Leader Integrative Capability: Multidisciplinary Expertise Fosters Innovation

Journal:	*Journal of Organizational Behavior*
Manuscript ID:	JOB-15-0429
Wiley - Manuscript type:	Research Article
Keywords:	problem construction, interdisciplinary teams, multidisciplinary expertise

Leader Integrative Capability: Multidisciplinary Expertise Fosters Innovation

Keywords: problem construction, interdisciplinary teams, multidisciplinary expertise

Abstract

Interdisciplinary team leaders with multidisciplinary expertise—a breadth of educational or work experience in multiple disciplinary areas—may have the integrative capability to identify research questions that cut across fields and to motivate members to draw upon their diverse disciplinary perspectives to yield novel insights. Results indicate that this relationship could be driven by leaders' ability to garner commitment from disciplinarily diverse team members who feel that the team's research question is aligned with their own disciplinary interests. We test and find support for the indirect relationship between leader characteristics (multidisciplinarity) and performance outcomes (innovativeness) through members' attitudes (goal commitment), using survey and demographic data from 32 interdisciplinary medical teams. To further uncover *how* leaders with multidisciplinary expertise foster commitment and innovation in interdisciplinary teams, we conducted a supplemental comparative case analysis of 5 teams using meeting transcripts. Mirroring the quantitative study, our findings reveal that leaders with multidisciplinary expertise strike a balance between depth (focus) and breadth (inclusiveness), fostering the development of more integrated and innovative research aims and work plans. This research sheds light on what work experiences and facilitation practices best equip team leaders for the difficult task of generating knowledge in interdisciplinary teams.

Leader Integrative Capability: Multidisciplinary Expertise Fosters Innovation

Great discoveries in science have often been attributed to the lone genius (Simonton, 1984). The empirical reality, however, is that generating solutions to complex scientific problems often requires interdisciplinary teams (Cummings & Keisler, 2005; Wuchty, Jones, & Uzzi, 2007) composed of individuals with diverse expertise that must be harnessed, integrated, and utilized effectively (e.g., Dahlin, Weingart, & Hinds, 2005; Kerr & Tindale, 2004). As expressed on the website of Stand Up To Cancer (SU2C, n.d.), an initiative that facilitates and funds interdisciplinary teams to combat a complex medical problem requiring the input of many disciplines,

> Collaboration, innovation, acceleration, targeted therapy and work that can quickly translate "from the lab bench to the hospital bed" are the principles that drive the SU2C Dream Teams and Innovative Research Grant recipients. Stand Up To Cancer enables the best and brightest in the cancer research community to work together on teams in a way that has never been possible before - all for the benefit of patients.

This type of reorganization of medical research is occurring throughout the medical ecosystem, with an emphasis on breaking down barriers between disciplines and fostering interdisciplinary collaborations (Saporito, 2013). Today, these diverse teams can be found at every major medical center, and many span institutions around the country and the globe (National Center for Advancing Translational Studies, 2015).

The unprecedented opportunity for discovery and the promise of scientific advancement, such as that achieved by the Human Genome Project (National Human Genome Research Institute, 2014), has led to a surge in federal and private financial support for interdisciplinary scientific collaboration (Saporito, 2013; Zerhouni, 2003). Although interdisciplinary science teams have suffered noteworthy failures, such as the crash landing of Virgin Galactic's suborbital space plane in the Mojave Desert (Borenstein, 2014), most failures entail not large public accidents, but rather wasted resources and lost opportunities to harness the team's capacity for knowledge integration and innovation. Often, effective collaboration among members of interdisciplinary teams is impeded by gaps in understanding created by the sheer breadth of intellectual distance that separates their expertise (Cronin & Weingart, 2007; Journet,1993), and such teams may struggle to leverage the value of their diverse expertise to achieve their goals (Derry, Schunn, & Gernsbacher, 2005). To overcome this challenge it is necessary to establish common ground through integrative "bridging work" to connect knowledge silos using a process of mutual adjustment (Mannix & Neale, 2005; Ospina & Foldy, 2010). The intensity of effort required to establish common ground depends on the degree of intellectual distance among team members and the extent to which knowledge differences require integration to achieve the team's collective aim. The interdisciplinary teams illustrated above exhibit high levels of both of these features, resulting in frequent and significant communication and coordination challenges (Cummings, Kiesler, Zadeh, & Balakrishnan, 2013; Kotha, George, & Srikanth, 2013).

An emerging field of research, the "science of team science" (SciTS), has recognized the need for research teams to develop a capacity for truly interdisciplinary collaboration (Lotrecchiano, 2013). Although attempts have been made to draw upon and apply theoretical frameworks to interdisciplinary teamwork (Fiore, 2008), many questions remain and warrant empirical investigation (Cooke & Hilton, 2015). Little evidence-based insight exists to guide efforts to mitigate the communication and coordination challenges (Balakrishnan, Kiesler, Cummings, & Zadeh, 2011) that arise among team members who have deep knowledge in their respective fields but who have obtained little training, understanding, or even positive affect toward the knowledge areas of others.

In this paper we draw on the concept of *integrative capacity* (Salazar, Lant, Fiore, & Salas, 2012). Integrative capacity is a team's potential to combine and transform knowledge through reciprocal social and cognitive integrative processes, mediated by a set of emergent states, that foster team performance outcomes that are necessary for scientific breakthroughs that require collaboration at the intersection of disciplines. The focus of this empirical study is on the characteristics and behaviors of the team leaders who have primary responsibility for managing communication and coordination challenges. We posit that leaders with an *integrative capability* have greater success in overcoming these obstacles to knowledge integration and innovative team outcomes. We define leader integrative capability as the extent to which a team leader is able to bridge intellectual distance, foster goal commitment among team members, and enable knowledge sharing and integration. Additionally, multidisciplinary expertise is proposed as an antecedent of integrative capability. Specifically, education and work experience in multiple disciplinary domains enables leaders to oversee the process of goal alignment and task coordination, thus enabling the team to collectively construct and represent the problem in a way that is compatible across disciplinary perspectives. This, in turn, creates a shared goal (i.e., to generate a solution to the problem), increases collective goal commitment, and bolsters the cross-boundary communication and coordination that spur knowledge integration and innovative outcomes.

To examine the relationship between leaders' multidisciplinary expertise and knowledge integration and the innovativeness of their teams' research goals and work plans, we studied 32 newly formed interdisciplinary medical science research teams. We found that innovation is indeed greater on average in those interdisciplinary teams whose leaders have multidisciplinary expertise, and that this effect is due to greater goal commitment garnered from team members. This indirect relationship suggests that leaders with greater integrative capability are effective at helping their teams craft research aims that both bridge the diverse expertise of members and mobilize their willingness to work jointly. To further explore how leaders with multidisciplinary expertise leverage the diverse perspectives of team members, a supplemental comparative case analysis was conducted, providing insight into the types of behaviors that distinguish leaders with integrative capability from leaders who lack it.

Theoretical Background

Interdisciplinary teams increasingly undertake complex scientific problems of large practical importance. In attempting to generate innovative solutions, these teams face the formidable challenge of integrating knowledge across members from diverse disciplines (Taggar, 2001) with underlying philosophical differences that shape their motivations, methods, evaluative criteria, and values (Eigenbrode, O'Rourke, & Wulfhorst, 2007). Years of socialization and training foster adherence and commitment to the core questions, problems, and approaches that are conventional in one's own field of expertise. Basic scientists, for instance, tend to focus on identifying the foundational mechanisms underlying complex problems, whereas applied scientists, such as physicians or surgeons, aim to provide effective delivery of a service or treatment (Stokols, Hall, Taylor, & Moser, 2008). Even within groups of basic or applied scientists, there are vast differences in knowledge and practice across disciplines. Thus effective interdisciplinary collaboration is hindered by the varied interests, perspectives, and skills of individual team members, and often creates significant communication and coordination challenges.

The wide and entrenched nature of the intellectual distance between members of interdisciplinary teams renders the simple sharing or pooling of ideas for the purpose of interdisciplinary innovation untenable. While the sharing of information and suggestions is a necessary component of team innovation, such sharing does not guarantee the type of emergent knowledge integration required for *inter*disciplinary team innovation, which requires a more involved process of cognitive integration (Klein, 1996; Stokols et al., 2008). Team members must, in these contexts, additionally strive to understand the underlying values, philosophies, methodologies, and work perspectives of team members from different disciplines (Eigenbrode et al., 2007). Thus, the ability of an interdisciplinary team to combine and integrate the knowledge and expertise of its members has an added prerequisite: representatives of different disciplines must deliberately seek to understand each other's contributions and perspectives (Salazar et al., 2012).

Given the increasing necessity of knowledge integration for innovation in response to complex problems (Wuchty et al., 2007), scholars are beginning to examine knowledge integration as a team-level capability (Gardner, Gino, & Staats, 2011). For example, Salazar and colleagues (2012) provided a theoretical framework that delineated facilitators and inhibitors of a team's *integrative capacity*—their potential to combine and transform knowledge through social (e.g., intra-team communication) and cognitive (e.g., the open consideration and contemplation of another's perspective) integrative processes, mediated by a set of emergent states (e.g., shared goals). Empirical work further supports the importance of communication behaviors in fostering knowledge integration, demonstrating that high quality communication (Gardner et al., 2011) and questioning others (Okhuysen & Eisenhardt, 2002) have a positive influence on team knowledge integration and task performance. Other research highlights the difficulties many teams have in utilizing these interdependent cognitive and social processes (Balakrishnan et al., 2011).

Team performance has been shown to improve when members identify with a superordinate goal (Kane, Argote, & Levine, 2005). Performance can be further enhanced when the shared goal is challenging and mutually created, motivating members to commit to the collective objective due to both its level of challenge and its appeal to the vested interests of each team member (Haslam, Wegge, & Postmes, 2009). In interdisciplinary science teams, members likewise have distinct and separate goals, but also possess the autonomy and skill to pursue them. A collective objective is therefore of paramount importance, and must be motivating enough to spur the effort needed to collaborate across disciplines. Unfortunately, little is known about how to help teams manage this process (Klein, 1996; Litchfield, 2008; Winter & Berente, 2012).

