.8% of support providers were also named as friends. Additionally, the networks were significantly more correlated than one would expect by chance, as measured via Quadratic Assignment Procedure (QAP) correlation tests, a method of calculating association between two matrices (Krackardt, 1987). Correlations decrease from Time 1 to Time 2, but the networks remain highly and significantly correlated (see Tables B2 and B3 below). These results indicate that students who study together or who seek out one another for support also tend to be friends and, at least in this course, that students' study and support networks are essentially subsets of their friendship network.

Table B2. QAP correlations between networks at Time 1

Time 1	Friendship	Study	Support
Friendship	1		
Study	.76	1	
Support	.72	.74	1

Table B3. QAP correlations between networks at Time 2

Time 2	Friendship	Study	Support
Friendship	1		
Study	.58	1	
Support	.63	.59	1

2d. Means, standard errors, and regression results for all dependent variables

Table B4. Means and standard errors for dependent variables

Outcome measures (Mean, SE) for affirmation (n=118) and control (n=108) groups

Friendship Network Variable	Control		Affirmation	
	Time 1	Time 2	Time 1	Time 2
Closeness, normalized	0.0027 (0.00006)	0.0028 (0.00004)	0.0027 (0.00005)	0.0030 (0.00005)
Betweenness, normalized	0.0023 (0.0005)	0.0015 (0.0004)	0.0017 (0.0003)	0.0019 (0.0004)
Total degree	4.52 (0.32)	3.60 (0.30)	4.81 (0.35)	4.65 (0.31)
Outdegree	2.82 (0.20)	2.26 (0.20)	2.77 (0.21)	2.94 (0.20)
Indegree	1.69 (0.17)	1.34 (0.13)	2.04 (0.18)	1.71 (0.16)
Average total tie strength	2.78 (0.14)	2.66 (0.16)	2.75 (0.14)	2.83 (0.13)
Average out-tie strength	2.62 (0.16)	2.26 (0.17)	2.54 (0.16)	2.66 (0.15)
Average in-tie strength	2.53 (0.18)	2.23 (0.18)	2.42 (0.16)	2.28 (0.16)
Number of old friends	-	1.33 (0.14)	-	1.69 (0.15)
Number of new friends	-	0.93 (0.12)	-	1.25 (0.12)
Proportion of old to new friends	-	0.60 (0.04)	-	0.54 (0.04)

Note. Time 1 = start of semester (baseline), Time 2 = end of semester (post-intervention)

Table B5. Regression results for dependent variables

Multiple linear regression results for all DVs reported in main text, plus p-values calculated through permutation tests where applicable

Friendship Network Variable (y)	Multiple linear regression on observed data					
	b_{1obs}	SE	t	95% CI	p	P_{perm}
<i>Time 1</i>						
Closeness, normalized	-0.001	0.003	$t(209) = -0.36$	[-0.008, 0.005]	.72	.69
Betweenness, normalized	-0.001	0.001	$t(209) = -1.09$	[-0.002, 0.001]	.28	.17
Total degree	0.47	0.49	$t(209) = 0.97$	[-0.49, 1.43]	.34	.29
Outdegree	0.05	0.30	$t(209) = 0.15$	[-0.55, 0.64]	.88	.88
Indegree	0.42	0.26	$t(209) = 1.64$	[-0.08, 0.93]	.10	.08
Total tie strength	0.06	0.20	$t(209) = 0.31$	[-0.33, 0.45]	.76	.74
Out-tie strength	0.05	0.23	$t(209) = 0.23$	[-0.40, 0.50]	.82	.84
In-tie strength	-0.01	0.24	$t(209) = -0.05$	[-0.49, 0.47]	.96	.95
<i>Time 2</i>						
Closeness, normalized	0.009	0.003	$t(208) = 2.86$	[0.003, 0.015]	.005	.007
Betweenness, normalized	0.001	0.001	$t(208) = 1.50$	[-0.0002, 0.002]	.14	.10
Total degree	0.99	0.30	$t(208) = 3.25$	[0.39, 1.59]	.001	.01
Outdegree	0.78	0.23	$t(208) = 3.41$	[0.33, 1.23]	< .001	.007
Indegree	0.24	0.15	$t(208) = 1.60$	[-0.06, 0.54]	.11	.23
Total tie strength	0.16	0.18	$t(208) = 0.84$	[-0.21, 0.52]	.40	.43
Out-tie strength	0.43	0.21	$t(208) = 2.02$	[0.01, 0.85]	.04	.08
In-tie strength	0.18	0.19	$t(208) = 0.92$	[-0.20, 0.56]	.36	.45
Number of old friends	0.48	0.21	$t(209) = 2.26$	[0.06, 0.90]	.02	-
Number of new friends	0.33	0.18	$t(209) = 1.83$	[-0.03, 0.68]	.07	-
Proportion of old (vs. new) friends ^a	-0.03	0.06	$t(150) = -0.57$	[-0.15, 0.08]	.57	-

Note. b_{1obs} = the intervention coefficient from the linear models fitted to the observed network for each dependent variable (i.e., b_1 in the model described in section 2e).

