ESSAYS ON COLLECTIVE CREATIVE PROBLEM-SOLVING

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General Abstract

Organizations increasingly turn to teams to address their most vexing problems based on their potential to synthesize diverse expertise and devise effective solutions. However, many studies document the ways that teams underperform despite the presence of adequate expertise. Much of this research has described the issues inhibiting teams from capitalizing on their expertise occurring during the processes of seeking or implementing a solution to a problem. However, the way teams formulate the problems that they face may also play an important role in how they leverage internal and external expertise to solve them. In this dissertation, I examine the processes through which teams understand the problems they address and how those processes influence teams' ability to capitalize on their members' expertise, and on the expertise of outside advisors, when solving problems.

"What is the problem?" Chapter 2 presents a quasi-experimental field study of research teams formulating a motivating problem for a grant proposal. I build on the conception of a problem as a gap between a current state and a desired state and manipulate teams' attention to focus on either the problem's current state or desired state. Analyses reveal a recursive, multi-level process where, during problem formulation, individual cognition influences team members' interaction, which influences social norms, which further reinforce individual cognition. Teams that focused on the current state treated problem formulation as a diagnostic process, evaluated ideas thoroughly as they were presented, and formulated problems that accurately addressed the situation's original concern, but that did not capitalize on their members' expertise. In contrast, teams that first focused on the desired state treated problem formulation as a creative process, combining ideas rapidly as they were presented, and formulated problems that both accurately addressed the situation's original concern, and that also drew more extensively on members' expertise.

"How can we leverage internal expertise to understand and solve the problem?" Chapter 3 examines the conditions under which members' expertise benefits team rapid adaptation and presents a multi-method study composed of an inductive qualitative phase and a field experimental phase with improv comedy teams. Observations and interviews suggest that members' trait perspective-taking plays an important role in team rapid adaptation because it allows members to quickly provide opportunities for teammates to succeed based upon their skills and attributes. A subsequent field experiment that manipulated team composition revealed that teams with high perspective-taking members better translated their expertise into performance than teams with low perspective-taking members by developing a higher level of emergent interdependence in their work.

"How can we leverage external expertise to understand and solve the problem?" Chapter 4 examines the role of outside advisors in the tasks of helping people identify and solve problems, with a particular focus on the impact of advisors' expertise and framing on advice content, people's perceptions of the advisor, and their performance. Across three experiments (one field and two lab studies), advisors with expertise in areas other than the domain of the focal task— complementary expertise advisors—were rated as less impactful, less enjoyable to work with, and less competent than advisors with expertise in the focal task's domain—domain expertise advisors. They were also chosen over a domain expertise advisor just 9% of the time. Despite these differences, participants with complementary expertise advisors consistently performed just as well or better than those with domain expertise advisors. These findings highlight people's tendency to avoid and dislike advisors who might identify new problems or

suggest familiar ideas, at the expense of exposure to unique perspectives and, potentially, of creative performance over time.

Chapter 1

Introduction

Consider the following scenario. A team of economists from a climate health organization is attempting to solve the problem of increasing CO^2 emissions, which are harming the environment. Airplanes are large contributors of carbon emissions, so when people purchase air travel tickets, they are given the option to offset their environmental impact by paying a fee. It is up to the team to determine how the money procured from these fees can be used to offset the harm done by the travel, and they are under a strict time limit—if the money raised from these offset fees is not redistributed soon, it will be forfeited back to the airlines. The team is aware that another large contributor to carbon emissions is the use of inefficient wood-burning stoves in rural communities throughout the world, and that providing families with high efficiency stoves could reduce global emissions. The team sees this as an effective solution—use the money from carbon offset fees to purchase high efficiency stoves for families around the world, resulting in net neutral carbon emissions.

Before shipping the idea, they run it by a team of advisors composed of other economists, who draw from their considerable expertise to provide some useful additions to the solution, such as including incentives for families to use their new stoves. They consider seeking advice from a team of anthropologists specializing in the areas of affected families, but given time constraints, decide against it. A year later, the results of the solution are analyzed, and it is revealed that families who received high efficiency stoves are not producing lower carbon emissions. As it turns out, with inefficient stoves, families were burning the minimum amount of wood they could manage to survive. But with high efficiency stoves, they cook more and heat their homes more, resulting in an equal amount of carbon emissions.

In this scenario, the team ended up solving a problem other than the one they set out to solve—they had provided better stoves to families around the world, but they had not reduced carbon emissions. In fact, if a hypothetical traveler were on the fence about traveling by plane, and they went on to purchase a ticket because of the option to "offset" the environmental impact, then the team's solution would actually have net *increased* carbon emissions.

Multiple components of this scenario—the team's attempts to understand the problem at hand, their decisions under time pressure, and their methods of seeking advice—are of great importance in organizational life. In fact, versions of this scenario are increasingly common in modern organizations, due primarily to its following three characteristics: 1) a complex, ill-structured problem, 2) a time-pressured context, and 3) a focal problem-solving unit with access to advisors with varying expertise. And, as the scenario above shows, each aspect presents opportunities to derail solution attempts, often resulting in solutions unaligned to problems.

These characteristics are interconnected in their emergence within organizational life. With constant technological advances, new tools and new ways of organizing have facilitated the pace of the development of new knowledge, along with reducing the time buffers between decision and action (Cunha et al. 1999; De Smet et al. 2020; Kozlowski and Bell 2003; Moorman and Miner 1998; Volberda 1996). With increased computing technology speed and capacity comes greatly increased problem complexity, resulting in everyday organizational problems becoming grander, more complex, and more uncertain, requiring diverse expertise to understand and solve. Because problems are too complex for any individual to address alone, workers trend toward developing expertise in more narrow fields and skills. That is, the "burden of knowledge" (Jones 2009) causes individuals to favor specialization of expertise, increasing the need for and value of experts, both to compose project teams (Argote 2013; Bechky and Okhuysen 2011;

Brown and Eisenhardt 1997; Kozlowski et al. 1999) and to advise those teams (Arendt, Priem, and Ndofor, 2005; Stephan, 2012; Ter Wal, Criscuolo, and Salter, 2020; Wuchty, Jones, and Uzzi, 2007). Beyond impacting the complexity of problems, these global changes have also influenced the speed of organizational life. On top of leading to more complex problems, this accelerated pace of activity has resulted in the increased prevalence of contexts that require quick decision-making and problem-solving (Bechky and Okhuysen 2011; Mannucci et al. 2020; Miner and O'Toole 2020).

Taken together, it is becoming more common for modern organizations to be faced with scenarios like the one described at the beginning of this section. In this dissertation, I address each of these aspects of team problem-solving—problem formulation, rapid adaptation, and incorporation of outside expertise—over the course of three empirical chapters consisting of two qualitative field studies, two field experiments, and two lab experiments.

I begin in Chapter 2 by examining the question of how teams of members with diverse expertise formulate ill-structured problems by conducting a quasi-experimental field study of research teams formulating a motivating problem for a grant proposal. I build on the conception of a problem as a gap between a current state and a desired state and manipulate teams' attention to focus on either the problem's current state—asking, "What is wrong with the present?"—or desired state—asking, "What could be great about the future?" Analyses reveal a recursive, multi-level process where, during problem formulation, individual cognition influences team interaction, which influences social norms, which reinforce individual cognition. Teams that focused on the current state treated problem formulation as a diagnostic process, evaluated ideas thoroughly as they were presented, and formulated problems that accurately addressed the situation's original concern, but that were less well-aligned with their members' expertise. In contrast, teams that first focused on the desired state treated problem formulation as a creative process, combining ideas rapidly as they were presented, and formulated problems that both accurately addressed the situation's original concern, and that were more well-aligned with their members' expertise.

Chapter 3 then examines the conditions under which members' expertise benefits team rapid adaptation in response to changing circumstances in the context of a multi-method field study with improv comedy teams. Observations and interviews in the initial inductive qualitative phase suggest that members' trait perspective-taking plays an important role in team rapid adaptation because it allows members to quickly provide opportunities for teammates to succeed based upon their skills and attributes. A subsequent field experiment that manipulated team composition revealed that teams whose members are high in trait perspective-taking better translated their expertise into performance than teams with low perspective-taking members by developing a higher level of emergent interdependence in their work.

Chapter 4 examines the complementary role of outside advisors in helping teams formulate and solve problems, particularly the impact of advisors' expertise and framing of advice on advice content, people's perceptions of the advisor, and their performance. Across three studies, advisors with expertise in areas other than the domain of the focal task—complementary expertise advisors—were rated as less impactful, less enjoyable to work with, and perceived to have more general expertise but still be less competent than advisors with expertise in the focal task's domain—domain expertise advisors. Complementary expertise advisors were also chosen over a domain expertise adviser just 9% of the time. Despite these differences, participants that chose or were assigned complementary expertise advisors consistently performed just as well or better than those with domain expertise advisors. These findings highlight people's tendency to avoid and dislike advisors who might identify new problems or suggest familiar ideas, at the expense of exposure to unique perspectives and, potentially, of creative performance over time.

Finally, Chapter 5 presents a discussion of the three empirical chapters as a whole to articulate theoretical and practical implications as well as future directions for research on creative problem-solving, particularly in teams.

Chapter 2

What's the Problem? A Qualitative Field Study of How Teams Formulate Ill-Structured Problems

Abstract

Though organizations regularly rely on teams to address problems as a part of their work, many teams underperform despite being composed of members with a high level of relevant expertise. Seeking answers to why this pattern exists, this study examines the role of the way a team defines the problem they are solving in shaping their use of member expertise. In a quasi-experimental field study of research teams formulating a motivating problem for a large grant proposal, I build on the conception of a problem as a gap between a current state and a desired end state, and manipulate teams' attention to focus primarily on either the problem's current state or the desired end state. Teams that first focused on the current state treated problem formulation as a diagnostic process, evaluated ideas thoroughly as they were presented, and formulated problems that accurately addressed the original, motivating concern but that did not draw extensively on their members' expertise. In contrast, teams that first focused on the desired state treated problem formulation as a creative process, combining ideas rapidly as they were presented, and formulated problems that both accurately addressed the original, motivating concern and that drew extensively on their members' expertise. The findings form the basis for a theorized framework of team problem formulation to guide future research.

Organizations increasingly turn to teams to address their most vexing problems based on their potential to synthesize diverse expertise and devise effective solutions (Argote, 2012; Kozlowski and Ilgen, 2006; Reiter-Palmon and Murugavel, 2018). Despite this, many studies document the myriad ways that teams underperform despite the presence of adequate expertise (Cronin and Weingart, 2007; Diehl and Stroebe, 1987; Kozlowski and Bell, 2003; Woolley et al., 2008). Much research has described the issues inhibiting teams from capitalizing on their expertise that occur during the processes of seeking or implementing a solution to a problem (e.g., Coursey et al., 2019; Diehl and Stroebe, 1987; Woolley et al., 2008). However, the stem of many of these behaviors may reside even earlier in the problem-solving process: in how teams formulate the problems that they go on to solve.

Foundationally, a problem exists when there is a gap between a current state (i.e., what is) and a desired state (i.e., what could be; Newell and Simon, 1972). A growing body of research is finding support for the notion that how a problem is formulated has substantial impact on how one approaches solving it, which in turn can influence problem-solving performance (Cromwell, Amabile, and Harvey, 2018; Cronin and Loewenstein, 2018; Harvey and Kou, 2013; Mitroff and Featheringham, 1974; Reiter-Palmon et al., 1997). Though nascent, this literature also suggests that teams in particular often have difficulty effectively leveraging their members' unique expertise when solving problems, in part because of how they understand those problems (Baer et al., 2013; Cronin and Weingart, 2007; Nijstad and De Dreu, 2012; Reiter-Palmon and Murugavel, 2018).

Teams struggle most with effective problem formulation when they face more ill-structured problems in which the parameters of the problem itself are very broad or unknown (e.g., we want to address climate change). In such cases, there are many potential pathways to a solution (e.g., reduce CO^2 emissions, regenerate the ozone layer, pass environmental public policy), providing teams more flexibility in the problem formulation process. This flexibility has the potential both 1) to allow teams to tailor problems to their expertise to facilitate expertise use during problem-solving (e.g., a team of lobbyists can formulate a climate change problem around climate policy) and 2) to cause teams to solve a problem that might address the original concern but does not resolve it (e.g., a team of lobbyists can develop a policy regarding vehicle fuel consumption when the larger concern is the production of cars themselves).

In fact, even in cases where teams face more well-structured problems with clear parameters, they may still need to go through a problem reformulation process in order to develop a shared problem formulation (e.g., when faced with a broken refrigerator cable, a team of family members must decide whether to fix the cable, buy a new fridge, keep the food cold some other way, etc.). The goal of the problem formulation process then is to define the problem's parameters to identify a smaller set of pathways to a solution, and while this process is likely necessary to varying degrees for problems all along the ill-structured-well-structured spectrum, it is most relevant the less structured a problem is. For example, formulating the problem as "without a refrigerator, how do we keep our food cold?" increases the structure of the problem by narrowing the scope of potential solutions to exclude shopping for a new refrigerator.

The ambiguity inherent in problems, particularly ill-structured ones, causes problem-solving teams to differ with regard to whether they focus their attention on the problem's current state (e.g., how do we fix the present? how do we repair the broken refrigerator cable?) or on the desired state (e.g., how do we create the future? how do we create a method of keeping food cold that doesn't require cables?). Because attention influences how people perceive and share information about problems (Dougherty, 1992; Stasser and Titus, 1985; Weingart et al., 2005), the way attention is focused may have a substantial impact on how teams formulate ill-structured problems (Cyert and March, 1963; Greve, 2008). Insights from construal level theory suggest that whether attention is focused on the more proximal current state or the more distal desired state will influence how members think about the situation (i.e., more concretely vs. more abstractly) and interact with each other (i.e., embracing convergence vs. divergence; Lieberman and Trope, 1998). Moreover, this focus of attention may also impact the degree to which a team works to 1) align the problem formulation with its expertise and 2) accurately resolve the situation's original concern. In this way, the focus of attention during problem formulation may also impact how team expertise is leveraged to effectively solve problems.

The current study examines how the focus of teams' attention during problem formulation might systematically produce different collaboration dynamics regarding knowledge sharing and expertise integration. I conducted a quasi-experimental field study with teams of scientists working to formulate problem focus areas for a research center grant proposal. The study manipulated how teams focused attention during the problem formulation process using different sets of prompts to guide discussions, focusing first on either the problem's current state or its desired state. In brief, I find teams that prioritize a problem's current state focus primarily on diagnosing problem elements and more proximal next steps in the present environment. This encourages members to focus more narrowly on evaluating specific ideas, often from within a single expertise domain, which leads teams to develop norms that discourage expansion of ideas that might encourage connections between members' expertise domains. By contrast, teams that prioritize a problem's desired state search more broadly to create novel problem elements from a potential future. This encourages broader cross-domain discussion among members and social norms that encourage expansion beyond and connections between domains. Analysis of the resulting dynamics informs a theoretical model describing the different approaches to collective problem formulation with implications for future research and practice to improve problem-solving in teams.

Theoretical Background

Problems: Ill-Structured to Well-Structured

A problem exists when a gap is identified between a current state (i.e., what is) and a desired state (i.e., what could be; Newell and Simon, 1972). Problems range along a spectrum from ill-structured to well-structured, determined by the specificity of the problem's parameters, its current and desired states. Much problem-solving research has focused on more well-structured problems rather than ill-structured ones—for example, many problem-solving studies present participants with a fully-formed task (Morais-Storz, 2019). In such cases, the potential pathways to arrive at a solution are limited by the bounded structure of the problem. The following is an example of a well-structured problem: a conservation organization identifies a single technological flaw in a tagging-based isopod tracking system (current state) and subsequently asks its research teams to develop a way to remedy this specific bug (desired state). Here, the current and desired states are identified with a high level of specificity, so the number of potential ways to arrive at a solution is relatively strictly bounded.

However, well-structured problems are rare in organizational life compared with more ill-structured problems (Baer et al., 2013; Hinsz et al. 1997; Lyles and Mitroff, 1980; Unsworth, 2001)—those in which the current and desired states are less specified and the number of potential pathways to arrive at a solution is larger due to the less bounded nature of the problem (Getzels and Csikszentmihalyi, 1967; Unsworth, 2001). Moreover, ill-structured problems do not readily conjure specific cognitive elements that might contribute to a solution, and thus especially require a formulation process that defines the problems' parameters and narrows the potential pathways bridging them (Cromwell et al., 2018). The following is an example of an ill-structured problem: a conservation organization asks its research teams to develop methods of reducing the impact of microfibers on animal behavior. Here, neither the current state nor the desired state is identified with a high level of specificity, so the number of potential ways to arrive at a solution is less bounded. For example, what methods should be used to reduce microfibers' impact? And on which animal behavior should the solution impact?

In all but the most well-structured cases, problems need to be formulated by solvers—what varies between problems along the spectrum is the degree to which the problem must be narrowed to allow for solutions to be generated. That is, ill-structured problems require the most formulation, and therefore the most room for error, as described below.

Formulating Ill-Structured Problems: Accuracy and Alignment

Given their prevalence in organizational life and the lack of literature addressing the topic, the literature would benefit most from a heightened focus on the formulation of more ill-structured problems. Problem formulation is defined here as the process of translating a set of contextual symptoms into a definition of a problem. It encompasses the intertwined processes of current state formulation and desired state formulation—the processes of directing attention toward the relevant aspects and boundaries of the inadequate current state and the adequate desired state. There is still much to understand about the processes influencing how current and desired states are interpreted and defined, as the focus of problem-solving research has traditionally been on bridging the gap between these states rather than defining it (Morais-Storz, 2019). Such understanding would greatly benefit problem-solving research as a whole given the sizable impact that the way a problem is formulated can have on how it is solved (Buyukdamgaci, 2003; Ma, 2009; Mumford et al., 1996; Reiter-Palmon, et al., 1998; Reiter-

Palmon, and Murugavel, 2018). In fact, many prolific problem-solvers throughout history have noted the vitality of problem formulation to their work, including Albert Einstein, who is credited with commenting that “the formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill” (p. 92, Einstein and Infeld, 1938).

Because of the ambiguity inherent in more ill-structured problems, a number of potential issues may arise when addressing them. For one, teams may first misidentify the problematic aspects of the current state and subsequently solve a problem that does not resolve the original concern, sometimes referred to as a Type III error (Mitroff and Featheringham, 1974). That is, the problem formulated is not a highly “accurate” problem. For example, when a service team learns that the women of a remote village have to walk many miles in difficult conditions to retrieve water, it might define the current state as a lack of nearby water and the desired state as a well in the village center. In reality, the women enjoyed the difficult walk because they were otherwise not permitted to leave their homes, revealing the actual problem to be different than the team initially believed.

A team might also formulate an “inaccurate” problem by first identifying a desired state and subsequently solving a problem (to arrive at that desired state) that does not resolve the original concern. This sometimes occurs because a team formulates the problem specifically to suit its members’ expertise, which can potentially come at the expense of the problem’s accuracy. For example, if the service team was composed of civil engineers, it might define the desired state as a world where no resident has to leave their home to retrieve clean water. While the team might be equipped to solve this problem, it still would not address the original concern—that the women of this village are not permitted to leave their homes—by doing so.

Therefore, the flexibility of ill-structured problems allows teams to adjust the problem to suit their expertise, potentially at the expense of its accuracy. This same flexibility also sets up the potential for the team to define the problem in a way that its available expertise is inadequate to solve it. That is, the problem formulated is not well "aligned" with the team. For example, in the scenario presented above, even if the service team recognized the issue of women not being permitted to leave their homes beyond the walk to water, it might perceive the current state as a lack of legislature empowering women in the region and the desired state as a passing of such legislature. However, given the team's lack of expertise in public policy, it is ill-equipped to solve such a problem. It might be better equipped to solve a problem centered around improving the conditions of the walk for the women, or creating more opportunities for them to naturally come together. Thus, while the team has defined an "accurate" problem, it has not defined an "aligned" problem that it has the expertise to solve.

These two pitfalls—the team is equipped to solve an inaccurate problem or the team is unequipped to solve an accurate problem—hinder many teams from leveraging their expertise to solve problems in organizations. Therefore, problem formulation becomes especially relevant when considering ill-structured problems because their inherent ambiguity allows the current and desired states to take multiple forms and thus allows for more pathways to solutions. For instance, consider the example of an ill-structured problem presented above: a conservation organization asks its research teams to develop methods of reducing the impact of microfibers on animal behavior. Here, the current state could be formulated as a lack of measurement technology for animal behavior, an ineffective research and development process in textile organizations, a lack of investor understanding for the degree of harm microfibers can cause animals, and so on. Similarly, the desired state could be formulated as a new material for goods that does not release microfibers, a way of tracking single microfibers through their lifecycle, a method of transporting animals out of microfiber-rich environments, and so on.