Literature on cross-functional teams (Mannix, Neale, & Goncalo, 2009; Paulus & Nijstad, 2003), sometimes called *multi*disciplinary teams (Parker, 2003; Van Der Vegt & Bunderson, 2005), has demonstrated how leaders can foster innovative outcomes by facilitating information sharing and by helping team members to pool their diverse sources of knowledge. Although knowledge sharing alone is insufficient for *inter*disciplinary teamwork, leader interventions have been shown to effectively elicit dissenting views (Schulz-Hardt, Brodbeck, Mojzisch, Kerschreiter, & Frey, 2006), enhance the use of varied cognitive capabilities through collaborative planning (Woolley, Gerbasi, Chabris, Kosslyn, & Hackman, 2008), and facilitate access to team members' diverse knowledge by prompting reflection on how group goals are achieved (van Ginkel & van Knippenberg, 2009). Thus, skilled leadership can help interdisciplinary teams to identify and develop collective research aims through a process of problem construction.

Although research has provided insight into how leaders shape a team problem-solving process once a problem has been defined (Reiter-Palmon & Illies, 2004; Zaccaro, Mumford, Connelly, Marks, & Gilbert, 2000), less is known about the problem construction process itself. This is a crucial issue in interdisciplinary teams, as problems tend to be ill defined, to be characterized by multiple possible goals and ways of solving the problem, and to have a variety of possible solutions (Reiter-Palmon & Illies, 2004). Although creative solutions to real-world problems can arise from this ambiguity (Mumford, Mobley, Reiter-Palmon, Uhlman, & Doares, 1991; Schraw, Dunkle, & Bendixen, 1995), their emergence and quality often depend largely on the problem construction process (Okuda, Runco, & Berger, 1991; Reiter-Palmon, Mumford, & Threlfall, 1998) and less on differences in intelligence and divergent-thinking skills (Runco & Okuda, 1988; Smilansky, 1984), calling to mind the adage "a problem well put is half solved."

Research suggests that leaders are primarily responsible for the management of the problem construction process, even in self-managing teams (Nygren & Levine, 1996; Reiter-Palman & Illies, 2004). When individuals representing different disciplines come together to solve an ill-defined and complex problem, the problem must often be (re)defined in terms of the terminology, methodology, and philosophy of the respective disciplines represented on the team before effective collaboration can begin. Restrictions on how a problem can be framed, and on the types of solutions that are appropriate, depend on the particular disciplines represented by team members and the multiple (and at times competing) goals that need to be integrated (Butler & Scherer, 1997; Stokes, 1999). When the problem-solving process is successful, each member perceives that his or her interests have been addressed. While the integration of diverse goals can result in more innovative problem construction and solutions (Reiter-Palman & Illies, 2004), interdisciplinary teams can easily fail to integrate the diverse goals and succumb to the conflict that can arise (Lovelace, Shapiro, & Weingart, 2001) if problem construction is attempted without the facilitative guidance of a leader with a broad base of multidisciplinary experience. Without such guidance, team members without multidisciplinary experience likely will not understand the perspectives taken by their disciplinarily diverse team members.

Leaders are likely to play a critical role in focusing team member efforts on the creation of a shared problem conceptualization and work plan, and a unifying research aim for which a solution would not be possible without the insights of members from each discipline. Yet without a leader with relevant multidisciplinary expertise, the creation of such a unifying goal that elicits collective commitment may be exceedingly difficult. A less experienced leader might fall into the trap of either selecting a research aim that is inclusive of everyone's interests but is too broad, or choosing a research aim that is too narrow—that is, one that includes the aims of a subset of members and excludes those of disciplinarily diverse others. When the research aim is too broad, the result is an ineffective process that lacks deep discussion concerning the substantive research question of interest (Nijstad & Stroebe, 2006). As a consequence, a team may find a broad area of investigation that is of mutual interest, but is not well defined or intellectually appealing enough to motivate members' commitment or effort. When the team focuses on a research aim that is too narrow, the problem fails to garner the commitment of all members. Ideally, a leader focuses the team on a manageable and interesting portion of the problem space that will enhance the engagement and commitment of all team members, making an integrative and innovative solution to the problem more likely (Coskun, Paulus, Brown, & Sherwood, 2000).

The advantage held by leaders with multidisciplinary expertise may be at least partially explained by the leader's increased perspective-taking ability, or the capacity to understand the thoughts, motives, and feelings of others (Parker, Atkins, & Axtell, 2008), which is augmented as a result of deep involvement with "alternative ways of thinking" (Weathersby, 1993). In-depth exposure to multiple disciplines and domains of practice allows a leader to engage in deliberate cognitive reframing that helps to bridge gaps in understanding across disciplines and enhances the integration of diverse perspectives and ideas (Hoever, van Knippenberg, van Ginkel, & Barkema, 2012). In applying the concept to an *inter*disciplinary research team context, we use the term *multi*disciplinary expertise to more accurately describe a scientist or clinician with a breadth of education and/or professional experience.

Multidisciplinary expertise serves to cultivate a leader's integrative capability through intrapersonal expertise heterogeneity (the functional diversity represented within the work and educational background of an individual; Bunderson & Sutcliffe, 2002) gathered through extensive work experience in more than one discipline or field of practice. Specifically, experience with the practices, values, and priorities of different disciplines provides a leader with multiple lenses through which to view potential research questions and problems, and fosters greater awareness of the multiple possible ways of conceptualizing the team's research problem. These leaders may spend more time deliberately considering the process of problem construction, and are more willing to facilitate the integration of the diverse knowledge and perspectives of team members. As a consequence, the leader with multidisciplinary expertise will be more adept at helping a team to construct a research problem, and at motivating joint effort.

Varied work experiences in multiple domains of research and practice provide leaders with a more flexible role orientation and the tendency to view their role more broadly, thus seeing themselves as spanning multiple domains (Parker & Axtell, 2001). They will also deliberately seek an understanding of how different disciplines approach their work and how disciplines are related to each other, conceptually and in practice. Insights regarding the cognitive capabilities and skills that team members from different disciplinary backgrounds possess can be leveraged in the planning of team collaboration, thus fostering creative synergy (Woolley et al., 2008). Also, by being legitimate knowledge brokers in the eyes of team members, they can help the team to establish a shared aim and increase commitment to pursuing this aim. Once a research goal is constructed appropriately, team members may then begin to uncover common research interests and make novel connections between their various disciplinary sources of expertise. Multidisciplinary expertise equips a team leader with the integrative capability necessary to guide team members through the process of identifying shared but specific research problems, and developing integrative and innovative solutions. Thus,

> ***Hypothesis 1:*** Interdisciplinary research teams led by individuals with multidisciplinary expertise will be rated higher on innovativeness than interdisciplinary research teams led by individuals without multidisciplinary expertise.

As shown, a critical precursor to effective collaboration in interdisciplinary science teams is the creation of a problem space and research aim that is simultaneously relevant, understandable, and challenging enough to interest and cater to the diverse members of the team. Team members are less likely to commit time and resources to a research aim that does not seem compatible with the perspectives, aims, values, and methodologies of their discipline and their career. A leader with integrative capability, however, will be more skilled at facilitating team dialogue that draws the attention and sincere consideration of members from each disciplinary group represented within the team, increasing the likelihood of effective collaboration.

A leader's openness to diverse disciplinary perspectives can also serve to reduce stereotyping and in-group favoritism (Galinsky & Moskowitz, 2000). This, in turn, fosters cooperative behavior (Parker & Axtell, 2001) including the elicitation of ideas that build upon those of others (Grant & Berry, 2011). Thus, by facilitating the identification of research questions and work plans that do not privilege the interests of a single discipline, but encompass those of multiple disciplines, leaders with multidisciplinary expertise more effectively appeal to each member of an interdisciplinary team, and increase team members' willingness to work jointly on the team's research questions. Team members are likely to commit to the collective team aims when they perceive the leader as embodying the team's diverse-but-unified interests (Haslam & Platow, 2001; Van Knippenberg & Hogg, 2004). A leader who serves as a role model for interdisciplinary collaboration (Conger & Kanungo, 1987) may encourage members to engage in cross-disciplinary problem construction by actively sharing and integrating distinct perspectives.

In summary, the leader of an interdisciplinary research team who is recognized by team members as embodying an interdisciplinary orientation and as valuing a range of perspectives will be more capable of facilitating a problem construction process that results in an integrative research aim, and will foster commitment that promotes team behaviors that facilitate integration. The experience of committing to a team's aims may bind team members to specific behavioral acts (Locke, Latham, & Erez, 1988) that facilitate effective interdisciplinary collaboration. Increased commitment helps to ensure that team members actively attempt to coordinate their efforts and aims (Zaccaro, Rittman, & Marks, 2002), increasing the likelihood that the team will exhibit a mutual openness to the contributions of others (Fleishman et al., 1991; Salazar et al., 2012) and creatively integrate ideas, which can lead to breakthroughs in understanding (Amabile, 1998; Gardner, 1994). Thus,

> ***Hypothesis 2:*** Goal commitment will mediate the relationship between leader multidisciplinary expertise and interdisciplinary team innovativeness, such that teams with leaders possessing multidisciplinary expertise will report higher goal commitment than those whose leaders lack multidisciplinary expertise.

Method

Research Site and Sample

The field study was set in a large medical center in the northeastern United States, referred to here as Metro Medical Center (MMC), which sought to reorganize the way it conducted medical research. Historically, medical professionals in the United States have organized themselves into disciplinary departments (i.e., silos) and knowledge communities with similar others (Weisz, 2006). As with many knowledge organizations (Blackler, 1995), the staff members at MMC responsible for knowledge creation (research scientists) and knowledge application (clinical researchers, physicians, and surgeons) are highly professionalized, with a great degree of autonomy over their time and tasks. Because these professionals identify strongly with the norms, practices, and interests associated with the scientific communities to which they belong, as a byproduct of many years of professional socialization (Journet, 1993), this site was deemed appropriate for examining differences in perspectives and methods that can hinder interdisciplinary, cross-boundary collaboration (Salazar et al., 2012).