^aamong those who identified any friends in the course at the end of the semester ($N = 167$)

2e. Study and Support Network Results

Study network. At the end of the semester, there were no significant differences between conditions in closeness or betweenness centrality in the study network (closeness: $b = .001$, $SE = .001$, $p = .43$; betweenness: $b = -1.74 \times 10^{-6}$, $SE = 3.99 \times 10^{-6}$, $p = .664$). Affirmed students had marginally more study partners than unaffirmed students at the end of the term (degree centrality: $b = .43$, $SE = .23$, $p = .06$) and studied significantly more often with their study partners than unaffirmed students (total tie strength: $b = .29$, $SE = .13$, $p = .03$).

Support network. There were no significant differences by condition in closeness or betweenness centrality in the support network (closeness: $b = .001$, $SE = .001$, $p = .10$; betweenness: $b = -3.60 \times 10^{-6}$, $SE = 8.27 \times 10^{-6}$, $p = .664$). Affirmed students had significantly more support-provision relationships in the course (degree centrality: $b = .37$, $SE = .18$, $p = .040$) and were significantly more likely to go to their support providers for support and vice versa than unaffirmed students (total tie strength: $b = .41$, $SE = .18$, $p = .03$).

2f. Alternative Explanations of Network Findings

Here we investigate two potential alternative explanations for the observed difference between conditions in friendships. We do not find evidence in support of these alternative explanations for the observed effects of intervention condition on students' social networks.

I. Perception of friendships

One possibility is that affirmed participants did not actually have more and closer friendships than unaffirmed participants by the end of the semester, but rather that they simply

had a rosier perception of their classmates and relationships in the course. In other words, perhaps the observed findings do not reflect a difference between conditions in actual social relationships, but instead a mere difference in *perception* of others. After all, past research has found that affirmed individuals report more positive other-directed feelings following the intervention than unaffirmed individuals (e.g., Crocker, Niiya, & Mischkowski, 2008).

Regarding this possibility, perceiving a friendship may in and of itself be beneficial, regardless of whether an actual friendship exists. For example, research on social support shows that perceived availability of support is as or more important for wellbeing as actually receiving support (Wethington & Kessler, 1986). Perceiving a friendship may correspond with perceiving that support and other social resources are available, potentially yielding benefits for the perceiver. Moreover, the perception that an individual is one's friend is not necessarily theoretically distinguishable from "actual" friendship (see, for example, research on long-distance friendship, which highlights the importance of subjective assessments of and attitudes toward friendship; Johnson, Haigh, Craig, & Becker, 2009).

That said, a strength of the social network methodological approach is that all participants provide information on social relationships in the course, which allows us to corroborate any one participants' friendship nomination with the nominations of others. For example, for any Participant A who names Participant B as a friend, we know whether Participant B named them back (i.e., whether the tie was reciprocal). This allows for the possibility of distinguishing between a friendship that is perceived by only one person in the pair and a mutual friendship reported by both individuals. If the observed difference between conditions were simply a matter of perception, we would expect that affirmed participants would name more classmates as friends at the end of the semester, but would have a lower proportion of reciprocal ties than

unaffirmed students (as in Figure B3 below). We thus compared affirmed and unaffirmed students' proportion of reciprocal friendship ties at the end of the semester.

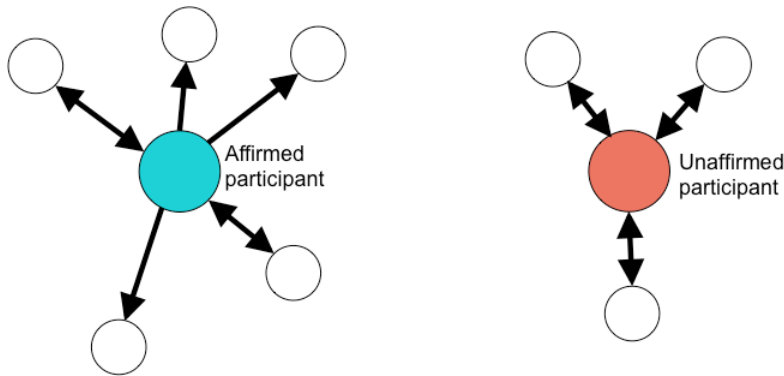


Figure B3. Demonstration of “rosy perception” explanation

Demonstration of expected results if difference between conditions reflected perception of friends, rather than actual friendships. In this demonstration, the average affirmed participant (left) names five friends, but only two (40%) are reciprocal. In contrast, the average unaffirmed participant (right) names only three friends, but all three (100%) are reciprocal. Thus, the results would suggest that affirmed participants would have more friends than unaffirmed participants, but in reality, unaffirmed participants have a similar number or more reciprocal friendships (which some might consider to be more “true” friendships).