Because each of these formulations falls at the intersections of different expertise domains, certain teams will be better equipped to solve certain formulations more effectively than others. Therefore, how a team formulates an ill-structured problem can have a sizable impact on how it makes use of its expertise when addressing a problematic situation. The question is, how do teams facing ill-structured problems formulate problems that are both highly accurate (i.e., solving the problem resolves the original concern) and well-aligned (i.e., the team has the expertise to solve the problem)?

Using a Meso Lens to Study the Formulation of Ill-Structured Problems

Answering this question calls for adopting a meso (i.e., multi-level) lens because expertise is possessed at the individual level but applied at the team level. Some prior research has examined problem formulation at the individual level, such as Reiter-Palmon and colleagues (1997) who examined the impact of individual problem construction ability on solution creativity (e.g., Basadur and Basadur, 2011; Csikszentmihalyi and Getzels, 1971; Reiter-Palmon et al., 1997). Other work has taken a team-level approach, including Baer and colleague's (2013) examination of the microfoundations of problem formulation strategy (e.g., Baer et al., 2013; Choo, 2014; Volkema, 2009), with recent work calling specifically for even more research on problem formulation as a collective process (Morais-Storz, 2019; Reiter-Palmon and Murugavel, 2018). Still other research has examined problem formulation processes at multiple levels, such as Lyles and Mitroff (1980) who studied the processes by which managers specifically and organizations more broadly become aware of and define problems (e.g., Lyles and Mitroff, 1980; MacDuffie, 1997).

Each of these works have contributed to a valuable foundation of understanding of problem formulation in organizations at varying levels of analysis, and the work that has examined cross-level influences is particularly important. A necessary next step is to expand this work to further explicate the interaction of problem formulation processes across levels of analysis. This could be done by adopting a meso lens that examines how individual-level factors like cognition and expertise influence and are influenced by team-level factors like interaction patterns and performance outcomes (Hackman, 2003; Rousseau and House, 1994). How problems and solutions are conceived and interact is complex (Cohen et al., 1972), and team members' cognitive representations of a problem may both influence and be influenced by the interaction patterns of the team (Cronin and Weingart, 2007; Feldman, 1984; Jacobs and Campbell, 1961; Postmes et al., 2001; Sherif, 1936). Because of this bidirectional process, a meso approach to studying how expertise is synthesized during team problem formulation is crucial to constructing a fuller picture of the phenomenon.

Focusing Attention During Problem Formulation

Using a meso lens, I aim to answer the question of how a team's primary focus on an ill-structured problem's current state versus its desired state might influence how the team formulates the problem. Teams may focus primarily on identifying the current state of things, noting which problematic characteristics the present context has, or on identifying a desired state of things, imagining which beneficial characteristics the future context could have. Focusing primarily on one state versus the other is likely to influence how members think about the problem formulation process, how they interact when undertaking it, and how well they are equipped to solve the problems they eventually define. However, the precise influence of these opposing focuses on team interaction and integration of expertise is unclear—prior research suggests that a focus on either state could influence team problem formulation in distinct ways with diverging outcomes, beneficial and detrimental.

Current-State Focus: Beneficial or Detrimental?

At the individual level, focusing attention on a problem's current state may lead team members to adopt a diagnostic (vs. creative) approach to problem formulation. This focus involves noting what wrongly exists in the present or what is lacking there and leads to a consideration of immediate next steps—"What is wrong with this situation?", "What don't we have?", "What do we do first?". This results in a close examination of the situation with the goal of diagnosing its issues. I draw on construal level theory (CLT) to found this argument. CLT holds that temporal distance influences mental representation, such that temporally closer events are perceived in more concrete terms, resulting in a greater focus on incidental details of ideas than on their essential components (Liberman and Trope, 1998; Trope and Liberman, 2003). To the team formulating the problem, the current state is temporally proximal compared to the desired state. In fact, a key finding of CLT research is that individuals place more value on information that is congruent with their level of construal (Liberman and Trope, 1998; Zhao and Xie, 2011); therefore, members of teams focusing on identifying the current state may think more concretely about their ideas and discuss information more rooted in knowledge (e.g., "What *is*?") than in imagination (e.g., "What *could be*?"). That is, they may observe or recall what they know is true about the current state of being and diagnose what is wrong or incomplete about it based upon that knowledge.

Then, at the team level, a focus on a problem's current state could have varying influences on how teams interact during problem formulation and on how accurate and aligned the formulated problem is. For one, thinking concretely about information rooted in knowledge about the current state could facilitate the formation of a clear starting point converged upon by all team members (Marks, Sabella, and Burke, 2002; Mathieu et al., 2000). Discussion of facts based upon shared knowledge, something at which teams tend to be quite good (Brodbeck et al., 2007; Larson et al., 1996; Stasser, 1999), could ensure the team holds a mutual understanding of the current state. Members could subsequently generate ideas regarding the formulation of the desired state while grounded in a consensus formulation of the current state, ensuring members remain on the same page (Cronin and Weingart, 2007; Cropley, 2006; Kohn, Paulus, and Choi, 2011; Harvey, 2013). Such discussion may manifest in interdependent interactions as new ideas for the desired state are evaluated based on how well they ameliorate the current state (Harvey and Kou, 2013).

However, members of teams focusing on the present state may differ in their perceptions of that current state, inhibiting the establishment of a common ground. People's perceptions of stimuli differ based on a variety of factors, including norms, values, culture, personality, and importantly, expertise (Bargh and Ferguson, 2000; Chi, Feltovich, and Glaser, 1981; Cramton, 2001; Hofstede, 1980; Rokeach, 1979; Simon, 1979; Williams and O'Reilly, 1998). Therefore, a team's attempt to focus on shared information about the current state of being may be difficult (Cronin and Weingart, 2007); a focus on the proximal current state could actually inhibit the formation of a shared starting point because concrete thinking provides limited flexibility to find commonalities between members' perceptions of the state (Trope and Liberman, 2003). That is, focusing on incidental details of ideas rather than their essential components, as outlined by CLT, may hurt teams' abilities to find overlap between ideas as members perceive information through their unique lenses (Hayes and Simon, 1974; Kruger, 1999; Trope and Liberman, 2003). This could subsequently inhibit knowledge combination, limiting the production of creative ideas (Cronin et al., 2011; Paulus, 2000; Taylor and Greve, 2006). Instead, teams may diverge along formulations of the current state as representational gaps drive wedges in understanding between members (Cronin and Weingart, 2007). Subsequently generating ideas regarding the formulation of the desired state without having achieved consensus on the current state could exacerbate these gaps, as one member's desired state may not ameliorate another member's current state. This lack of consensus would likely inhibit the synthesis of the team's expertise into the ultimate formulation of the problem, as the team may need to prioritize certain members' perspectives at the expense of others' (Baron, 1988).

In addition, a focus on the current state may ground members' cognition and the team's discussion in both the present's inadequacies and the immediate next steps to alleviate those inadequacies. This proximal focus of attention to a linear step-by-step process may cause teams to escalate commitment to a plan of action in solving the problem that does not maximize the accuracy or alignment of the problem formulation. For example, if a service team diagnoses the present inadequacy as the women of a village needing to walk to retrieve water, they may quickly decide to find ways of alleviating the need for a walk as a next step, thereby missing the idea that the walk itself might not be the true concern.

Desired-State Focus: Beneficial or Detrimental?

In contrast, focusing on a problem's desired state at the individual level may lead team members to adopt a more creative (vs. diagnostic) approach to problem formulation. Identifying visions of a desired context involves noting not what wrongly exists in the present, but envisioning what could exist in the future—"What could be?"—and results in an imaginative consideration of potential futures. Drawing again on CLT, temporal distance influences mental representation such that temporally further events are perceived in more abstract terms, resulting in a greater focus on essential components of ideas than on their incidental details (Liberman and Trope, 1998; Trope and Liberman, 2003). To the team formulating the problem, the desired state is temporally distal compared to the present. Therefore, members of teams focusing on identifying the desired state may think more abstractly and discuss information more rooted in imagination (e.g., "What *could be*?") than in knowledge (e.g., "What *is*?"). That is, they may draw from expertise in domains beyond the current context and create a new future based upon that expertise. Once the desired state is determined, teams may subsequently define the current state as the issue prohibiting the realization of that desired state.

At the team level, a focus on a problem's future state could have varying influences on how teams interact during problem formulation and on how accurate and aligned the formulated problem is. For one, thinking abstractly could facilitate connections between ideas generated by members with expertise in distinct domains. If teams focus on ideas' essential components rather than their incidental details, they may be better able to synthesize ideas during problem formulation such that the collective expertise of the team is represented in the eventual formulation of the problem (Trope and Liberman, 2003; Weingart et al., 2005). The use of an abstract lens could facilitate cognitive processes such as accommodating others' ideas by adjusting one's framework for interpreting the environment (Fiske and Linville, 1980), which can help eliminate representational gaps without sacrificing the innovative combinations of diverse expertise (Cronin et al., 2011; Cronin and Weingart, 2007). That is, team members may notice the compatibility of their and others' diverse ideas, resulting in a problem formulation that strives for a desired outcome that is achievable given the expertise available to the team.

However, finding the connections between ideas may be difficult when team members are generating ideas rooted in unique expertise. Expertise influences how individuals think and communicate (Bargh and Ferguson, 2000; Chi, Feltovich, and Glaser, 1981; Simon, 1979), so a team composed of unique members brainstorming without a shared foundation—such as an agreed-upon current state—may suffer from communication issues and representational gaps (Cronin and Weingart, 2007; Cropley, 2006; Kohn, Paulus, and Choi, 2011; Harvey, 2013; Marks et al., 2002; Mathieu et al., 2000). That is, members may end up "speaking different languages" as a result of their expertise. Moreover, the abstract thinking resulting from focusing on a distal desired state could inhibit teams from distilling their ideas down into a focused problem statement (Trope and Liberman, 2003). Without much consideration for the incidental details of ideas, teams may remain at too high a level to formulate an actionable problem that members agree on. Discussions may manifest in confusing interactions as members explain their ideas at abstract levels that make it difficult for their teammates, who do not possess the same expertise and thus do not "speak the same language," to understand and contribute to (Baron, 1988).

Summary

Overall, it appears that a focus on a situation's current state or on its desired state during problem formulation has the potential to result in diverging effects on individual cognition, team interaction, and the accuracy and alignment of a team's formulated problems. Understanding these effects should help shed light on how teams formulate ill-structured problems and start the process of generating suggestions for structuring team problem formulation discussions in practice. Given that the extant literature does not clearly support hypothesized predictions, an exploratory approach was taken to this research.

Method

Research Setting

Study design, data collection, and data analysis, all detailed here to enhance replicability (Aguinis, Hill, and Bailey, 2019; Tong, Sainsbury, and Craig, 2007), were modeled after established qualitative processes in the social sciences (e.g., Cook and Campbell, 1979;

Eisenhardt, 1989; 2021; Pistrang and Barker, 2012; Strauss and Corbin, 1990). Specifically, I employed a quasi-experimental study design wherein teams are placed into conditions based upon theoretically important dimensions (Cook and Campbell, 1979; Eisenhardt, 1989). These dimensions—whether a team's initial focus was on the current state or the desired state—facilitated the identification of boundary conditions of the observed phenomena and the construction of new theory on team dynamics within those boundaries. The data was collected via participant observation, transcription of team meetings, and acquisition of team-generated documents. It was analyzed using open, axial, and theoretical coding techniques, with certain coding procedures being done in conjunction with a research assistant. Additional study materials (e.g., communications, data, analysis) may be found online at: https://osf.io/5qhza/?view_only=b888895be4804d6c85090a7d82f1c3f7.

In order to understand how teams formulate ill-structured problems, data were collected from a context where teams are explicitly tasked with formulating an ill-structured problem (Eisenhardt, 1989): a workshop intended to formulate the motivating problem for a multi-million-dollar engineering research center grant proposal. The workshop was hosted to address the first stage of the grant application process, which required a preliminary proposal outlining what problem the team proposes to address and, subsequently, what knowledge and technology is needed to address it. It was scheduled approximately six months from the first grant proposal deadline so that there was sufficient time to develop ideas into a formal proposal.

The workshop placed a minimal set of guidelines on participating teams. Grant application requirements were open-ended in nature, broadly requiring proposals to identify a critical societal problem and propose research topics within the general realm of engineering that hold promise in solving that problem. In addition, while teams had freedom to formulate their problems however they chose, the organizers of the workshop presented a number of relevant topics at the onset, as they were interested in developing proposals focused on identifying critical societal problems that can be addressed using autonomous technologies. Therefore, teams were very loosely constrained by the workshop's structure such that they were granted a high degree of flexibility within a broad set of boundaries.

Given that neither the current state nor the desired state of the problem were explicitly formulated for teams this context can be characterized as an ill-structured problem (Simon, 1973). This characterization, along with the loose structure imposed by workshop organizers, is evidenced by wording used in the workshop's invitation that was sent to potential participants, which indicates the motivation to formulate significant problems but does not clearly identify the specific parameters of those problems. This wording also emphasizes a focus on teamwork in pursuing its goals:

> We want to identify critical societal problems that can be addressed using autonomous technologies, and identify interesting testbeds for research. We also want to identify the fundamental knowledge gaps and science advances, technological barriers, and testing that can achieve our vision. Another goal is to help us begin to work as a team.

The workshop presented a rare opportunity to study problem formulation in a natural setting, both because defining a problem was the group's focal objective, a rarity in organizational work where problem formulation and problem solving are often interwoven processes, and because the considerable value of the research grant meant teams were highly motivated to formulate problems effectively. These contextual aspects make this setting "particularly suitable for illuminating and extending relationships and logic" among constructs related to problem formulation (p. 27; Eisenhardt and Graebner, 2007), and help this study provide insights that hope to spur future deductive and quantitative research.

Participants

Twenty-eight researchers (32 percent female) representing four universities across the United States participated in the workshop, making up four teams ranging from five to eight members. Each team's membership included at least one woman with at least two universities represented. Team composition is detailed in Table 1, including information on gender, university affiliation, and primary expertise for each member. The workshop was organized and hosted by one institution in the Mid-Atlantic United States, and at least one administrative person from this university was present in all teams to facilitate discussions and ensure the video-conferencing technology functioned properly. While all participants had expertise in the broad discipline of engineering, there was much variance in expertise within the field—research specialties included environmental sustainability, automated transportation, organizational theory, artificial intelligence, data privacy, and many more.

Procedure

Approximately a week prior to the workshop, participants completed an individual survey asking them to provide consent for the research and to state their engineering research expertise. These self-reported domains of expertise were supplemented by research information gathered from participants' Google Scholar profiles. The workshop took place over two days using a web-based video conferencing software. The first day was dedicated generally to providing participants an overview of the task at hand and to engaging in initial discussions of the grant application requirements.

To structure the second day of the workshop, a quasi-experimental design was employed (Cook and Campbell, 1979; Keppel and Wickens, 2004). Participants were semi-randomly assigned to one of four teams and met for one hour, each with the task of formulating a problem to be addressed in the grant proposal. Participant assignment was characterized as semi-random because the workshop organizers assigned teams such that diversity of expertise and university affiliation would be approximately even across teams. While this was not truly random assignment, teams were composed so as to increase diversity, theoretically reducing the number of potential confounding variables at play in this design (Cook and Campbell, 1979; Keppel and Wickens, 2004).

Teams' documents, observers' notes, and discussion transcripts from team meetings were gathered during data collection. While interacting, team members typed notes and suggestions on a working document that updated in real time. These documents provided important data supplemental to the qualitative data, as it codified the ideas that reached consensus during team discussion. In addition, I sat in on portions of each team's meeting and took detailed notes of team dynamics, expression of ideas, and so on. This was done in order to capture any spur-of-the-moment observations or questions that could subsequently be examined using the codified data. All four team meetings were audio and video recorded and transcribed.

Intervention

Teams' problem formulation discussions were manipulated such that they focused first on either the problem's current state or its desired state. The intervention was implemented at the outset of each team's meeting on the workshop's second day. Half of the teams received a set of prompts emphasizing the current state and the other half received a set of prompts emphasizing the desired state. The delivery of the intervention is derived from research indicating that how teams launch their interactions can have great influence on how they operate and perform (Ericksen and Dyer, 2004; Hackman and Wageman, 2005; Marks, Zaccaro, and Mathieu, 2000; Mathieu and Rapp, 2009). Prompting teams to focus first on either the problem's current state or its desired state causes those states to be salient in members' minds, and salient topics have been shown to influence individual cognition and team interaction (Bargh and Gollwitzer, 1994; Trope and Liberman, 2003; Weingarten et al., 2016; Woolley, 2009).

In the current-state focus condition, teams were initially asked to discuss the first focal problem that must be addressed—“What do we do first?” This initial prompt nudged teams to focus first and foremost on the situation’s current inadequacy and immediate next steps by identifying what are the most pressing concerns of the present and promoting a temporally proximal level of construal (Trope and Liberman, 2003). Teams were subsequently asked to discuss the pathway of steps following from that first problem—“Where do we go from there?”—and the ultimate goal of the proposal—“Where do we end up?” By leading with consideration of the current state and immediate next steps, the subsequent prompts were designed to be interpreted in relation to the present context. All teams used the clearly marked spaces on their shared documents to input responses to the prompts.

In the desired-state focus condition, teams were initially asked to discuss the ultimate goal of the proposal—“Where do we end up?” This initial prompt nudged teams to focus first and foremost on the situation’s desired outcome by identifying what are the imagined realities of the future and promoting a temporally distal level of construal (Trope and Liberman, 2003). Teams were subsequently asked to discuss the pathway of steps leading to that ultimate goal—“How do we get there?”—and the first focal problem that must be addressed—“What do we do first?” By leading with consideration of the desired state, the subsequent prompts were designed to be interpreted in relation to the future context. Again, all teams used the clearly marked spaces on their shared documents to input responses to the prompts.

Data Analysis

To facilitate data analysis, I took steps to familiarize myself with the research setting well prior to when the workshop occurred. In addition to attending the workshop totaling six hours across two days, I attended multiple meetings between various workshop organizers and participants totaling approximately 13 hours. These included both lab group meetings in which participating researchers presented original research and strategic meetings discussing workshop attendees and planning workshop logistics. These experiences were beneficial because they familiarized the overarching goals of the project, the topics of focus for the participating researchers, and, broadly, the field of engineering. This provided an appreciation of the field's directions, the extant gaps in knowledge and technology, and the language used to express these ideas, which helped me grasp ideas and connections that members presented and facilitated qualitative analysis. At the same time, my outside perspective helped when I needed to view team discussion content on an abstract level. Data analysis included examination of audio recordings and transcriptions of each team meeting along with each team's working document and the author's first-hand observations. Transcripts totaled 44 pages containing 24,072 words. The analytical process proceeded in three general phases, with certain aspects done in conjunction with a research assistant to bolster validity of the analysis.

First Phase of Analysis

First, two initial passes through the transcripts of all four teams were conducted, noting any broad patterns that became evident using open coding techniques. These passes were supplemented with viewings of team videos while reading transcripts to gather less-codifiable information such as pauses, tone, and laughter. Following these passes, short memos were written that synthesized intuitions from the passes with notes taken during the workshop itself and observations made during the read-throughs (Strauss and Corbin, 1967). This high-level examination illuminated differences between teams with regard to both speaking patterns and discussion content, including the frequency and duration of speaking turns, the scope of knowledge domains considered during discussion, and the degree to which teams focused on combining ideas or evaluating them.

Second Phase of Analysis

Given these emergent themes, I conducted a second phase of analysis composed of axial coding, which involves linking a dataset's categories to broader themes and constructs (Strauss and Corbin, 1998). This analysis advanced the pursuit of three goals: to link the categories revealed in phase one to broader constructs, to develop measures of those constructs in this research context, and to capture any variance in these measures between conditions (Eisenhardt, 1989). This was done by analyzing transcripts using systematic line-by-line coding of the data while simultaneously referencing relevant literature on group processes, expertise integration, and problem formulation (Cook and Campbell, 1979; Eisenhardt, 1989; Strauss and Corbin, 1998).