The leadership at MMC advocated and oversaw the formation of interdisciplinary research teams. Following the official announcement of an internal competition to spur reorganization in October 2007, 61 teams submitted a letter of intent to form interdisciplinary teams around various disease topics of interest. Teams that entered the competition were formed autonomously by scientists and clinicians in response to a call for proposals, and had not existed prior to the announcement (e.g., had never been awarded internal or external funding as a unit). Because of the stated interdisciplinary purpose of the reorganization and the desire to further scientific understanding that could have clinical implications (i.e., translational work that bridges "bench" and "bedside"; Zerhouni, 2003), teams tended to draw members from various biomedical professions, ranging from basic researchers working at the cellular level to clinical researchers working primarily with human populations, as well as applied scientists and practitioners with various clinical areas of expertise. Most team members worked primarily in only one of MMC's discipline-based departments, and each team had members representing two or more distinct disciplinary areas.

After 3 months of collaboration, each team submitted a proposal providing details about the disease-focused research question that the team wished to address. The scientific and managerial work plan detailing how team members would collaborate to achieve the team's aims was included in the proposal, permitting an assessment of the integration of perspectives, tools, and concepts across disciplines represented within the team. The novelty of the proposed ideas, as well as the potential extent to which the ideas could advance scientific knowledge, were assessed by a strategic leadership committee composed of 13 expert investigators selected by the Vice Dean of Research. This committee comprised individuals from across the organization who had made significant contributions to the field of medicine over the course of their careers, and represented a wide range of disciplines. At each stage of the competition, these experts provided their assessment of each team's research proposal using a number of NIH metrics, and ultimately chose to award six teams the designation "Centers of Excellence." Although some expert raters were also members of interdisciplinary research teams, these individuals removed themselves from the evaluative process when conflicts of interest presented themselves.

We administered a cross-sectional survey at MMC to all team members who were members of the institution. Only individuals who became members of the newly formed teams were included in the present analysis. The survey was distributed and collected before team members learned about their team's final innovativeness rating. Respondents were unaware of their performance or position in the competition (i.e., whether they were selected as semifinalists or finalists) when reporting their perceptions of their team. Because of factors such as varying response rate and the merging of multiple teams into single teams, the resulting sample size for analysis was a total of 245 individuals in 32 teams. Teams in this sample were generally medium sized (*M* = 13.85, *SD* = 12.43). On average, teams were composed of individuals who had been at the organization for approximately 18 years, and most team members were affiliated faculty. Survey data were used in combination with rosters providing demographic data about team members as well as the expert ratings of team proposal innovativeness.

Variables and Measures

Innovativeness. Team innovativeness was measured using the expert committee's rating of each team's research proposal. In their assessment, the committee used criteria developed by the National Institutes of Health (http://www.niaid.nih.gov/researchfunding/grant/strategy/pages/5scoring.aspx#b). This scale ranged from 1 (*not at all innovative*) to 6 (*very innovative*). Such criteria considered the extent to which the team's proposed research plan integrated diverse disciplinary perspectives and advanced the current state of understanding regarding the medical disease of focus. Highly innovative proposals proposed original means to fill knowledge gaps and address opportunities or roadblocks in the field. Each team was rated by at least three committee members. Interrater reliability was satisfactory, above .6 (Bliese, 2000), and enabled aggregation of rating scores.

Leader multidisciplinary expertise. In this setting, leaders tended to be principal investigators (PIs) on prior projects. We used information provided in CVs to discern whether team leaders had substantive experience in more than one discipline. We reviewed a broad sample of CVs and developed a list of 16 indicators of training and work in either academic research or clinical medical practice (see Appendix). Our coding scheme was as follows: A leader was judged to have a high level of multidisciplinary expertise if he or she had 6 or more indicators of education and training in *both* a disciplinary-based area of research (e.g., biology, oncology, pathology) *and* clinical practice drawing on the discipline of medicine. We coded leaders as having a moderate degree of multidisciplinary expertise if they had 6 or more indicators of education and training in the discipline of medicine, and 2 or 3 indicators of research-oriented experience, such as first author on research publications, or received awards for basic research (or vice versa: 6 or more indicators of research-oriented experience and 2 or 3 indicators of medical education and training). Leaders who were solely researchers or clinicians were judged to have no multidisciplinary expertise if they had 6 or more indicators in only one of the two domains and 1 or 0 indicators in the other domain. We created an ordinal variable with the values of *none* (0), *moderate* (1), and *high* (2) to capture this coding schema.

Goal commitment. We used a 6-item measure to assess goal commitment, adapted from Hollenbeck, Klein, O'Leary, and Wright (1989). Responses for each item ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Sample items included "It is hard to take this goal seriously," "I think that this is a good goal to shoot for," and "It would not take much to make me abandon this goal" (reverse coded). We added an original item stating, "I feel that the team will be able to achieve this goal" to the measure to assess the perceived difficulty of the research goal. Cronbach's alpha for this scale was .81. Team member perceptions of goal commitment were aggregated to the team level, as justified via the use of an intraclass correlation (ICC2; Shrout & Fleiss, 1979), as all 32 teams had acceptable within-group agreement, above .6.

Control Variables

Team size. We were able to determine team size from team rosters. The average team size was 17 members.

Academic rank diversity. Academic rank refers to whether team members held the rank of assistant, associate, or full professor, and was coded from individual CVs. A measure of diversity was computed using Blau's (1977) formula, $1 - p^2_i$, where p is the proportion of a group in each of the i categories. A higher index score indicates greater heterogeneity within the team.

Team disciplinary diversity. Similarly, disciplines and areas of practice represented on each team were coded using information from member CVs, and a diversity measure was computed using Blau's (1977) formula. Since extant literature highlights the diminishing return of increased disciplinary heterogeneity (Gibson & Vermeulen, 2003), we controlled for this curvilinear effect in our model.

Proportion of team members who have collaborated with the leader. A leader's previous collaborative experience with teammates could affect their innovativeness (Guimera, Uzzi, Spiro, & Amaral, 2005). This variable measured the proportion of team members who have co-authored a publication with the team leader. Information was taken from CVs.

Leader's status. A leader's status within the organization could influence team members' goal commitment and bias raters' perception of the originality of the team's ideas (Smith, DiTomaso, Farris, & Cordero, 2001). We coded status using a dummy variable indicating whether the leader had an endowed chair.

Team member multidisciplinary expertise. Given research illustrating the impact of team members' intrapersonal functional heterogeneity (Bunderson & Sutcliffe, 2002) we controlled for team *member* multidisciplinary expertise. Procedures for measuring the leader's multidisciplinary expertise were used for the team members as well. Using Blau's (1977) calculation, we measured each team's proportion of members with multidisciplinary expertise.

Team member perceptions. Prior research suggests that team member perception of the degree of psychological closeness with other team members (Uleman, Rhee, Bardoliwalla, Semin, & Toyoma, 2000) and perceived interconnectedness between the self and the group (Gaertner & Schopler, 1998) can affect team member receptivity and commitment to team goals. These established measures of psychological closeness and interconnectedness by the above-mentioned authors were included in the survey distributed to respondents.

Results

Table 1 presents means, standard deviations, and correlations for all variables. Table 2 presents results for Hypotheses 1 and 2. We tested the hypotheses using a simple mediation model. Prior to analysis, all measures were mean centered (Aiken & West, 1991). Hypothesis 1 predicted a positive relationship between the multidisciplinary expertise of a leader and the innovative performance of the team. Hypothesis 2 predicted that the relationship between multidisciplinary expertise and team innovativeness would be mediated by a teams' goal commitment. We conducted the test of the mediation hypothesis using the method developed by Preacher and Hayes (2004), as it more flexibly and accurately addresses mediation with the use of bootstrapping. Testing indirect effects with bootstrapped confidence intervals avoids power problems associated with small samples, and circumvents challenges introduced by asymmetric and other non-normal sampling distributions of indirect effects (MacKinnon, Lockwood, & Williams, 2004). The meditational analysis was performed using Hayes's (2013) PROCESS macro for SPSS. This macro allows for the testing of the indirect mediation effect $a*b$, utilizing both the conventional Sobel test method and bootstrapped confidence intervals.

<< Insert Table 1 here >>

<< Insert Table 2 here >>

Table 2 presents three models. The first model tests the effects of the independent variable on goal commitment, the first step of the mediation analysis. The multidisciplinary expertise of the leader has a significant positive effect on the aggregate level of goal commitment in the team. The second model tests the effects of the independent variable on team innovativeness, without including the goal commitment variable. The multidisciplinary expertise of a leader was positively related to innovativeness before accounting for a goal commitment (B = .59, $p < .05$), supporting Hypothesis 1. The third model includes the goal commitment variable. Goal commitment has a significant positive effect on team innovativeness, and the effect of leader multidisciplinary expertise is no longer significant. These results support Hypothesis 2, indicating that the path between the independent variable (multidisciplinary expertise) and the mediator (goal commitment) demonstrated a positive and significant association (B = .65, $p < .01$), and goal commitment also positively predicted team innovativeness (B = .53, $p < .01$).

Together, the findings lend support for an indirect effect, such that leaders with greater multidisciplinary expertise may lead their teams to be more innovative through the goal commitment that they garner. The inclusion of goal commitment in the mediation model renders the relationship between the multidisciplinary expertise of the leader and innovativeness nonsignificant (B = .25, *p* = n.s.), suggesting what has been conventionally referred to as "complete mediation" (Baron & Kenny, 1986). The indirect effect of goal commitment attained statistical significance (Sobel $z = 2.09$, $p < .05$), using a bootstrapping method (with 10,000 bootstrapped samples). The bootstrapped 99% confidence interval around the indirect effect did not contain zero (LLCI = .01, ULCI = 1.18), similarly indicating statistical significance.