There was no significant difference between conditions in proportion of reciprocal ties among participants who named at least one friend at the end of the semester ($b = 0.004$, $SE = 0.05$, $t(150) = 0.09$, $p = 0.93$; see Figure B4 below). Although this analysis does not definitively rule out that the difference in reported ties between affirmed and unaffirmed students was simply a difference in perception of others, it does not support that conclusion.

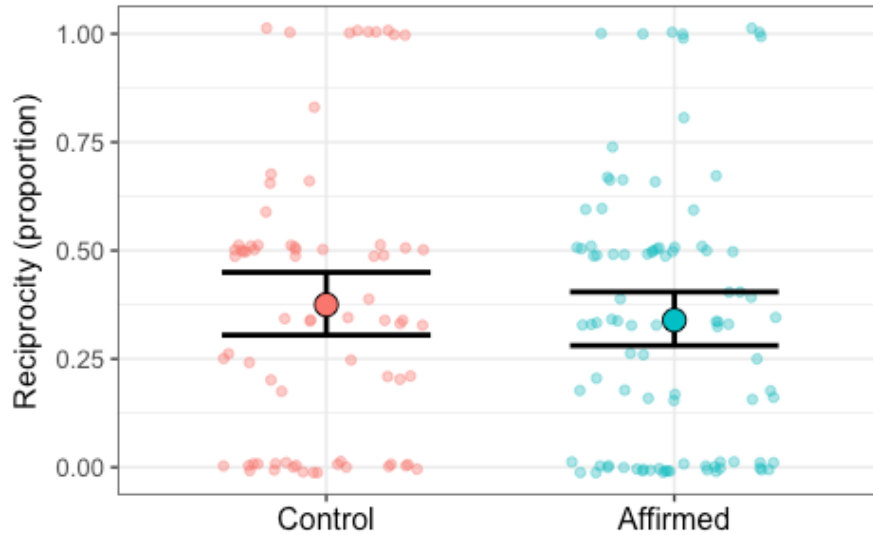


Figure B4. Difference between conditions in friendship reciprocity

No significant difference between conditions in friendship reciprocity at the end of the semester. Error bars show bootstrapped 95% confidence intervals. Mean proportion of reciprocal ties at the end of the semester for the control condition was .37; mean for affirmation condition was .34. Past research has found that approximately .4-.6 of reported friendship ties were reciprocal (Almaatouq, Radaelli, Pentland, & Shmueli, 2016; Rambaran et al., 2017; Vaquera & Kao, 2008). The reciprocity values in this study are on the low end because participants were allowed to nominate classmates who were not participating in the study (and thus could not nominate the participants back). Calculating reciprocity of ties only within nominations of friends who were participants in the study yields a mean proportion of reciprocal ties of .65 for the control condition and .56 for the affirmation condition, and still no significant differences between conditions ($b = -.08$, $SE = .07$, $t(128) = -1.25$, $p = .21$).

II. Attention to survey

Because participants nominated friends in the class through an online questionnaire, it is possible that a difference in attention paid to the survey could affect the social ties students reported. For example, a participant who paid more attention to carefully recalling their friends in the course could list more friends than a participant who was more carelessly speeding through the survey without paying attention. If the affirmation intervention caused participants to attend more carefully to the questionnaire than those in the control condition, this could explain

why affirmed participants reported more social ties at the end of the semester than unaffirmed participants.

To investigate this potential alternative explanation, we examined participants' level of attention paid to the survey through two attention check questions embedded within each questionnaire (e.g., "If you are paying attention, please select 'Strongly Agree'"). Intervention condition did not predict responses to these questions on the end-of-semester questionnaire ($t(211.42) = 0.88, p = .38$), suggesting that intervention condition did not affect the level of attention participants devoted to the questionnaires. This analysis does not support the conclusion that the difference in reported ties between affirmed and unaffirmed students was simply a difference in attention paid to the survey.

