Structurally Redundant Heterogeneity and Group Performance*

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January 2013
(draft being revised for resubmission to Organization Science)

* We have benefited from the advice of Matt Bothner, Ronnie Chatterji, Jason Davis, Scott DeRue, John Paul Ferguson, Pranav Garag, Steve Kahl, Michael Lenox, Greg Liegel, Dave Mayer, Damon Phillips, Ray Reagans, Maxim Sytch, and Jim Westphal, as well as seminar participants at the 2012 Duke Strategy Conference and the Columbia University Business School. Correspondence may be directed to Ned Smith, Stephen M. Ross School of Business, University of Michigan, 701 Tappan St., #4446, Ann Arbor MI, 48019, nedsmith@umich.edu.
**Structurally Redundant Heterogeneity and Group Performance**

We argue that the performance benefits of interpersonal heterogeneity are subject to three common failure points. First, heterogeneous people tend to *homogenize* over time with repeated exposure, leading any benefits of interpersonal heterogeneity to decay with time. Second, groups composed of heterogeneous people tend to be *fragile*; they are both more likely to experience turnover and are more adversely affected when such turnover results in a loss of unique knowledge from the group. Simple redundancy—i.e., pairing each person in a heterogeneous group with a similar counterpart—offers a potential solution to the first two failure points but also gives rise to a third: heterogeneous groups composed of homogenous subgroups are likely to *fragment*. A structural solution exists for groups with internal hierarchical divisions. We refer to the arrangement as *structurally redundant heterogeneity* (SRH) and characterize it as one where heterogeneity exists among people within a hierarchical level but homogenous subgroups exist between levels. Using 23 years of panel data from the National Basketball Association (NBA), we find that teams exhibiting SRH perform better than others. Three underlying mechanisms account for this effect and closely align with the three failure points of heterogeneity: first, the positive effect of heterogeneity among teams' core players on performance decays more slowly for teams with SRH; second, teams with SRH are less negatively affected by turnover among core players; third, teams with SRH exhibit a higher degree of coordination and cooperation, which has a positive effect on performance.
INTRODUCTION

Theories extolling the performance benefits of interpersonal heterogeneity are scattered widely throughout the social, organizational, and managerial sciences. While varying in several notable ways—for example, the dimensionality of heterogeneity, the underlying mechanisms linking heterogeneity to group performance, the necessary environmental conditions for heterogeneity to be beneficial—the collection of these theories offers a compelling narrative. At risk of gross generalization, the narrative goes something like this: interpersonal heterogeneity engenders creative problem solving (e.g., McLeod, Lobel, Cox 1992; Hoffman and Maier 1961; Bantel and Jackson 1989; Mannix and Neale 2005) by increasing breadth of perspective and improving the quality of ideas (e.g., Hoffman 1979; Milliken and Martins 1996; Burt 2004) through extended search (e.g., Hastie 1986; Bantel and Jackson 1989; Eisenhardt and Schoohoven 1990; Wiersema and Bantel 1992) and enhanced collaborative memory (Hastie 1986, Gigone and Hastie 1993; Rajarm and Pereira-Pasarín 2010) to positively affect group performance (e.g., Hambrick, Cho, and Chen 1996). Some research has even gone as far as to suggest that when constructing groups, interpersonal heterogeneity trumps individual ability (Hong and Page 2004). As compelling of a narrative as this may be, it is often at odds with empirical research designed to observe and quantify the performance benefits of heterogeneous groups, teams, and organizations. A comprehensive review paper by Williams and O'Reilly (1998) highlights just how tenuous the link between interpersonal heterogeneity and performance is, finding, on average, a negative effect of heterogeneity on group performance across a sample of 80 papers spanning 40 years.

The real merit in Williams and O'Reilly's (1998) review is not in questioning the many theoretical benefits of heterogeneity, however, but rather in shifting attention to the reasons why
such benefits may be difficult to realize. For example, several studies have demonstrated a link between interpersonal heterogeneity and dysfunctional group dynamics such as elevated turnover and low interpersonal cohesion (Jackson et al., 1991; O'Reilly, Caldwell, and Barnett, 1989; for a review, see Milliken and Martin, 1996). Our first aim in this paper is to reduce these reasons to three basic types, what we call the three failure points of heterogeneity. They are; (1) heterogeneous people tend to homogenize—i.e., talk alike, think alike, and act alike—over time and with repeated exposure; (2) groups of heterogeneous people are inherently fragile; and (3) heterogeneous groups tend to fragment into homogeneous subgroups. Because each of these three failure points can undermine the purported benefits of heterogeneity, it is necessary for groups, teams, and organizations to overcome them simultaneously if they should strive to sustainably experience the benefits of heterogeneity.

Our second aim is to offer one potential, unified solution to the three failure points we identify. We refer to the solution as structurally redundant heterogeneity (herein, SRH).

Beginning with the observation that many groups, teams, and organizations are divided into two or more hierarchical levels (Harrison & Klein 2007; Haley et al 2011; Anderson and Brown 2010; Korn, Milliken, and Lant 1992, Bantel Jackson 1989) SRH captures the arrangement whereby interpersonal heterogeneity exists within levels, but similarity exists between levels. For instance, should the top level of a two-level group include persons of types A, B, and C—for our purposes here, types refer to uniqueness in identity, background, or knowledge, more specifically—then having persons of types A, B, and C also represented in bottom level would equate to the group having SRH. To illustrate SRH visually, consider the hypothetical group in figure 1. While this configuration could feasibly represent any number of groups, teams, or organizations—e.g., professional service firms, medical teams, project-based workgroups, sports
teams, etc—for simplicity, think of it as an academic department divided into junior and senior level faculty. Letters signify either doctoral training or research specialty. Redundancy (i.e., homophily) comes in the form of two faculty members having comparable doctoral training or research interests. SRH exists when those two faculty members span the junior/senior divide. Should the composition of all senior faculty be heterogeneous—i.e., many backgrounds or research interests represented, as many departments in fact are—then several instances of redundancy between junior and senior ranks would amount to a department high in SRH.

To identify and explore the effects of SRH, we use panel data on team performance in the National Basketball Association (NBA) for the 1986–2008 seasons. We limit our analysis to the simplest case of two levels and describe them using the terms primary and secondary. Focusing our attention on a single player characteristic—the conference in which a player competed during his college experience, a variable we hold to be analogous to knowledge and functional background in organizational and groups contexts—we develop hypotheses related to SRH and the salient mechanisms linking it to team performance. The mechanisms on which we focus are directly analogous to the three failure points of heterogeneity—homogenization, fragility, and fragmentation. Our results indicate that teams high in SRH perform better, on average. Moreover, we find that that an observed positive effect of heterogeneity among teams' core players on team performance decays more slowly for teams with SRH; that teams with SRH are less negatively affected by turnover among core, or primary level players; and finally, that the effect of SRH on performance is partially mediated by high levels of interpersonal coordination and cooperation.

Before moving on to develop our arguments in more detail, it is useful to consider the scope and generalizability of our assumptions and arguments. To begin, we are operating
conceptually in an environment where there are real—even if unrealized—performance benefits to interpersonal heterogeneity. Prior empirical research has shown that such environments are likely to be those exhibiting uncertainty (Boeker 1997; Canella et al. 2008) and demanding innovation and/or high "information processing" (e.g., Deszo and Ross 2012; Knippenberg et al. 2004). In other words, we assume a context where interpersonal heterogeneity should have a positive effect on group performance and theorize about the reasons why such benefits may fail to materialize. Second, we are envisioning a setting wherein all members of group identify primarily with a singular common goal. We consider the impact of relaxing this assumption following the discussion of our results. Finally, while our dual focus on knowledge-based heterogeneity and hierarchy-based levels aligns closely with Carton and Cummings (2012) discussions of diversity- and disparity-based "faultlines," we acknowledge that these two dimensions may not readily generalize to all forms of interpersonal heterogeneity. We consider these issues further—including generalizations beyond hierarchical divisions—as well as discuss several theoretical and applied implications of our findings, in the discussion section.

**INTERPERSONAL HETEROGENEITY**

Heterogeneity is often viewed as the lifeblood of productive and innovative teams, groups, and organizations (Bantel and Jackson, 1989; see also Mannix and Neale, 2005). In complex environments especially, heterogeneity enhances breadth of perspective, improves the quality of ideas, and fosters creativity via the recombination of unique knowledge and perspectives (Boeker 1997; Canella et al. 2008; Deszo and Ross 2012; Knippenberg et al. 2004; Hoffman, 1979; McLeod, Lobel, and Cox, 1992; Milliken and Martins, 1996; Burt, 2004). Research on top management teams, for example, has demonstrated that groups of managers with heterogeneous educational and functional backgrounds garner a performance advantage.
This outcome is attributed to the fact that groups of heterogeneous people tend to engage in more comprehensive search, considering both more information and information from more diverse sources (Hastie 1986). As a result, such groups tend to consider more alternatives and exhibit greater creativity in both actions and reactions (Bantel and Jackson, 1989; Eisenhardt and Schoohoven, 1990; Wiersema and Bantel, 1992).