Several control variables were significant. Both team size (B = .02, $p = .05$) and perceived interconnectedness between the self and the team (B = .72, $p < .05$) were significantly related to innovativeness. Team disciplinary diversity was found to have a relationship with goal commitment, exhibiting both a linear (B = −19.61, $p < .05$) and a curvilinear (B = 16.01, $p < .01$) component, such that members were less likely to continue reporting higher goal commitment as diversity increased. In the mediation model, team size (B = .04, $p < .05$) and previous collaboration with the leader (B = 1.63, $p < .05$) were also positively associated with innovativeness. The proportion of the team members to have collaborated with the team leader (B = .02, p = n.s.) was not significantly associated with goal commitment or innovativeness.

Discussion

The findings provide evidence that leaders with multidisciplinary expertise will help disciplinarily diverse team members collaborate to achieve integrative, innovative outcomes that leverage the contributions of multiple disciplines through the fostering of team members' the goal commitment. Several important questions remain unanswered concerning exactly *how* leaders with multidisciplinary expertise foster commitment and innovation in interdisciplinary teams, including specific behaviors used to facilitate the creation of shared team aims. We sought to further explore and understand the "black box" of what leaders with multidisciplinary expertise say and do to galvanize effort and commitment. To do so, we conducted an exploratory qualitative study on a subset of teams from the larger sample, as described in the next section.

Supplementary Qualitative Analysis

Data

Information for this supplementary analysis was collected when we administered the survey for the quantitative study. Thus, there was no prior indication that any of the teams observed would be rated highly on knowledge integration or innovativeness, as all data were collected when teams were in the early phase of the competition. Recruitment began by inviting teams to participate in individual interviews via an email solicitation to all teams who had previously agreed to participate in the quantitative study. Twelve teams, representative of the larger sample of 32 teams in terms of size and disciplinary diversity, responded to our solicitation. Following the recommendation of Yin (2013) for case selection, we selected a subgroup of 5 of the 12 responding teams to observe during team meetings. Three of the five team leaders had high multidisciplinary expertise, while the others had little or none. This provided us with the opportunity to compare the processes and outcomes of teams with and without leaders with multidisciplinary expertise.

Interviews with both team members and team leaders, in teams with and without leaders with multidisciplinary expertise, provided additional information concerning how education and work experiences across domains served to shape the integrative capabilities of leaders of interdisciplinary research teams. In addition to the interviews, the lead researcher directly observed 30.5 hours of team meetings over a period of 6 months for the five selected teams; all the teams' meetings took place at the research site and typically lasted 60 to 90 minutes. With the team members' consent, 60 minutes of meeting proceedings were recorded and transcribed for each of the five teams for comparison purposes. The transcribed meetings all took place in the first half of proposal creation, facilitating a greater understanding of how team leaders uncovered and meshed together the interests, ideas, and skills of team members. Notes were voice-recorded during observations, and further elaborated upon each evening after the team meetings (Emerson, Fretz, & Shaw, 1995).

We also conducted 46 semi-structured interviews (Wengraf, 2001) with interdisciplinary team members and leaders. Interviews typically lasted between 30 and 60 minutes. Interviews were recorded and professionally transcribed. Interview questions broadly focused on each interviewee's disciplinary background, their role in their interdisciplinary team, and the consequences of their participation in the team, both for the individual and for the team as a whole. Interviews occurred at different phases of the team collaboration because of scheduling issues. The interview protocol was somewhat flexible, and the interviewer's inquiries were partially changed as informants shared their experiences and as teams progressed in their collaborative process. In combination with transcript data from team meetings, responses from interview data helped the researchers to understand the experience of participating in teams with leaders possessing varying degrees of multidisciplinary experience.

In addition, we collected 27 documents from each team, including draft proposals and final proposals, team rosters, emails between members, and external ratings of team proposals. Given the aforementioned availability of external ratings of team innovativeness by a panel of experts, the qualitative analysis of team process could be associated with performance ratings assigned to each team's proposal. From the panel of expert raters we collected an additional measure assessing the extent to which proposals illustrated the active integration of the full range of disciplinary and professional perspectives and tools available to each team. Integration was rated by at least three experts from the strategic science committee using a Likert scale ranging from 1 (*not at all integrative*) to 6 (*very integrative*).

Analysis

We employed a comparative case analysis approach to explore how leaders with and without multidisciplinary expertise viewed themselves and their role in an interdisciplinary team, how they shaped their team's research objectives, managed communication and coordination in the team, and established a work plan to address the team's research aim. We used a grounded theory approach to analyzing the data (Glaser & Strauss, 1967). The qualitative data analysis software HyperRESEARCH was used to manage interview and team meeting transcripts and field notes. As recommended by Lincoln and Guba (2002), we also used peer briefings to periodically discuss interpretations of the data with colleagues not involved in the study, and multiple data sources were used to corroborate interpretations.

The grounded theory approach included three stages. First, qualitative interview and observational data underwent open coding (Strauss & Corbin, 1998). As the researcher interacted with teams in the qualitative study, commentaries and memo notes were written about emerging themes related to team leadership and team functioning. Based on these insights, an initial list of codes was developed around our topic focus (i.e., integrative capabilities of leaders) while also allowing for new themes to emerge from the data. Thus, codes emerged from the data rather than from any outside source (Agar, 1980). We added new codes as they emerged during the process of analyzing the data. When leaders engaged in communication that was thought to be task relevant (e.g., defining the team's research problem, generating alternative solutions, assessing alternative solutions, or establishing means for executing plans) these communications were coded. We also coded for brief statements of support and encouraging vocalizations (e.g., "uh-huh" and "go on"; Duncan, 1972) that facilitated task-related dialogue among team members. Those communications that reflected messages other than the leader's own, such as a clarification of goals set by management, were not included in analysis.

Second-order, or axial coding was used to search for instances of particular leader behaviors and to also convert them into higher order categories of behaviors. We identified four second-order categories of leader behaviors: (1) *clarifying the purpose*, (2) *confining the problem space*, (3) *forming connections*, and (4) *comprehensive participation*. These distinct categories of leader behaviors were then classified under two aggregated emergent theoretical dimensions:

leader breadth and *leader focusing*. Table 3 provides definitions and examples of these categories of behaviors. Two coders, blind to the team identity, identified all second-order codes throughout the transcripts. They obtained an acceptable level of interrater reliability of at least 80%. Remaining disagreements were resolved through discussion.

<< Insert Table 3 here >>

Findings

Leader Beliefs and Perceptions

Based on our investigation, leaders with multidisciplinary expertise viewed themselves and their role in the team differently than leaders with a less diverse professional background. Notably, most leaders with multidisciplinary expertise discussed being trained to work in both clinical and research settings, making statements such as “I am kind of trained in two disciplines medically, both pediatrics and dermatology,” and subsequently provided extensive narratives about training in various labs, clinical programs, or residency fellowships. Often, the educational pathway involved 5 years of training to complete a medical degree and then several *additional* years to gain the competencies required to see patients in a specialized clinical area.

When discussing their daily activities outside of their participation in an interdisciplinary team, leaders with multidisciplinary expertise often voiced frustration at having to choose between the disciplinary areas that they had been trained in, either being required to act primarily as a researcher or having to exclusively treat patients in a clinical capacity. For instance, one individual occasionally saw geriatric patients as a clinical psychiatrist, but spent most of his time in the laboratory pursuing research on the cell biology of neurodegenerative diseases. A common theme among leaders with multidisciplinary expertise was the perception that interdisciplinary teams provided them with a context in which to integrate distinct aspects of their training and identity. One shared,

> [There are] several different facets of the work that I do and the facets are not exactly integrated fully, or they haven't been up until now and that's one of the interests in putting together [an interdisciplinary team], is that it *does* bring together the facets that have been part of my life.

Another stated that "[the interdisciplinary team] brings my whole portfolio of interest together in something that allows me to use all the skills that I have."

How Do They Lead Interdisciplinary Research Teams?

Leaders with multidisciplinary expertise often discussed leading interdisciplinary teams as an opportunity to bring together disciplines with distinct strengths and approaches to address a research problem. They also described their function as leader in these disciplinary diverse team contexts as one of an integrator. One team leader expressed:

> I'm a MD/PhD and have lived in both worlds. I thought, I should probably step up to the plate, but do it in a way, where it is not about me—it's about making the teamwork. Foster interactions so that people feel like everyone is getting something out of it. The team together could be much better if we were to bring in all of these different elements. People will feel like it is really worthwhile.

To understand whether leaders with multidisciplinary expertise approached their roles differently than their counterparts, especially with regard to the problem construction process at the onset of team collaboration, we first identified all references to leaders helping to develop specific disease-related research questions. Leader behaviors facilitating problem construction across disciplinary boundaries during team meetings were compared across teams, so that we could identify which behaviors were more commonly employed by leaders with multidisciplinary expertise to assist interdisciplinary teams in defining their research questions and collective problem-solving approaches. As a preliminary check on the assumption of leader influence on team processes, the number of times that leaders spoke during team meetings was assessed relative to all of the other team members, and team leaders were found to be important contributors to the team discussion. Across the five teams, leaders spoke an average of 23 times, compared to the team, who spoke an average of 116 times during the 60-minute meetings.

Leaders with multidisciplinary expertise were more likely to focus the team around a specific and complex aspect of the disease problem, while simultaneously fostering breadth of participation. Multidisciplinary expertise permitted leaders to avert the traps of an overly broad, shallow problem exploration, or an overly narrow exploration relying too heavily on a single disciplinary perspective. Instead, this unique experience and training resulted in integrative leadership that enabled disciplinarily diverse team members to construct a way to approach a complex research question by drawing on their diverse perspectives, interests, and frameworks. We return to the data once again to elaborate on how leaders with multidisciplinary expertise simultaneously fostered breadth and depth during the problem construction process.

Fostering depth. The theoretical dimension of fostering depth was defined by two codes capturing leader behaviors that served to focus the interaction of team members from different disciplines to create conditions that would facilitate knowledge sharing and knowledge integration. These codes were (1) *Confining the problem space* so that each individual from different professional backgrounds can meaningfully contribute to the collaborative effort and (2) *clarifying the purpose* of the group by requiring that the team's efforts lead to the integration of ideas, methods, and approaches with the goal of solving a collective problem. When confining the problem space, these leaders avoided generalist dialogue and fostered substantive solution-oriented discourse that engaged the interests and talents of team members from multiple disciplines. One leader with multidisciplinary expertise, for example, started out team meetings by stating, "Looking at [specific research area] is good in that it cuts across a wide sprawl of phenomena. I think it's a translational piece that can interface with the kinds of skill sets that we have and the kind of research projects we might like to address."