2g. Mediation Analyses

For analyses determining whether the effects of affirmation on students' social networks resulted in positive downstream effects on students' retention in the biology track, we measured whether students enrolled in the second half of the biology course in the subsequent spring semester using the subsequent semester's course roster. This retention data was available for every student in the study sample. Thus, we had retention data from all 290 participants who completed the intervention. Intervention condition significantly predicted whether students took the next biology class in this sample ($b = 0.69, SE = 0.29, p = .02$). However, end-of-semester social network data was only available for the 226 "completers." The effect of intervention condition on next-semester biology retention dropped below the threshold for significance when the sample was limited to these 226 participants ($b = 0.50, SE = 0.34, p = .14$). We chose to do Bayesian mediation analyses because this estimation procedure allowed us to retain the data from all 290 participants by allowing for missing mediator data. However, frequentist analyses in

the sample of 226 yield a similar pattern. Tables B6 and B7 are tables of the Bayesian and frequentist mediation results, respectively. Overall, the analyses show that closeness centrality, total degree centrality, and number and strength of the friendships participants nominated (outdegree and out-tie strength) mediate the relationship between intervention condition and next-semester biology retention.

Table B6. Bayesian mediation analysis results

Table of mediation analysis results using Bayesian estimation (on the full sample of 290 participants who completed the intervention) with 30,000 iterations and uninformative (default) priors (*calculated using Mplus path analysis with a categorical dependent variable and continuous mediating variable with missing data*)

Mediator	Estimate	SE	95% CI	$p_{positive-effect}$	Percent of total effect mediated
Closeness					
Average indirect effect	0.133	0.063	[0.035, 0.277]	.003	31%
Average direct effect	0.292	0.175	[-0.054, 0.637]	.048	
Betweenness					
Average indirect effect	0.000	0.002	[-0.004, 0.004]	.475	0%
Average direct effect	0.396	0.166	[0.074, 0.725]	.008	
Total degree					
Average indirect effect	0.159	0.069	[0.051, 0.318]	.001	40%
Average direct effect	0.233	0.178	[-0.119, 0.583]	.095	
Outdegree					
Average indirect effect	0.140	0.064	[0.041, 0.289]	.001	35%
Average direct effect	0.253	0.177	[-0.095, 0.601]	.076	
Indegree					
Average indirect effect	0.060	0.050	[-0.015, 0.179]	.058	15%
Average direct effect	0.332	0.173	[-0.007, 0.674]	.028	
Total tie strength					
Average indirect effect	0.070	0.051	[-0.009, 0.188]	0.043	17%
Average direct effect	0.340	0.172	[0.003, 0.680]	0.024	
Out-tie strength					
Average indirect effect	0.175	0.076	[0.050, 0.347]	0.002	41%
Average direct effect	0.244	0.180	[-0.111, 0.599]	0.087	
In-tie strength					
Average indirect effect	0.026	0.034	[-0.021, 0.111]	0.134	6%
Average direct effect	0.386	0.169	[0.055, 0.719]	0.010	

Note. Estimate = mean of posterior distribution; *SE* = standard deviation of the posterior distribution; $p_{positive-effect}$ = posterior distribution density below zero (i.e., the probability that the

effect is not above zero). Average estimated total effect¹⁹ = 0.411, *SE* = 0.176, 95% CI [0.069, 0.760], *p*_{positive-effect} = .010. Variables bolded in table significantly mediated the relationship between intervention condition and next-semester biology retention (i.e., *p*_{positive-effect} of indirect effect < 0.05 and 95% CI does not include 0). Analyses presented in table controlled for the baseline measure of the network variable, but results do not differ meaningfully in analyses that do not include this covariate (except that, without including the baseline measure as a control, in-degree significantly mediates the relationship between intervention condition and next-semester biology retention).

Table B7. Frequentist mediation results

Table of mediation analysis results using frequentist estimation (on the 226 “completers” only) with confidence intervals computed through nonparametric bootstrapping with 10,000 simulations (*calculated using ‘mediation’ R package version 4.4.6*)

Mediator	Estimate ^a	95% CI	<i>p</i>	Percent of total effect mediated
Closeness				
Average indirect effect	0.036	[0.006, 0.07]	0.01	42%
Average direct effect	0.050	[-0.056, 0.15]	0.38	
Betweenness				
Average indirect effect	0.000	[-0.015, 0.02]	0.95	0%
Average direct effect	0.084	[-0.023, 0.19]	0.12	
Total degree				
Average indirect effect	0.044	[0.011, 0.08]	0.003	57%
Average direct effect	0.033	[-0.070, 0.13]	0.555	
Outdegree				
Average indirect effect	0.040	[0.012, 0.08]	0.002	54%
Average direct effect	0.035	[-0.070, 0.14]	0.513	
Indegree				
Average indirect effect	0.013	[-0.010, 0.04]	0.28	17%
Average direct effect	0.063	[-0.037, 0.16]	0.22	
Total tie strength				
Average indirect effect	0.013	[-0.009, 0.04]	0.28	17%
Average direct effect	0.062	[-0.042, 0.17]	0.24	
Out-tie strength				
Average indirect effect	0.037	[0.003, 0.08]	0.029	51%
Average direct effect	0.036	[-0.065, 0.14]	0.485	
In-tie strength				
Average indirect effect	0.004	[-0.010, 0.02]	0.53	6%
Average direct effect	0.076	[-0.028, 0.18]	0.16	

Note. Estimated total effect (standardized estimate) = 0.079, 95% CI [-0.02, 0.19], *p* = .13.