In spite of these (and many other; see Mannix and Neale 2005 for a review) illustrations of the virtues of interpersonal heterogeneity, the corpus of teams and organizational research also includes many exceptions which find no and sometimes even negative performance effects of heterogeneity on performance (for two recent examples, see Rose 2007; Eklund et al 2009). The Williams and O'Reilly (1998) review article referenced above highlights some of the most salient examples, concluding with a view that interpersonal heterogeneity, in and of itself, tends to have a negative effect on performance unless steps are taken to counteract certain dysfunctional group dynamics that can result from interpersonal heterogeneity. In the end, the theoretical benefits of heterogeneity are simply difficult to realize due to the many complexities around motivating, coordinating, and assimilating heterogeneous people (Greening and Johnson, 1997; Hambrick and D’Aveni, 1992). Herein lies this paper's motivating question: how can one structure a group of heterogeneous individuals such that the benefits of heterogeneity can be experienced over time? To answer this question we begin below by identifying three of the primary reasons why heterogeneous groups fail.

THREE FAILURE POINTS OF INTERPERSONAL HETEROGENEITY

Three things must be true for a group of heterogeneous people to sustainably experience the benefits of their heterogeneity. First, people must remain heterogeneous, holding fast to their idiosyncrasies lest they assimilate to the views of others in the group, eliminating any benefits of
heterogeneity. Second, heterogeneous groups must be stable enough to withstand exogenous shocks. Specifically, heterogeneous groups must either discourage the exit of individuals—especially those having unique knowledge or skills—or minimize reliance on any one individual. Finally, the group must remain cohesive. Accordingly, we propose the three primary (though not necessarily only) failure points of interpersonal heterogeneity include *homogenization*, *fragility*, and *fragmentation*. We describe each in more detail below, discussing in turn both the theoretical rationale for each failure point and one or more empirical instantiations of it from existing research.

*Homogenization:* We refer to homogenization as the process whereby diverse people begin to resemble one another—in thoughts, action, or knowledge—over time (e.g., Carpenter 2002). Homogenization comes in two basic forms, a strong form wherein initially diverse people actually become more alike over time, and a weak form wherein diverse people simply act alike. Both forms of homogenization, though the latter especially, occur in part as a function of etiquette biases and the "group paradox"—the observation that people's desires to connect with others in a group reduces the likelihood that people share their real opinions, especially when such opinions differ from others in the group (Burt 2007; Berg and Smith 1995; Bourdieu 2002). Behaviorally speaking, homogenization is often manifest in the form of "discussion cascades" (Sunstein and Hastie 2008) and results in group-think (Janis 1972; Pfeffer 1983; Bantel and Jackson 1989) and adherence to the majority opinion and/or status quo (Rose 2007). Several empirical examples align with the homogenization as we imagine it. Stasser (1985), for example, found that groups of people tend to focus discussion on previously shared information rather than unshared (but nevertheless relevant) information during deliberations. Stroebe, Diehl, and Abakoumkin (1992) extend this logic in an experimental study on group problem solving,
finding that four people working together generate fewer unique solutions to a problem than four people working independently. Watson, Kumar, and Michaelson (1993) offer an even stronger link, establishing that the performance of heterogeneous groups tends to converge to the performance of homogeneous groups as collective experience increases (Watson, Kumar, and Michaelson, 1993).

Fragility: The second failure point of interpersonal heterogeneity relates to the inherent fragility of heterogeneous groups. As in failure point number one above, there are two underlying forms of fragility, one structural and another behavioral. To illustrate the structural one, consider again the hypothetical three-person group depicted in the introduction. In this group, knowledge is idiosyncratic to and therefore distributed among three types of people, A, B, and C. If the performance of this group were a function of its underlying heterogeneity—our guiding scope condition—then it holds that the group is highly dependent on the presence of each individual member. Loss of any one member could be catastrophic (cf., Bothner, Smith, and White 2010). This structural feature poses a real and significant problem for highly heterogeneous groups as behavioral evidence suggests that it is precisely such groups that are most likely to experience member exit and turnover (Jackson et al., 1991; O'Reilly, Caldwell, and Barnett, 1989; for a review, see Milliken and Martin, 1996; see also Smith-Lovin 2007, p. 116).

Simple redundancy—create a group of six people consisting of two A's, two B's, and two C's, to build on our running example—offers a potential solution to failure points one and two. Behaviorally speaking, individuals are more inclined—indeed, they feel "psychologically safer"—to express their unique opinions when they are part of like-minded subgroups (Asch 1952; Gibson and Vermeulen 2003). Simple redundancy should therefore act to mitigate the
process of homogenization. Group fragility, too, should be lessened by simple redundancy: not only will the group be less affected by the exit of any one individual—her knowledge will be retained in her redundant counterpart—but following from earlier logic, individuals themselves will be less likely to exit due to the presence of a similar counterpart. Homogenous subgroups foster feelings of personal satisfaction, motivation, and commitment (Pfeffer, 1983; Cartwright, 1968; Beal et al., 2003).

*Fragmentation:* Despite these beneficial effects, simple redundancy leads to failure point number three, fragmentation. Following prior theory, we view fragmentation as the tendency for homogenous subgroups within a larger, heterogeneous group to faction along "faultlines" created by those subgroups (Lau and Murnighan 1998). The process of group fragmentation begins when forces of homophily lead similar people—especially similar people in otherwise heterogeneous contexts—to disproportionately associate with one another (McPherson, Smith-Lovin, and Cook 2001). Blau (1977) depicts people's tendencies to identify with similar others (i.e., form homogenous subgroups) over a primary group as the most destructive force affecting groups and organizations. Blau's argument has since been supported by empirical research demonstrating that homogenous subgroups create social barriers and constitute a principal impediment of group cohesion (see also Lau and Murnighan, 1998 on "fault lines"; Akerlof and Kranton, 2010; O’Leary and Mortensen, 2010). When group cohesion is undermined, group performance will suffer.

**STRUCTURALLY REDUNDANT HETEROGENEITY**

To sustainably experience the benefits of interpersonal heterogeneity, a group, team, or organization must resist homogenization, overcome fragility, and remain cohesive. As we described in the prior section, simple redundancy accomplishes the first two of these objectives
but also increases the likelihood of group fragmentation. SRH, as we come to argue in this section, may accomplish each of the three objectives simultaneously. To do this, SRH leverages disparity-based faultlines—lines dividing groups into two or more hierarchical levels (Harrison and Klein 2007; Carton and Cummings 2012)—to allow for homogeneous subgroups to exist without a corresponding spike in the risk of group fragmentation. Although some groups, teams, and organizations will not present such hierarchical divisions, many do. In fact, hierarchy has been regarded in prior organizational research as a fundamental and ubiquitous form of social organization (Cohen & Zhou, 1991). Hierarchy helps to establish social order, reduce intragroup conflict, and facilitate social coordination (Halevy, Chou, and Galinsky, 2011; Magee and Galinsky, 2008; Van Vugt, Hogart, and Kaiser, 2008). To the best of our knowledge, this is the first paper to consider the role of hierarchy in enabling groups to overcome the unique challenges of interpersonal heterogeneity (so as to experience its benefits over time).

There are several reasons why hierarchy should lower the probability of subgroup-based fragmentation. To highlight a few, consider again the hypothetical case of the academic department. Following prior research, we should expect that two colleagues with overlapping research interests are at risk of identifying more with one another than with the department at large (e.g., Blau 1977). Such subgroups pose some threat to the overall cohesion of the department. Now consider the case when those two colleagues span the junior-senior boundary. Concerns about upward mobility (on the part of a junior colleague) and simultaneous identification with both rank and research specialty (on the part of both junior and senior colleagues) should function to lower the probability that the colleagues in question will in fact identify more (or solely) with one another. We are not suggesting that cross-level subgroups, as our example illustrates, will never present a risk of fragmentation, but only that they present less
of a risk. Cross-level subgroups are further unique in that they characterize mentoring relationships that function to provide support to and reduce turnover among lower-level group members. Like subgroups more generally, we suspect that some benefits may work in the opposite direction as well. Namely, higher-level members of homogenous, cross-level subgroups may, through frequent interactions with that subgroup, may be better able to preserve their own uniqueness within the larger collective.