Although the problem space became more confined and could have proved to limit member inclusion, these new parameters simultaneously invited discussion from a broad set of team members because of the deliberate way in which the problem was constructed. Each team member became able to offer contributions, as the problem space had been narrowed enough to be relevant to their specialized expertise. Members expressed how much they enjoyed "seeing how other people think about [the] problem and how they could adjust their thinking and vice versa to inform each other." The facilitation of this kind of exchange across disciplinary domains helped the team to establish collective aims around this defined problem space relevant to the capabilities of each discipline represented within the team.

In teams led by leaders *without* multidisciplinary expertise, by contrast, the problem space remained vague and broadly defined. One team leader began a team meeting by stating,

> I see this as more of a roadmap or just a general proposal in broad terms where we want to get to, what's the major accomplishments, and what the general approach would be with a lot of details, odds and ends, to be worked out.

Team members expressed that they would frequently engage in discussion about questions such as, "What are we—what do they want . . . what's really going on here, and what should we do?" rather than refining the problem area and establishing goals for team accomplishment. During one meeting, a team member expressed concern that the group had not developed any "fine-grained hypotheses" and that they might not be providing sufficient detail for reviewers to know what they would be setting out to research.

Our analysis also suggested that effective team leaders fostered depth by helping to clarify the purpose of their team's collaboration by outlining guidelines for the team's final proposal. Although all teams were at least implicitly aware that their team project should reflect the team's underlying disciplinary diversity, some leaders explicitly emphasized the ultimate need to represent in their proposal the deliberate integration of knowledge and skills across disciplinary domains. Teams with leaders who possessed multidisciplinary expertise tended to clearly state these expectations. For instance, one leader with multidisciplinary expertise stated at the start of a meeting that "When the proposal is written up it will describe linkages and efficiencies across [research] programs and translations across training programs, so that they all benefit. We need to describe linkages to other research programs and philanthropy."

In contrast, a leader without multidisciplinary expertise stated less enthusiastically, "Before we leave here, I would like to, in addition to having thoughts about assignments, think about how this project links to others we've got. . . ." Leaders lacking multidisciplinary expertise were less adamant about the disciplinary integration of the team's final project, and communicated the need for it less urgently. Rather, these leaders framed their team's project benefits as complementary and additive within a broader set of research projects. An example of broadly clarifying the team's goals without detailed mention of integrative processes or outcomes is as follows: "We're trying to get the general sense of the direction we want it to be." Leaders without multidisciplinary expertise were more likely to regard interdisciplinary linkages as an afterthought, setting low expectations for true knowledge integration across disciplines.

Fostering breadth. The theoretical dimension of fostering breadth encompassed two codes that capture leader behaviors aimed at including a wide range of team members' ideas and approaches, helping create of a broader pool of knowledge from which to draw during their collaboration. These codes were (1) *forming connections* between the interests and ideas of members through prompts and questions and through the development of team infrastructure, and by motivating team members from different disciplines to seek points of synergy with other members; and (2) promoting *comprehensive participation* to ensure that diverse experts were equally represented within the team's problem space.

Whereas "clarifying the purpose" concerns how well the *leader* synthesized diverse aims across team members, "fostering connections" refers to motivating team members to seek out these points of connection *themselves*. These codes consisted of leaders prompting team members to build connections by identifying "links between areas," or to move "backwards" from clinical findings to identify the underpinnings of basic research. In an effort to include basic researchers in a conversation about a clinical trial, one leader said, "I would focus on some of this going backward, in terms of, how does this really work? What are the mechanisms of the cellular and cell pathology levels . . . for instance?" Similarly, some leaders with multidisciplinary expertise asked members to go "sideways" and consider exploring alternative methodologies that might complement approaches currently being used (e.g., genomics or imaging).

On other occasions, connecting behaviors were more direct, and leaders would explicitly ask how the findings or ideas from one area could benefit, complement, or advance another. When a basic scientist presented initial results from a clinical trial, proposing that the group pursue the same avenue of work, the leader clarified by asking, "How can it be used in a basic science lab, once it is a workable use at the clinical lab? It seems that there is a way to modulate the effect. What are the consequences of that?" By asking members to reflect on how their work might intersect with that of others, leaders with multidisciplinary expertise encouraged members to make connections between research areas across disciplinary domains to understand one another's interests, finding complementarity with their own. Finally, leaders with greater multidisciplinary expertise often identified resources that could be shared across disciplinary constituents to support common needs, such as statistics or imaging capabilities, and foster joint work.

Further, leaders with multidisciplinary expertise tended to place more emphasis on comprehensive or balanced participation. One leader with multidisciplinary expertise stated, “We do translational research from basic to community to population health and policy, we do training and we have clinical services.” Such statements, made over the span of a 60-minute meeting, emphasize to members that each perspective and approach to the team’s problem is necessary and valuable. If a conversation appeared to be favoring the interests of a single discipline over others, leaders with multidisciplinary expertise would often pause the conversation and interject words of caution. One leader warned, “Be careful. There’s nothing left for [basic] research from what I’m hearing.” Additionally, if a particular member possessed knowledge that was relevant to the research topic, these leaders made an effort to include that member’s input, regardless of the discipline from which the contribution originated.

In contrast, conversation in teams with leaders without multidisciplinary expertise focused almost exclusively on one area of research, with minimal effort exerted to include other relevant sets of expertise. For instance, one clinical researcher who had attended several meetings of an interdisciplinary team led by a leader with unidisciplinary training shared,

> From the meetings that I’ve been to, I think the focus may be more basic science, certainly initially. If there would be a component that related to clinical stuff, we could work together. My answer would be that from my part, from [our clinic] the work would be seamless.

This quote suggests that some team members perceive a lack of opportunity to include all types of disciplinary approaches in the problem construction process, despite the ease and potential benefits that could arise from such collaboration.

Does Leader Integrative Capability Foster Knowledge Integration and Innovation?

Knowledge integration and innovativeness tended to be higher in teams led by leaders with high multidisciplinary expertise. For example, the following is an excerpt from a team's final proposal that demonstrates both the formulation of an integrative problem and a novel approach to solving it:

> This project will focus on [drug treatment mechanisms 1 and 2] in [this disease] and will span the basic science [how exactly the treatment is having its effect], clinical neuroscience and neuroimaging [effect on neurons, synapses, and receptors], pharmacological and behavioral therapies [examine role of certain transporters and the expression of behaviors in adolescent mice] to clinical adoption spectrum [aim to get drug for use in people].

Another leader with multidisciplinary expertise shared an additional example of a team leveraging multiple disciplinary sets of expertise as a product of their collaborative efforts:

> We're interested in the clinical manifestation of [this type of disease], and so they had been working mostly in the lab, with peripheral blood, and we were trying to develop a project where we examine some of the things they looked at in peripheral blood in cells. With the radiology groups, they're trying to develop sophisticated imaging techniques to look at heterogeneity of this process in [the organ we are looking at], and they're trying to correlate that to develop standards for sort of physiologic principles. So they do a lot of modeling with the physiologists, and we brought them patients—normal patients, asthma patients with varying degrees of severity—to sort of try to test and see if their models are working. We're connecting on various sorts of . . . on all levels, really.

Table 4 provides juxtaposition of our qualitative analysis with the ratings of the five teams from the expert panel who assessed team proposals. Consistent with findings of our quantitative analysis, interdisciplinary teams possessing leaders with multidisciplinary expertise tended to develop more innovative knowledge outputs. As judged by the external committee of expert raters, teams with leaders with multidisciplinary expertise had high average scores on both integration ($M = 5.25$) and innovation ($M = 5.49$; 7-point Likert scale). In contrast, those teams led by a person without multidisciplinary expertise were judged to have lower average ratings of both integration (M = 3.38) and innovation (M = 3.6). Study 2 yields insight into specific leader behaviors that are associated with this difference in performance.

<< Insert Table 4 here >>

General Discussion

Our results suggest that leaders with multidisciplinary expertise have a more developed integrative capability and are better able to guide interdisciplinary science teams in the production of innovative and integrative knowledge products. Teams with leaders possessing work experiences in both clinical practice and basic research created research proposals and work plans that integrated the multiple disciplinary perspectives represented in their team more clearly and effectively than did teams led by individuals without this diverse experience. The quantitative mediation analysis in Study 1 provides evidence that the positive relationship between a leader with multidisciplinary expertise and team innovativeness may be driven by the goal commitment of team members. Leaders with multidisciplinary expertise may be able to yield novel team outputs because of their ability to encourage team members from different disciplines to feel committed to and willing to work on their team's shared research problem.

Study 2 offered a deeper understanding of how leaders with multidisciplinary expertise see themselves and their role in an interdisciplinary research team, as well as specific ways in which they foster commitment from diverse team members. This qualitative comparative case analysis revealed that leaders with multidisciplinary expertise engaged in problem framing and construction differently than leaders with experience in only a single domain. Analysis of team meetings revealed that leaders with multidisciplinary expertise more often emphasized breadth and depth of the research problem simultaneously. These leaders were more likely to explicitly clarify the purpose of the team's research endeavor and encourage members to work collaboratively across disciplines to solve a common problem. Teams with leaders trained in a single disciplinary domain focused on specific aspects of the problem and often struggled to involve disciplinarily diverse team members in the problem construction process. When these leaders emphasized breadth, the problem construction process evolved in an unclear and vague fashion.

Theoretical Implications

This research advances understanding of how leaders can foster innovative outcomes in teams that are diverse, and extends it into the context of interdisciplinary collaboration. The results suggest that individuals who have experience working across multiple disciplinary domains are better equipped to foster innovative outcomes in interdisciplinary teams. Leaders with multidisciplinary expertise are able to integrate the interests and efforts of team members from multiple disciplines by facilitating the formation of shared team goals that appeal to the interests of all team members, regardless of their professional background. Interdisciplinary team leaders with this integrative capability are able to appeal to the interests of multiple team members through the careful crafting of a common research problem that is simultaneously inclusive enough to be engaging for each team member (breadth) and has sufficient operational specificity (depth) to allow team members to directly contribute to a team's processes and outcomes, regardless of the discipline in which a member was trained.