As above, analyses presented in table controlled for the baseline measure of the network variable; results did not differ meaningfully in analyses that did not include this covariate.

^aStandardized estimates

¹⁹ Due to the Bayesian estimation approach, there were slight variations in the estimated total effect across models; thus, the total effect reported here is averaged across the total effect estimates of the eight models reported in *Table B6*.

Appendix C: Supplementary Information for Chapter IV

This appendix contains supplementary information for Chapter IV, *A Network Analysis of Echo Chambers in Online News Coverage of a Nationally Polarizing Race-Related Event*.

1. Methods

1a. Details of sources in final sample

Of the 69 targeted media sources, two were indistinguishable in search functionality (Huffington Post and HuffPost Black Voices) and were thus combined. Additionally, we did not find relevant articles for three sources (BlackPlanet, Mediatakeout, and WorldStarHipHop). Finally, while Pew Research Center (2015) identified “Yahoo/ABC News Network” as one online media source, Yahoo and ABC had separate sites and search functionalities, and were thus included in the dataset as two sources. The final sample thus consisted of 3,284 articles from 66 online news sources ($n = 52$ top overall outlets, $n = 14$ top African American-oriented outlets).

1b. List of departures from pre-analysis plan

- i. Measurement of source political leaning: When writing our pre-analysis plan, we had anticipated using Pew Research Center’s (2015) data on audience demographics. When we began analysis, we found that this dataset had little overlap with the top media sources we collected (only 14 sources) and thus sought out alternative data (described in detail below).
- ii. Measurement of focus on race: We departed from the method described in our preanalysis plan to calculate sources’ focus on race in Ferguson articles, as measurement

of these concepts using Word2Vec was clearly more accurate than the one we specified in advance. See details below.

- iii. **Measurement of Linguistic Intergroup Bias:** In our preregistration, we had originally proposed examining evidence for linguistic intergroup bias by measuring solely the concreteness of language used in Ferguson articles. However, a reviewer rightly suggested that we take into account the affective context of the language, given that linguistic intergroup bias predicts that more concrete language will be used when describing positive outgroup characteristics, whereas more abstract language will be used when describing negative outgroup characteristics. Our originally proposed approach, looking only at concreteness, would not have picked up on the context-dependent nature of linguistic intergroup bias. Thus, after receiving the first round of reviews on this paper, we adjusted our analytical approach, deciding instead to measure the correlation between language concreteness and valence such that both aspects were taken into account. We acknowledge that this approach still has clear limits, given our inability to restrict analysis to concreteness and valence of language used to describe an *outgroup* specifically, as is dictated by the theory of linguistic intergroup bias.

1c. Race measurement (and additional information on Word2Vec)

For our concept of interest (race), we obtained the Word2vec²⁰ vectors for each word we chose to represent this concept (“black”, “white”, “race”, “ethnicity”, “diversity”), and averaged them together (see note below about the use of the word “diversity” for this concept). This yielded a point in 300-dimensional space that represents the average of the concept expressed by

²⁰ <https://code.google.com/archive/p/word2vec/>

our input words. Then, to obtain a race score for each article in our corpus, we computed the cosine similarity of the Word2Vec vector representation for that word and the average representation for race. The degree to which a given article’s language reflects the concept of race was then expressed as the average cosine similarity of the words in the article in relation to the overall dictionary representation. This method yielded document-level scores that range from -1 (perfect dissimilarity) to 1 (perfect similarity).

In our pre-analysis plan, we specified that we would measure linguistic emphasis on race by building a dictionary of race-related terms. This process was specified to be automated, such that we would start with *seed* words and build up the dictionary by finding words that occurred in similar contexts. In particular, we modeled our approach after that of Balasubramanyan and colleagues (2012). Here, we began with seed words “black,” “white,” “race,” “ethnicity,” and “diversity” per our preregistration, then appended words that scored high on a measure of Pointwise Mutual Information. This approach clearly had relatively poor performance, as indicated by the top 5 words selected by this metric (*the*, PMI=13.99; *steals*, PMI=10.75; *pendleton*, PMI=10.70; *nuder*, PMI=10.67; *nieces*, PMI=10.54). We note that further down the list are words that one would expect (e.g. *stereotyped*, PMI=9.09, position 15; *ethnicities*, PMI=8.71, position 26).