HYPOTHESES

By simultaneously addressing the three failure points of interpersonal heterogeneity, we expect that SRH should enable teams, groups, and organizations to capture many of the benefits of a properly integrated, cohesive group while supporting the contribution of diverse skill sets and perspectives. In other words, we expect SRH to allow a group to experience the benefits inherent to both interpersonal heterogeneity and homogeneity without having the two arrangements undermine one another. This is our basic hypotheses (H1): SRH will positively affect group performance.

The precise causal structure linking SRH to group performance involves overcoming each of the three failure points. We consider them in order here. Following both Ash (1952) and Gibson and Vermeulen (2003), we expect that individuals should be more inclined to express opinions—including opinions that deviate from the majority opinion—when they are members of like-minded subgroups. In the absence of such subgroups, heterogeneous opinions may fail to surface, resulting in homogenization and eventually undermining any advantages of interpersonal heterogeneity (Azzi 1993). Because SRH creates subgroups of like-minded individuals, we believe SRH will allow for meaningful heterogeneity to be preserved over time. In other words, we anticipate that groups, teams, and organizations high in SRH will be less
subject to processes of homogenization. Accordingly, we expect (H2): SRH will slow the decay rate (usually ascribed to the passage of time and increasing collective experience) of a positive effect of interpersonal heterogeneity on performance.

Next we consider fragility. We propose that SRH should moderate the consequences of turnover in a group's personnel. Consider an analogy to biology. In biology, a robust system is one that can “maintain functionality in the face of various external and internal perturbations” (Kitano, 2002:206–10; for examples of adaption to organizational research, see Moody and White, 2003, and Bothner, Smith, and White, 2011). A robust biological signaling pathway, for example, is one that persists despite changes in molecular concentrations and the loss of what first appears to be essential genes. We expect SRH in group contexts to work in much the same way. Specifically, SRH should mitigate the consequences of a disruption such as the loss of a vital team member by allowing for redundant personnel (i.e., persons with similar knowledge and experience, for instance) to substitute for deleted personnel (e.g., exiting or otherwise ineffective persons). In an extension of our empirical analyses (see footnote 10) we assess differences between direct substitution versus a more generalized "preservation of knowledge." Indeed in any instances, direct substitution should not be necessary—for example, there should be no reason to promote a junior faculty member to preserve the knowledge of a redundant, departing senior member. The fact that groups exhibiting SRH are better equipped to preserve the total cache of knowledge of the group should render these groups more robust. This leads to (H3): Groups with SRH should be less (negatively) affected by disruptions, such as the loss of a primary level member.

Our final hypothesis is concerned with fragmentation and hinges on past research showing that in group and organizational settings hierarchy establishes social order, reduces
intragroup conflict, and facilitates social coordination, which in turn improves performance (Halevy et al. 2001, Halevy, Chou, & Galinksy, 2011). Furthermore, when interpersonal homogeneity spans hierarchical levels it is likely to foster mutualism, mentorship, and individual satisfaction (see Vecchio and Bullis, 2001, for a study on supervisors and subordinates in the military). Building on this, we believe that homogenous subgroups are less likely to fragment into competing, acrimonious factions when those subgroups span disparity-based, hierarchical levels.\(^1\) In this respect we see links between SRH and what Wegner (1985) and others (Hollingshead, 2001; Lewis, 2003) have referred to as “transactive memory systems” (TMS), whereby unique subgroups are (explicitly or implicitly) identified as possessing certain kinds of knowledge, freeing other subgroups to possess alternative kinds of knowledge. TMS allow group members to rely on one another for learning, communicating, and recalling an array of information that is broader than any single person (or subgroup of similar people) might reasonably manage. The division of cognitive labor characterized by TMS is important because it allows individuals to focus on their own areas of expertise, and, as Blau (1977) predicted, enables a group of heterogeneous individuals to coordinate their behavior (see also Huber and Lewis, 2010, on "cross understanding"). Accordingly, we expect, (H4): SRH reduces the risk of fragmentation and has a positive, but indirect effect on group performance via its direct effect on group cohesion. In other words, group cohesion—we will come to measure this, following Halevy et al. (2011) as "interpersonal coordination and cooperation"—should mediate some of the positive effect of SRH on performance.

METHODS

The National Basketball Association

\(^1\) Of course, the existence of knowledge-based subgroups should also lessen the likelihood that disparity-based subgroups fragment.
To assess our hypotheses, we examined how SRH affected the performance of teams in the National Basketball Association (NBA) in the 1986–2008 seasons. The NBA is the world’s premiere basketball league, comprising 30 teams (as of 2008) located predominantly in major metropolitan areas in the United States and Canada. Several considerations led us to our choice of data. First we believe professional basketball is an appropriate context to assess the effects of group composition on group performance. A given NBA team typically plays three to four games each week against disparate opponents located in different cities across North America. Given the intense demands of the NBA season, we believe this context fulfills one of our most basic scope conditions—that is, a complex, uncertain environment. Second, because of the popularity and reach of professional basketball, we were able to gather qualitative support—in the form of interviews with coaches, players, agents, and media—for several of our methodological and measurement strategies. Third, our measures of team composition—not only SRH, but also heterogeneity more generally—fit naturally into a basketball context, where team members are divided into primary (frequent players) and secondary (infrequent players) levels. Fourth, data on both teams and individual players are systematic and widely available. The majority of the data we used for our analysis come from www.basketball-reference.com. Salary data come from Patricia Bender's website (http://www.eskimo.com/~pbender/). Fifth, there is a well-established precedent for using sports data, and data from the NBA in particular, to test new organizational theories, constructs, and mechanisms (e.g., Keidel, 1987, Bothner, Kim, and Smith, 2011; Kilduff, Elfenbein, and Staw, 2010; for papers using NBA data specifically, see Halevy, Chou, Galinsky, and Murnighan 2011; Berman, Down, and Hill, 2002; Staw and Hoang, 1995; Pfeffer and Davis-Blake, 1986; and Ethiraj and Garg, 2011). Sixth, we were able to verify a positive effect between heterogeneity among teams’ primary players and team performance in
the context of professional basketball, another necessary scope condition for our arguments about SRH. Finally, unlike other organizational contexts in which measuring performance can involve significant subjectivity, performance in professional basketball is much more straightforward: wins.

Despite the many conveniences and advantages of using sports data to address organization theoretic questions, professional basketball deviates from traditional organizations in several important ways. We note two here that strike us as the most salient given our focus. First, sports teams are unified by a common goal, to win. Second, a player's upward mobility on a sports team depends on either the exit or downward mobility of another player. While common goals and "vacancy chain"-like (White 1971) mobility do describe—or at least partially describe—many kinds of groups, teams, and organizations, it is important to consider these things when thinking beyond our empirical case.

**Team Performance.** In the course of a regular season, which typically runs from late October to mid April, an NBA team will play 82 games. The one exception that falls within the range of our data occurred in 1998 when the NBA season was cut short due to failed contract negotiations between players and owners. Existing data from 1998 are excluded from all analyses due to this irregularity. As a result, we are able to use the number of games each team won as a season-level indicator of team performance. The resulting distribution of the variable, \( \text{Won} \), is naturally bell-shaped with a mean of 41 and a standard deviation of 12.9 for the 21 seasons in our sample. The most games any team won in a single season is 72: the Chicago Bulls in 1995. The Dallas Mavericks and Denver Nuggets posted the fewest number of wins (11) in 1992 and 1997, respectively. The reward for performing well during the regular 82-game season
is making it to the NBA playoffs, a 16-team seeded tournament that determines a season champion.