This process resulted in identification of the following key constructs, along with appropriate methods of measuring them in this context: relevant knowledge breadth, which is the breadth of knowledge that a team considered relevant to the problem formulation discussion at a given time; problem-expertise match, which is the degree to which a team worked to construct the problem based upon its members' expertise; and idea combination versus idea evaluation, which is the degree to which teams favored combining ideas as they were presented to generate new ideas versus thoroughly evaluating the unique ideas as they were presented. In this way, the development of relevant constructs and their measures was an iterative process in which emergent themes from the data were matched to definitions of constructs drawn from the literature, which were used to guide the generation of valid measures specific to this context, which were subsequently compared against extant research on the topic to ensure validity.

Measuring relevant knowledge breadth. To measure the breadth of knowledge considered relevant by each team, a descriptive coding analysis was conducted by breaking down speaking turns into their main ideas, motivations, and characteristics (Miles and Huberman, 1994; Ritchie and Spencer, 1994; Strauss and Corbin, 1990). I then identified whether or not statements incorporated knowledge from domains adjacent to that of the present discussion—specifically, I read each statement, and coded "1" if it actively incorporated or welcomed knowledge from adjacent domains, otherwise "0." For example, one statement that would be coded as indicating a high breadth of knowledge considered relevant is: "What would be...the state of the art right now in terms of the technical features that need to be had?...That would help me ground how to think about social equity stuff." Here, the speaker actively worked to broaden the discussion beyond the current focus—technical development—to include an adjacent domain—social equity—thereby considering a wider range of domains relevant to the problem.

Measuring problem alignment. To measure the ways in which teams integrated available expertise into the formulation of problems, statements were identified regarding whether or not they drove the problem toward the collective expertise of the team. Statements that referenced the speaker's or a teammate's research or domain of knowledge were checked against the individual's stated expertise, and if accurate, were coded "1" (high in expertise integration), otherwise "0." For example, one member stated: "From the infrastructure perspective, I think we need smart materials that can react to the users' preferences." This was coded as high expertise integration because it worked to drive the problem toward the expertise of the team by referencing expertise held by the speaking member, smart city infrastructures. In addition, if an individual posed a question regarding the expertise of a teammate, it was coded whether or not that teammate responded to the question. For example, one team member asked: “How do we get (Member 5’s) idea of energy poverty...is that part of this?” Because Member 5 then responded to this call for input, this was coded as high expertise integration.

The degree to which expertise was integrated into teams’ problem formulation was also measured by analyzing written problem statements. All teams noted their ideas in real time on a shared document under headings associated with each of the intervention’s prompts. Because teams’ responses to the desired state prompt—“Where do we end up?”—included their ideas about the ultimate goal of the project, these responses represented how they perceived the broad problem that the research center would strive to solve. That is, this prompt’s answer represented the culmination of the workshop. In some cases, teams produced multiple responses to this prompt—these responses were merged to produce a single problem statement by extracting and combining primary themes. To ensure validity of these problem statements, this process was completed independently by the author and a research assistant, with both researchers arriving at nearly identical final statements.

To measure problem-expertise match, these statements were coded regarding the degree to which they integrated team expertise. A descriptive coding analysis was utilized to break down each problem statement into parts corresponding to different research areas. It was then determined whether or not each research area matched the expertise of at least one member of that team. For example, if a team with expertise in a) efficient energy, b) drone technology, and c) delivery systems had generated a problem statement reading: “We need a a) fuel efficient b) drone c) delivery system that is d) equitable for everyone,” the team would have been assigned a 1.25:1 problem-expertise match because it possessed expertise in three of the four categories mentioned in its problem statement. This coding process also included totaling the number of categories mentioned in the problem statement that the team did not have expertise in. This helped to distinguish between, for example, a statement that included three categories represented on the team and one category unrepresented, and another statement that included three categories represented on the team and five unrepresented categories.

Measuring idea combination vs. idea evaluation. A different measurement process was necessary to measure the degree to which teams favored combining unique ideas as they were presented to generate new ideas versus thoroughly evaluating the unique ideas as they were presented. This need was a result of idea evaluation rarely taking the form of explicitly critiquing ideas posed by teammates. Rather, teams varied fundamentally in how ideas were treated once they were shared. Some teams dedicated time and space to the presentation of each idea and, once all ideas were presented, selected those deemed high quality to be incorporated into the problem statement—this displayed an emphasis on idea evaluation. Other teams worked to elaborate and evolve each idea as it was presented without much time for presentation or evaluation of any individual ideas, and eventually arrived at a problem statement—this displayed an emphasis on idea combination.

Therefore, a team's emphasis on evaluation versus combination was measured by observing the way members presented their unique ideas and the subsequent discussion (or lack thereof) around them. For example, a team whose discussion consisted of members delivering fewer, longer, and more detailed explanations of their ideas would be characterized as displaying a stronger emphasis on idea evaluation because the ideas were provided ample space to be explained in full and compared with existing ideas. In contrast, a team whose discussion consisted of members delivering more, shorter, and less detailed explanations would be characterized as displaying a stronger emphasis on idea combination because ideas were built upon and elaborated by teammates.

Textual analysis. An even more granular analysis was then conducted to examine team conversational dynamics in greater depth with the goal of understanding how cognitive and social processes were working in conjunction during team problem formulation. This analysis took two forms: manually tracing the inception and evolution of individual ideas through discussions (Satterstrom et al., 2020; Weingart, 1997) and examining speaking patterns (e.g., speaking turns, speaking distribution) and language usage (e.g., questions posed) using LIWC textual analysis software (Tausczik and Pennebaker, 2010). This also included coding the knowledge domains used in problem statements and the number of times those categories were mentioned throughout team discussions (see Appendix A).

Third Phase of Analysis

In the final phase of data analysis, theoretical coding, I drew from the data to develop a theoretical framework explaining the observed differences between conditions. This process involved moving between reviewing the data, consulting the literature, drawing process models, and writing memos until a coherent framework was developed that explained how the way teams integrate expertise into the formulation of ill-structured problems varies depending on the focus of its attention on the problem's current or desired state.

Following the completion of these coding procedures for each team, cross-team analysis was conducted (Ericksen and Dyer, 2004; Miles and Huberman, 1994). This involved comparing the qualitative descriptions, coded discussions, and textual analyses—first within-condition and then between-condition—to identify key similarities and differences. These analyses yielded thematic consistencies within conditions and inconsistencies between conditions, as detailed in subsequent sections. These data patterns provided a substantial basis for a multi-level framework of expertise integration during team formulation of ill-structured problems to be derived.

Discussion of Results

Results are presented by condition, beginning with teams that focused attention first on the current state of the problem followed by those that focused on the future state. The evidence presented here is primarily qualitative and steeped in context and nuance, so the results are discussed in this section in more depth than in a traditional results section to facilitate presentation of the data.

Current-State Focus Teams

Textual Analysis

I report on textual analysis first, before continuing to content analysis. Textual analysis results are presented in Table 2. Current-state focus team discussions were characterized by one member speaking for an extended period of time while others listened. This was evidenced by stark differences in the average number of words used per speaking turn and in the variance of words per turn across experimental conditions. To calculate these measures, each speaking turn (i.e., from when one member began speaking until when another member began speaking) was separated into a distinct segment. The number of words were totaled for each speaking turn, revealing that current-state focus teams used nearly double the amount of words per turn as desired-state focus teams (mean turn length: 100.21 words vs. 51.99 words; both current-state teams had longer average turn lengths than both desired-state focus teams). In addition, current-state focus teams took far fewer speaking turns of fewer than 100 words than desired-state focus teams (88 turns vs. 192 turns) and more speaking turns of greater than 400 words (9 turns vs. 1 turn). This suggests that individual members of current-state focus teams tended to exhaust or at least speak at length on a given topic rather than having multiple members iterate rapidly on that topic.

Concrete Thinking and Limited Knowledge Combination

I then examined the scope of knowledge that teams considered relevant, along with to what degree teams shared their expertise and integrated it into their problem formulation discussions. Much of the behavior of current-state focus teams appeared to stem from a tendency to employ concrete thinking when formulating the problem, likely a result of the proximal construal brought on by focusing on the problem's current state during problem formulation.

Narrow discussion scopes. When a discussion centered around a topic outside of their expertise, members of current-state focus teams tended to behave in one of two ways: 1) contribute on the established discussion topic without connecting their own expertise, or 2) remain silent until the topic changed. Regarding the first behavior, members in many cases explicitly stated that they were speaking from outside of their expertise. For example, members stated, "So I don't work directly on this, but this may be a pathway..." "I know that there is this automated demand response that there are mechanisms to enable this, but I'm not sure how well this is integrated with the current technology..." and "I do not know how 'Alexa' gets data. That is not my purview..." That is, many of these speakers explicitly offered the caveat that they were operating outside of their expertise when they contributed to team discussions, and this was confirmed by cross-checking their reported expertise areas.

What might have promoted this hesitancy to broaden a discussion's scope? The tendency to stay focused on a single discussion topic may have been the result of members trying to avoid tangents that might distract team members from thoroughly evaluating ideas as they were presented. Keeping discussion scopes narrow allowed ideas to receive the full attention of the team, likely facilitating the evaluation of their worth. Additionally, because ideas resulting from the combination of adjacent knowledge domains would likely be highly novel (Miron-Spektor and Beenen, 2015), another influence may have come from apprehension regarding how these novel ideas would be evaluated by the team (Henchy and Glass, 1968; Mueller et al., 2012). Members might have been hesitant to share newly-formed ideas resulting from combining ideas on the spot, as this could lead to poor evaluations from teammates that were experts in one of the knowledge domains (Sanbonmatsu et al. 1992; Yates et al. 1978). Moreover, given the focus on the problem's current state, which is perceived to be rooted in first-hand experience and spurs concrete thinking, creativity is less likely to be valued highly in these teams. Therefore, anticipation of social evaluation facilitated by a focus on the current state may have nudged current-state focus team members to avoid contributing ideas that referenced multiple domains. In fact, research has found that even in contexts where creativity is explicitly stated as highly valued, people tend to display biases against highly novel ideas and sometimes against those who posed them (Mueller et al. 2012; Sanbonmatsu et al. 1992).

Extended silences. The other common behavior of members lacking expertise in a discussion topic was to remain silent, as evidenced by further textual analysis. To map discussions over time, each team's transcript was divided into quarters based on words spoken. For each team, the number of times at least one member spoke zero times in a quarter was totaled—considerably more members of current-state focus teams spoke zero times in at least two quarters than members of desired-state focus teams. In fact, over half of current-state focus team members remained silent for at least half of the team's entire meeting, twice as much as desired-state focus team members (54 percent vs. 27 percent). As one example, a member of a current-state focus team spoke three times in the first quarter of their team's discussion, and then did not speak again. A member of the other current-state focus team spoke twice in the first quarter, once in the second, and then not again.

Together, current-state focus team members' hesitancy to bridge knowledge domains and extended silences suggest that they tended to prioritize a discussion's focal topic, and so as a result they spoke primarily when it was "their turn" (i.e., when they possessed expertise). If a conversation centered around a domain outside of their expertise, members either remained silent or contributed ideas on that topic without connecting their own expertise. Both of these behaviors suggest that these teams considered a limited scope of knowledge relevant within any given discussion. If an idea was adjacent to the focal topic of discussion, it was unlikely to be voiced, thereby favoring a focused discussion that allowed experts to contribute without interruption. As members developed understanding of when speaking up was or was not appropriate (Detert and Edmondson, 2011), these interaction patterns likely crystallized into social norms that prioritized lending discussion space to a single topic (Cialdini and Trost, 1998; Feldman, 1984).

Unanswered calls for expertise. An additional behavior that appeared to limit the combination of ideas and integration of expertise during problem formulation involved the frequency of unanswered questions. In a handful of cases, members of current-state focus teams attempted to combine knowledge by providing opportunities for teammates to link their expertise to the current discussion. They did this by calling for team input on a specific topic or directly asking a teammate for their thoughts. However, few of these opportunities were taken, as teammates appeared hesitant to lead a discussion on a tangent, preferring to focus intently on a single topic at a time. The following exchange between three members, displayed in Figure 1a, stands as an example:

> *Member 1*: This is more on the hardware… like smart meters and the control algorithms that you will develop. So, I think (Member 2), that's kind of your area of research…I have no idea how you can make building occupants feel comfortable with giving up control.
> *Member 2*: Hopefully, (Member 3) does.
> *Member 1*: And then how do you aggregate individual decisions? I don't know if you can build agent-based models or use utility functions, maybe, to integrate functions. And so that requires building utility functions for individual decision makers…
> …
> *Member 3, on a new topic*: So, I mean, one question immediately that comes up is, how do we do all this and clearly lots of information sharing is needed…

In this example, Member 1 made a point about smart grids and control algorithms, calling on Member 2 to speak on their expertise. They also mentioned occupant comfort, identifying a gap in their knowledge. Member 2, who did indeed have expertise in smart grids, did not answer Member 1's call. They did call on Member 3 to address the knowledge gap identified by Member 1, albeit in a fairly indirect way that did not necessitate an immediate response. After a brief silence, Member 1 then continued on to conclude their point. This was followed by a short, overarching note on the discussion's effectiveness by Member 2, and then Member 3 introduced a new topic altogether. In this example, though two calls for teammates to contribute expertise to the discussion were put forth, the recipients of those calls did not volunteer information in response. While this dynamic resulted in Member 1 having the floor to articulate their thoughts in full, it did not allow teammates to build upon those ideas by contributing their own perspectives. These interaction patterns facilitated few connections built across domains, resulting in novel ideas being presented but then existing primarily in isolation without elaboration from teammates.

The limited instances when a member did respond to a call for iteration or elaboration came when a member directly asked a teammate for their input. In one of the examples of this behavior, a member whose expertise was in data privacy was not contributing while the discussion was focused on a problem in a domain other than data privacy. Melding data privacy into the current conversation could have facilitated knowledge combination, and may have driven the problem toward the team's collective expertise—that is, it may have facilitated the formulation of a problem residing at the nexus of data privacy and the other members' expertise domains. This member's silence was eventually pointed out by another member, who may have recognized that the first member may be able to contribute their expertise to the conversation: "(Member 4), you've been quiet on this one..." Member 4 then contributed, drawing from their expertise in data privacy. This interaction may have been crucial to the formulation of the problem, as data privacy was eventually included in the team's problem statement.

These examples suggest that current-state focus teams required explicit requests for input in order to offer knowledge that lay adjacent to the conversation's domain. This may well have been both because members were not considering outside domains relevant during discussions and because social norms had been established that discouraged the incorporation of adjacent knowledge into discussions—outside ideas were unlikely to be generated and even less likely to be shared. What were instead prioritized were focused conversations that centered around topics presented by single team members.

Such a dynamic appears to pose issues to teams as they formulate ill-structured problems. These issues become more evident when the behaviors discussed thus far are considered in tandem. Say Member 1 has expertise in drone technology and Member 2 has expertise in equitable energy use. Member 1 begins a point about how to ensure drone delivery systems reach the maximum number of customers. They might recognize that expertise on inequity could be useful here, but, anticipating that Member 2 will discuss inequity when it is their turn, Member 1 does not mention the topic when they have the floor. They feel doing so would be redundant or step on Member 2's toes, since Member 2 is the expert, not Member 1. Meanwhile, Member 2 might also recognize the potential connection while listening, but does not contribute because they feel that doing so might take the discussion in a direction other than the one Member 1 had in mind and inhibit the team from thoroughly evaluating Member 1's idea. Over time, this dynamic would reduce combinations of knowledge across domains and inhibit highly creative problem formulations, potentially at the expense of integrating members' expertise into problem formulations.

Proposition of, but not combination of, new ideas. In contrast to a tendency to only contribute to ongoing discussions when possessing expertise, when a member was the one to launch a discussion on a new topic altogether, they tended to push outside of their expertise, citing the need to avoid redundancy with other members. For example, one member stated, "I tried to be complementary toward what others might write already..." while another said, "I tried to think a little bit beyond technology because many of the things will be covered by others in our group…" A key element of these statements is the anticipation of redundancy rather than the actual recognition of it. Current-state focus teams may have created an issue such that if everyone tries to be complementary to everyone else, the members' actual expertise may not actually be discussed.

Interestingly, the tendency to avoid redundancy might, at first glance, suggest that current-state focus teams valued unique ideas and therefore considered a broader scope of knowledge and displayed enhanced knowledge combination. For instance, this behavior is actually in contrast to classic studies that highlight the detriments of teams' tendencies to discuss shared information (e.g., Stasser and Titus, 1985). However, in the absence of the parallel tendency to incorporate adjacent knowledge domains into ongoing discussions, the disparate ideas can exist in isolation and are less likely to be combined into novel ideas. Therefore, while current-state focus team members pushed beyond their expertise at times to propose new ideas, they tended not to do so once an idea was proposed.

Therefore, these four behaviors common in current-state focus teams appeared to result in a narrow scope of knowledge considered relevant to any given discussion, limited knowledge combination, and limited integration of members' expertise into the formulations of problems: 1) contributing within the knowledge domain of the current discussion without incorporating one's own adjacent expertise, 2) remaining silent when not an expert in the current discussion topic, 3) rarely responding to calls for expertise, and 4) actively pushing outside of one's expertise in anticipation of being redundant with others' ideas when starting a new discussion.

Concrete Thinking and Thorough Idea Evaluation

Despite many of these behaviors appearing detrimental to effective formulation of ill-structured problems, current-state focus teams may have simultaneously reaped benefits from their interactive dynamics in the form of thorough evaluation of ideas. Problem-solving research suggests that team convergence upon certain ideas deemed worthy of further elaboration is often necessary for ideas to be developed and eventually implemented (Cropley, 2006; Kohn, Paulus, and Choi, 2011; Harvey, 2013). While the diagnostic discussions of current-state focus teams were not conducive to sparking creativity, they did facilitate the thorough evaluation of each idea such that ideas that accurately addressed the original, motivating concern were converged upon (Egeth 1967; Harvey and Kou, 2013; Mueller and Harvey, 2021; Rietzschel et al., 2010). This may have resulted in problem formulations that, while not positioned at the intersection of members' expertise, were accurate in diagnosing concerns with the present situation.

This was likely the case because the concrete thinking spurred by a proximal construal of the problem's current state and the resulting interaction patterns ensured that members were provided space to explain their ideas in full. Importantly, the topics of discussion in this study's context were complex, and members were drawing from decades of nuanced research in their arguments—that is, many of the ideas being shared were likely difficult to articulate concisely without glossing over crucial components. Therefore, it may have been useful for members to have the floor for extended periods of time to convey ideas effectively and build credibility for them such that their quality could be properly evaluated by the team (Harvey and Kou, 2013; Mueller and Harvey, 2021; Sanbonmatsu et al. 1992; Yates et al. 1978). Recall that current-state focus teams displayed far longer speaking turns than future-state focused teams (mean speaking turn length: 100.21 words vs. 51.99 words; turns of fewer than 100 words: 88 vs. 192; turns of greater than 400 words: 9 vs. 1). For instance, in the detailed example provided in the above section, because Member 2 did not speak at length in response to Member 1's initial call, Member 1 was able to continue on and reach the conclusion of their point. It could be that, as a result, the team as a whole was now able to effectively evaluate whether the points raised by Member 1 were accurate in diagnosing a concern of the current state to be used in the team's formulation of the problem. Had the team been given only an abstract summary of a complex idea, it would have far less information to base an evaluation upon.

Final Problem Statements

The lack of knowledge combination between members, while providing space for the effective evaluation of ideas, appeared to result in reduced integration of expertise into team problem statements. Difficulty in fully integrating expertise into team performance is not unusual in teams, as one of the biggest challenges of team coordination is producing a team product that leverages its members' abilities synergistically (Larson, 2013). A more common outcome is that the team's output reflects the ideas or expertise of only a subset of its members—perhaps the most expert but also perhaps the loudest, most persuasive, or most prototypical (Mayo, Woolley, and Chow, 2020). Importantly, this does not necessarily mean that the team performs objectively poorly, only that it may have not fully capitalized on its available resources.

Analysis of problem statements, shown in Table 3, revealed that current-state focus teams did not completely match their problem formulations to their collective expertise. In fact, only one current-state focus team generated a problem statement at all, while the other team was not able to generate a final statement due to time constraints. In it, the team referenced six research domains, which were discussed with varying frequency through the team's meeting: transportation (mentioned 12 times during team discussion), efficiency/sustainability (mentioned 19 times), economics (mentioned 2 times), data ethics/inequity (mentioned 7 times), public health (mentioned 10 times), and privacy (mentioned 16 times). Four out of the six research domains—transportation, efficiency/sustainability, data ethics/inequity, and privacy—were represented by team members' expertise, indicating a 1.5:1 problem-expertise match. This breakdown was reflected in the discrepancy in mentions between domains in which the team had expertise (mentioned 13.5 times during discussion on average) and those in which it did not (mentioned only 6 times on average). Therefore, this team was set to address a problem that covered a wide range of domains that included those in which it did not have expertise.