In contrast, using the distributed representation method in the paper, the words in our corpus that are closest as measured by cosine similarity to the concept of race (composed by taking the average of word vectors for “black,” “white,” “race,” “ethnicity,” and “diversity,”) are *blacks* (similarity=.61), *gender* (similarity=.60), *multiracial* (similarity=.59), *nonblack* (similarity=.58), and *nonwhite* (similarity=.58). Thus, with the clear poor performance of the

PMI method, and the clearly excellent performance by the distributed representation method, we opted to use the latter approach for measuring race as well as individualism and egalitarianism.

Although we preregistered “black,” “white,” “race,” “ethnicity,” and “diversity” as our seed words for the concept of race, one of our reviewers rightly pointed out that “diversity” could refer to a number of other concepts besides race. Following this comment, we repeated the distributed representation method described above without the word “diversity,” and re-ran the associated assortativity analysis. The results did not meaningfully change. Without “diversity” as a seed word, the closest words measured by cosine similarity were *racial* (similarity=.60), *blacks* (similarity=.60), *whites* (similarity=.59), *caucasians* (similarity=.58), and *nonwhite* (similarity=.57). As reported in the main text, the original assortativity analysis including the word “diversity” indicated that the network was not significantly assorted by use of race-related words ($r_{\text{race-orig}} = .14, p = .39$); without “diversity,” the results supported the same conclusion ($r_{\text{race-revised}} = .15, p = .33$).

1d. Valence measurement

LIWC. There are a variety of ways to calculate valence using LIWC dictionaries. Following our preregistration plan, we calculated valence (i.e., the direction of emotionality expressed in the text) by dividing the total number of words that appeared in the positive emotion LIWC dictionary by the total number of words that appeared in either the positive or negative emotion LIWC dictionary. This yielded the proportion of positively valenced words out of all the emotion words in the text, such that a number above .5 indicates a higher proportion of positive compared to negative words, whereas a number below .5 indicates a higher proportion of negative compared to positive words. This method has been used to calculate valence in past

work (e.g., Godbole, Srinivasaiah & Skiena, 2007; Tan, Friggeri & Adamic, 2016). There is no reason to believe that this method should be fundamentally better or worse than other methods that have also been used in past work (e.g., taking the difference between positive and negative emotion words); to ensure that the results of these methods were indeed comparable, we ran an additional analysis in which we calculated valence by subtracting negative emotion words from positive emotion words. Using this difference score LIWC valence method, we replicated our original results using the proportion method, finding that the network was significantly more assortative by valence than would be expected by chance ($r_{(\text{val-L-diff})} = .20, p = .01$).

VADER. VADER combines a larger-than-typical number of terms with a set of rules for modifying the intensity or direction of sentiment using context (e.g., use of exclamation points, intensifying words, negations). VADER works at the level of short texts, so we scored the sentiment of each sentence and averaged these for each article.

1e. Source political leaning measurement

As part of another study unrelated to the work reported here, we obtained data on how individuals viewed the sources in our dataset. We collected data from a survey posted to Amazon Mechanical Turk and a Clearvoice panel of American homeowners. Although 1968 participants began this survey, the final sample consisted of 1556 people (922 female; median year born = 1975; 855 from Clearvoice). The majority of exclusions occurred because participants did not complete the survey ($n=374$), with a smaller number excluded because their response pattern indicated that they were not paying attention (i.e. straightlining responses combined with a fast completion time; $n = 38$).

For the purposes of this work, we obtained three pieces of information from participants. First, we asked participants to indicate their political beliefs on a seven-point scale that ranged from *Extremely Liberal* to *Extremely Conservative* (coded as -3 to +3). Responses to this measured indicated a small liberal bias in our data ($M = .21, SD=1.67$). Next, participants indicated how frequently they got news from each media source on a six-point scale that ranged from *Never* to *Daily* (-2.5 to +2.5), with an additional option of *Have not heard of this site*. Excluding sites that participants indicated they had not heard of, we then asked participants to indicate how much they trusted each source on a five point scale that ranged from *Mostly Distrust* to *Mostly Trust* (-2 to +2). Two sources from our sample were not included in the survey: Houston Chron and ClutchMagazine.

To estimate the political leanings of each source, we fit a multilevel model to the trust ratings. The model was of the form:

$$trust_{ij} = B_0 + P_{0j} + S_{0i} + S_{1i}X_{ij} + e_{ij}$$

where B_0 is a global intercept, P_{0j} are the participant-specific deviation from the global intercept, S_{0i} are the source-specific deviation from the global intercept, S_{1i} are the estimated effects of political belief on the trust ratings for source i , and X_{ij} is a vector of political belief scores for source i , participant j . The final term, e_{ij} is the residual variance.

We used the source-specific estimates of political belief on trust as the estimates of source political orientation. These estimates can be interpreted as the change in trust for each unit change in political belief, where higher scores indicate increased trust among conservatives and lower scores indicate decreased trust among conservatives.