Literature on leadership frequently discusses ways in which a leader can effectively promote the integration of subordinates' actions through problem construction (e.g., Nygren & Levine, 1996; Reiter-Palman & Illies, 2004; Zaccaro et al., 2002). Using a comparative case analysis, we advance understanding of this topic by revealing some of the processes leaders can use to facilitate goal-setting and problem construction processes in teams seeking to solve complex questions. Our findings suggest that when defining team problems and deciding how to approach them, leaders with multidisciplinary expertise facilitated inclusion of diverse team members while simultaneously narrowly confining the purpose and problem space. This led to the construction of problems that fostered commitment from team members and increased their willingness to draw upon their varied knowledge, skills, and resources when developing plans to approach the interdisciplinary team's shared research question. The outcome of such reciprocal exchange (Balakrishnan et al., 2011) between team members helped teams tap into their integrative capacity (Salazar et al., 2012) and produce more innovative research proposals.

Previous research has demonstrated that the intrapersonal functional heterogeneity of individuals could have implications for managerial (Campion, Cheraskin, & Stevens, 1994; Hitt & Tyler, 1991) as well as team outcomes (Bunderson & Sutcliffe, 2002). Building upon these findings, the results from the current research suggest that leaders with intrapersonal heterogeneity in the form of multidisciplinary expertise affect the internal dynamics of a team and its performance, even when controlling for the multidisciplinary expertise of team members. This finding suggests that multidisciplinary expertise of a leader may be of particular importance in teams where knowledge integration is essential for the generation of solutions and new ideas. These leaders may be better attuned to the characteristics and behaviors of members, and can help determine what is expected and acceptable in cross-disciplinary team interactions.

Interviews with leaders with multidisciplinary expertise suggest that these leaders do perceive their role as flexible, or as a bridge between distinct work groups. They also tend to have a concept of how diverse sets of disciplinary expertise are related to and can complement one another. Our research illustrates how leaders may leverage their own unique boundary-spanning role across disciplinary knowledge silos, and how they are able to use their heightened understanding of the disciplines represented in the team to help team members identify problem spaces that would be fruitful, collectively motivating avenues for investigation. This research, therefore, reinforces results from recent work exploring the important internal boundary-spanning activities, including relational aspects of building trust and caring for others, that leaders of interdisciplinary teams do both inside and outside of the team (Benoliel & Somech, 2014). Findings from this study suggest that the integrating behaviors of leaders may help to generate additional internal relational processes in teams that help enhance their effectiveness.

Future Directions and Practical Implications

First, we encourage further research regarding the training and development of investigators in science, specifically with respect to the impact of educational programs seeking to teach interdisciplinary or translational approaches to scientific research. It is possible that extensive training and educational experiences in multiple disciplinary domains and areas of practice may foster the development of leader integrative capability, as well as other skills that can advance scientific discovery at the intersection of fields. Additionally, the utilization of communication behaviors oriented toward the goal of problem construction identified in this study can also provide actionable role-based team training and instruction that can enhance team performance (Salas, DiazGranados, Weaver, & King, 2008). In summary, this research adds to the call for evidence-based recommendations for how to best foster solutions to complex social and medical problems when doing so requires integrating perspectives of diverse experts.

Limitations

Although this study makes a variety of contributions to our understanding of the relationship between leader characteristics and behavior and the performance of interdisciplinary science teams, it is also important to acknowledge the limitations of the research. This study was conducted in a single organization undergoing an organizational intervention to foster the use of interdisciplinary research teams to promote knowledge creation. Because we situated our study in a single organization and sampled only those professionals who chose to participate, many factors about the context are held constant. These include reward systems, organizational culture, and interest in joining an interdisciplinary team, among others. Although the decision to focus our study on teams embedded in the same organization enabled us to limit variation in the organizational context as well as obtain an assessment of each team's innovativeness from a committee of world-renowned experts, the capacity for generalization to other teams of the same type in other organizations is limited. Also, we were only able to capture a single-item measure of innovativeness, although it should be noted that the expert raters were uniquely trained to discern the novelty of knowledge products produced by the teams both for the purposes of evaluating the proposal and as a direct consequence of their deep immersion in their areas of practice (Sawyer, 2012).

Finally, the teams in our study were working together for only a brief period of time while engaged in a single specific task, and the presence, consistency, and duration of potential effects of interdisciplinary team leaders with multidisciplinary expertise may be more or less notable in teams engaged in different tasks over a longer period of collaboration. Such inferences cannot be discerned from the current studies. We do believe, however, that findings from this study could generalize to many other professional project-based organizations where teams work together for only months at time (Huckman, Staats, & Upton, 2009; Nembhard & Edmondson, 2006). We encourage future research to explore the influence of leaders with multidisciplinary expertise on interdisciplinary team innovativeness, using a longitudinal approach in order to fully understand the boundary conditions of leader influence.

Conclusion

This research reveals important insights concerning how leaders can promote innovation and the advancement of scientific knowledge in teams that draw together experts from two or more distinct disciplines. Specifically, we find that some leaders are able to actively develop the capacity of interdisciplinary science teams to integrate and generate new knowledge, while others fail to do so. Insights from this work have many practical implications for how to best prepare and train team leaders to bridge the gaps of understanding between team members in interdisciplinary contexts—by fostering the development of goals that enhance goal commitment from diverse team members due to their explicit breadth and depth. Well-constructed research aims can have a positive impact on team performance, and the importance of having leaders with a range of relevant professional experience in these teams is apparent. This is particularly the case when task performance involves high cognitive interdependence and deep-level knowledge integration. By using the insights from this research about how leaders with multidisciplinary expertise can make team processes such as problem construction more effective, we believe it is possible to enhance the innovative potential of disciplinarily diverse science teams.

REFERENCES

Aiken, L. S., & West S. G. (1991). *Multiple regression: Testing and interpreting interactions.* Thousand Oaks, CA: SAGE.

Agar, M. (1980). *The professional stranger: An informal introduction to ethnography.* New York, NY: Academic Press.

Amabile, T. M. (1998). How to kill creativity. *Harvard Business Review, 76,* 76–87.

Balakrishnan, A. D., Kiesler, S., Cummings, J. N., & Zadeh, R. (2011). Research team integration: What it is and why it matters. In *CSCW '11: Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work* (pp. 523–532). New York, NY: ACM.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51,* 1173.

Benoliel, P., & Somech, A. (2014). The role of leader boundary activities in enhancing interdisciplinary team effectiveness. *Small Group Research, 46,* 83–124.

Blackler, F. (1995). Knowledge, knowledge work and organizations: An overview and interpretation. *Organization Studies, 16,* 1021–1046.

Blau, P. M. (1977). *Inequality and heterogeneity: A primitive theory of social structure*. New York, NY: Free Press.

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. K. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations* (pp. 349–381). San Francisco, CA: Jossey-Bass.

Borenstein, S. (2014, November 2). Firey failures raise questions about private sector rocket science. *Global News.* Retrieved from http://globalnews.ca/news/1649295/fiery-failures-raise-questions-about-private-sector-rocket-science

Bunderson, J. S., & Sutcliffe, K. M. (2002). Comparing alternative conceptualizations of functional diversity in management teams: Process and performance effects. *Academy of Management Journal, 45,* 875–893.

Butler, A. B., & Scherer, L. L. (1997). The effects of elicitation aids, knowledge, and problem content on option quantity and quality. *Organizational Behavior and Human Decision Processes, 72,* 184–202.

Campion, M. A., Cheraskin, L., & Stevens, M. J. (1994). Career-related antecedents and outcomes of job rotation. *Academy of Management Journal, 37,* 1518–1542.

Conger, J. A., & Kanungo, R. N. (1987). Toward a behavioral theory of charismatic leadership in organizational settings. *Academy of Management Review, 12,* 637–647.

Cooke, N. J., & Hilton, M. L. (Eds.). (2015). *Enhancing the effectiveness of team science.* Washington, DC: National Academies Press.

Coskun, H., Paulus, P. B., Brown, V., & Sherwood, J. J. (2000). Cognitive stimulation and problem presentation in idea generation groups. *Group Dynamics: Theory, Research, and Practice, 4,* 307–329.

Cronin, M. A., & Weingart, L. R. (2007). Representational gaps, information processing, and conflict in functionally diverse teams. *Academy of Management Review, 32,* 761–773.

Cummings, J. N., & Kiesler, S. (2005). Collaborative research across disciplinary and organizational boundaries. *Social Studies of Science, 35,* 703–722.

Cummings, J. N., Kiesler, S., Zadeh, R. B., & Balakrishnan, A. D. (2013). Group heterogeneity increases the risks of large group size: A longitudinal study of productivity in research groups. *Psychological Science, 24,* 880–890.

Dahlin, K. B., Weingart, L. R., & Hinds, P. J. (2005). Team diversity and information use. *Academy of Management Journal, 48,* 1107–1123.

Derry, S. J., Schunn, C. D., & Gernsbacher, M. A. (Eds.). (2014). *Interdisciplinary collaboration: An emerging cognitive science*. New York, NY: Psychology Press.

Duncan, S. (1972). Some signals and rules for taking speaking turns in conversations. *Journal of Personality and Social Psychology, 23,* 283.

Eigenbrode, S. D., O'Rourke, M., & Wulfhorst, J. D. (2007). Employing philosophical dialogue in collaborative science. *Bioscience, 57,* 55–64.

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2001). Participant observation and fieldnotes. In P. Atkinson, A. Coffey, S. Delamont, J. Lofland, & L. Lofland (Eds.), *Handbook of ethnography* (pp. 352–368). London, England: Sage.

Fiore, S. M. (2008). Interdisciplinarity as teamwork: How the science of teams can inform team science. *Small Group Research, 39,* 251–277.