Interestingly, despite a more focused discussion that included extended time dedicated to specific topics, this team produced a problem statement that covered a broad scope of areas, more than any other team in either condition. Because current-state focus teams tended to discuss ideas in isolation from each other rather than emphasizing idea combination, attempts to focus discussion on single topics in this context may have counterintuitively produced a broader problem. This team appeared to incorporate all ideas deemed relevant to the original concern—

that is, it generated a highly accurate problem—regardless of whether or not their members' held expertise in those areas—that is, it generated only a moderately aligned problem.

Desired-State Focus Teams

Textual Analysis

Turning next to analyzing desired-state focus teams, textual analysis revealed that these teams tended to display more conversational interaction, more evenly distributed speaking patterns, and to ask more questions than current-state focus teams. Desired-state focus teams took more total speaking turns than current-state focus teams (224 turns vs. 124 turns), took more turns of fewer than 100 words (192 turns vs. 88 turns), and, as discussed above, were less likely than current-state focus teams to be silent for large portions of team discussions. This suggests that desired-state focus teams engaged in more frequent iteration on ideas and displayed highly interactive conversational dynamics. These teams also generated more speaking turns that contained a question than current-state focus teams (35 turns vs. 24 turns)—because questions posed to teammates can stimulate knowledge combination and because desired-state focus teams were likely to respond to questions when they were posed, this further displays the interactive nature of these teams' discussions.

Abstract Thinking and Ample Knowledge Combination

Much of the behavior of desired-state focus teams appeared to stem from a tendency to employ abstract thinking when formulating the problem, likely a result of the distal construal brought on by focusing on the problem's desired state during formulation.

Broad knowledge scopes. In contrast to current-state focus team members, desired-state focus team members often voluntarily connected their expertise to team discussions, even when that expertise domain was adjacent to the discussion topic. Generally, this was done either 1) through a member speaking up to broaden the discussion by including their individual expertise or 2) through a member pulling a teammate into the discussion because of their expertise.

As an example of the former behavior, one member—with expertise in psychology and behavioral science—contributed to a conversation that was focused on a topic adjacent to their expertise—decision-making of smart infrastructure, which includes both the technology behind buildings' adaptations and the information informing those adaptations. After the discussion touched on how smart buildings can make decisions based upon occupant feedback, this member noted:

> The building manager, and owner, is not explicitly represented here…It'd be important to generalize what we're talking about a little bit just to be explicit about…those are the important stakeholders here.

This statement applied insights from behavioral science to the domain of smart infrastructure by considering the perspectives of building managers in how smart buildings make decisions. The speaker, who had been silent in this particular discussion to this point, broadened the discussion by incorporating their expertise. The member followed this statement up by alluding to the importance of bridging adjacent knowledge areas when working in an interdisciplinary team, saying "I think (consideration of multiple stakeholders is) super important because even in engineering versus more social science, we tend to think about things a little bit differently." This sentiment was echoed by another member of a desired-state focus team who explicitly mentioned the need for cross-domain use of expertise, saying, "If we can discover the fundamental knowledge in this domain, then this can also apply to other domains."

The suggestion to "generalize" put forth by the member in the pull quote above along with the encouragement to pursue ideas that apply to multiple domains further indicates that this team worked to keep discussions abstract to encourage incorporation of insights from diverse domains. By generalizing above the specific technology and guiding information involved in smart infrastructure, this team was able to perceive behavioral science as a domain relevant to the discussion, allowing the behavioral science expert to contribute. The benefit of this interaction was immediately acknowledged by a teammate, who commented:

> Yeah, I like this point a lot. We usually oversimplify and we just look at one kind of stakeholder right like all the stuff that I was thinking about is just that there are individuals and then there is a consensus, but that's not right.

In fact, members of both desired-state focus teams mentioned the need to keep discussions abstract—a result of the distal construal level of desired-state focus teams (Trope and Liberman, 2003). One member described the potential detriment of thinking too concretely, noting that their thinking to that point in the discussion had been “on a different level of abstraction, which is maybe too low for our discussion.” Another member appeared to agree, describing their thinking in comparison as “very much more abstract.” A third noted that “when we talk about these systems we're talking about it in the abstract” and that their ideas regarding areas outside of their expertise were “more general in terms of the technical aspects.” And again, the member above noted the importance of generalizing during problem formulation discussions because doing so can reveal important information that might otherwise have been missed while searching among the weeds. These examples illustrate how desired-state focus teams actively worked to discuss ideas at abstract levels. Doing so appeared to allow non-expert members to contribute to discussions by recognizing connections between ideas at the level of essential components and by feeling encouraged to share those novel ideas (Edmondson, 1999; Mueller et al. 2012). Thus, the abstract representation of ideas may have facilitated knowledge combination by resulting in social norms that reduced evaluation apprehension (Henchy and Glass, 1968; Mueller et al. 2012).

In all likelihood, these social norms solidified over time, as evidenced by more instances of ideas that combined knowledge domains emerging from the analysis. In another example of a member broadening a discussion to incorporate their expertise, an expert in smart city infrastructures offered their point of view during a discussion about data collection that was started by a teammate. They first acknowledged the discussion to that point, saying, “I think leveraging the data collection infrastructures that are already out there, similar to what I think (Member 5) mentioned, (is important).” They then contributed their perspective on the topic stemming from their expertise, adding:

> But from the infrastructure perspective, I think we need smart materials that can react to the user preferences. So one of them is (name of a laboratory), which is in (university). They build materials which are intelligent. And also data-driven flexible facilities—facilities that can adapt based on the data that they receive from the sensors.

Similarly, an expert in data ethics and computer science integrated their knowledge of computer science into a discussion immediately following a teammate’s point about maintaining privacy while providing personalized services. They said:

> I saw a computer science problem that is very similar to something that I've been working on lately...to arrive at the consensus configuration based on individual preferences is what we're after here … I'm thinking about how to drive a consensus over individuals preferences, and so ways to get there in my mind are by looking at some insights from Game Theory.

Here, the member recognized a link between the essential components of two ideas from adjacent fields—the issue of providing private personalized service in engineering and a theoretical problem rooted in game theory from computer science—and voiced that combination to the group.

In another example, when the discussion trended toward drone technology and delivery systems, a member with expertise in the sociology of engineering, but not in drone technology, stated, “My background is in social areas and sociology, so I don't know drones.” They went on to make their point regarding the social implications of drone delivery, concluding, “That was my trying to be really granular, at least about the social side of things...I don't know much about the technical side.” Here, the member was able to contribute their expertise to the current discussion by contributing a complementary perspective to the topic, despite it not initially being situated within their expertise. This behavior is in contrast to that observed in current-state focus members, who tended to either contribute outside of their expertise in such situations or simply remove themselves from the conversation. A current-state focus member in this specific scenario may have either drawn from what they did happen to know about drone technology to contribute, or remained silent. Doing so would likely have resulted in a conversation more focused on a single topic (i.e., drone tech), but would not have facilitated the incorporation of knowledge from adjacent domains (i.e., sociology).

Asking questions to broaden knowledge scopes. Other types of comments worked to broaden conversations to include a wider range of domains, such as when members asked questions in areas beyond their expertise so that they could better connect that expertise to the discussion. This behavior had the additional benefit of spurring more interactive discussion, further facilitating knowledge combination. For instance, one member with expertise in sociology asked, “What would be...the state of the art right now in terms of the technical features that need to be had?...That would help me ground how to think about social equity stuff.” Another with expertise in ethics, policy, and cognitive science asked, “As people are talking or otherwise, if you work on the technical problems…if we can throw like, just a two-to-five-word description of what that problem is into the…chat…we might have a list of...the 12 things that would need to be solved on the technical side.”

As evidenced from these examples, efforts to broaden discussions often entailed teams shifting focus from solely on technical aspects to including more behavioral ones. This was not exclusively the case though, such as when one member with expertise in shared mobility connected that expertise to a conversation about public versus private sector control of automated delivery devices. Like the example from the computer science expert, this member recognized the commonalities between ideas and made those commonalities explicit, noting:

> This is a type of problem that I work with in ride sharing systems. So in essence that the systems are not equitable; they are more accessible to people who are better off. By injecting a small amount of subsidies, you can actually make some changes in terms of how people are served on what groups of people are set. So this is a possibility.

Overall, members of desired-state focus teams actively attempted to connect their expertise to all team discussions regardless of topic, resulting in a broader scope of domains considered relevant at a given time. These focus teams' creative discussions (as opposed to current-state teams' diagnostic ones) likely then crystallized into social norms that encouraged sharing novel ideas and asking questions about others' expertise, which helped overcome the evaluation apprehension that often accompanies sharing new ideas (Henchy and Glass, 1968; Mueller et al. 2012; Sanbonmatsu et al. 1992; Yates et al. 1978).

Answered calls for expertise. Beyond expanding the discussion through the contribution of adjacent expertise, desired-state focus team members also worked to broaden discussions by pulling in teammates with expertise indirectly relevant to the focal topic, thereby facilitating the combination of teammates' expertise. For example, one member mentioned energy poverty, which was a teammate's expertise, in an attempt to link it to the conversation that was occurring, saying: "How do we get (Member 6's) idea of energy poverty...is that part of this?" A different member mentioned another teammate who had expertise in machine learning, saying, "I would be curious what (Member 7) thinks about this because I think he had an idea of how to coordinate between subsystems using machine learning…" While current-state focus teams too asked questions of teammates, those teammates did not often respond to such calls. Desired-state focus team members more often responded to both direct and indirect calls for input, seizing the opportunity to combine knowledge.

Similarly, members might defer questions to teammates with expertise in the question's domain, thus working to combine the expert's knowledge with the current idea and increasing the number of members active in a discussion. The following exchange between three members, displayed in Figure 1b, stands as an example of these points:

> *Member 8*: The very first problem I think is in the beginning of the sustainability metrics and selecting viable alternatives. You know, drones exist, robotic electric vehicles exist, all of that's out there. But figuring out which ones make the most sense to pursue is where I'd start.
> *Member 9*: And do you see drones as a way of last mile delivery, or something else?... What is the spatial area that drones can actually cover?
> *Member 8*: So that I'll have to defer to (Member 10). He's done a lot of work in this space. I don't work with flying drones at all.
> *Member 10*: You can get about a four- to six-kilometer range for a package…up to two kilograms.

Here, Member 8 finished a point regarding food delivery systems while mentioning drone technology. Member 9, who did not have direct expertise in drone technology and may have been looking for ways to connect their expertise to the current discussion, followed up on the point with a question about drones. In response, Member 8, who was not an expert in drones, deferred to Member 10, who did have drone technology expertise, thus incorporating a new member into the interaction to share knowledge.

These exchanges explain how desired-state focus teams were able to keep so many members regularly involved in discussions. Because members perceived and often articulated topics abstractly in terms of their essential components, others were better able to recognize connections across knowledge domains (Trope and Liberman, 2003). Voicing these connections either by sharing one's own expertise or by calling in a teammate resulted in more evenly distributed participation in team discussions over time. Moreover, this appeared to facilitate the integration of the team's expertise into the formulation of the problem (Cropley, 2006; Kohn, Paulus, and Choi, 2011; Harvey, 2013).

Abstract Thinking and Limited Idea Evaluation

However, desired-state focus teams could have simultaneously accrued detriments from their interactive dynamics in the form of limited evaluation of ideas. While the discussions of desired-state focus teams sparked creativity and facilitated the integration of members' diverse expertise into problem formulation discussions, they may have come at the expense of diligent idea evaluation (Harvey and Kou, 2013). Current-state focus teams were careful not to interrupt teammates or pull adjacent knowledge domains into discussions so as to ensure ideas received thorough evaluation of quality. Desired-state focus teams did not hold back in such endeavors, thereby limiting the amount of time dedicated to any one idea in terms of both presentation and evaluation. These teams displayed extremely few long speaking turns, suggesting single ideas were not given ample space to be explained in detail. This could potentially cause unqualified ideas to be selected as relevant to the problem. Therefore, although these teams generated creative ideas situated at the intersections of their members' expertise, the ideas that they selected during problem formulation had the potential to be less accurate in addressing the original, motivating concern. However, while such a detriment may have been theoretically possible, there was little evidence of such an effect, as described below.

Final Problem Statements

The two desired-state focus teams referenced four and five research domains respectively in their statements: efficiency/sustainability (mentioned 11 times during team discussion), human-building interaction (mentioned 3 times), smart infrastructure/machine learning (mentioned 5 times), optimization (mentioned 26 times), and data ethics/inequity (mentioned 6 times) in one team; efficiency/sustainability (mentioned 22 times), data ethics/inequity (mentioned 38 times), shared mobility (mentioned 9 times), and transportation/delivery (mentioned 19 times) in the other. In both statements, all knowledge domains were matched to expertise held by at least one member of the team, indicating a 1:1 problem-expertise match.

Interestingly, despite the tendency to include many adjacent knowledge domains in their discussions, both desired-state focus teams produced problem statements that covered fewer areas than either current-state focus team. Desired-state focus teams tended to discuss tangentially related ideas in tandem, and allowing discussions to incorporate multiple topics simultaneously in this context may have counterintuitively produced a more focused problem. Unlike current-state focus teams, these teams incorporated only ideas falling within the realms of their members' expertise—they generated well-aligned problems. Additionally, these ideas appeared to accurately address the original, motivating concern, despite interaction patterns that de-emphasized idea evaluation—they generated highly accurate problems.

Emergent Framework of Team Problem Formulation

When formulating ill-structured problems, teams' focus of attention appears to impact how they interact in conversation, how they share, combine, and evaluate ideas, and how they integrate expertise into problem formulations. In this study, teams that focused on the temporally proximal current state treated problem formulation as a diagnostic process. Their members tended to construe the team discussion concretely, discussing individual ideas thoroughly, and moving sequentially from one knowledge domain to another while displaying limited synthesis of those domains. Eventually, they developed social norms encouraging narrow, highly focused discussions that ensured ideas received thorough evaluation. Members did not interact in ways that facilitated the generation of highly creative ideas borne from combined knowledge domains and suited to teams' expertise. However, their interaction patterns did facilitate the evaluation of individual ideas with regard to their relevance to the original, motivating concern. These processes resulted in final problem statements that were moderately aligned with the team's expertise, but that were highly accurate in addressing the situation's motivating concern (if a statement was generated at all).

In contrast, teams that focused on the temporally distal desired state treated problem formulation as a creative process. Their members tended to construe the team discussion abstractly, discussing ideas in tandem, and considering multiple knowledge domains simultaneously while displaying extensive synthesis of those domains. Eventually, they developed social norms encouraging broad discussions that facilitated the combination of ideas. They interacted in ways that facilitated the generation of highly creative ideas borne from combined knowledge domains and suited to teams' expertise. These patterns resulted in final problem statements that were well-aligned with the teams' expertise. However, because these teams did not focus attention on diagnosing the problem's current state, their interaction patterns did not facilitate the evaluation of individual ideas with regard to their relevance to the original, motivating concern. Interestingly, while the de-emphasis of idea evaluation could have caused these teams' problem statements to be less accurate in addressing the situation's motivating concern, there was little evidence that such a result occurred. This suggests that desired-state focused teams in this context were able to formulate problems that both suited their expertise and addressed the situation's motivating concern. A potential reason for this finding is discussed later.

The patterns observed here shed light on two distinct socio-cognitive processes by which teams integrate expertise while formulating ill-structured problems, depending on which component of the problem they focus their attention. The multi-level framework in Figure 2 depicts how these processes both occur through similar iterative processes leading to different outcomes, drawing upon the idea that cognitive processes can influence social processes, which can influence cognitive processes (Kozlowski and Ilgen, 2006; Reiter-Palmon and Murugavel, 2018; Zuzul and Tripsas, 2020). Specifically, the observed behaviors suggest the presence of an iterative process in which 1) members' perceived level of construal influences individual cognition of the problem formulation process, 2) which influences team interactive patterns such as how knowledge is shared, combined, integrated, and evaluated, 3) which solidify into social norms as the behavior is repeatedly observed by teammates, 4) which reinforce the individual cognition set in motion by the construal of the problem formulation process.

Individual Cognition → Team Interaction

Team members' cognitive processes can greatly influence how a team interacts (Ericksen and Dyer, 2004; Hackman, 2012; Kozlowski and Klein, 2000). So when a team faces a problem, members' perspectives regarding the nature of the problem will affect how the team converses (Cronin and Weingart, 2007; Marlow et al., 2018; Stewart and Barrick, 2002). When focusing on the temporally proximal current state of a problem, team members fixate on concrete ideas by attending to known facts about the present and working to distinguish what is true from what is not (Trope and Liberman, 2003). Because the high tangibility of the present stimulates this type of analytical thinking, current-state focus teams will tend to treat problem formulation as a diagnostic process—they will search for the right ideas by presenting them clearly and evaluating them thoroughly, with little emphasis on combining ideas as they are presented.

In contrast, when focusing on the temporally distal desired state of a problem, team members attend to abstract ideas by imagining the future and working to create what could be (Trope and Liberman, 2003). Because the low tangibility of the future stimulates this type of imaginative thinking, teams will tend to treat problem formulation as a creative process—they will search for novel ideas by combining ideas as they are presented in quick iterations, with little emphasis on evaluating those ideas (Harvey and Kou, 2013; Osborn, 1957).

Team Interaction → Social Norms

A team's interaction patterns will soon carve out its social norms, which are unwritten rules regarding how members should behave in the group setting (Pepitone, 1976; Sherif, 1936). As acknowledged social rules, norms govern behavior consciously or unconsciously (Cialdini and Trost, 1998; Feldman, 1984; Jacobs and Campbell, 1961; Postmes et al., 2001). In teams focusing on a problem's current state, interaction patterns characterized by long speaking turns aimed at explaining ideas in detail will crystallize into conversational norms, encouraging discussions to center around one topic at a time and discouraging contributions from domains adjacent to that topic. They will also discourage interruptions or contributions before a teammate has concluded their speaking. Such social rules will limit the combination of knowledge between members and the scope of knowledge considered during a given discussion, but facilitate the thorough presentation and evaluation of ideas to properly diagnose the problem.

In teams focusing on a problem's desired state, interaction patterns characterized by short speaking turns aimed at building upon and combining ideas will eventually crystallize into conversational norms. These norms will encourage discussions to incorporate multiple domains at a time and encourage contributions from domains adjacent to a focal topic. Such social rules will inhibit the ability to present ideas in great detail and may inhibit thorough evaluation of them, but will also stimulate knowledge combination by increasing the scope of knowledge considered during a given discussion.

Social Norms → Individual Cognition

Eventually, as members experience social rewards for certain behaviors and social punishments for others, their cognitive processing will grow to reflect the normative behavior (Cialdini, 1993; Cialdini and Trost, 1998; Harvey and Enzle, 1981). For example, Ciladini, Reno, and Kallgren (1990) found in a series of experiments on littering conducted in naturalistic settings that differences in the perceived social norms of a given context influenced how participants perceived the situation itself, and subsequently how they behaved. In teams formulating problems, as members experience social rewards or punishments for certain behaviors (e.g., positive or negative responses from teammates), these injunctive norms—what one “ought” to do—will influence how members think about the problem formulation process (Cialdini et al., 1990; Cialdini and Trost, 1998; Festinger, 1954; Gilbert, 1995; Opp, 1982). That is, the established social norms will provide contextual information upon which members will base their thinking.

For teams that focus on a problem’s current state, abiding by social norms that discourage cross-domain discussion will cause members to think in a similarly concrete fashion. That is, they will actively consider fewer knowledge domains adjacent to the focal topic of a conversation, even including those in which they have expertise. Instead, members will tend to focus more on evaluating ideas, checking them against their own knowledge of the present state. The result for such teams is the reinforcement of a perception of problem formulation as a diagnostic process in which ideas are presented and evaluated based on how well they identify the original, motivating concerns in the current environment.

In contrast, for teams that focus on a problem’s desired state, abiding by social norms that encourage knowledge integration across domains causes members to think in ways that are broader and unrestrained by domain (Basadur and Basadur, 2011; Cialdini and Trost, 1998).