1f. Source-level estimation

For all source-level language estimates, we fit an intercept-only Bayesian multilevel model, with the source-specific intercepts allowed to vary (i.e. a random-intercepts model).

Formally, the model was of the form:

$$y_{ij} = B_0 + S_{0j} + e_{ij}$$

where B_0 is a global intercept, S_{0j} are the source-specific deviations from the global intercept, and e_{ij} is the residual variance. The prior for this model was a weakly-informative normal distribution centered on zero with a standard deviation of 5. In subsequent analyses, we obtained the non-centered source specific intercepts (i.e., we added the fixed effect to each of the random effects to obtain the score for each source, $y_j = B_0 + S_{0j}$). This model form was necessary because our data consist of articles nested within sources. By using a hierarchical model, we are accounting for this non-independence in our observed data.

1g. Computation

A number of software packages and programming languages were used to process and compute the metrics and non-parametric statistics described here. Assortativity coefficients and community analyses were calculated using the ‘igraph v1.0.1’ package in R (Csardi & Nepusz, 2006). Linguistic processing was done in Python 2.7 using the standard scientific computing stack: numpy, scipy (Jones, Oliphant, Peterson, & others, 2001–2001--), pandas (McKinney, 2010), scikit-learn (Pedregosa et al., 2011) and text-specific modules gensim (Řehurek & Sojka, 2010), nltk (Bird, Klein, & Loper, 2009), spacy (Spacy, 2017). Bayesian models used to estimate source-level estimates of text-based metrics were fit in R 3.3.1 using Stan (Stan Development Team, 2016) and the RStanArm interface (Stan Development Team, 2016), with much of the

data processing completed using the set of tidyverse packages (tidyr, dplyr, stringr) (Wickham, 2017).

1h. Note on the use of r_{com} metric

One caveat of using Shizuka and Farine's (2016) r_{com} method in this context is that this method was originally developed for animal social networks that are subject to sampling error (because associations between animals may not be sampled equally). In such cases, confidence in community assignments depends both on the actual structure of the network and sampling error. Our hyperlink network collection procedures leave little room for sampling error, so the actual degree of segregation in the network is the primary factor determining confidence in our community assignments.

This difference represents a potential limitation of the interpretation of r_{com} in our community analysis results. While the use of this metric is equally valid in our network as a measure of confidence in the community structure we detected, the threshold above which Shizuka and Farine (2016) suggest an r_{com} value should be interpreted as robust evidence for community structure may not be. Given that sampling error in a network would increase uncertainty and decrease reliability in community assignments (thus depressing r_{com}), networks subject to sampling error may need to reach a lower threshold of similarity of community assignments across bootstrap replicates to infer that community structure is robust. In contrast, our news hyperlink network is unlikely to suffer from sampling error, so the primary source of uncertainty in community structure derives from the extent to which sources show fidelity to specific community subgroups. In such a situation, the threshold for r_{com} to be interpreted as evidence of robust community assignments may need to be higher. If true, the implication for the present study might be that the communities of news sources we detected may be less robust than

originally thought. Given the usefulness of r_{com} as a metric of community robustness (Shizuka & Farine, 2016), future work examining the use of this method in other types of networks would be valuable.

2. Results

2a. Assortativity by source type

In addition to the analyses presented in-text, we also examined whether sources tended to link to other sources with a similar target audience according to their classification by Pew Research Center (2015), i.e., African American oriented versus general audience. The network was significantly more assortative by source type than would be expected under a null model ($r_{type} = .23, p < .0001$), indicating that the top general audience sources were more likely to link to other top general audience sources, while top African American-oriented sources were more likely to link to other top African American-oriented sources.

2b. Assortativity by American value themes

We also examined the extent to which sources employed independent but complementary value themes that tend to be emphasized by American media, particularly in coverage of race-related issues: *individualism* and *egalitarianism* (Kellstedt, 2000). In this context, individualism and egalitarianism map onto the Moral Foundations Theory concepts of fairness as proportionality versus fairness as equality (Haidt, 2013): individualism describes the idea that people should get ahead on their own and earn what they get without assistance, while egalitarianism describes the belief that everyone should have an equal opportunity to succeed even if it requires intervention by the government or another party (Kellstedt, 2000). We chose

these constructs because past research has highlighted that differential emphasis of these values by the press when covering race-related issues can affect the public's attitudes toward race and policy (Kellstedt, 2000; Brewer & Gross, 2005). Examining assortativity by these themes was part of our pre-registration; however, we did not include these themes or their related analyses in the main text due to space constraints.