Fleishman, E. A., Mumford, M. D., Zaccaro, S. J., Levin, K. Y., Korotkin, A. L., & Hein, M. B. (1991).Taxonomic efforts in the description of leader behavior: a synthesis and functional interpretation. *Leadership Quarterly, 2,* 245–287.

Gaertner, L., & Schopler, J. (1998). Perceived ingroup entitativity and intergroup bias: An interconnection of self and others. *European Journal of Social Psychology, 28,* 963–980.

Galinsky, A. D., & Moskowitz, G. B. (2000). Perspective-taking: Decreasing stereotype expression, stereotype accessibility, and in-group favoritism. *Journal of Personality and Social Psychology, 78,* 708–724.

Gardner, H. (1994). The patterns of creation. *Helix, 3*(2), 36–43.

Gardner, H., Gino, F., & Staats, B. (2011). Dynamically integrating knowledge in teams: Transforming resources into performance. *Academy of Management Journal, 55,* 998–1022.

Gibson, C., & Vermeulen, F. (2003). A healthy divide: Subgroups as a stimulus for team learning behavior. *Administrative Science Quarterly, 48,* 202–239.

Glaser, B. S., & Strauss, A. A. (1967). *The discovery of grounded theory.* New York, NY: Aldine DeGruyter.

Grant, A. M., & Berry, J. W. (2011). The necessity of others is the mother of invention: Intrinsic and prosocial motivations, perspective taking, and creativity. *Academy of Management Journal, 54,* 73–96.

Guimera, R., Uzzi, B., Spiro, J., & Amaral, L. A. N. (2005). Team assembly mechanisms determine collaboration network structure and team performance. *Science, 308*(5722), 697–702.

Haslam, S. A., & Platow, M. J. (2001). The link between leadership and followership: How affirming social identity translates vision into action. *Personality and Social Psychology Bulletin, 27,* 1469–1479.

Haslam, S. A., Wegge, J., & Postmes, T. (2009). Are we on a learning curve or a treadmill? The benefits of participative group goal setting become apparent as tasks become increasingly challenging over time. *European Journal of Social Psychology, 39,* 430–446.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.

Hitt, M. A., & Tyler, B. B. (1991). Strategic decision models: Integrating different perspectives. *Strategic Management Journal, 12,* 327–351.

Hoever, I. J., van Knippenberg, D., van Ginkel, W. P., & Barkema, H. G. (2012). Fostering team creativity: Perspective taking as key to unlocking diversity's potential. *Journal of Applied Psychology, 97,* 982–996.

Hollenbeck, J. R., Klein, H. J., O'Leary, A. M., & Wright, P. M. (1989). Investigation of the construct validity of a self-report measure of goal commitment. *Journal of Applied Psychology, 74,* 951–956.

Huckman, R. S., Staats, B. R., & Upton, D. M. (2009). Team familiarity, role experience, and performance: Evidence from Indian software services. *Management Science, 55,* 85–100.

Journet, D. (1993). Interdisciplinary discourse and "boundary rhetoric": The case of SE Jelliffe. *Written Communication, 10,* 510–541.

Kane, A. A., Argote, L., & Levine, J. M. (2005). Knowledge transfer between groups via personnel rotation: Effects of social identity and knowledge quality. *Organizational Behavior and Human Decision Processes, 96,* 56–71.

Kerr, N. L., & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology, 55,* 623–655.

Klein, J. T. (1996). *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities.* Charlottesville, VA: University of Virginia Press.

Kotha, R., George, G., & Srikanth, K. (2013). Bridging the mutual knowledge gap: Coordination and the commercialization of university science. *Academy of Management Journal, 56,* 498–524.

Lincoln, Y. S., & Guba, E. G. (2002). Judging the quality of case study reports. In A. M. Huberman & M. B. Miles (Eds.), *The qualitative researcher's companion* (pp. 205–215). Thousand Oaks, CA: Sage.

Litchfield, R. C. (2008). Brainstorming reconsidered: A goal-based view. *Academy of Management Review, 33,* 649–668.

Locke, E. A., Latham, G. P., & Erez, M. (1988). The determinants of goal commitment. *Academy of Management Review, 13,* 23–39.

Lotrecchiano, G. R. (2013). A dynamical approach toward understanding mechanisms of team science: Change, kinship, tension, and heritage in a transdisciplinary team. *Clinical and Translational Science, 6,* 267–278.

Lovelace, K., Shapiro, D. L., & Weingart, L. R. (2001). Maximizing cross-functional new product teams' innovativeness and constraint adherence: A conflict communications perspective. *Academy of Management Journal, 44,* 779–793.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39,* 99–128.

Mannix, E., & Neale, M. A. (2005). What differences make a difference? The promise and reality of diverse teams in organizations. *Psychological Science in the Public Interest, 6*(2), 31–55.

Mannix, E. A., Neale, M. A., & Goncalo, J. A. (Eds.). (2009). *Creativity in groups*. Bingley, England: Emerald.

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review, 26,* 356–376.

Mumford, M. D., Mobley, M. I., Reiter-Palmon, R., Uhlman, C. E., & Doares, L. M. (1991). Process analytic models of creative capacities. *Creativity Research Journal, 4,* 91–122.

National Center for Advancing Translational Studies. (2015). *About the CTSA program.* Retrieved from http://www.ncats.nih.gov/ctsa/about

National Human Genome Research Institute. (2014). *All about the Human Genome Project (HGP).* Retrieved from http://www.genome.gov/10001772

Nembhard, I. M., & Edmondson, A. C. (2006). Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. *Journal of Organizational Behavior, 27,* 941–966.

Nijstad, B. A., & Stroebe, W. (2006). How the group affects the mind: A cognitive model of idea generation in groups. *Personality and Social Psychology Review, 10,* 186–213.

Nygren, R. E., & Levine, E. L. (1996). Leadership of work teams: Factors influencing team outcomes. In M. M. Beyerlein, D. A. Johnson, & S. T. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams* (Vol. 3, pp. 67–104). Greenwich, CT: JAI Press.

Okhuysen, G. A., & Eisenhardt, K. M. (2002). Integrating knowledge in groups: How formal interventions enable flexibility. *Organization Science, 13,* 370–386.

Okuda, S. M., Runco, M. A., & Berger, D. E. (1991). Creativity and the finding and solving of real-world problems. *Journal of Psychoeducational Assessment, 9,* 45–53.

Ospina, S., & Foldy, E. (2010). Building bridges from the margins: The work of leadership in social change organizations. *Leadership Quarterly, 21,* 292–307.

Parker, G. M. (2003). *Cross-functional teams: Working with allies, enemies, and other strangers*. John Wiley & Sons.

Parker, S. E., Atkins, P. W. B., & Axtell, C. M. (2008). Building better work places through individual perspective taking: A fresh look at a fundamental human process. *International Review of Industrial and Organizational Psychology, 2,* 149–196.

Parker, S. K., & Axtell, C. M. (2001). Seeing another viewpoint: Antecedents and outcomes of employee perspective taking. *Academy of Management Journal, 44,* 1085–1100.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, 36,* 717–731.

Paulus, P. B., & Nijstad, B. A. (Eds.). (2003). *Group creativity: Innovation through collaboration*. New York, NY: Oxford University Press.

Reiter-Palmon, R., & Illies, J. J. (2004). Leadership and creativity: Understanding leadership from a creative problem-solving perspective. *Leadership Quarterly, 15,* 55–77.

Reiter-Palmon, R., Mumford, M. D., & Threlfall, K. V. (1998). Solving everyday problems creatively: The role of problem construction and personality type. *Creativity Research Journal, 11,* 187–197.

Runco, M. A., & Okuda, S. M. (1988). Problem discovery, divergent thinking, and the creative process. *Journal of Youth and Adolescence, 17,* 211–220.

Salas, E., DiazGranados, D., Weaver, S. J., & King, H. (2008). Does team training work? Principles for health care. *Academic Emergency Medicine, 15,* 1002–1009.

Salazar, M. R., Lant, T. K., Fiore, S. M., & Salas, E. (2012). Facilitating innovation in diverse science teams through integrative capacity. *Small Group Research, 43,* 527–558.

Saporito, B. (2013, April 1). The conspiracy to end cancer. *Time, 181*(12), 30–36.

Sawyer, K. (2012). Extending sociocultural theory to group creativity. *Vocations and Learning, 5,* 59–75

Schraw, G., Dunkle, M. E., & Bendixen, L. D. (1995). Cognitive processes in well□defined and ill□defined problem solving. *Applied Cognitive Psychology, 9,* 523–538.

Schulz-Hardt, S., Brodbeck, F. C., Mojzisch, A., Kerschreiter, R., & Frey, D. (2006). Group decision making in hidden profile situations: Dissent as a facilitator for decision quality. *Journal of Personality and Social Psychology, 91,* 1080.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86,* 420–428.

Simonton, D. K. (1984). Creative productivity and age: A mathematical model based on a two-step cognitive process. *Developmental Review, 4,* 77–111.

Smilansky, J. (1984). Problem solving and the quality of invention: An empirical investigation. *Journal of Educational Psychology, 76,* 377.

Smith, D. R., DiTomaso, N., Farris, G. F., & Cordero, R. (2001). Favoritism, bias, and error in performance ratings of scientists and engineers: The effects of power, status, and numbers. *Sex Roles, 45,* 337–358.

Stand Up To Cancer. (n.d.). *SU2C cancer research teams.* Retrieved from https://www.standup2cancer.org/su2c_cancer_research_teams

Stokes, P. D. (1999). Learned variability levels: Implications for creativity. *Creativity Research Journal, 12,* 37–45.

Stokols, D., Hall, K. L., Taylor, B. K., & Moser, R. P. (2008). The science of team science: Overview of the field and introduction to the supplement. *American Journal of Preventive Medicine, 35,* 77–89.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Procedures and techniques for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage.

Taggar, S. (2001). Group composition, creative synergy, and group performance. *Journal of Creative Behavior, 35,* 261–286.