Members will actively consider more knowledge domains adjacent to the focal topic of a conversation, including those in which they have expertise. As a result, they will tend to spend less energy evaluating ideas as they are presented, instead working to build upon those ideas or make connections across domains instead. The result for such teams is the reinforcement of a perception of problem formulation as a creative process in which ideas are presented and elaborated with the goal of defining a problem suited to the team's expertise.

Outcomes: Accuracy, Alignment, and Minimal Structures

Because the two socio-cognitive processes differ in their emphasis on idea evaluation and idea combination, the problems produced by these iterative cycles may differ with regard to how accurate the problem is at addressing the original, motivating concern and how well-suited it is to the team's expertise.

On the one hand, a focus on the problem's current state ensures that when ideas are evaluated, they are judged by team members who are thoroughly informed of how the ideas address the situation's motivating concern (Harvey and Kou, 2013). On the other hand, this focus affords the problem less malleability to align with the expertise of the team. This emphasis works to ensure a team does not solve the "wrong" problem, but could result in them facing a problem they are not equipped to solve. In an example of a worst-case scenario, a team without expertise in electrical engineering may correctly identify that a malfunctioning generator is the cause of a power outage in a TV studio. But if it defines the current state as a malfunctioning generator and the desired state as a fixed generator, it has formulated a problem in an area in which the team does not have expertise. This is a highly accurate problem because it identifies the present inadequacy, but not a well-aligned problem because the team is not equipped to solve it.

In contrast, a focus on the problem's desired state affords the problem more malleability to align with the expertise of the team. On the other hand, this focus generally does not allow ideas to be shared in full or given space for thorough evaluation because of the rapidfire discussions (Paulus, 2000). This emphasis works to ensure a team faces a problem they are equipped to solve, but could result in them solving a “wrong” problem. In an example of a worst-case scenario, if a team with expertise in electrical engineering identifies that a fixed generator will cause power to return to a darkened TV studio, when in reality the issue stemmed simply from an unflipped switch, the team has formulated the wrong problem. This is a well-aligned problem because it is one that the team could solve, but not a highly accurate summary of the original concern.

These countervailing effects appear to have the potential to represent a tradeoff between problem accuracy and alignment, mirroring a common phenomenon where organizations sometimes pursue multiple performance goals at the expense of each other (Cyert and March, 1963; Greve, 2008; Hu and Bettis, 2018). However, the desired-state focused teams in this study were able to generate problems that satisfied both criteria in that they were aligned to teams’ expertise while still being highly accurate in addressing the original concern. The reason for this outcome may stem from the minimal structures put in place by the workshop organizers, who designed the problem formulation task such that teams were afforded restricted autonomy. Minimal structures are sets of guidelines and agreements that loosely constrain behavior by allowing flexibility within a set of boundaries (Kamoche and Cuha, 2001; Vera, Nemanich, Vélez-Castrillón, and Werner, 2016). Teams in this study’s context were instructed to ideate generally within the field of engineering with a focus on improving societal functioning, and thus were granted a broad, but finite, idea space to work within during their problem formulation discussions. The presence of these minimal structures helped nudge all teams to generate a highly accurate problem, as the range of problems considered accurate is relatively large.

Desired-state focus teams, which were inclined to define problems aligned to their expertise, were therefore able to satisfy both criteria by generating problems that were accurate and well-aligned. It stands to reason then that a desired-state focused team is more likely to generate a problem that is both accurate and well-aligned in problem formulation contexts with only minimal structure.

General Discussion

This work makes a number of significant contributions to problem-solving research. First, it provides insight as to how the formulation of problems can influence the translation of member expertise into team problem-solving performance. While much extant work has approached this topic by examining how expertise is mobilized once teams are at work on an established problem, this study suggests that examining how teams define the problems they go on to solve will also be important in deepening our understanding of this relationship. Therefore, it reveals opportunities for future research to seek ways for teams to reach their potential through the effective formulation of problems. For example, better understanding of the conditions under which teams can formulate problems that both address situations' motivating concerns and are aligned to members' expertise could reveal interventions that greatly enhance problem-solving performance.

Second, this research draws attention to the importance of the current and desired states that compose a problem as focus points of attention. We have long understood a problem as a gap between a current state and a desired state (Newell and Simon, 1972), but to this point, little research has considered the potential effects on problem formulation of making one state more salient than the other. This study suggests that saliency of one state over the other impacts how team members think and interact. It also presents fruitful opportunities for future research, such as discovering for which types of problems emphasizing one state over the other is beneficial or which types of individuals compose teams that perform best when focusing on one state or the other.

Third, the insights drawn from this multi-level research result from analysis of the socio-cognitive processes that influence problem formulation behavior and outcomes, which bridges levels of analysis by highlighting the cyclical relationship of individual cognition, team interaction patterns, and social norms. Viewing problem formulation through this meso lens enhances our understanding of how individuals influence teams and vice versa (Hackman, 2003; Rousseau and House, 1994), an increasingly important bi-directional relationship as teams become the primary problem-solving entities in modern organizations (Argote, 2012). Given individuals' propensity to differ in how they perceive problems as a function of their expertise (Cronin and Weingart, 2007) and the influence of social norms on individual cognition (Cialdini and Trost, 1998), a meso perspective is crucial for research in the pursuit of understanding problem formulation at the team level.

Fourth, this study's empirical process is distinct from much prior research in a number of ways and offers new insights as a result. The foundational laboratory studies examining problem formulation at the individual and team levels have built a tremendous platform upon which this study builds and broadens by examining the phenomenon in the field (e.g., Getzels and Csikszentmihalyi, 1964; Mumford et al., 1994; Reiter-Palmon and Murugavel, 2018; Reiter-Palmon, et al., 1997; Reiter-Palmon, et al., 1998). Moreover, though there is some empirical work examining team problem formulation outside of the lab, the present research advances beyond purely observational study to include comparison groups in teams formulating problems in a field setting focused specifically on problem formulation (Reiter-Palmon, 2018).

Limitations and Future Directions

As with any study, a number of limitations of this work present directions for future research. First, this study is not exempt from many of the usual limitations of qualitative research, including use of a small sample, a single context, and the lack of a paradigm that enables claims of causality. While these concerns are valid—the data presented here does not represent causal links—I worked to partially mitigate them by utilizing semi-random assignment, analyzing large amounts of textual and content data from each team, and recruiting a participant group that sampled multiple different populations (e.g., diverse in university employer, engineering sub-field, age, and gender). It is also crucial to emphasize that the goal of this qualitative work, like the foundational work upon which it is based, is to understand real-world phenomena from a specific context and build theoretical frameworks that help to explain those phenomena in other contexts (Eisenhardt, 1989; 2021). By immersing myself in the data and drawing insights from these rich interactions, I aimed to construct a framework that links relevant constructs in ways that generalize beyond this specific context. I look forward to learning of future research's insights regarding problem formulation at multiple levels of analysis, and hope the present work can act as a foundation for this future research.

Second, the limitations of these data do not allow for examination of the link between problem formulation and problem-solving performance. While I can posit that teams that formulate more accurate and more aligned problems will perform better when solving those problems, this study does not present evidence for that position. Future research should work to connect these phases, as doing so would allow for examination of how problem formulation influences the degree to which expertise is translated into problem-solving performance, a key objective of teams and organizations.

Third, though a strength of this study is that it is able to provide insights specifically regarding problem formulation as a process, an accompanying weakness stems from the fact that, in some cases, the formulation and solving processes are intertwined and iterative (Amabile, 1983; Reiter-Palmon et al., 1997). Future research could further develop understanding of how these two processes influence each other in the context of teams that vary in which state of the problem they focus upon.

Fourth, this study manipulated the primary focus that teams took when formulating the problem, so future research is needed to examine the conditions under which teams are more likely to adopt a current- or desired-state focus. Which types of contextual cues or team characteristics might cause teams to focus more on the current state or the desired state? For example, one might expect teams to be more likely to adopt a current-state focus in more threatening or time-pressured environments where the current state is highly salient. Or, given that focusing on the desired state involves generating imaginative ideas that may be subject to social scrutiny, perhaps teams with lower levels of psychological safety will be more likely to adopt a current-state focus. Answering these and similar questions would be beneficial for problem formulation research moving forward.

Fifth, despite team conflict being a common construct theorized about and measured in research on problem formulation (e.g., Cronin and Weingart, 2007; Reiter-Palmon and Murugavel, 2018), conflict is not discussed in depth in this study. Cursory analyses of transcripts suggested that all teams in this sample displayed a low degree of conflict. This could be due to the intervention employed in this study, which applied to the team as a whole and thus may have unified members' problem perceptions more than in other team contexts. In any case, given the prevalence of conflict in extant discussions of problem formulation at the team level, future research would do well to focus on how attention to problems' current or desired states might influence team conflict.

Tables and Figures

Table 1—Problem-Solving Approach Condition and Composition of Teams

Condition	Member 1	Member 2	Member 3	Member 4	Member 5	Member 6	Member 7	Member 8
Current-State Focus Team 1	*Male, A* Machine learning; Sensing systems; Building energy management ...	*Male, D* Autonomous systems; Human-robot interaction ...	*Female, C* Infrastructure maintenance; Building automation ...	*Male, B* Transportation Engineering; Diversity/culture of inclusion ...	*Female, A* Energy systems; Environment ...	*Male, A* Computer security and privacy ...	*Male, D* Security and privacy; Cyber-physical systems ...	*Male, B* Human-centered and systems design ...
Current-State Focus Team 2	*Male, A* Transportation; Energy and environment ...	*Male, B* Computational sensor networks; Autonomous systems ...	*Male, A* Infrastructure systems; Engineering economics ...	*Female, A* Privacy; Security	*Male, B* Optimization; Smart city infrastructures ...			
Desired-State Focus Team 1	*Female, A* Human-building interaction; Agent-based modeling ...	*Male, B* Optimization and machine learning; Smart city infrastructures ...	*Female, C* AI/AI policy; Data ethics/data science ...	*Male, B* Algorithm design and analysis; Computer science education	*Female, A* Sustainability analysis; Energy poverty ...	*Male, A* Decision science; AI/Machine learning; Psychology ...	*Female, A* Building inform. modeling; Information tech ...	
Desired-State Focus Team 2	*Female, D* Shared mobility; Multi-modal Transportation ...	*Male, B* AI/Machine learning; Data science ...	*Male, A* Causal learning/ discovery; Cognitive science ...	*Male, A* Organizational theory/sociology; Inequity ...	*Male, A* Environmental sustainability, Last-mile food transportation/ delivery ...	*Male, A* Sustainable transport. systems; Multi-modal transportation modeling ...	*Female, D* Future scenario modeling; Environmental impacts of emerging tech	*Male, A* Transportation; Energy; Automation

Note. Gender, university affiliation, and top research interests for each member. All members marked with the same letter (A, B, C, or D) are affiliated with the same university.

Table 2—Problem-Solving Approach Condition and Textual Analysis

	Total Words	Total Speaking Turns	Words per Speaking Turn	St. Dev. of Speaking Turn Length
Current-State Focus Teams	12,448	124	100.21	152.75
Future-State Focus Teams	11,663	224	51.99	76.84
	Speaking Turns < 100 Words	**Speaking Turns > 400 Words**	**Total Speaking Turns Containing a Question**	**% of Members who Spoke Zero Times in at Least Two Quarters**
Desired-State Focus Teams	88	9	24	54%
Desired -State Focus Teams	192	1	35	27%

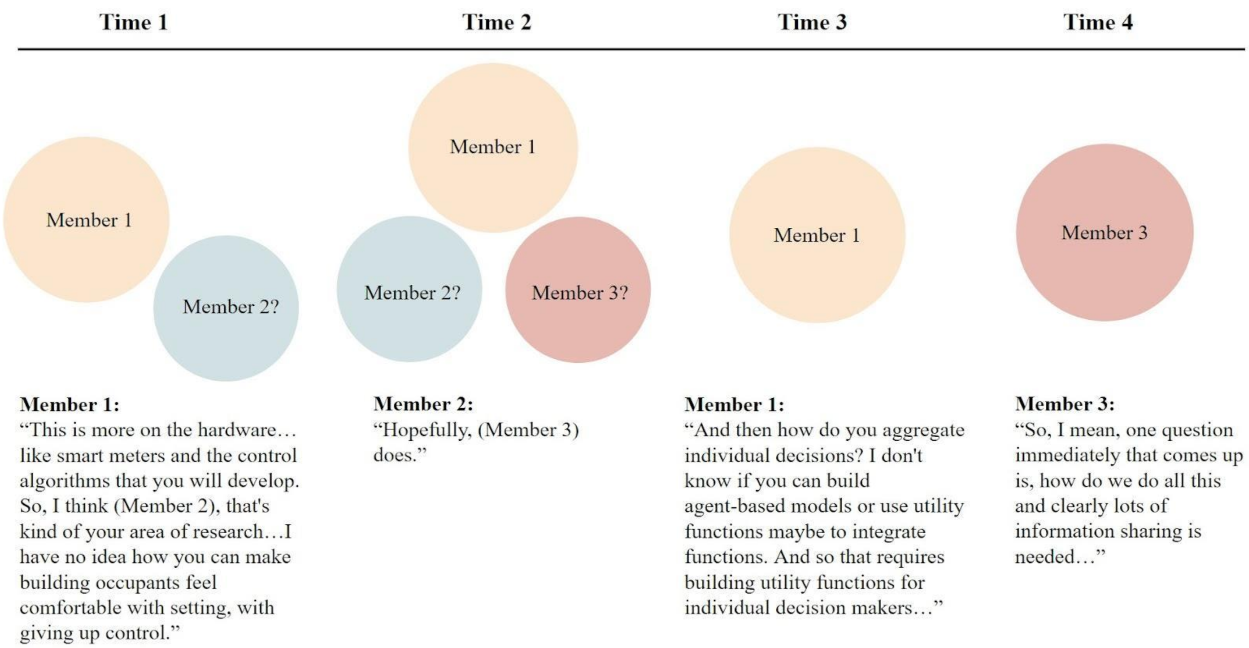
Note. Quarters were determined by dividing transcripts into quarters based on word count. Total words and total speaking turns are presented here as averages across the two teams in each condition.

Table 3—Problem-Solving Approach Condition and Team Final Statements

Condition	Problem Statement	Research Areas Mentioned in Problem Statement	Member Expertise Represented in Problem Statement	Problem Alignment
Current-State Focus Teams	How do we design "transportation with efficiency, economics, equity, accessibility, sustainability, safety, public health, reliability, resilient, privacy?"	Transportation/delivery Efficiency/sustainability Economics Data ethics/inequity Public health Privacy	Transportation/delivery Efficiency (i.e., sustainability) Inequity (i.e., culture of inclusion) Privacy	1.5:1
	No statement generated	*No statement generated*	*No statement generated*	*N/A*
Desired-State Focus Teams	How do we design an "efficient and adaptable building that provides personalized services to the group as a whole with equal access to everyone?"	Efficiency/sustainability Human-building interaction Smart infrastructure/ML Optimization Data ethics/inequity	Efficiency (i.e., energy poverty, sustainability) Human-building interaction Smart infrastructure/ML Optimization Data ethics/AI policy	1:1
	How do we design a "sustainable, equitable, reliable, connected, and safe drone delivery system?"	Efficiency/sustainability Data ethics/inequity Shared mobility Transportation/delivery	Efficiency (i.e., sustainability) Data ethics/inequity Shared mobility Transportation/delivery	1:1

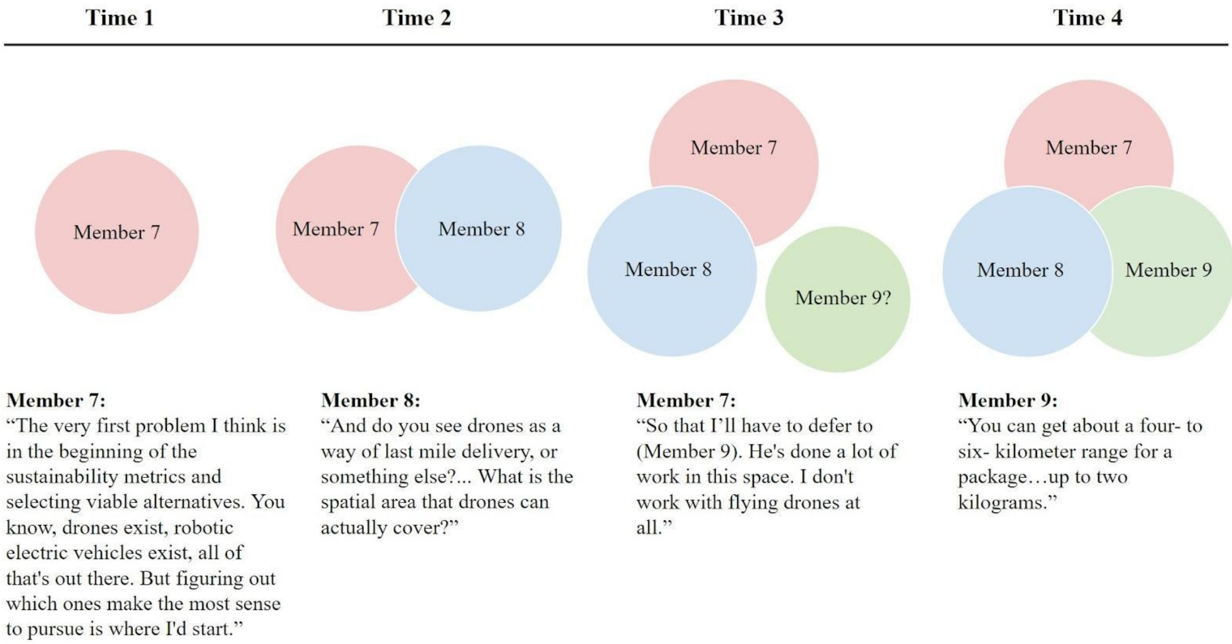
Figure 1—Knowledge Combination Across Conditions

Figure 1a—Current-State Focus Team Example



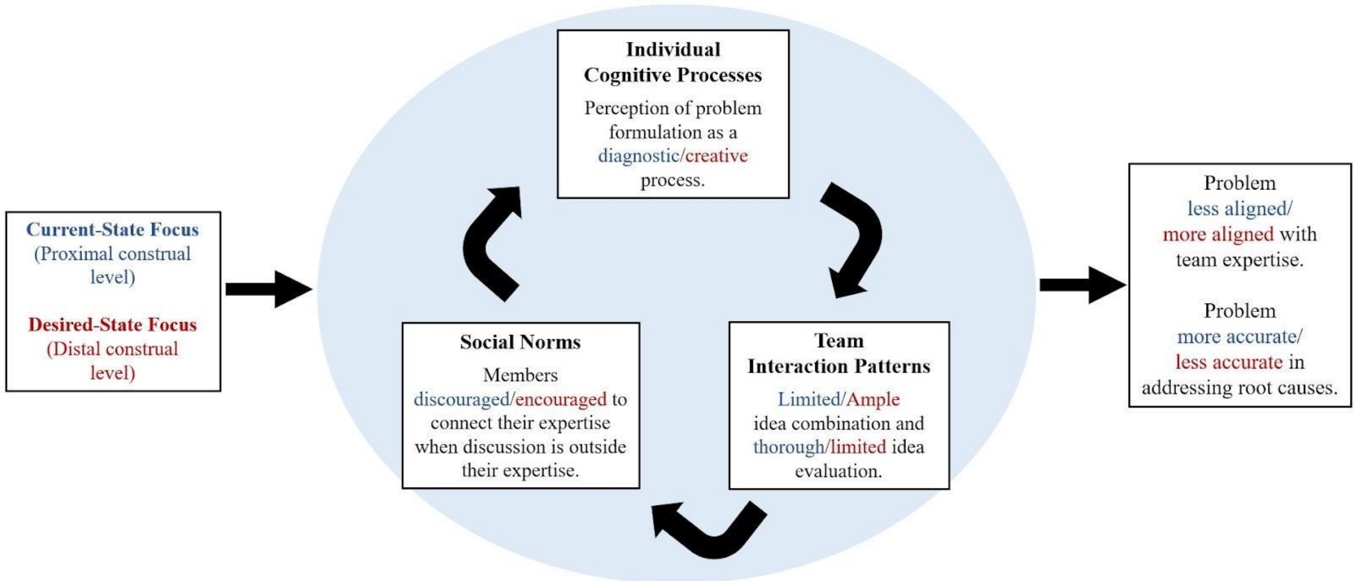
Note. Representative example of current-state focus teams' knowledge combination processes. Here, Member 1 introduces a new topic, calls on Member 2 to build upon one of their points, and states a relevant gap in their current knowledge. Member 2 does not address the first call, but mentions Member 3 with regard to the knowledge gap. Member 1 then continues to build upon their initial points. Finally, Member 3 does not address the suggestion that they might be able to fill the knowledge gap, but introduces a new topic. Thus, two potential opportunities for knowledge combination between the three members were not realized.