**Knowledge / Playing Style.** Holding constant several team- and individual-level predictors of performance, we expect the composition of a team’s personnel to have a robust effect on team performance. Our measures of heterogeneity and SRH capture variations in team compositions with respect to players' experience with and knowledge about a style of play, as determined by their college playing experiences. In a context such as professional basketball, where all new team personnel arrive with similar amounts of experience in terms of years played, variations in styles of play—either players' own style or the style about which players' are most knowledgeable—are comparable to variations in knowledge and expertise (i.e., "functional background") one would find among personnel in many traditional groups and organizations. If heterogeneity in a team’s knowledge base is associated with team performance, then assessing teams’ compositions with respect to styles of play should offer the closest approximation of this important relationship. We anticipate, following prior research, that knowledge heterogeneity among teams' primary players will enhance competitive preparedness and have a positive effect on team performance (e.g., Bantel and Jackson, 1989; Pelled et al., 1999; see also Fligstein, 1990).²

We chose to proxy for knowledge about a given style of play using data on the college conferences in which NBA players' played (see Heckman, 1999 on the lasting effects of early knowledge acquisition, even as professional experience increases). We are not arguing that all players from a single conference will necessarily adopt a playing style that is characteristic of that conference, but simply that players from a given conference will have a strong

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² We acknowledge that other dimensions exist on which one might determine heterogeneity among players, such as race or age, and control for the most relevant of these differences.
understanding of the kind of play associated with a conference due to repeated exposure and coaching. It is necessary for our analysis then that conferences vary in play. According to a prominent Division I National Collegiate Athletic Association (NCAA) coach, “There are definitely distinct playing styles by conference.” This coach went on to explain to us that whereas some conferences, such as the Atlantic Coast Conference (ACC), are known for their pressure defenses, others, such as the Pacific ten (Pac-10) or the Big-East, are known for their execution of fast breaks and physicality, respectively. We learned from this coach that conference-specific styles result from intense competition and inter-team mimicry that occurs primarily within conferences. Standout college coaches such as Bob Knight (Indiana, Big Ten), Gean Keady (Purdue, Big Ten), Dean Smith (UNC, ACC), or Mike Krzyzwaski (Duke, ACC) are imitated by rival coaches and therefore drive the playing styles of their respective conferences. Imitation, in other words, occurs largely as a necessary response to competition. Because of the frequency and intensity of within-conference play, the coach emphasized that most of the learning that occurs at the coaching level—and therefore filters down to the players in the form of instruction—is limited to learning from within-conference coaches and teams. This is because coaches spend the majority of their time watching and studying teams against whom they are about to compete. Moreover, to compete against a set of teams with a certain style of play, learning that style is important. We assume that this process of learning and imitation results in conference-level similarity among teams with respect to the conference’s dominant playing style. In actuality, all that needs to be true for our operationalization to be useful is for teams within a conference to be more alike, on average, than teams between conferences.

Measuring Heterogeneity and SRH
Maximum heterogeneity characterizes a set of players having no overlap in the college conferences in which they played. Minimum heterogeneity amounts to complete overlap in conferences.

**Team Heterogeneity.** We determine team-level heterogeneity using information on the college conferences of all players on the roster. Specifically, we calculated team-level heterogeneity as

\[ T_{i,t} = 1 - \sum_j \left( \frac{S_j}{N_{i,t}} \right)^2, \]

where \( S_j \) is the number of players on team \( i \) from conference \( j \) and \( N_{i,t} \) is the total number of players on team \( i \) at time \( t \). Team-level heterogeneity is a reverse-coded variant on the Herfindahl concentration index. Players that did not play in the NCAA prior to entering the NBA, either because they entered the NBA directly from high school or attended college outside the United States, were dropped from the version of the measure that appears in the regression models below. Results are consistent when these players are included and treated as either completely homogeneous (i.e., as if they are all from the same conference) or completely heterogeneous (i.e., as if they are all from conferences different from one another and different from all others on the team).

**Primary Level Heterogeneity.** To compute primary level heterogeneity, we first needed to define a team’s primary, as opposed to secondary, level. We considered several alternatives, including using only the starting five players or weighting a player’s influence by his share of minutes played over the course of the season. The first alternative—starting five—is problematic as there are several examples where a “sixth man” or “seventh man” should be considered part of a team’s primary level. Similarly, fewer than five players may make up a team’s primary level and several secondary level players may share the remaining minutes but should not be considered primary. The weighting alternative, though producing (statistically significant) results
comparable to those we show below, presented problems for our conceptualization and estimation of SRH, as it requires treating several players as partial members of both primary and secondary levels. In the end, we opted to parse teams into primary and secondary levels using a threshold of minutes played during a season. We assigned individuals who played more than 1800 minutes over the course of 82 games (approximately 22 minutes per game, or two-thirds of a standard deviation above the average number of minutes played per game for all NBA players) to the primary level. We considered all others to be in the secondary level. We subjected this threshold to sensitivity analyses by moving it several hundred minutes in both directions before computing heterogeneity in the primary level, heterogeneity in the secondary level, and SRH, and find our effects are not significantly affected within a range of 200 minutes in the upward direction and 300 minutes in the downward direction. Note that by opting for a threshold approach, we allow for between-team variation in the number of players assigned to the primary level. This number ranges from two to eight with a mean of 4.7. We assess the robustness of all primary findings to this measurement feature following the reporting of main results.

Having determined the primary level, we computed primary level heterogeneity using the college conferences of only those players assigned to that level. We calculated primary level heterogeneity as:

$$P_{i,t} = 1 - \sum_j \left( \frac{S_j}{n_{i,t}} \right)^2,$$

where $S_j$ is the number of players in the primary level of team $i$ from conference $j$ and $n_{i,t}$ is the total number of players in the primary level of team $i$ at time $t$. Primary level heterogeneity is thus equivalent to overall team heterogeneity but is calculated using only the set of players determined to make up the primary level. Like most of the existing research on top management teams, we expect primary level heterogeneity to
positively affect team performance. Follow the same logic just described we also computed secondary level heterogeneity, $S_{i,t}$, which will prove useful in isolating SRH.

**Structurally Redundant Heterogeneity.** SRH captures overlap between the primary and secondary levels. If a member of the primary level played in the Big 10 conference while in college, for instance, one or more secondary level members who also played in the Big 10 would constitute instances of SRH. To calculate SRH, we began by treating both primary and secondary levels as unique vectors with lengths equal to the number of college conferences. Vector elements then account for the number of players in the primary or secondary level from the conference corresponding to the element. SRH is the standardized dot product between the two vectors, or $R_{i,t} = \frac{p \cdot s}{N_{i,t}}$, where $p$ is the primary level vector, $s$ is the secondary level vector, and $N_{i,t}$ is the standardization term that equals the number of players on the roster for team $i$ at time $t$. A team will have zero-level SRH when there is no overlap in the college conferences between players in the primary and secondary levels. Mathematically, maximum SRH occurs when all players on the team come from the same college conference, and is equal to $R = \sum p \times \sum s$. Empirically, no such cases exist in the data. Moreover, as noted above, because SRH appears alongside both team and primary level heterogeneity in many of our models, a significant effect of SRH will amount to covariation between SRH and performance that is orthogonal to the effects of the other team composition variables. In other words, maximum SRH offers no additional information above the measure of team-level heterogeneity. According to H1, we expect SRH to positively affect team performance.

**Estimation and Control Variables**

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3 Results are consistent when $N$ is removed from the denominator and included as a separate covariate.
To test our main hypothesis, H1, we estimated a series of OLS regression models of the following form:

\[
\text{Won}_{i,t} = \beta X_{i,t-1} + \gamma Z_{i,t} + \theta_1 T_{i,t} + \theta_2 P_{i,t} + \theta_3 S_{i,t} + \theta_4 R_{i,t} + \mu_i,
\]

where \( \text{Won}_{i,t} \) is the performance of team \( i \) over the course of season \( t \) measured by the number of wins out of a possible 82 games. Our unit of analysis is therefore the team-season. The matrices \( X_{i,t-1} \) and \( Z_{i,t} \) contain team-level time-varying covariates. The only difference between the covariates in the two matrices is the time at which they are measured. \( X_{i,t-1} \) includes several indicators of team performance measured for the preceding season and therefore serve as controls for team quality. These controls include per-minute averages, calculated across all members on the team, for points made, offensive rebounds, defensive rebounds, turnovers, shooting percentage, and free-throw percentage. By computing per-minute averages, we not only control for raw quality but also team efficiency. By comparison, \( Z_{i,t} \) includes controls for several descriptive characteristics of the team, computed during the focal season. These characteristics include average height of team members, average age (and the standard deviation of age; see Berman et al., 2002), average draft selection number, and the total and team-specific experience of the current coach, measured in years.

Team level heterogeneity, primary and secondary level heterogeneity, and SRH are captured by \( T_{i,t} \), \( P_{i,t} \), \( S_{i,t} \), and \( R_{i,t} \), respectively. The measures of team composition are added to models iteratively to establish independence in the effect of SRH. We are ambivalent about the effect of \( \theta_1 \) and \( \theta_3 \) (on \( T_{i,t} \) and \( S_{i,t} \)) but expect \( \theta_2 \) (on \( P_{i,t} \)) to be positive, indicating a positive effect of primary-level heterogeneity on performance. We also expect \( \theta_4 \) (on \( R_{i,t} \)) to be positive, indicating a positive effect of SRH on performance. To reiterate, because SRH offers no additional information when team heterogeneity reaches its theoretical minimum (i.e., complete homogeneity), a positive effect of SRH is contingent on a significant and positive effect of...
primary group heterogeneity (i.e., $\theta_2 > 0$). If, counter to our expectations, primary group heterogeneity negatively affects team performance (i.e., $\theta_2 < 0$), any advantage to SRH should be captured entirely by the team-level heterogeneity metric and would be indistinguishable from an effect of team heterogeneity alone.