Uleman, J. S., Rhee, E., Bardoliwalla, N., Semin, G., & Toyama, M. (2000). The relational self: Closeness to ingroups depends on who they are, culture, and the type of closeness. *Asian Journal of Social Psychology, 3,* 1–17.

Van Der Vegt, G. S., & Bunderson, J. S. (2005). Learning and performance in multidisciplinary teams: The importance of collective team identification. *Academy of Management Journal, 48,* 532–547.

van Ginkel, W. P., & van Knippenberg, D. (2009). Knowledge about the distribution of information and group decision making: When and why does it work? *Organizational Behavior and Human Decision Processes, 108,* 218–229.

Van Knippenberg, D., & Hogg, M. A. (2004). *Leadership and power: Identity processes in groups and organizations.* Thousand Oaks, CA: Sage.

Weathersby, R. (1993). Sri Lankan managers' leadership conceptualizations as a function of ego development. In J. Demick & P. M. Miller (Eds.), *Development in the workplace* (pp. 67–89). Hillsdale, NJ: Erlbaum.

Weisz, G. (2006). *Divide and conquer: A comparative history of medical specialization*. Oxford, England: Oxford University Press.

Wengraf, T. (2001). *Qualitative research interviewing: Biographic narrative and semi-structured methods*. Thousand Oaks, CA: Sage.

Winter, S. J., & Berente, N. (2012). A commentary on the pluralistic goals, logics of action, and institutional contexts of translational team science. *Translational Behavioral Medicine, 2,* 441–445.

Woolley, A. W., Gerbasi, M. E., Chabris, C. F., Kosslyn, S. M., & Hackman, J. R. (2008). Bringing in the experts: How team composition and collaborative planning jointly shape analytic effectiveness. *Small Group Research, 39,* 352–371.

Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science, 316,* 1036–1039.

Yin, R. K. (2013). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage.

Zaccaro, S. J., Mumford, M. D., Connelly, M. S., Marks, M. A., & Gilbert, J. A. (2000). Leader skill assessment: Measures and methods. *Leadership Quarterly, 11,* 37–64.

Zaccaro, S. J., Rittman, A. L., & Marks, M. A. (2002). Team leadership. *Leadership Quarterly, 12,* 451–483.

Zerhouni, E. (2003). The NIH roadmap. *Science, 302,* 63–72.

Table 1
Bivariate Correlations

	M(*SD*)	1	2	3	4	5	6	7	8	9	10	11
1. Rank Heterogeneity	.58(.17)	1.00										
2. Team Disciplinary Diversity	.67(.17)	−.03	1.00									
3. Team Size	17.16(.14)	.25	.52**	1.00								
4. Proportion of Team Members who have collaborated with PI	.27 (.20)	−.26	−.16	−.41*	1.00							
5. Perceived Interconnectedness to the Group	3.86(.68)	.18	−.19	.15	.07	1.00						
6. Closeness to Group	3.63 (1.36)	.00	−.15	−.07	−.09	.14	1.00					
7. Leader Endowed Chair	.40(.49)	−.23	.12	.07	.27	.24	.04	1.00				
8. Member Multidisciplinary Expertise	.09(.10)	.16	.23	.26	−.24	.10	.34	.02	1.00			
9. Leader Multidisciplinary Expertise	.56(.50)	.11	.39*	.48*	−.24	.13	.27	.35	.41*	1.00		
10. Goal Commitment	4.97 (1.00)	.01	−.05	.20	.02	.61	.07	.30	.32	.45**	1.00	
11. Innovativeness	4.00(.89)	−.28	.10	.33	.21	.11	.00	.43	.18	.48**	.49**	1.00

Note. Pearson pair-wise correlation coefficients, $n = 32$.
** p value < 0.01. * p value < 0.05.

Table 2

Analysis of Mediation Model

***N* = 32**	Goal Commitment		Innovativeness		Innovativeness	
	B	*SE*	B	*SE*	B	*SE*
0. Constant	8.39*	1.49	6.56	2.51	2.13	2.29
1. Team Rank Heterogeneity	−1.06	−1.12	−1.85	.95	−1.28	.72
2. Team Disciplinary Diversity	−19.61*	5.22	−3.92	6.88	6.42	5.32
3. Team Disciplinary Diversity Squared	16.01*	4.88	1.67	5.57	−6.78	4.18
4. Team Size	−.02	.02	.03*	.01	.04*	.01
5. Proportion of Team Members who have collaborated with PI	−.54	.84	.91	.87	1.21	.72
6. Interconnectedness Between Self and Group	.72**	.21	.18	.28	−.57*	.28
7. Closeness to Group	−.10	.13	−.08	.12	−.03	.10
8. Leader Endowed Chair	−.03*	.34	.31	.32	.29	.26
9. Member Multidisciplinary Expertise	2.29	1.67	1.01	1.79	−.19	1.62
10. Leader Multidisciplinary Expertise	.64*	.23	.59*	.28	.26	.22
11. Goal Commitment					.52**	.15
***R*-squared**	.88		.78		.83	
Adj. *R*-squared	.78		.61		.69	
***F*-Statistic**	6.23		2.85		5.21	

** p value < 0.01. * p value < 0.05.

TABLE 3

Examples of Leader Integrative Communication Behaviors

Function	Leader Behaviors	Definition	Example
Focus	Clarifying Goals	**Clarifying** the purpose of the group by emphasizing that the team's efforts should lead to the integration of ideas, methods, and approaches to solve a common problem	• We have to redefine a little bit the kind of translational studies . . . so that it is not a project here, making a project here and a project here, but rather, some projects will go the full length all the way across, others that may break up others and then start in the middle. • It's a collaborative proposal. So there might be people who in here who—I mean it doesn't have to have the whole group, but there might be people within this group who could work together. • So in terms of what I thought was that the business plan, so this proposal is unique as Joe pointed out to me the other day in that it is really disease-focused Center of Excellence and it has got a very rich in central clinical program and then it has got I think also the underpinnings of a lot of terrific science that interfaces with that clinical stuff.
Focus	Confining Problem Space	**Confining** the problem space so that many diverse individuals can contribute to working together meaningfully	• The team worked on developing specific hypotheses for research or on delivering narrow aspects of clinical care.
Breadth	Comprehensive	Promoting **comprehensive** participation by ensuring that diverse experts are equally represented within the team	• We typically do translational research from basic to clinical community to population health and policy. We do training both in clinical training and research training and we have clinical services. • Just because we don't have the representation here, let me just mention one thing. We have done a lot of work in the asthma world, community work. So we have worked with many, many, many, many communities and whether they were [inaudible] asthma groups or the American Lung Association. We do think we need someone involved in here. • So my overall impression at least is that this [research topic] has a lot of potential for funding—especially when you combine these thoughts about the basic mechanisms, the imaging aspects, the neuromonics and other clinical trial experiments.
Breadth	Fostering Connections	**Connecting** interests and ideas of members through prompts and questions and the development of infrastructure	• I would focus on some of this going backward, in terms of, how does this [clinical treatment] really work? What are the mechanisms of the cellular and cell pathology levels? And also what is the variability in response, both at the animal level and human level? • What I thought is that in terms of the research narrative, you have the clinical component, which Joe is going to take care of. And then there is what I would say somewhat more the basic aspects of the disease. And I thought this total set adds up to a solid research program. • But one of the things that really I think could be potentially very exciting is clearly thinking about biomarkers or how can we translate work . . . how can we access that in human side, whether it's in clinical trials or from samples of genetic correlation.

Table 4

Relationship of Leader Integrative Communication Behaviors to Integration and Innovation During a 60-minute Meeting

		Team 1 Selected Finalist	Team 2 Selected Finalist	Team 3	Team 4	Team 5
Demographic Information	**Leader Multidisciplinary Expertise**	Yes	Yes	Yes	No	No
	Team Size	20	18	18	15	26
Integrating Communication Behaviors	**Clarifying Goals**	3	2	0	0	1
	Confining Problem Space	1	1	2	0	0
	Comprehensive	2	4	2	1	0
	Fostering Connections	15	6	9	2	1
	Integrating Communication Behaviors (Total)	21	13	13	3	2
Performance Ratings	**Integrative Goals Rating**	5.68/6	5.01/6	4.88/6	4.43/6	2.33/6
	Innovative Ideas Rating	5.72/6	5.24/6	4.68/6	4.0/6	2.49/6
	Overall Expert Ranking	Rank 1 of 5	Rank 2 of 5	Rank 3 of 5	Rank 4 of 5	Rank 5 of 5

Appendix
Coding Schema for Multidisciplinary Expertise

Using curriculum vitae, points are given for clinical and research experiences. A balanced portfolio (e.g., 4–6 points from each category of experiences) indicates high multidisciplinary expertise.

	Clinical Experience	**Example**	**Yes or No**
1	MD	Degree in Medicine	1 or 0
2	Intern & Residency	In clinical area of practice	1 or 0
3	Clinical Fellowship	In clinical area of practice	1 or 0
4	Licensure & Certification	American Boards, Clinical License	1 or 0
5	5 Years of Practice	Time span from medical school to date	1 or 0
6	Professional Clinical Societies	American Board of Pain Medicine, Anesthesiology, or other clinical specialty	1 or 0
7	Awards–Clinical	Top Doctor, Who's Who	1 or 0
8	Leadership in Clinical Centers	Director of Cancer Center, Parkinson's, Geriatrics	1 or 0

	Research Experience Indicators	**Example**	**Yes or No**
1	PhD	Degree in disciplinary area (Biology, Biochemisty, Pathology)	1 or 0
2	Research Fellow or Postdoc	Participation in research in a lab or center	1 or 0
3	5 Years of Research Experience	Time span from first to last publication	1 or 0
4	Participation in Research-Oriented Boards	Institutional Review Board, NIH/NSF review committees, National Academy of Sciences	1 or 0
5	Peer Reviewed Publications	1st or 2nd authorship evident	1 or 0
6	Research Awards	Albert Einstein Gold Medal; Outstanding Women in Science; Young Investigator Award; Career Scientist	1 or 0
7	Research Support	PI or co-PI on Grants	1 or 0
8	Leadership in Research Lab	Director of their own research lab	1 or 0