Figure 1b—Desired-State Focus Team Example



Note. Representative example of desired-state focus teams’ knowledge combination processes. Here, Member 7 introduces a new topic, and Member 8, seeking to connect their expertise, follows up with a question. Member 7 defers to Member 9 because of their expertise, who responds to the question. Thus, two potential opportunities for knowledge combination between the three members were realized, commencing an interconnected discussion involving three members.

Figure 2—Emergent Theory of Team Problem Formulation



Chapter 3

Is More Expertise Always Better? Perspective-Taking and Expertise in Team Rapid Adaptation

Abstract

As technological advances quicken the pace of organizational life and raise the value of specialized expertise, organizational teams are increasingly being composed of experts and called upon to respond to rapidly changing environments. However, though member expertise is often emphasized as crucial to team success, recent work has suggested it can be neutral or even an impediment when teams are asked to rapidly adapt to a changing environment. This study examines the conditions under which members' expertise on a task benefits team rapid adaptation. I conducted a multi-method study in a setting where rapid adaptation is paramount—an improvisational theater company. Observations and interviews suggest that members' trait perspective-taking plays an important role in team rapid adaptation because it allows members to quickly provide opportunities for teammates to succeed based upon their skills and attributes. A subsequent field experiment that manipulated team composition revealed that teams with high perspective-taking members better translated their task expertise into performance than teams with low perspective-taking members by developing a higher level of emergent interdependence in their work.

As the world continues to make innovative technological advances, new tools and new ways of organizing have facilitated the pace of the development of new knowledge, along with reducing the time buffers between decision and action (Cunha et al. 1999; De Smet et al. 2020; Kozlowski and Bell 2003; Moorman and Miner 1998; Volberda 1996). These technology-driven changes have led to two major consequences for how organizations conduct work. The first is the heightened pace of activity, leading to increasing prevalence of contexts that require rapid adaptation—the quick and adaptive response to changing environments (Bechky and Okhuysen 2011; Mannucci et al. 2020; Miner and O'Toole 2020). The second is the increasing need for and value of experts, as the "burden of knowledge" (Jones 2009) leads to a specialization of expertise and, consequently, a greater reliance on teamwork for problem-solving (Stephan 2012; Wuchty et al. 2007). But with mixed evidence on the influence of expertise on flexibility and adaptation (Dane 2010), whether or not the growth in the use of teams to synthesize expertise will facilitate rapid adaptation is unclear.

As a result of these trends, organizations continue to turn to teams to address their most pressing problems (Argote 2013; Bechky and Okhuysen 2011; Brown and Eisenhardt 1997; Kozlowski et al. 1999; Vera and Crossan 2005). Extant research suggests including members on a team with expertise in the team's task will benefit performance (e.g., Benner 1984; Bunderson 2003; Ericsson and Lehmann 1996; Kahneman and Klein 2009; Klein 1998). Thus, even in situations requiring rapid adaptation, organizations will likely draw together their relevant experts. However, other research has started to call the perceived sweeping benefits of expertise on a task into question, suggesting it may be neutral or even detrimental to team performance under certain conditions (e.g., Frensch and Sternberg 1989; Woolley et al. 2008). Because of arguments that expertise on a task can result in reduced flexibility when that task evolves (Chi

2006; Dane 2010; Sternberg 1996), conditions requiring rapid adaptation may prove challenging for teams of experts. Therefore, as these two modern organizational trends develop in parallel, the pressing question emerges of how involving experts in rapid adaptation will influence performance.

To address this question, this study examines the conditions under which teams that need to engage in rapid adaptation can do so while effectively using member expertise. In order to generate new insights on this issue, I conduct a multi-method study in a context where integration of individual skill and rapid adaptation are central to the work—an improvisational comedy theater company. The study employs an abductive approach, whereby qualitative data collected from improvisational comedy teams supplements extant literature in formulating testable hypotheses. These hypotheses are subsequently tested in a field experiment conducted in the same setting. The findings serve to generate middle range theory, building upon rich, empirical data from one specific context to create a steppingstone to the development of more general, high-level theory explaining relationships between broader constructs (Eisenhardt and Bourgeois 1988; Merton 1949). To this end, this multi-method study provides important insights from a particular rapid adaptation context to support development of more general theory for understanding the relationships of expertise, adaptation, and team performance.

Theoretical Background

Rapid Adaptation

Rapid adaptation, true to its name, is the quick and adaptive response to changing environments. As organizational teams face more situations characterized by the swift influx of information that require rapid response to that information (Baker et al. 2003; Bechky and Okhuysen 2011; Moorman and Miner 1998; Weick 1993), the ability to rapidly adapt effectively is of growing importance (Baker and Nelson 2005; Ciutchta et al. 2021; Mannucci et al. 2020;

Miner and O'Toole 2020; Mintzberg 1973; Weick 1998). With future technological innovations likely to only further increase the pace of organizational life, teams that are able to effectively adapt on the fly will likely be the ones best equipped to perform at a high level.

Rapid adaptation can be understood with regard to two dimensions of behavior: the speed of a behavior and its degree of novelty (see Figure 1). "Rapid" refers to speed; specifically, the amount of time separating the beginning and end of the behavioral process (less time = higher speed; Fisher and Amabile 2009). For example, there is a difference in behavioral speed between routinely executing a standard operating procedure in a period of contextual stability (e.g., a firefighting team completes a routine check of their trucks and equipment) and quickly executing an emergency protocol in response to a contextual change (e.g., after receiving a fire call, the firefighting team follows protocol by quickly preparing the necessary equipment and departing the station). "Adaptation" refers to the degree to which a behavior is a novel reaction to a context (more novel, unprepared reaction to context = higher adaptation; Burke et al. 2006; Christian et al. 2017). For example, there is a difference in degree of novelty between quickly executing an emergency protocol in response to a contextual change (e.g., the firefighting team responding to the fire call described above) and quickly composing a novel response to a contextual change (e.g., when the firefighters find themselves trapped in a gulch with a fire approaching, the team burns the ground underfoot so that the fire passes around them; as described in Weick 1993). This last example represents rapid adaptation, which falls at the high end of both dimensions as it entails quickly (high speed) composing a novel response to an environmental change (high novelty).

Rapid adaptation can take a number of forms. For one, bricolage—when a team "makes do" with what resources they have available when adapting (Baker and Nelson 2005; Baker et al.

2003)—can be a form of rapid adaptation, if carried out quickly. Without time to gather additional resources, a team might display bricolage by quickly using available tools in new ways to adjust to contextual changes. However, bricolage could also be employed more deliberately if time is not one of the limited resources. Therefore, the most representative form of rapid adaptation is improvisation—"the deliberate and substantive fusion of the design and execution of a novel production" (Miner et al. 2001, p. 314). Behavioral speed is at maximum in improvisation because idea generation and idea implementation occur simultaneously (Miner et al. 2001). In addition, improvisation represents a very high degree of novelty because it necessarily represents a new response to a contextual change. Improvisation may be employed as a response to an unforeseen problem (e.g., when the audio goes out on a live news show, a TV production team improvises a way to deliver the time-sensitive news to the audience in silence) or an unforeseen opportunity (e.g., when a prestigious client drops a competitor from a project at the last second because the client wants a cutting edge technology for the project, a consulting team improvises a pitch for a new device; Fisher and Amabile 2009). Because improvisation is so representative of rapid adaptation, examining improvisational teams is likely to provide useful insights to the study of team rapid adaptation.

But despite its utility if employed effectively, rapid adaptation is not always successful, particularly at the team level (Miner and O'Toole 2020; Stachowski et al. 2009; Vera and Crossan 2004; Weick 1998). Quickly adjusting behavior appropriately under changing conditions generally asks individuals to display cognitive flexibility and situational composure (Dane 2010; Fisher and Amabile 2009; Fisher and Barrett 2018; Staw et al. 1981) and teams to display coordinated collaboration without explicit planning (Bechky and Okhuysen 2011; Miner and O'Toole 2020; Vera and Crossan 2004). For example, teams composed of members displaying rigidity in contexts calling for flexibility—such as applying an outdated routine to an unprecedented situation (e.g., Frensch and Sternberg 1979; Gilbert 2005)—are unlikely to adapt effectively. Similarly, teams displaying uncoordinated behavior under changing conditions—such as when members solve different problems as a result of incongruent representations of the problem (Cronin and Weingart 2007)—are also likely to adapt poorly. Because of the potential for ineffective behavior in these increasingly common adaptive contexts, the performance gap may widen between teams that are effectively prepared for rapid adaptation and those that are not. The question arises then regarding how a team can prepare to be unprepared.

Expertise and Performance

Team members' expertise may well play a role in how prominent the potential detriments of rapid adaptation are in affecting team rapid adaptation performance. As the value of deep expertise continues to rise as the problems that organizations face become steadily more complex, more teams may find themselves composed of domain experts (Stephan 2012; Wuchty et al. 2007)—that is, people possessing extensive content and procedural knowledge in the general domain of the problem they are trying to solve.

In many contexts, deep knowledge of a problem domain is likely to enhance team efficacy in solving problems in that domain, given the intuitive and evidence-based belief that expertise in a given problem domain generally improves performance (Bunderson 2003). Expertise is regularly perceived as a beneficial quality and emphasized by industry jobs as crucial to organizational success (Alberts 2007; Bunderson 2003; Ericsson et al. 2007; Gandhi and Sauser 2008). Its benefits are also identified in much academic research relating to effective decision making and high performance across fields (Benner 1984; Ericsson et al. 2006; Haerem and Rau 2007; Kahneman and Klein 2009). In particular to adaptation, expertise has again been found to be beneficial in many cases, as deep knowledge of a topic can provide fodder for knowledge combination, enhancing the generation of novel and useful ideas and allowing teams to solve new problems using old knowledge (Amabile 1988; Taylor and Greve 2004). For example, teams with members high in expertise can leverage their wealth of knowledge to outperform low expertise teams on creative tasks (Nijstad and Stroebe 2006). In addition, teams with expertise in organizational routines or standard operating procedures have been shown to be able to recombine pieces of that expertise to adjust to changing environments (Baker et al. 2003; Crossan et al. 2005; Kendra and Watchendorf 2003; Moorman and Miner 1998), indicating that expertise can be a source of flexibility (Feldman 2000).

However, other research suggests the relationship between expertise and adaptation is more complex (Dane 2010). Expertise appears to carry limitations (Holyoak 1991; Lewandowsky and Thomas 2009), including the potential to have a detrimental effect on flexibility (Chi 2006; Kyriakopoulos 2011; Lewandowsky et al. 2007; Sternberg 1996). Research suggests that expertise, if applied rigidly, can facilitate cognitive entrenchment, reduce novelty, and result in poor performance under changing conditions (Dane 2010). For example, teams composed of domain experts have been observed to generate fewer novel ideas than low-expertise groups due to fixation on expertise vocabulary (Coursey et al. 2019), and some work has even highlighted the contingent potential of expertise on flexibility (Kyriakopoulos 2011). In addition, experts can be outperformed by novices when a focal task's process is changed (Frensch and Sternberg 1989) and expertise in the form of organizational routines can, in certain cases, result in rigidity and path dependence (Gilbert 2005; Miller and Friesen 1980).

Therefore, evidence spread across multiple literatures suggests that expertise possesses the potential to either provide the necessary fuel for effective rapid adaptation or contribute to detrimental rigidity. Some have worked to reconcile this expertise-flexibility tension from a cognitive perspective at the individual level (Dane 2010), but the literature lacks clear understanding of how teams might leverage expertise to enhance rapid adaptation performance. Given the increasing prevalence of contexts calling for rapid adaptation, the heavy reliance on teams to address such contexts, and the rising value of experts in organizations, better understanding of how member expertise might enhance team rapid adaptive performance will be highly beneficial for modern organizations. Until such understanding is achieved, management literature may not be fully equipped to prescribe managers in composing, structuring, or training those teams likely to face quickly changing environments.

Developing Middle Range Theory

The current research strives to enhance understanding of the role of expertise in team rapid adaptation. It does so in part by generating middle range theory that connects empirical data to higher-level theory (Eisenhardt and Bourgeois 1988; Merton 1949). Middle range theory is a key component of coherent bodies of research because it bridges the wide gap that often exists between the focused, specific hypotheses of much empirical work and the grand, all-encompassing theories that seek to explain behavior on a systemic level. As Merton (1949) writes, middle range theory lies “between the minor but necessary working hypotheses that evolve in abundance in day-to-day research and the all-inclusive systematic efforts to develop unified theory that will explain all the observed uniformities of social behaviour, organization and social change” (Merton 1949, p. 39). By developing these connections, rich, data-driven insights may fit more effectively within broader theories of behavior.

Therefore, this multi-method study took an abductive approach that incorporated two phases. First, a qualitative investigation was undertaken with improvisational comedy teams that produced rich data from observations, interviews, and survey responses. This data was used in iteration with existing literature to formulate testable hypotheses. Then, those hypotheses were tested in a subsequent field experiment with improvisational teams. In this way, this study develops middle range theory that connects the insights drawn from analysis of data collected from a particular rapid adaptation context to more general theory regarding the relationships of expertise, adaptation, and team performance.

Phase 1: Preliminary Qualitative Research

Method

Research Setting and Participants

An abductive approach was taken to this research, wherein qualitative data were collected, analyzed, and used in combination with extant literature to formulate hypotheses that were subsequently tested in a field experiment (Behfar and Okhuysen 2018; Weick 1989). Such an approach was most appropriate given that, though I had hunches regarding variables potentially relevant in the expertise-team rapid adaptation relationship, I did not feel the extant literature alone could support a set of highly defensible hypotheses. I therefore collected qualitative data to supplement existing research during hypothesis generation. Study data, analysis code, communication with the theater company, and other study materials may be found online at https://osf.io/2hgs5/?view_only=d36bdbdf1f35428da498a31553465c3b.

To understand how members' expertise might affect a team's ability to adapt rapidly, data were collected from a context where such rapid adaptation is the focal task that teams undertake (Eisenhardt, 1989; Yin 1994): an improvisational comedy theater company located in the Mid-Atlantic United States. Given the difficulty of predicting and observing episodes of rapid adaptation in modern organizations (Miner et al. 2001; Fisher and Barrett 2019), a site where rapid adaptation, like improvisation, is repeatedly and transparently observable was valuable in addressing my research question. Use of non-traditional organizations has been important to the study of phenomena that are "uniquely or most easily observed in non-business or non-managerial settings but nonetheless have critical implications for management theory," such as the phenomenon of focus here (Bamberger and Pratt 2010, p. 668).

My extensive experience with improvisational theater—along with extant research's arguments that principles of improvisation derived from the theatrical context offer promising utility for more traditional organizations (Miner and O'Toole 2021)—provided insight into the utility of addressing the study's focal research questions in this context, including the site's relevance to modern organizational teams that frequently face situations calling for rapid adaptation. Unlike traditional theater, improvisational theater contains no script whatsoever—the context, setting, characters, and narrative are all created by the performers as the scene progresses (Halpern et al. 1994; Mannucci et al. 2020). That is, all stages of the creative process are carried out simultaneously and teams are continuously responding to a novel environment. Thus, insights gained from this context may be particularly relevant to organizational teams that enter rapidly changing environments with the knowledge that they will likely need to adjust on the fly, such as emergency medical teams, SWAT teams, firefighter teams, product development teams, news reporting teams, and so on (Bechky and Okhuysen 2011; Brown and Eisenhardt 1997; Klein et al. 2006; Weick 1993). One shared aspect of improvisational theater teams and other organizational teams facing rapid adaptive contexts is the tension between drawing on existing expertise without rigidly employing past behaviors where they no longer apply (Barrett 1998; Dane 2010; Kamoche and Cunha 2001; Vera and Crossan 2005). The presence of this tension across settings indicates that insights into a general theory of how expertise influences team performance may be gained from studying teams in the improvisational theater through the development of middle range theory (Merton 1949).

Using a deliberate sampling technique, theater management contacted all actors on their mailing list (approximately 100) to participate in this research, resulting in 53 responses (45% female, $M_{Age} = 40.01$, $SD_{Age} = 13.07$). I had no previous relationships with any of the actors or the management. Outside of the theater, the participants occupied a wide variety of organizational positions—salesperson, professor, graduate student, schoolteacher, clinical therapist, call center employee, software engineer, journalist, lawyer, and more—indicating that this pool of participants contained improvisers from a variety of backgrounds, trained in a variety of disciplines.

Despite their differences in profession, participants noted improvising frequently outside of the theater, providing more evidence that improvisation is relevant to modern organizational life. All were asked to state the frequency with which they improvise in their day jobs (1 = "Never", 4 = "Often"), with an average response of 3.11 (SD = 0.96). Additionally, 85% of participants were able to provide an explicit example of improvisation at their work (see Table 1 for participant responses). Select examples include: "A coworker was floundering during a presentation, I started asking questions that helped him regain his train of thought without being obvious;" "I was facilitating an anger management group, and my clients didn't seem to be understanding (the) concepts … I switched gears during the group and created a fictitious scenario to demonstrate how people think, feel, and respond differently to the same situation. My clients ended up understanding when I switched my tactics;" and "When I give talks I leave portions of the talk out and just say what comes to my mind." These responses provide representative examples of how improvisation manifests in organizational settings.

Data Collection

The data collection process, detailed below to enhance replicability (Aguinis et al. 2019; Tong et al. 2007), was modeled after established qualitative processes in the psychological, sociological, and management literatures (e.g., Pistrang and Barker 2012; Ritchie and Spencer 1994; Strauss and Corbin 1990; Valentine et al. 2015), including utilizing an in-depth study of a single organization to collect data (Eisenhardt and Graebner 2007). On top of years of attending various improvisational theater performances, speaking informally with actors, and reading first- and second-hand accounts of improvisational performances in a variety of contexts (e.g., theater, business, sports), I spent a considerable amount of time at the focal theater company (11 site visits over 6 months lasting between 1 and 3 hours) observing practice sessions, attending official performances, and in both formal and informal conversations with actors, all the while either video recording or taking extensive notes.

To begin, a survey was administered to participants that included both measures of individual differences and open-ended questions eliciting qualitative responses. The survey was distributed to all actors registered at the theater company for voluntary completion. All participants provided informed consent, and ninety-six percent of participants passed all three attention checks.[1] To allow participants freedom to express their ideas and experiences with regard to improvisational technique and process, the open-ended questions were administered with unlimited time and space to respond, and participants were clearly informed that the procedure was endorsed by the theater management and therefore no response could harm their opportunity to continue performing at the theater (Pistrang and Barker 2012). Sample questions included: "What are some skills that are important to have when improvising in a team?" "In your performances, how often do you draw upon past ideas, narratives, ready-mades, actions, scenes, etc. that you have utilized in prior improvisational performances, updating them for the

[1] Two participants did not pass 100% of the attention checks. However, the content of both of these responses were consistent with the other 51 responses, indicating that adequate attention was paid to the survey, and that neither response significantly influenced any themes identified or conclusions drawn from the data.

current scene?” and “How do you prepare to improvise?” All open-ended questions are included in Appendix A.

Two in-depth follow-up interviews were conducted to gather more insight into survey responses, with questions derived from specific survey responses (e.g., “Many actors noted ‘gift giving,’ empathy, and emotional intelligence as crucial skills in team improv. Can you explain ‘gift giving’ and state whether you agree these skills are beneficial for team improv? If not, why not? If so, why are they important?”). These interviews provided participants space to elaborate on their ideas or explain concepts in more detail. Given the depth and consistency of the total batch of responses following the completion of survey administration and interviews, with specific individual experiences and examples generally being all that differed, it was concluded that sufficient data had been collected to effectively supplement extant research in the process of formulating testable hypotheses.

Data Analysis

The preliminary stage of data analysis was iterative with data collection, in that initial open coding was conducted on survey responses to reveal necessary areas of elaboration to emphasize in follow-up interviews (Strauss and Corbin 1990). These areas were selected by identifying evident patterns in survey responses that might benefit from more in-depth explanation due to implied importance to the relevant phenomena, along with less frequent responses that were unique in interest or that were difficult to understand. This allowed room to explore, in subsequent interviews, new directions that emerged from the written responses and to gain additional theoretical insights beyond the first round of data collection. Once these interviews were completed, primary data analysis began.