For the computation of individualism and egalitarianism values, we used a distributed word representation approach as used to calculate the other linguistic measures. The concept of individualism, or the idea that people should get ahead in society on their own, was represented as the average of the word vectors for “earn,” “deserve,” “merit,” “warranted,” and “entitled.” The concept of egalitarianism, the idea that everyone should have an equal opportunity to succeed, was represented as the average of word vectors for “egalitarian,” “equal,” “fair,” “injustice,” and “equity.” These words were drawn from Kellstedt's (2000) content analysis dictionary obtained from the author (P. M. Kellstedt, personal communication, July 11, 2017).

Analyses revealed no significant assortativity by individualism ($r_{ind} = .12, p = .89$) or egalitarianism ($r_{egal} = .12, p = .74$), indicating that sources were not more likely than chance to link to other sources that had a similar focus on individualism or egalitarianism value themes.

2b. Sample hyperlink sentences

To illustrate the ways in which sources in our dataset hyperlinked to one another in the context of the Ferguson shooting coverage, we have selected representative samples of 10 sentences in which a source linked to another source within its same community (within-community links) and 10 sentences in which a source linked to a source outside its community (between-community, or cross-cutting, links). For each example below, the linked text is bolded.

Within-community examples:

Source: Huffington Post

Link Destination: Freep

A Missouri chapter of the **Ku Klux Klan is working** to raise money for Darren Wilson, the police officer who shot and killed unarmed black teenager Michael Brown in Ferguson, Missouri, on Aug. 9.

Source: The Guardian

Link Destination: Huffington Post

Missouri state Sen. Maria Chappelle-Nadal **said that she was hit by tear gas.**

Source: Time

Link Destination: ABC

Brown's death in particular is **raising major ongoing protests** precisely because, contrary to police accounts, witnesses claim that he had his **hands up in the air** in surrender when he was shot.

Source: The Root

Link Destination: New York Times

The violence comes after news reports that a private autopsy ordered by the family of Michael Brown showed that the unarmed teenager, who was fatally shot by a police officer Aug. 9, was shot six times, including twice in the head, according to the **New York Times.**

Source: Daily Mail

Link Destination: NBC

Police told **NBC** that the person who Anonymous had named online is a dispatcher and was not involved in the Ferguson shooting on Saturday.

Source: NY Daily News

Link Destination: Yahoo

Meanwhile, **Yahoo News published the first photo** of Wilson.

Source: The Root

Link Destination: Daily Mail

A report by the Daily Mail points out that Brown appeared to be wearing the same outfit in the surveillance footage that he was wearing when he was gunned down.

Source: Gawker

Link Destination: Huffington Post

According to a statement made by Justice Department Spokesman Brian Fallon, Attorney General Eric Holder has **ordered the Department of Justice** to perform a second autopsy on Michael Brown, due to the ""extraordinary circumstances"" of the case.

Source: TheBlaze

Link Destination: Daily Mail

But on Tuesday, the Daily Mail published **messages that Wilson allegedly sent** to his friend, Jake Shepard, offering the public a possible glimpse into the life of the embattled cop.

Source: Gawker

Link Destination: CBS

According **CBS affiliate KMOX**, funeral arrangements for Brown are on hold until a second autopsy can be performed.

Between-community (cross-cutting) examples:

Source: Huffington Post

Link Destination: CNN

New audio has surfaced that allegedly captures the moment when Michael Brown, an unarmed black teenager, was shot dead by Darren Wilson, a white police officer, on Aug. 9.

Source: BET

Link Destination: NBC

Intertwined in the track is an **account** of the shooting from witness Dorian Johnson, 22, Brown's friend who was walking with him the day he was killed.

Source: Slate

Link Destination: New York Times

Photo 6 in **this New York Times slide show**, among others, remains in my mind.

Source: Ebony

Link Destination: Washington Post

When Southern Black churches were being bombed in 1996, the nation wanted to hear from Bill Clinton, not **Attorney General Janet Reno**.

Source: Huffington Post

Link Destination: Fox News

According to the Milwaukee police chief, the officer was **defending himself in a violent situation**.

Source: The Blaze

Link Destination: Fox News

“I hate to say this, but I’m going to tell you what you need to hear as opposed to what you *want* to hear!” Gentry, identified by Fox as a **minister** and who is based in Los Angeles, said earlier in the week.

Source: Huffington Post

Link Destination: ABC

Some protesters threw Molotov cocktails at police towards the end of Wednesday night, **the Associated Press reported.**

Source: Salon

Link Destination: CNN

His young administration now faces its first major crisis after the **death of Eric Garner**, an unarmed black man arrested for selling untaxed cigarettes, who was apparently placed in a chokehold by a white officer, in defiance of NYPD rules.

Source: NPR

Link Destination: NBC

The chaos after dusk came **after a unity rally** that drew thousands of community members on Sunday afternoon.

Source: The Root

Link Destination: Fox News

“The small group of people are creating a huge mess,” Ferguson Mayor James Knowles told news station **KTVI-TV** about the looting.