We add a team-level fixed effect, represented by $\mu_t$, in the course of our robustness checks and discuss it in more detail following reporting of the main results below. Table 1 includes descriptive statistics and a correlation matrix for all variables used in the analysis. Tables 2 and 3 report the results of all primary estimation models and robustness tests. Tables 4 and 5 include results from our mechanism tests. Because of the panel structure of our data, we report robust standard errors that are clustered by team and heteroskedasticity consistent.

**RESULTS**

Model 1 includes all control variables as well as our measure of team-level heterogeneity. We omit a full discussion of the control variables but results are consistent with both our expectations and prior studies that use basketball data (e.g., Berman et al., 2002). The results of model 1 suggest a negative effect of team-level heterogeneity (though we will come to show that this effect is spurious). A one-standard-deviation increase in team heterogeneity equates to one fewer win over the course of a season. This effect is comparable in magnitude to an additional one and a half years of team-specific coaching experience and is one-third the effect size of a standard-deviation change in a team’s lagged shooting percentage, one of the most important predictors of a team’s performance. We add primary level heterogeneity to model 2. Consistent with our necessary condition, we find a positive effect of heterogeneity among players in the primary level on team performance. A one-standard-deviation increase in the heterogeneity of players in the primary group amounts to 3.25 additional wins over the course of a season. For the
average NBA team (41 wins), this effect amounts to an 8% increase in the number of wins during a single season. With one exception—the average age of all players on the team—the effect of primary level heterogeneity is the strongest predictor of team performance in model 2. Heterogeneity among team's primary players is beneficial. The effect of team-level heterogeneity remains negative and significant in model 2.

Two explanations for the team composition effects shown in model 2 are possible. Given the contrasting effects of team-level and primary-level heterogeneity on performance, it is possible that the observed negative effect of team-level heterogeneity ($\theta_1 > 0$) results entirely from the secondary level. In other words, an optimal team composition could be one where members of the primary level are completely heterogeneous and members of the secondary level are completely homogenous, independent of considerations about the relatedness of the two levels. We tested this possibility in model 3 before analyzing our SRH construct. In contrast to this explanation, the coefficient estimate on the secondary level heterogeneity measure was insignificant ($t = 0.50$). The results of model 3 offer prima facie support for the second possible explanation: redundant heterogeneity between levels (i.e., SRH) indeed constitutes an important but so far overlooked property of group composition.

Model 4 tests the effect of SRH directly and renders results consistent with H1. A one-standard-deviation increase in redundant heterogeneity amounts to an additional 1.50 wins over the course of a season. Inclusion of the redundant heterogeneity term does not affect the coefficient estimate of primary level heterogeneity. In model 5 we reintroduce team-level heterogeneity to establish independence in the effect of SRH. The effect of team-level heterogeneity is insignificant in model 5 ($\theta_1 = -28.94, t = 3.11$ in model 2 vs. $= -10.22, t = 0.84$ in model 5). Post-estimation tests confirm multicollinearity does not account for any of the
effects in model 5.\textsuperscript{4} In the discussion section, we return to model 5 to consider the possibility that team-level (or organizational-level, more generally) heterogeneity may, in some instances, be a spurious construct. For now, we limit our focus to the two significant team composition variables, primary level heterogeneity and SRH, and assess their robustness. Following the robustness checks, we test H2, H3, and H4.

The results of model 4 and 5 suggest a sweet spot. Among NBA teams, performance is most strongly associated with the following team structure: a maximally heterogeneous set of primary players—where heterogeneity is measured according to the playing styles to which individuals become accustomed during their pre-professional experience—that is redundant with the set of players in the secondary level. Due to the consistently larger size of the secondary level, it is impossible to say whether perfect redundancy—that is, exact mirroring of the primary level in the secondary level—is optimal, though additional tests did indicate the associations between performance and both primary-level heterogeneity and SRH are monotonically increasing, at least within the range of the observed data. The aggregate effect of a one standard-deviation shift in both primary level heterogeneity and SRH, in the direction of the signs on each coefficient, equates to 4.4 additional wins over the course of a season, or a 10.7% increase in winning frequency for a team posting average performance. In a sport in which as few as one game can dictate whether a team advances to the playoffs and has a chance to compete for the championship, these team-composition effects are significant, both statistically and substantively.

**Robustness Checks**

\textsuperscript{4} The tolerance values—measured as the reciprocal of the variance inflation factor, a standard measure of collinearity—of team heterogeneity, primary group heterogeneity, and SRH are .55, .84, and .54, respectively, all of which are well above the .10 threshold for concern advocated in Kutner, Nachtsteim, and Neter (2004).
Before exploring the three mechanisms described in H2, H3, and H4, we subjected the results in model 4 to a series of additional tests and robustness checks. First, the observed effect of SRH on performance could be due an effect of differences in the quality of college conferences. For instance, were an NBA team to have five people from the Atlantic Coast Conference (ACC)—one of college basketball's most dominant—one in an otherwise heterogeneous primary level and the other four in the secondary level, the sheer number of quality players on the team might translate into positive performance that nevertheless looks like our generalized conception of SRH. To account for this possibility, we included 33 count variables that capture the number of players on a given NBA team during a given season from each of the 33 college conferences represented in our data. Results are reported in model 6, though in the interest of space, we suppressed coefficient estimates for the 33 additional variables. Importantly, the dual effects of primary group heterogeneity and SRH are unaffected.

Next, because our threshold approach forces between-team variation in the number of players assigned to the primary level, we wanted to guard against the possibility that the number of players in the primary level versus the measured SRH between primary and secondary levels drives the effect of SRH. We did so by including a control for the number of players in the primary level for every team-year observation. Likewise, we found in the data several instances where the size of the secondary level was significantly larger than the average, even after controlling for the size of the primary level. A thorough investigation of the data indicated these observations are due to heavy trading years. For example, if a team trades a number of players during the course of a season, both their roster and, by way of our threshold approach, the size of the secondary level will appear larger than normal. To account for this infrequent occurrence, we

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5 In the models shown, we include this additional control as a continuous variable. In a model not shown, we also fit the control as a series of dummies, or a spline. There was little loss of information in using the continuous variable approach.
assigned a dummy variable, retooling, equal to one for a team-year observation when the number of players on the roster was greater than 19, or the mean team size plus one standard deviation. The data contained 97 instances of retooling. We expected retooling to be negatively related to team performance, as heavy trading is likely to present a significant disruption. Model 7 includes the two additional variables just described. Having one additional person in the primary level—that is, having one additional person play more than 1,800 minutes in a season—equates to 1.63 additional wins. This effect may be due to a kind of “superstar” effect (see Ethiraj and Garg, 2011), whereby additional star players simply translate into better team performance. The effect of the retool dummy is negative and significant, as expected. Importantly, the effects of primary level heterogeneity and SRH are robust to these additions.

Model 8 includes a fixed effect, $\mu_i$, for each of the 30 teams in the panel to adjust for all time-invariant components of team quality. As a result, coefficient estimates in model 8 account for within-team effects. Model 9 layers on top of model 8 an autoregressive framework—in the form of a Prais-Winsten AR(1) model—to capture and adjust for autocorrelation, given the panel nature of the data and periodic occurrence, common in both sporting and organizational contexts, of multi-year team dominance (e.g., the Los Angeles Lakers during much of the 2000s) or deference (e.g., the Dallas Mavericks in the early 1990s). The advantage of using a Prais-Winsten AR(1) model, as opposed to including a lagged dependent variable on the right-hand side of a regression, is that it does not force one to drop an entire time period of data from the analysis.6 Results of the fixed effects and fixed effects AR(1) models are consistent with prior models.

**Mechanism Tests**

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6 A Durbin-Watson test on the untransformed model confirms the presence of autocorrelation ($h = 1.29$). Autocorrelation is well accounted for using the AR(1) transformation ($h = 1.81$).
Having established the robustness of SRH (and primary level heterogeneity), the remaining models 10.1, 10.2, and 11 in Table 4 and 12.1 and 12.2 in Table 5 test H2, H3, and H4 and are designed to investigate some (though not necessarily all) of the possible mechanisms underlying the significant, positive effect of SRH on performance. H2 states that SRH should counter the process of homogenization and therefore slow the decay rate of the positive effect of primary-level heterogeneity on performance. We assess H2 using a split sample approach. Model 10.1 uses those observations in which SRH is below the sample mean. Model 10.2 is the result of a regression using observations in which SRH is above the sample mean. The important predictors in models 10.1 and 10.2 are primary level heterogeneity, weighted team experience, as measured in Berman et al. (2002)\(^8\), and an interaction between the two. As we noted previously, earlier studies (Harrison et al., 1998; Carpenter, 2002) have found that the effect of interpersonal heterogeneity on performance typically decays as the collective experience of organization or group members increases. We argue that this effect may be due to the fact that over time, heterogeneous individuals begin to think like one another, thereby undermining the advantages associated with heterogeneity. Accordingly, we expect that in teams with little SRH, the interaction between primary level heterogeneity and team experience will be negative and significant (as the main effect of primary level heterogeneity is positive). When SRH is high, H2 predicts experience should have less of an effect on the relationship between heterogeneity and team performance; that is, the interaction effect should be reduced in magnitude or altogether insignificant. The results of models 10.1 and 10.2 offer support for H2. Among teams with

\(^7\) The advantage of using a split sample, as opposed to a three-way interaction, is ease of interpretation. Results are consistent when using a three-way interaction between primary-level heterogeneity, team experience, and SRH.