Primary data analysis included descriptive, thematic, axial, and theoretical coding (Charmaz 2006; Miles and Huberman 1994). First, a descriptive coding analysis of each open-ended question response was conducted to identify common ideas across responses by breaking down each response into its main ideas based on participant vocabulary and phrasing (Miles and Huberman 1994; Ritchie and Spencer 1994; Strauss and Corbin 1990). For example, a longer response about paying attention to others when improvising in order to predict their behavior would be coded as inferring teammates' improvisational intentions. A thematic coding analysis subsequently revealed common second-order themes described repeatedly by participants (Miles and Huberman 1994). For example, the idea described above combined with a code representing the preparation to be aware of others' mental states to better anticipate their choices would be aggregated to a second-order theme of the cognitive process of attempting to understand teammates' preferences, abilities, and cognitive states.

Axial coding, which involves linking a dataset's categories to broader themes and constructs, was then utilized to cluster these ideas based on thematic similarity and abstract from the first- and second-order concepts to higher-level groupings (Strauss and Corbin, 1990). This was an iterative process conducted between data and extant research that entailed searching the literature to identify higher-order constructs that matched the second-order themes. The research question and the qualitative data analysis to this point guided the initial literature search into individual differences in cognition and prosociality, team interactive processes, and the relationships of expertise, flexibility, and creativity—as noted, this research was motivated in part by hunches regarding the influence of team composition on expertise use in rapid adaptation. Once a construct from extant research was identified as potentially relevant, the data were consulted to check the construct's validity in this context. This process was repeated until constructs were sufficiently matched to the data. For example, the theme of attempting to understand others' perspectives, preferences, abilities, and cognitive states suggests the relevance of the construct of perspective-taking in team improvisation.

Finally, theoretical coding was used to identify potential relationships between constructs. This also involved iterating between the data and extant literature to develop specific hypotheses through sorting and organizing codes identified in previous rounds of analysis. The relationships revealed in this analysis are described in depth in the following sections as they motivate stated hypotheses.

Hypothesis Generation

Perspective-Taking and Team Improvisational Performance

The qualitative investigation revealed the ways in which member perspective-taking affects team improvisational performance, including how it influences the effect of expertise on performance. Perspective-taking is a cognitive process in which individuals attempt to understand others' preferences, values, and needs by adopting their viewpoints (Davis 1983; Grant and Berry 2011; Parker and Axtell 2001; Piaget 1932). Many participants noted that being skilled at "tuning in to other peoples' feelings and predicting their thoughts" and "listening to teammates and inferring their intent" was essential to their improvisational success in teams. Others echoed the sentiment of understanding the views of others, especially when they held different perspectives. For example, one participant, above the average age of the sample, noted:

> Sometimes it is difficult for me to work with millennials who have limited experience and only concentrate on popular culture for their scenes, but I try (to) open my eyes and ears to popular culture, so that I am familiar with their mindsets.

Another participant described a situation of responding to questions about their research, saying:

> I'm a PhD student and when I present my work, I have to be prepared to get questions from people who see my work from a different perspective, and I have to try to

> understand that perspective both to answer their questions and to improve what I'm doing.

These statements exemplify an active effort to take the perspective of teammates to enhance team improvisational performance. Multiple participants cited “selflessness,” “emotional intelligence”, “empathy,” and “not being apathetic” as vital skills for team improvisation. While mentions of empathy could suggest a more emotional than cognitive process (Davis 1983), it became clear after analyzing all responses that it was the understanding of others’ mental states, rather than the feeling of others’ emotions, that drove team success. Therefore, the term empathy was likely used as it often is colloquially (i.e., any time one behaves selflessly, including understanding others’ points of view), when the actual construct being described was perspective-taking. For example, many participants noted that behaviors that helped them actively incorporate others’ perspectives were important to improvise effectively within a team. That is, behaviors such as active listening and focused attention on teammates were generally described as important insofar as they provided rich information regarding others’ intentions, preferences, and abilities, indicating a thematic emphasis on understanding teammates’ perspectives. For instance, respondents noted that “active listening” was critical because it provided vital information for improv scenes such as “understanding tendencies of teammates,” while another implied that its importance lay in how it allowed them to “build a world and relationship with partners.” Another participant described how being able to read their teammates allowed them to become aware of when to end the scene before it went off track, saying, “you become familiar with your teammates’ habits and behaviors on stage, and can read them, so there is usually no problem ending scenes.” These statements suggest that when one listens with intent to understand a teammate’s perspective, they gather information on that teammate’s thoughts, feelings, and intentions, which then provides pathways forward for the improvisational scene that benefit all involved. One actor even described their reactions to teammates who do not display perspective-taking behavior, saying, "Sometimes, I feel like saying to improvisors, who are not listening, not receptive and not open to suggestions…have you already formulated a scene in your head that does not include me?" Thus, it is apparent that, when improvising in a team, cognition and behavior that provides insight into teammates' preferences, abilities, and cognitive states is beneficial.

Perspective-taking surfaced again when participants were asked how they prepared to improvise, as a number of the preparation exercises described directly involved reading teammate's emotions and intents or paying deep and full attention to others with the goal of understanding their mental states. For example, one respondent enjoyed participating in "mirroring exercises where everyone makes eye contact and tries to stay present and read…each other's emotions," while another stated that their preparation was to "make a very conscious effort to pay attention to what others are saying to me and how well I am fully listening to them." This first exercise is clearly an attempt to practice perspective-taking. Implied in the second is that the effort and attention will provide useful information about the others' mental states and characteristics, suggesting perspective-taking behavior. It should be noted that these respondents described preparation geared toward teammates or other people more generally as opposed to preparations involving more individual improvisational technique, such as brainstorming comedic phrases or character types.

Overall, this pattern of responses indicating the beneficial role of member perspective-taking in team improvisational performance invokes recent findings by Mannucci et al. (2020), who suggest that more collaboratively oriented improvisers "focus on understanding, nurturing, and expanding social structures" and "place value in being members of an open-minded community in which diverse views and unplanned, out-of-the-box actions are accepted and encouraged" (Mannucci et al. 2020, p. 22). Perspective-taking involves acknowledgement and incorporation of others' preferences, tendencies, and abilities into one's decision making (Davis 1983; Ku et al. 2015; Parker and Axtell 2001; Piaget 1932), and the qualitative data speak to how and why perspective-taking is important to effective team improvisation. Individuals high in perspective-taking form mental representations of both themselves and others, consider others' points of view and the context affecting their behavior, tend to be charitable and generous, and tend to be parts of effectively functioning groups (Caruso et al. 2006; Cialdini et al. 1997; Davis et al. 1996; De Dreu et al. 2000; Galinsky et al. 2005; Galinsky et al. 2008; Ku et al. 2015). As many of these themes emerged from the qualitative data, they suggest that teams composed of more members with high perspective-taking will exhibit better improvisational performance. Beyond this, the data also provide insight into how perspective-taking influences team-level behavior and how it facilitates the flexible use of member expertise. Such processes are discussed in the subsequent sections.

H1: Member perspective-taking has a positive effect on team improvisational performance.

The Mediating Role of Emergent Interdependence

Through what mechanisms might team member perspective-taking benefit team improvisational performance? The qualitative data suggest that perspective-taking influences a team's emergent interdependence—the degree to which a team operates interdependently beyond the influence of a task's structure—which then enhances improvisational performance (Caruso and Woolley 2008; Eisenhardt 1997; Raveendran et al. 2020; Wageman and Gordon 2005). Because improvisational tasks undertaken by teams are often performed best when the team makes synergistic use of its abilities and resources (Miner and O'Toole 2020), performance in these contexts is highly influenced by how interdependently the team is able to work. For instance, one participant described the importance of operating interdependently within an improvisational episode, noting the benefits of providing teammates with "positive cues for them to respond to that keep the scene going in a direction that has a good outcome for everyone involved." Another reiterated the importance of working interdependently through close collaboration, stating, "when you are on an improv team, collaboration is crucial…The more successful teams work together," while a different participant echoed, "if you can't collaborate, then you may as well not be a part of a team, as collaboration is the key to good improv." Another actor described the results of a less interdependent approach to team improvisation: "When performers take a more independent approach, the scenes feel forced and inauthentic. Performers tend to detach from the scenes when there is someone basically bullying their ideas onto the stage." Each of these quotes indicate that the best performing teams improvise as a unit by continually building off each other's decisions.

Team interdependence is often thought of as a structural variable, where task and reward characteristics shape team behavior (Courtright et al. 2015; Kozlowski and Bell 2003). However, in many situations, the level of emergent interdependence exhibited in team behavior varies despite the presence of identical structural conditions (Caruso and Woolley 2008; Raveendran et al. 2020; Wageman and Gordon 2005). Wageman and Gordon (2005) describe such cases as when "team members are assigned collective responsibility for the team's work, but the remaining elements of interdependence—the technology, the distribution of resources, and the process instructions—are left open" (Wageman and Gordon 2005; p. 688). That is, two teams facing the same task context might differ in the degree to which they operate interdependently while approaching the task, as when the participant quoted above described more and less independent improvisers. Due to the highly unstructured nature of improvisational tasks, this is a context in which emergent interdependence is likely to vary—some teams may address an unexpected, time-pressured situation by operating in close collaboration and working together to generate a response, while others may address it independently with members responding in an isolated fashion.

Highly interdependent teams are those in which members' behaviors, perspectives, preferences, and abilities exert a large influence on others' behavior (Caruso and Woolley 2008; DeChurch and Mesmer-Magnus 2010; Wageman and Gordon 2005). High perspective-taking individuals tend to be very attentive to these inputs, suggesting teams composed of such individuals will exhibit a high level of emergent interdependence (Davis 1983; De Dreu et al. 2000; Kozlowski and Bell 2003; Parker and Axtell 2001). For example, research finds that individuals high in perspective-taking are more interdependent in negotiations, incorporating partners' views into their decision making (De Dreu et al. 2000; Galinsky et al. 2008; Hoever et al. 2012). Recent work also suggests that perspective-taking can lead to enhanced information elaboration (Leroy et al. 2020) and knowledge sharing (Gerpott et al. 2020), indicating a higher level of interdependence between these coworkers. The gap in interdependence between those high and low in perspective-taking may be especially large in improvisational contexts that have the potential to trigger rigidity. In these contexts, explicit communication and strategic planning between team members is generally not possible and environmental stimuli are often highly salient and threatening due to their unfamiliarity (Rico et al. 2008; Staw et al. 1981). These contextual characteristics can result in prioritization of environmental stimuli (e.g., evolving tools, constraints, judges) and ignorance of social stimuli (e.g., team members' abilities, preferences, states), reducing emergent interdependence. This tendency is likely to be exacerbated in teams composed of low perspective-taking members.

The qualitative data presented here indicate that teams with high perspective-taking members work to incorporate knowledge about team members into their behavior, resulting in a higher level of emergent interdependence. For example, many participants described working to adjust the scene to accommodate teammate strengths by providing opportunities, supporting choices, and giving "gifts," which was the most-used phrase in responses. Specifically, actors described crucial team improvisational behaviors such as "providing opportunities for teammates to further explore their ideas," "giving 'gifts' to teammates that build on their original choices," "making your scene partner look like a genius," and "prioritizing your partner." Another participant described the role of perspective-taking in facilitating interdependent behavior, noting the importance of "understanding where your teammates are trying to go…" (i.e., perspective-taking) "…so you can support them" (i.e., emergent interdependence).

Clearly, respondents believed that actively supporting teammates was vital to team performance, with a specific bent toward being generous. The responses collectively emphasized providing opportunities for teammates to excel and consciously crafting the scene such that teams collaborated closely. That is, providing opportunities for others based on knowledge of others' traits and states was a vital part of designing the situation such that the team could address it interdependently with its collective strengths. One actor put it simply, saying, "teams need to set each other up for success," which echoes established guidebooks on improvisation, such as that by Halpern and colleagues (1994), which states that "the best way to look good is to make your fellow players look good" (Halpern et al. 1994, p. 43).

In sum, teams composed of members high in perspective-taking appear to be more likely to incorporate teammates' perspectives into their improvisational behavior, resulting in greater emergent interdependence. And while perspective-taking has been shown to be beneficial for a variety of team tasks (Ku et al. 2015), the insufficient time for strategic planning and the saliency of environmental stimuli in improvisational contexts may make perspective-taking especially important for emergent interdependence and team performance in such contexts.

> *H2: Member perspective-taking has a positive indirect effect on team improvisational performance via team emergent interdependence.*

The Effect of Member Expertise on Team Improvisational Performance

But how does the expertise of an improvisational team's members affect the team's performance? Why do highly skilled improvisers not necessarily improvise well in a team (e.g., Barrett 1998; Kamoche and Cunha 2001; Mannucci et al. 2020; Vera and Crossan 2005)? If member perspective-taking facilitates team emergent interdependence because members' behaviors are informed by teammates' abilities, then it follows that member perspective-taking could influence the degree to which expertise is beneficial for team improvisational performance. That is, when improvisational teams are composed of low perspective-taking members, they may be more likely to independently fall back on ideas and behaviors that worked in prior contexts rather than operate interdependently to make generative use of their expertise.

Crucial to the idea that expertise can be generative or inhibitive is that the elements of improvised behavior need not be completely novel (Baker et al. 2003; Weick 1998). When improvising, team members often draw from an existing pool of procedural and declarative knowledge (Cunha et al. 2016; Cunha et al. 1999; Kyriakopoulo 2011; Moorman and Miner 1998) as documented by organizational improvisation training which includes guiding principles such as "draw on reincorporation and ready-mades" (Vera and Crossan 2005). Effective improvisation at the team level involves both re-combining members' extant knowledge, experiences, and abilities in novel ways and incorporating completely novel behaviors to design an action tailored to the specifics of the current situation (Baker et al. 2003; Baker and Nelson 2005; Cunha et al. 1999; Moorman and Miner 1998; Miner and O'Toole 2020).

However, established knowledge and patterns of behavior can cause teams of people to be rigid when adhered to too closely (e.g., Coursey et al. 2019; Dane 2010; Miner and O'Toole 2020). While the flexible, novel combinations of these existing elements applied alongside entirely novel ideas can result in high levels of improvisational performance, teams do not always re-combine their members' knowledge in novel ways. Instead, they might apply the knowledge as is, repeating their behaviors and reactions, resulting in rigidity and suboptimal performance (Barrett 1998; Kamoche and Cunha 2001; Kyriakopoulo 2011; Mannucci et al. 2020; Vera and Crossan 2005). This is unlikely to result in effective improvisation, as how a team improvised in the past, even if effective at that time, is rarely an effective method for reacting the new context—not only are the environmental stimuli different in the new context (e.g., tools, constraints, judges), but the social stimuli are often different as well (e.g., team members' abilities, preferences, states). Therefore, effective team improvisation involves 1) flexibly re-applying members' expertise in novel ways 2) based on the environmental and social stimuli of a novel context. Thus, it follows that expertise alone is not sufficient for team improvisational success.

Due to the rigidity that can result from expertise (Dane 2010), some expert improvisational teams implement past strategies, with diminishing returns. One participant described members of such teams, who fall back on established behaviors as "creature(s) of habit," noting their tendency to:

> ...repeat their ‘improv situations’ and their ‘improv environments’ over and over again. They type-cast themselves. They play the same character they are comfortable with over and over and over again...the characters are so entrenched in their psyche they can’t let it rest.

This participant’s description of cognitive entrenchment—a high level of stability in one's domain schemas—is important (Dane 2010). The adaptation, creativity, and improvisation literatures have all presented a general puzzle regarding knowledge and flexibility, with extant knowledge found to be generative at times, as when teams use old knowledge to solve new problems, and inhibitive at others, as when teams are constrained by their prior knowledge of a subject (Coursey et al. 2019; Dane 2010; Frensch and Sternberg 1989; Gilbert 2005; Kyriakopoulo 2011; Vera and Crossan 2005). As Miner and O’Toole (2018) state that the research supports “memory’s potential to both enhance and reduce improvisation’s value” (Miner and O’Toole 2018, p. 22). In fact, participants in this study described the importance of “bringing a brick, not the wall” in team improvisation as a way of articulating that members must contribute to the team’s performance without rigidly force-fitting preconceived ideas against the will of the team. Understanding under what conditions this optimal knowledge combination occurs is key to helping teams capitalize on available expertise.

Based on the qualitative evidence presented above and findings from the literature, a team’s members’ perspective-taking is likely to influence the degree to which members’ expertise enhances team improvisational performance. Team members low in perspective-taking are more likely to narrow their focus to their personal goals and perceive less of a need to perform as a team (Ellis 2006; Galinsky et al. 2005; Leroy et al. 2020; Mathieu et al. 2000), which can result in more independent work and reduced knowledge recombination between members (Dietz et al. 2017; Driskell et al. 1999; Gerpott et al. 2019). Without exposure to and consideration of novel perspectives, members risk cognitive entrenchment, potentially causing knowledge to be applied to a novel context as it was to a past context—that is, untailored to the present situation's specific characteristics (Dane 2010). This is likely to hurt team improvisational performance. One participant described situations when improvisers take self-centered approaches without considering teammates' perspectives, displaying how teammates of such members will not effectively apply their expertise. They recalled thinking about such teammates, "You've obviously planned the whole scene in your head beforehand, so what am I doing here?" Because the scene incorporates only one member's perspective, their teammates' expertise is unlikely to be utilized. The participant went on to say that this behavior, indicative of low perspective-taking, tells them that teammates:

> …are not listening, not interested in responding to the gift, and are more interested in pursuing their own thought processes and planned scene rather than building the mutual scene...It's a real let down, because it kills the scene dead in its tracks.[2]

Moreover, while the contextual characteristics of situations calling for improvisation (e.g., time-pressure, threat) tend to make environmental stimuli highly salient, perspective-taking heightens the tendency to nevertheless incorporate social stimuli (e.g., teammates' traits and states) into one's behavior. Doing so facilitates the generative use of expertise by providing opportunities based upon teammates' expertise as described in the previous section. Such behavior reduces the likelihood of implementing outdated ideas where they do not apply (Leroy et al. 2020; Radaelli et al. 2014; Staples and Webster 2008) and allows for capitalization on diversity in generating and implementing creative ideas (Hoever et al. 2012; Mannucci et al. 2020). This logic is supported by the qualitative data in this study, such as when one participant with a high level of improvisational expertise ascribed their ability to be novel and collaborative when working in a team to a perspective-taking mentality, saying, "I'm extremely flexible and

[2] This self-centered teammate behavior may also have negative effects on team satisfaction or cohesion, as the participant went on to liken this behavior to "being slapped with a wet fish."

empathetic to different cultures and people, so I can pretty much be given a suggestion and run with it." In sum, members' expertise may be more beneficial for improvisational performance via emergent interdependence in teams with members high in perspective-taking.

H3: The positive effect of team member expertise on team improvisational performance via emergent interdependence is stronger the higher the members' perspective-taking.

Phase 2: Field Experiment with Improvisational Teams

Method

Research Setting and Participants

To test the proposed hypotheses, a field experiment was conducted using a team composition manipulation at the same improvisational theater company that was the focus of Phase 1. Participants were recruited from the pool of actors registered in classes or participating on formal improv teams at the theater company. All participants who volunteered to participate in the experiment had also provided qualitative data presented above. Data collection took place over a span of five months (August 2019 through January 2020) and included six shows. Each show consisted of multiple sets, which are the times when improvisational teams performed on stage. For each show, teams were composed from the pool of available participants for that show. In total, 44 individuals participated in shows, making up 56 different teams (55% female, M_{age} = 40.41, SD_{age} = 13.50). Teams were composed such that no team performed together twice. In addition, a total of 34 audience members who volunteered to come to each show were recruited to rate team performances by a researcher approaching them to ask if they would like to participate in a research study. Audience members could be any member of the broader population, and thus likely varied in their expertise regarding improvisation. Additionally, though audience members were not identified in the recruitment process, it did not appear to me that any audience members were present at more than one show.

Procedure

All individuals provided consent and completed a survey measuring various individual differences, including perspective-taking. This survey was completed well prior to when team data collection began. Over the following five months, six shows took place at the theater. Shows were free to the public. Three-person teams were composed prior to each show, and participants did not know who their teammates were until approximately 15 minutes before they performed their set. Once teams were announced, all participants completed a pre-set survey regarding expectations of the upcoming show and prior experience with teammates. Then teams performed their sets for the audience. Sets were limited to exactly eight minutes of performance time, and all teams were video recorded. Following each set, each participant completed a post-set survey measuring perceptions of the performance. Each recruited audience member also rated teams' performances after their sets.