\(^8\) Berman et al. (2002) compute weighted team experience as the collective experience of all players on a given team weighted by the importance of players according to game-time minutes. They find that collective team experience is an important predictor of team performance and that the effect of collective experience diminishes as experience approaches a maximum (empirically speaking) value.
greater than average redundancy, team experience has no bearing on the association between primary level heterogeneity and performance.\(^9\)

H3 predicts a reduction in the severity of a shock or disruption to a primary level’s personnel. As is likely the case for many kinds of groups and organizations, team performance in the NBA should be negatively affected when a key player is rendered less effective—for instance, by leaving the team or becoming injured, or experiencing any other sort of event that decreases his performance. For every team-year observation, we assign a dummy variable, \(primary\ level\ shock\), that is equal to one when the number of players assigned to the primary level decreases. Approximately 22% of all observations receive a one according to this criterion.

Model 11 includes both the dummy variable and an interaction between the dummy and SRH. The coefficient on the interaction term is positive and significant, supporting H3. Whereas a team with zero SRH will lose on average 5.5 additional games per year following a shock to the primary level, the same shock translates into only 0.86 fewer wins for a team with the median level of SRH.\(^{10}\)

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\(^9\) The lack of significance on the primary level heterogeneity term in model 10.2 does not, of course, imply the main effect is insignificant for this sample of data. A model run on the same sample of data (i.e., observations have greater than average SRH) without the interaction term establishes the main effect is indeed present (= -21.07, t = -2.47). This model is omitted from the table but is available from the authors. Furthermore, the 0.00 coefficient on team experience in model 10.2 also deserves additional explanation. It is important to remember that this is not a main effect. What the coefficient illustrates is that at the highest level of measured SRH, the effect of experience approaches zero. At first glance this result is intriguing. Upon further inquiry, it proves to have a logical explanation. Recall that the highest theoretical values of SRH will occur when all members of the group are homogenous. Accordingly, the results in model 10.2 suggest that experience is less important in highly homogenous teams, a result that is consistent with arguments about the benefits—simpler coordination, faster movement down a learning curve, etc.—of interpersonal homogeneity. This result further highlights the importance of model 5, which establishes the independent effect of SRH holding constant team-level heterogeneity.

\(^{10}\) In an additional analysis we investigated whether direct (one-to-one) substitution is necessary for the effects in model 11 (H3). To do this we computed a variant of SRH where we only considered two players to be redundant if they played in the same conference and play the same position. This change has a dramatic effect on the distribution of SRH values, shifting the median closer to zero as opportunities for redundancy are diminished. As main effect, the estimated coefficient on this variable is positive but not significant. Similar results holds when used in the interaction term in model 11, i.e., coefficient is negative but insignificant. These results imply that the "substitution"-related benefits of SRH are about more than direct, one-to-one substitution, but rather capture a retention of knowledge.
Finally, H4 states that SRH may affect team performance indirectly through a direct effect on team cohesion. To test H4, we follow Halevy et al's (2011) approach to compute team "cooperation and coordination" in the NBA. For details on the measure, we defer to the earlier paper. To summarize it here, "coordination and cooperation" is an aggregate measure of team's (standardized) assists, turnovers (reverse-coded), defensive rebounds, and field-goal percentage. As the prior authors demonstrate empirically, these four measures specifically "capture intragroup coordination and cooperation more than other aspects of on-court performance" (2011, p. 4). Accordingly, we expect cooperation and coordination to mediate some of the positive effect of SRH on performance. The regression models in Table 5 offer support for this mediation hypothesis. The left-most model replicates model 4 from Table 2 to serve as a baseline. Model 12.1 regresses each of the covariates in model 4 on the measure of cooperation and coordination. Both primary-level heterogeneity and SRH have positive and significant effects in this model. Model 12.2 includes cooperation and coordination as a regressor and offers evidence of partial mediation. The effect of SRH on performance in model 12.2 is significantly weakened, though remains significant at the 0.05 level, a result consistent with partial mediation. The results of a Sobel-Goodman (Sobel, 1982) test for mediation indicate coordination and cooperation mediates approximately 41% of SRH’s effect on performance.

**DISCUSSION AND CONCLUSION**

Our aim has been to add to our understanding of the relationship between organizational composition and performance. Specially, we endeavored to demonstrate the importance of a new construct—structurally redundant heterogeneity—that in addition to traditional interpretations of interpersonal homogeneity and heterogeneity, underscores the association between the composition of a group’s personnel and its performance. Unlike homogeneity and heterogeneity,
SRH’s principal point of differentiation is that it is realized between various levels of a group, team, or organization. By demonstrating the role SRH can plan in allowing a group to sustainably experience the benefits of interpersonal heterogeneity, we hope that this paper adds a previously overlooked emphasis on structure to research on group and organizational composition.

Using data from the NBA, we found evidence in support of the hypothesis that cross-level redundancy in individuals’ knowledge and experience has a positive main effect on team performance. Moreover, we demonstrated three discrete mechanisms by which SRH is useful: first, it preserves the positive effect of interpersonal heterogeneity on performance over time; second, it diminishes the negative effect of turnover among members of a team’s primary level; and third, it affects team performance indirectly by positively affecting team cohesion (i.e., cooperation and coordination). Consequently, one of our primary contributions has been to demonstrate how the benefits of heterogeneity among organizations’ personnel can be captured in organizations and groups exhibiting SRH. Unlike prior research that has focused explicitly on the tradeoff between heterogeneity and homogeneity, we believe future investigations should be attentive to the additional information SRH offers.

We further advocate that groups and organizational researchers should seek out additional opportunities to embed structural considerations firmly into discussions and analyses of interpersonal heterogeneity and homogeneity. Consider our empirical result showing the positive effect of team-level heterogeneity on performance was spurious (model 5): although the implications of this result are, of course, limited by our research setting, when SRH was added to models predicting performance, the previously negative and significant effect of team-level heterogeneity was rendered insignificant. This finding suggests that only a particular kind of
organizational homogeneity—cross-level homogeneity in an organization with multiple, redundant levels—was beneficial. Had we not measured and included SRH in models predicting performance, the results of our analysis might have been misinterpreted as supporting (erroneously) a claim that optimal team structure combines heterogeneity among people in primary roles with homogeneity among people in secondary ones.

More generally, in recognizing that homogeneity and heterogeneity may operate differently at various organizational and group levels—and, of course, between levels—our study marks a call for future research to actively consider and account for these differences. Organizations and groups are seldom egalitarian in their construction. The heterogeneity of tasks that organizations and groups routinely take on and division of labor under which many organizations and groups operate ensure the structural arrangements present within a collective may vary dramatically between levels (Rousseau, 1985). From social networks research, for instance, we know organizational networks often devolve into core-periphery structures (Borgatti and Everett, 1999) and may develop distinct status hierarchies that separate elites from non-elites (Phillips and Zuckerman, 2001). Research on the effects of homogeneity and heterogeneity that does not account for these existing fault lines may fall short of capturing some of the dynamics governing the relationship between organizational composition and performance.

Scope Conditions and Additional Considerations

Because earlier empirical work has not considered SRH, highlighting the conditions we believe are necessary for observing its effects is important. We have noted several already but will attempt to be more comprehensive here. The first condition is about the kinds of organizations and groups in which SRH might be created and maintained. Like most studies we are limited in our ability to make generalized statements because of our singular empirical
context. Nevertheless, we argue, like a number of studies before ours (e.g., Berman et al. 2002; Keidel, 1987), that our setting is generally representative of many kinds of organizations and groups. Research and professional organizations—academia, medicine, law, and consulting, for instance—are perhaps the closest analogs to our context, given their inherent bi- or multi-level structures. Consequently, we have reason to believe that the effects of SRH we observed should also be observable in those settings. We are equally interested, however, in identifying SRH and its effects in alternative contexts. For example, although we conjectured the effects of SRH are contingent on an organization having one or more disparity-based faultlines (i.e., hierarchy), simple redundancy might affect performance in “flat organizations” (Worthy, 1950) as well. Indeed, as more organizations transition from being traditional hierarchies to flat structures, identifying the natural fault lines across which redundancy might operate constitutes an important theoretical and empirical question. In such instances SRH might be measured using not hierarchical divisions, but horizontal ones—departments, for instance. Because our present theorizing leverages heavily the importance of hierarchy, we hesitate to make claims about the generalizability of SRH to such cases.

The preceding references to alternative kinds of organizations bring to light a second scope condition and associated avenue for future inquiry. In our analysis of basketball teams, we limited our attention to players who, for all intents and purposes, can be presumed to identify with the same basic task: play basketball well and win.\(^{11}\) We did not measure SRH, for example, between players and the group of people employed by the team responsible for marketing or sales. As a result, we are limited in our ability to make claims about the role of SRH in groups and organizations marked by multiple goals and/or exceptionally differentiated tasks (Fishbach

\(^{11}\) We are not at all opposed to the possibility that secondary players, as we identified them, take on a “supporting” task that differs notably from players in the primary group.
and Dhar, 2005). This limitation does not imply that SRH cannot exist or cannot produce similar positive effects in such settings. Although achieving some of the advantages of SRH may be difficult—an NBA team’s marketing representatives hardly constitute viable direct substitutes for players—some of the other benefits of redundancy we observed—overall group cohesion, specifically—may be achievable. In other words, future research might analyze whether the effects (and which effects) of SRH hold when distinct organizational or group levels pursue differentiated tasks.\(^\text{12}\)

A third scope condition relates to a common and real concern about generating and maintaining redundant systems, be they biological, electronic, or social: the cost of redundancy may exceed its benefits. Generating redundancy in computer networks, for instance, means purchasing and maintaining additional components that in the course of normal operation may have no effect on the performance and reliability of the network. In biological systems, unique cells often carry out redundant functions to protect the integrity of the system from the deletion of any one cell, but maintaining those additional cells requires additional energy. In a group or organization, redundancy implies having enough personnel to maintain both meaningful heterogeneity—according to the logical condition necessary for redundancy to be different from homogeneity—and between-level redundancy. Naturally, few organizations would hire redundant personnel and then, much like redundant switches in a computer circuit, allow them to sit idly until they are needed as substitutes. Our results indicate, however, that unlike computer and biological systems, SRH is about more than protecting an organization against periodic shocks. That SRH facilitates group cohesion and slows the decay of the benefits of interpersonal heterogeneity implies effects that are qualitatively different than redundancy in electronics and

\(^{12}\) At the suggestion of a reviewer, we computed SRH between coaches and players, both primary group players and entire rosters. Although coefficients were in the same direction as presented here, results were far from significant. These results and further interpretation of them are available from the authors.
biology. Quantifying these benefits in the light of the costs associated with generating and maintaining SRH marks a particularly interesting avenue for future inquiry.

Finally, in the course of our analysis, we tested and found support for three mechanisms underlying the relationship between SRH and performance, but these need not be the only three. Future research might fruitfully explore other means by which redundancy positively affects certain organizational and group outcomes. For example, in developing our hypotheses we suggested that groups containing homogenous subgroups should face less turnover overall. We tested this empirically using the NBA data but found no evidence for this mechanism. This is perhaps unsurprising given the many constraints around mobility in professional sports—i.e., drafts, trades, contracts, free agency, etc. In more traditional contexts where mobility is determined more by the individual one might find different outcomes.

One further avenue might be to examine how an effect of SRH waxes and wanes according to changes in environmental and competitive conditions. To draw on innovation research (e.g., Anderson and Tushman, 1990), one might ask whether SRH is a more useful firm characteristic during periods of incremental or radical change. By promoting and helping maintain the positive effects of heterogeneity, SRH should enable groups and organizations to forestall the rigidity commonly associated with homogeneous collectives. However, because SRH is geared toward reproducing the same kind of heterogeneity in one period that was present in the previous period, how SRH would either prepare or hinder an organization during periods of radical change remains to be seen.
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Figure 1: Redundancy in an Organization or Group with 2-level / Core-Periphery Structure
| Variable                                | Mean  | S.D.  | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | 18    |
|-----------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. Number of wins                       | 41.00 | 12.88 |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 2. Team concentration                   | .16   | .04   | .12   |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 3. Primary group concentration          | .24   | .12   | -.34  | .05   |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 4. Redundancy                           | .30   | .16   | .18   | .62   | -.21  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 5. Height                               | 78.93 | .60   | .08   | .09   | .01   | .10   |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 6. Age                                  | 26.98 | 1.30  | .48   | -.02  | -.14  | .00   | -.06  |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 7. SD Age                               | 3.89  | .82   | .23   | .09   | -.09  | .11   | .07   | .49   |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 8. Draft selection                      | 31.37 | 5.39  | .13   | .10   | .13   | -.07  | .23   | .08   | .10   |       |       |       |       |       |       |       |       |       |       |       |       |
| 9. Points, t-1                          | .31   | .04   | .41   | .07   | -.10  | .02   | .04   | -.05  | .27   |       |       |       |       |       |       |       |       |       |       |       |       |
| 10. Offensive rebounds, t-1             | .04   | .01   | .14   | .01   | -.04  | .00   | .20   | .15   | -.13  | .23   | .54   |       |       |       |       |       |       |       |       |       |       |
| 11. Defensive rebounds, t-1             | .10   | .01   | .35   | .06   | -.07  | .02   | .21   | .42   | .26   | .29   | .62   | .56   |       |       |       |       |       |       |       |       |       |
| 12. Turnovers, t-1                      | .05   | .01   | .12   | -.08  | .02   | -.10  | -.01  | .19   | -.10  | .21   | .62   | .42   | .46   |       |       |       |       |       |       |       |       |
| 13. FG Percentage, t-1                  | .36   | .04   | .42   | -.10  | .02   | .09   | .42   | .08   | .25   | .86   | .55   | .77   | .59   |       |       |       |       |       |       |       |       |
| 14. FT Percentage, t-1                  | .58   | .07   | .37   | -.10  | .05   | .05   | .41   | .15   | .25   | .78   | .44   | .75   | .53   | .88   |       |       |       |       |       |       |       |
| 15. Coach total experience              | 5.36  | 6.16  | .13   | -.03  | -.01  | -.07  | .06   | .09   | -.12  | .05   | .08   | .14   | .07   | .05   | .04   | .05   |       |       |       |       |       |
| 16. Coach team experience               | 1.80  | 2.29  | .25   | -.05  | -.13  | -.03  | .01   | .24   | .09   | -.02  | .14   | .06   | .09   | .06   | .11   | .10   | .43   |       |       |       |       |       |
| 17. Number in primary group             | 4.72  | 1.05  | .33   | .16   | -.42  | .21   | .03   | .11   | .01   | .10   | .04   | .06   | .00   | .10   | .10   | .07   | .04   |       |       |       |       |       |
| 18. Retool                              | .17   | .37   | -.27  | -.18  | .12   | -.08  | -.06  | .05   | -.17  | -.16  | -.10  | -.08  | -.03  | -.13  | -.10  | -.04  | -.12  | -.28  |       |       |       |
### Table 2
Robust OLS Regression Predicting Season Wins, NBA 1986-2008*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>-28.94</td>
<td></td>
<td>-10.30</td>
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<tr>
<td></td>
<td>(9.98)*</td>
<td>(9.30)**</td>
<td></td>
<td>(12.20)</td>
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</tr>
<tr>
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<td>27.39</td>
<td>26.58</td>
<td>24.31</td>
<td>24.98</td>
<td></td>
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<tr>
<td></td>
<td>(5.24)**</td>
<td>(5.55)**</td>
<td>(5.17)**</td>
<td>(5.29)**</td>
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<tr>
<td></td>
<td>(9.61)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>SRH</td>
<td></td>
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<td>9.38</td>
<td>7.66</td>
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</tr>
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<td></td>
<td></td>
<td>(2.73)**</td>
<td>(3.52)**</td>
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</tr>
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<td>Average height</td>
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<td>(0.85)</td>
<td>(0.78)</td>
<td>(0.80)</td>
<td>(0.76)</td>
<td>(0.77)</td>
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<tr>
<td>Average age</td>
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<td>3.03</td>
<td>2.92</td>
<td>3.03</td>
<td>3.05</td>
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<tr>
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<td>(0.40)**</td>
<td>(0.40)**</td>
<td>(0.37)**</td>
<td>(0.38)**</td>
<td>(0.39)**</td>
</tr>
<tr>
<td>SD Age</td>
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<td>0.43</td>
<td>0.12</td>
<td>0.10</td>
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<td>(0.71)</td>
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<td>Draft selection</td>
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<td>0.17</td>
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<tr>
<td></td>
<td>(0.11)</td>
<td>(0.10)</td>
<td>(0.10)</td>
<td>(0.10)+</td>
<td>(0.10)+</td>
</tr>
<tr>
<td>Points, t-1</td>
<td>98.41</td>
<td>86.33</td>
<td>94.18</td>
<td>88.12</td>
<td>86.44</td>
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<tr>
<td>Offensive rebounds, t-1</td>
<td>-223.58</td>
<td>-234.81</td>
<td>-235.64</td>
<td>-241.05</td>
<td>-239.78</td>
</tr>
<tr>
<td></td>
<td>(71.89)**</td>
<td>(68.14)**</td>
<td>(68.94)**</td>
<td>(67.67)**</td>
<td>(68.06)**</td>
</tr>
<tr>
<td>Defensive rebounds, t-1</td>
<td>48.47</td>
<td>59.62</td>
<td>60.84</td>
<td>64.39</td>
<td>63.37</td>
</tr>
<tr>
<td></td>
<td>(57.72)</td>
<td>(58.41)</td>
<td>(57.86)</td>
<td>(57.23)</td>
<td>(57.84)</td>
</tr>
<tr>
<td>Turnovers, t-1</td>
<td>-288.08</td>
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<td>-265.39</td>
<td>-241.69</td>
<td>-235.46</td>
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<tr>
<td></td>
<td>(63.25)**</td>
<td>(69.57)**</td>
<td>(69.65)**</td>
<td>(71.09)**</td>
<td>(69.57)**</td>
</tr>
<tr>
<td>FG Percentage, t-1</td>
<td>69.01</td>
<td>68.85</td>
<td>64.08</td>
<td>68.72</td>
<td>69.58</td>
</tr>
<tr>
<td></td>
<td>(32.26)*</td>
<td>(30.01)*</td>
<td>(29.06)*</td>
<td>(29.79)*</td>
<td>(30.22)*</td>
</tr>
<tr>
<td>Coach total experience</td>
<td>0.10</td>
<td>0.12</td>
<td>0.12</td>
<td>0.13</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.10)</td>
<td>(0.10)</td>
<td>(0.10)</td>
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<tr>
<td>Coach team experience</td>
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<td>0.43</td>
<td>0.46</td>
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<tr>
<td></td>
<td>(0.22)**</td>
<td>(0.21)*</td>
<td>(0.21)*</td>
<td>(0.20)*</td>
<td>(0.21)*</td>
</tr>
<tr>
<td>Constant</td>
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<td>-184.47</td>
<td>-166.22</td>
<td>-158.67</td>
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<td>(68.22)*</td>
<td>(64.87)*</td>
<td>(63.31)**</td>
<td>(62.62)*</td>
<td>(63.18)*</td>
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<tr>
<td>(R^2)</td>
<td>0.37</td>
<td>0.43</td>
<td>0.42</td>
<td>0.44</td>
<td>0.44</td>
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<tr>
<td>(N)</td>
<td>582</td>
<td>582</td>
<td>582</td>
<td>582</td>
<td>582</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%
* Heteroskedasticity-consistent robust standard errors are in parentheses, clustered by team.
Table 3
**Additional Analysis and Robustness Checks, OLS, Fixed-Effects, and Prais-Winsten AR(1)**
**Regressions Predicting Season Wins, NBA 1986-2008**

<table>
<thead>
<tr>
<th>Variable</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneity, Primary</td>
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<td>17.27</td>
<td>13.33</td>
<td>11.36</td>
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<tr>
<td></td>
<td>(5.83)**</td>
<td>(4.90)**</td>
<td>(4.82)**</td>
<td>(4.75)*</td>
</tr>
<tr>
<td>SRH</td>
<td>8.44</td>
<td>7.28</td>
<td>6.32</td>
<td>5.78</td>
</tr>
<tr>
<td></td>
<td>(2.70)**</td>
<td>(2.64)**</td>
<td>(2.76)*</td>
<td>(2.67)*</td>
</tr>
<tr>
<td>Number in primary group</td>
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<td>1.68</td>
<td>1.40</td>
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</tr>
<tr>
<td></td>
<td>(0.46)**</td>
<td>(0.47)**</td>
<td>(0.44)**</td>
<td></td>
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<tr>
<td>Retool</td>
<td>-4.36</td>
<td>-4.28</td>
<td>-4.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.35)**</td>
<td>(1.41)**</td>
<td>(1.42)**</td>
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</tr>
<tr>
<td>Constant</td>
<td>-156.69</td>
<td>-151.95</td>
<td>-82.30</td>
<td>-18.82</td>
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<tr>
<td></td>
<td>(65.94)*</td>
<td>(58.40)*</td>
<td>(67.21)</td>
<td>(52.24)</td>
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<td>Team Fixed Effect</td>
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<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Conference Count</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.48</td>
<td>0.47</td>
<td>0.57</td>
<td>0.46</td>
</tr>
<tr>
<td>$N$</td>
<td>582</td>
<td>582</td>
<td>582</td>
<td>582</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

+ significant at 10%; * significant at 5%; ** significant at 1%

* Heteroskedasticity-consistent robust standard errors are in parentheses, clustered by team.

** Coefficients for all controls in Table 2 models included but not shown
Table 4  
**Mechanism Tests, OLS Regressions Predicting Season Wins, NBA 1986-2008***

<table>
<thead>
<tr>
<th>Variables</th>
<th>10.1***</th>
<th>10.2***</th>
<th>11</th>
</tr>
</thead>
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<td>Heterogeneity, Primary</td>
<td>45.49</td>
<td>14.91</td>
<td>23.91</td>
</tr>
<tr>
<td></td>
<td>(8.56)**</td>
<td>(15.43)</td>
<td>(5.06)**</td>
</tr>
<tr>
<td>SRH</td>
<td>6.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.01)+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team experience, Weighted</td>
<td>12.16</td>
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</tr>
<tr>
<td></td>
<td>(2.80)**</td>
<td>(3.58)</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity, Primary x Team experience</td>
<td>-11.65</td>
<td>2.57</td>
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</tr>
<tr>
<td></td>
<td>(3.41)**</td>
<td>(4.43)</td>
<td></td>
</tr>
<tr>
<td>Core shock</td>
<td></td>
<td>-5.52</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.56)**</td>
<td></td>
</tr>
<tr>
<td>Core shock x SRH</td>
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<td>16.44</td>
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<td></td>
<td></td>
<td>(4.77)**</td>
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</tr>
<tr>
<td>Constant</td>
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<td>-75.24</td>
<td>-165.98</td>
</tr>
<tr>
<td></td>
<td>(77.82)</td>
<td>(92.26)</td>
<td>(60.18)**</td>
</tr>
<tr>
<td>$R^2$</td>
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<td>0.37</td>
<td>0.44</td>
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<tr>
<td>$N$</td>
<td>310</td>
<td>272</td>
<td>582</td>
</tr>
</tbody>
</table>

+ significant at 10%; * significant at 5%; ** significant at 1%
* Heteroskedasticity-consistent robust standard errors are in parentheses, clustered by team.
** All prior controls included but not shown
*** Model 11.1 (11.2) is run on a subset of data having lower (higher) than average redundancy
Table 5  
*Mechanism Tests, OLS Regressions Predicting Season Wins, NBA 1986-2008* **

<table>
<thead>
<tr>
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<th>Won</th>
<th>C&amp;C</th>
<th>Won</th>
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</thead>
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<td>Heterogeneity, Primary</td>
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<td>0.80</td>
<td>14.61</td>
</tr>
<tr>
<td></td>
<td>(5.38)**</td>
<td>(0.23)**</td>
<td>(4.61)**</td>
</tr>
<tr>
<td>SRH</td>
<td>9.38</td>
<td>0.32</td>
<td>5.52</td>
</tr>
<tr>
<td></td>
<td>(2.67)**</td>
<td>(0.10)**</td>
<td>(2.60)*</td>
</tr>
<tr>
<td>Coordination &amp; Cooperation</td>
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<td></td>
<td>12.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.14)**</td>
</tr>
<tr>
<td>Constant</td>
<td>-166.22</td>
<td>-5.43</td>
<td>-100.17</td>
</tr>
<tr>
<td></td>
<td>(63.88)*</td>
<td>(3.79)</td>
<td>(51.89)+</td>
</tr>
</tbody>
</table>

Proportion of total effect explained (Sobel Goodman) 0.41
R² 0.44 0.35 0.63
N 582 582 582

+ significant at 10%; * significant at 5%; ** significant at 1%
* Heteroskedasticity-consistent robust standard errors are in parentheses, clustered by team.
** All prior controls included but not shown