Intervention

Team composition was manipulated by composing teams based on differences in individual perspective-taking. As part of the survey administered at the onset of the project, all participants completed the four-item measure of perspective-taking from Grant and Berry (2011). The survey was completed once by all participants multiple days or weeks before any shows took place. This was a conscious experimental design decision made to strengthen the claim that perspective-taking is an individual trait that affects team performance, rather than a cognitive state, as could be argued had it been measured the same day as team performance (e.g., Hu and Judge 2017). The scale's validity and reliability has been demonstrated using supervisor-report measures of behavior in existing work (e.g., Davis et al. 1996). Team members indicated the extent to which statements were accurate (1 = "Very accurate", 7 = "Very inaccurate") (α = .91). A sample item is: "I frequently try to take other people's perspectives."

Because not all participants were available to participate in every show, participants indicated whether they were available to participate in a given show. Then, for each show, the pool of available participants for that show was divided into high and low perspective-taking pools based on a median split of that particular pool.[3] Teams of three were then randomly assigned from within the high and low pools of participants for each week, generating teams of either all high or all low perspective-taking members. In some cases, a participant performed on multiple teams across the different shows over the five months; analyses controlled for this multiple team membership. Following random assignment, team membership was adjusted whenever necessary such that no three members performed together more than once. As a manipulation check, the mean level of perspective-taking in high and low teams was calculated. Teams in the high perspective-taking condition had significantly higher levels of perspective-taking (n = 29; M_{HiPT} = 6.34) than teams in the low perspective-taking condition (n = 27; M_{LoPT} = 4.96; $t(54) = -14.32$, $p < .001$). To capture the full granularity of the perspective-taking measure, perspective-taking was operationalized as a continuous variable in all analyses.

Measures

Team performance. Given the format of the improv shows, in which teams performed sets for a viewing audience, an audience consensus technique was employed (e.g, Amabile 1982) to measure team performance. As the purpose of the improv show is to entertain the people who attend, this performance measure comes directly from the teams' "client" and therefore adequately captures a team's performance, as outlined by Hackman (1987) when describing measures of performance in organizations. Thus, audience members who attended the shows

[3] Each week's teams were inspected following this calculation to ensure there were no cases where those falling below (or above) the median split might still be high (or low) in perspective-taking relative to the entire sample because a majority of total participants that week were high (or low) in perspective-taking. The lowest average perspective-taking of teams in the high perspective-taking condition was .75 out of 7 points higher than the highest average perspective-taking of teams in the low perspective-taking condition.

judged teams' performance based on their own definitions of improvisational quality (Amabile 1982). Importantly, because improvisational processes generally cannot reliably produce a particular type of outcome and therefore should not be expected to (Fisher and Barrett 2019), this is an adequate measure of improvisational performance in that it requires only that the product be viewed as enjoyable by an audience (Hackman 1987). Therefore, there exist numerous iterations of a "good" performance on this improvisational task, and teams may approach those iterations via numerous pathways. This measure allows improvisational performance to be captured without unreasonably narrowing the range of definitions of success in this context.

At each of the six shows, audience members rated the quality of each team's set (1 = "Poor", 7 = "Excellent"). Audience members varied between shows, and, in total, 34 different raters judged team performance, with an average of five raters judging each team. Because each team was rated by a different set of raters randomly drawn from the population of potential raters, ICC(1) was computed to assess agreement, which reached an acceptable value for aggregation (ICC(1) = .41, $p < .001$; Bliese 2000; LeBreton and Senter 2008; McGraw and Wong 1996). Rater scores were averaged for each team.[4]

Member expertise. The more improv classes a participant had completed, the more domain expertise they possessed. As the focal comedy theater provides five levels of theater classes, with higher classes being more advanced, the highest level of class that each participant had completed was recorded. Participants must graduate from one class to advance to the next level, so those who have completed more class levels have acquired more expertise in the process of improvisation. If participants were new to the focal theater, they indicated the

[4] Actor participants also indicated their perceptions of their team's performance. The three scores for each team were averaged (ICC(1) = .14, p = .054). This perceived performance was significantly correlated with audience-rated performance (r = .49, $p < .001$); the audience-rated performance measure was utilized in all analyses.

comparable class level they had completed at a previous theater. This provided an unobtrusive measure of expertise for each member. The average level of class experience from each team's three members was taken as the team's level of expertise. Minimum and maximum values of this measure were also considered and tested, resulting in similar outputs.

Emergent interdependence. Extant work argues that, given the very same structural interdependence, teams can vary in their emergent interdependence, or the degree to which they work interdependently on a task (Caruso and Woolley 2008; Raveendran et al., 2020; Wageman and Gordon 2005). In this context, while teams were structured to operate as a highly interdependent unit, they could vary significantly in the level to which they did so. For instance, some teams might develop scenes by handing them off sequentially, where only one or two people are on the stage at a time. In such a case, each person could pick up wherever the last person departed, and then proceed to spin their own story with minimal connection. When offstage, members do not interact. This behavior would represent a low level of emergent interdependence, as there was only minimal interaction between members. By contrast, when members are on the stage together, they must integrate more completely with what the other members are saying or doing. The more members are on the stage together simultaneously, the more interaction between members, and the greater the emergent interdependence (see Appendix B for images of different subsets of a team on stage during the same set).

To evaluate the level of emergent interdependence in each team, videos of each team's performance were coded by totaling the amount of time that the team had one member, two members, and three members on stage simultaneously. In this context, more simultaneous members on stage signals greater emergent interdependence as explained above, so the amount of time two members were on stage was multiplied by two, and the amount of time three members were on stage was multiplied by three to compute the team's emergent interdependence score. No credit was given for time when only one member was on stage. This score was then divided by the total amount of seconds the team performed to standardize scores across teams. For example, Team 1 had one member on stage for three seconds, two members on stage for 163 seconds, and three members on stage for 294 seconds. Their total emergent interdependence score was 0(3) + 2(163) + 3(294) = 1,208 / 460 = 2.63.

Controls. Participants indicated before each performance if they had performed with any of their teammates in the past, and a variable was created to control for *team experience*. Teams were coded as 1 if any two members of the team had performed together, 2 if all three members had performed together as a team, and 0 otherwise. In only one case had a team performed together as a unit in the past. This variable controls for the possibility that prior experience working together influences an individual's ability to take perspective and therefore affects team improvisational performance, allowing for the focus to be on perspective-taking as a trait difference. Because data collection took place over six separate shows, the *week of observation* was controlled for.

Finally, because trait perspective-taking may be correlated with other individual difference variables, four additional variables with potential links to perspective-taking were measured to test for confounds of the team member perspective-taking composition manipulation: trait mindfulness was measured using the Mindfulness Attention Awareness Scale (Brown and Ryan 2003; correlation with trait perspective-taking at the individual level in this sample: $r = -.17$), trait emotionality was measured using the measure from Gosling et al. (2003; $r = -.05$), social sensitivity was measured using the Reading the Mind in the Eyes test (Baron-Cohen et al. 2001; Woolley et al. 2010; $r = .03$), and performance on a brainstorming task was measured as total ideas generated (Korde and Paulus 2017; r = -.26).[5] At the team level, only trait mindfulness differed significantly across conditions (M_{HiPT} = 3.41, M_{LoPT} = 3.52, t = 2.63, p = .01) and none were significantly correlated with team improvisational performance.

Results

Tests of Hypotheses

Descriptive statistics and correlations between study variables are presented in Table 2. Multiple membership models (MMM; Browne et al. 2001) were run to test the proposed hypotheses. MMM allows one to address the fact that individuals may have served on multiple teams during the course of data collection, which creates a lack of independence between teams. By including a combination of random effects for each member, the variance explained by individuals for each team can be partitioned. The R package M2LwiN and iterative generalized least squares methods were used to fit the models. OLS models, reported in Table A1 in Appendix C, showed very similar results to MMM.

Hypothesis 1 predicted that team perspective-taking would be beneficial to team improvisational performance. Mean team member perspective-taking had a significant effect on team performance (B = 0.31, p < .05; Table 3, Model 1).

Hypothesis 2 predicted that emergent interdependence would mediate the positive effect of member perspective-taking on team improvisational performance. Testing for mediation was conducted using a bootstrapping technique, though the nature of the data (i.e., non-independent observations) renders such a technique a conservative test of mediation in multiple membership contexts (Gupta and Woolley 2018; Hayes 2013). A 5,000-iteration bootstrapped mediation

[5] Participants were given three minutes to generate responses to the following prompt: “Imagine if everyone born after 2018 had an extra thumb on each hand. This thumb would be built just as the present one, but located on the other side of the hand. It faces inward, so that it can press against the fingers just as the regular thumb does now. Here is the question: What practical benefits or difficulties will arise when people start having this thumb?”

analysis testing the indirect effect of team member perspective-taking on improvisational performance via emergent interdependence and controlling for week of observation and prior team experience using PROCESS Macro model 4 (Hayes 2013; Preacher and Hayes 2004) revealed a confidence interval including zero (b = 0.09, SE = 0.08, 95% CI: [-0.01, 0.28]), though the effect did trend in the predicted direction.

Finally, hypothesis 3 predicted that member expertise would be more beneficial to team improvisational performance via emergent interdependence when teams were composed of high perspective-taking members. First, the interaction of member expertise and member perspective-taking on team improvisational performance was found to be significant (B = 0.47, $p < .04$; Table 3, Model 2). The interaction was probed to examine data patterns and Figure 2 shows that perspective-taking was more beneficial for team performance the more expertise the team had (B = 0.76, SE = 0.27, $p < .01$). Next, the interaction of member expertise and member perspective-taking on emergent interdependence was found to be significant (B = 0.18, $p < .01$; Table 3, Model 3), bearing a similar pattern of results: expertise increased emergent interdependence for teams with high perspective-taking members (B = 0.18, SE = 0.07, $p < .02$) but not for teams with low perspective-taking members (B = -0.11, SE = 0.08, $p < .14$). Finally, a moderated mediation analysis controlling for week of observation and prior team experience using PROCESS Macro model 7 revealed a confidence interval excluding zero (b = 0.23, SE = 0.14, 95% CI: [0.01, 0.56]).[6] Figure 3 shows that member expertise was beneficial for team improvisational performance via emergent interdependence only when member perspective-taking was high.

[6] This moderated mediation model was not significant when using minimum or maximum measures of team members' expertise.

In addition, this moderated mediation analysis was significant when controlling for member mindfulness, emotionality, social sensitivity, and brainstorming performance (b = 0.25, SE = 0.14, 95% CI: [0.03, 0.58]). Thus, while one cannot test for all possible alternative explanations, these results give further confidence to the idea that perspective-taking is uniquely driving the observed effects.

Discussion

In this field experiment, members' expertise only benefited team improvisational performance via emergent interdependence when teams were composed of high perspective-taking members. This suggests that, though it may be intuitive to compose teams likely to face rapidly changing contexts with high-expertise members, doing so may not necessarily benefit improvisational performance. Moreover, member perspective-taking appears to be one relevant factor in determining the effect of expertise on team improvisational performance (Dane 2010; Miner and O'Toole 2020).

This study makes a number of methodological contributions to research on the use of expertise in rapid adaptation. The field experiment avoided common method bias by using a behavioral measure of emergent interdependence, an unobtrusive measure of member expertise, and a judge-based measure of performance, all characteristics rare in a field characterized by many foundational theoretical, qualitative, laboratory, and correlational studies (Burke et al. 2006; Christian et al. 2017; Ciuchta et al. 2021; Fisher and Barrett 2019). Furthermore, this study directly addresses calls for more rigorous research methods emphasizing causal claims when studying rapid adaptation such as improvisation (Ciuchta et al. 2020; Fisher and Barrett 2019). Specifically, Ciuchta and colleagues (2020) note the dearth of "quantitative studies of time-varying causal models of improvisation subprocesses and intermediate variables" using "a mixed-methods design" that includes "an experiment or, even better a field experiment" (Ciuchta et al. 2021, p. 22).

General Discussion

The multi-method study reported here finds evidence that, counterintuitively, teams composed of high expertise members will not necessarily outperform less expert teams in rapid adaptation contexts, and that expertise only appears to help teams rapidly adapt when they are composed of high perspective-taking members. The qualitative data from Phase 1 suggests that member expertise could have a beneficial or detrimental effect on team rapid adaptation performance depending on how that expertise was employed by the team. The subsequent field experiment in Phase 2 supports this notion by finding that only in teams composed of high perspective-taking members did expertise enhance team rapid adaptation performance via emergent interdependence. Taken together, the two phases explain that perspective-taking enables the generative use of members' expertise in rapid adaptation contexts by facilitating the formulation of problems that are suited to the team's strengths. These problems may therefore be addressed by drawing interdependently upon members' expertise, resulting in strong rapid adaptation performance.

This study has important implications for modern organizational teams that are called upon to face an increasing amount of rapid adaptation contexts. For one, it suggests that a key to unlocking the potential of a team's expertise under quickly changing conditions lies in the individual differences of its members. This is particularly important given the rise in value of expertise, which tends to result in teams being increasingly composed of domain experts. This research joins a growing body of work finding that simply composing teams with experts is not enough to facilitate rapid adaptation performance. To avoid misusing team expertise in crucial rapid adaptation contexts, managers must also consider additional factors to fully capitalize on their teams' expertise—this study rules in trait perspective-taking as one relevant factor, and explains why that is the case.

In addition, literature examining the effect of expertise on rapid adaptation has noted the importance of incorporating real-time environmental information when applying expertise to help avoid rigidity (Moorman and Miner 1998; Vera and Crossan 2004; 2005). For example, when a client drops a competitor from a high-value project, a consulting team might improvise a last-second pitch, drawing upon its expertise in the technical aspects of its proposed solution. But crucially, the team must update the pitch on the fly based on evolving information regarding the client's impatience with the competing firm as the project has gone over schedule and over budget. When it hears this news, the team switches the emphasis of its pitch from the technical aspects of the proposed solution to its dedication to and history of balancing efficiency and effectiveness.

However, the study reported here reveals the importance of an additional factor, finding that the incorporation of social stimuli—teammates' abilities, preferences, and cognitive states—into team rapid adaptation enhances the ability to apply expertise effectively based on a changing environment. For example, while updating its pitch in response to new information, the team might also design the pitch around its members' strengths. First, the client's focus on timeliness and logistics might cause the team to switch its lead presenter from an inspirational, big picture speaker to a more pragmatic, down-to-earth presenter. Second, when a member reveals to the team that they are feeling nervous about the presentation, the team might assign them a behind-the-scenes support role rather than a speaking one. Finally, because the client was frustrated about a lack of even an early-stage prototype, the team might redesign its pitch around a prototype that has already been engineered by a domain expert on the team who can speak on its potential.

In contexts calling for rapid adaptation such as the one described above, adjusting behavior based upon both environmental and social stimuli appears to help teams dynamically formulate problems that both 1) accurately address the underlying issues in the environment and 2) can be solved by interdependently drawing upon members' expertise. Therefore, simply possessing expertise is not sufficient to rapidly adapt effectively—in order for expertise to be generative, members must incorporate how their teammates are perceiving the situation into their behavior to stimulate interdependence and play to their strengths.

As mentioned previously, these findings hold intriguing implications for rapid adaptation in more traditional organizational contexts than the theater company utilized here, especially those in which surprises are expected, such as first responder teams or new product development teams (Bechky and Okhuysen 2011; Brown and Eisenhardt 1997; Eisenhardt, 1989). For one, they could represent an answer to the difficult question of how a team can prepare to be unprepared: teams both armed with accurate knowledge of teammates' stable characteristics prior to the task and primed to perspective-take during the task may be in a good position to translate expertise into effective rapid adaptation. Priming perspective-taking could be particularly beneficial, as team composition research can face difficulties in practical application because some organizational work does not allow for flexible assembly of teams. Research has shown that perspective-taking can be manipulated using various types of prompts and exercises (e.g., Batson et al. 1997; Galinsky and Moskowitiz, 2000; Galinsky et al. 2008), so while it is measured here as a stable individual characteristic, the observed results may hold when manipulating perspective-taking instead (e.g., Galinsky et al. 2008; Wang et al. 2014). Future research should confirm this position, because if so, managers could implement relatively quick perspective-taking interventions when teams are called upon to address situations calling for rapid adaptation, potentially boosting performance.

In total, through the development of middle range theory (Eisenhardt and Bourgeois 1988; Merton 1949), this study works to bridge the gap between empirical findings of a specific context—an improvisational theater company—and higher-level theories of behavior—the relationship between expertise and adaptation. Adopting an abductive, multi-method approach that incorporates both qualitative and quantitative data is particularly useful for bridging this gap when studying phenomena that are difficult to observe in everyday organizational settings. The more inductive, qualitative stage of the research process allowed me to become immersed in the empirical context and revealed the relevant constructs to measure in the subsequent deductive, quantitative stage. In this way, this study contributes to literature on expertise and adaptation both via its specific findings regarding member perspective-taking, emergent interdependence, and the use of expertise in rapid adaptation and via the progress it makes toward a more coherent body of research on these topics.

Limitations and Future Directions

Naturally, this research is not without limitations, which provide opportunities for future work. First, this study focuses on a team's ability to improvise well, given its decision to improvise. Future research could examine how team compositional factors, such as member perspective-taking, influence a team's propensity to improvise. How might a team's distribution of expertise influence the propensity to improvise (e.g., Vera and Crossan 2004), and how might perspective-taking impact this effect? Second, teams in this study were composed such that all three members were either high or low in perspective-taking, but future research could examine these variables in the contexts of other team sizes and compositions, such as larger teams or teams with only majority high or low perspective-taking members.

Third, despite research displaying the effectiveness of perspective-taking interventions, other work has found that people who consider others' perspectives are not always accurate in their perceptions (Eyal et al. 2018; Ku et al. 2015). While the study reported here finds that teams with members high in perspective-taking set each other up for success based on awareness of teammates' abilities, preferences, and cognitive states, these data do not permit verification that what a teammate perceives as another's perspective is actually their perspective. However, if individuals high in perspective-taking were inaccurate in their perceptions of others' perspectives in this sample, we would expect teams composed of such members to experience a performance detriment, as they would be "giving gifts" that set their teammates up for failure rather than for success. This is counter to what is observed in the data. So while the high perspective-taking individuals in this sample appeared to be accurate in their perceptions of teammates, researchers and practitioners must be wary of perspective-taking that results in inaccurate perceptions and ineffective behavior.

Regarding the relationship of expertise and rapid adaptation, the task-relevant expertise in this context was improvisational expertise and team performance was measured in the theater context. However, the observed effects may differ if a team's expertise is on a specific task that then must be adapted due to changes in context (e.g., an accident at work means a team of master carpenters must complete a task without their preferred tools). Future research could examine how expertise on a specific task influences team rapid adaptation of that task, and whether member perspective-taking influences that relationship. Additionally, while experience working with team members is controlled for in this study, such experience likely plays a role in team performance when facing contexts calling for rapid adaptation (Vera et al. 2016). This could even be because it enhances perspective-taking behavior or emergent interdependence, though no evidence was found for the latter in this study. Researchers should continue to examine team experience's role in rapid adaptive performance and the mechanisms through which it works, ideally using longitudinal methodologies to observe effects over time (Fisher and Barrett 2019; Orlikowski 1996).

Finally, while the use of the improvisational theater as the research context allowed rich qualitative data to be collected and a field experiment to be conducted in a setting where teams must face contexts calling for rapid adaptation, data from more traditional organizational contexts are not presented. Thus, while these findings likely translate well to teams that anticipate they will be engaging in improvisation (e.g., emergency response teams), their generalizability to teams in other organizational contexts where improvisation is often a result of an unforeseen problem or opportunity is less clear. Given the general consistency of research findings on improvisation across traditional and non-traditional contexts (Ciutchta et al. 2020; Miner and O'Toole 2020) and given that the majority of participants in this sample noted utilizing a high level of improvisation in their disparate professions, it may be predicted that these findings do generalize to more traditional organizational contexts where improvisation is not as focal or as highly anticipated. However, additional research is needed to determine the degree of the generalizability.

In sum, this research explicates the role of team member perspective-taking as a moderating factor in the relationship between member expertise and team rapid adaptation performance, presenting potential answers to the tricky question of how a team can prepare to be unprepared and make better use of its members' expertise when facing rapid adaptation contexts.

Tables and Figures

Table 1

Participant Examples of Improvisation at Work

"A coworker was floundering during a presentation, I started asking questions that helped him regain his train of thought without being obvious"	"When I give talks I leave portions of the talk out and just say what comes to my mind."
"I worked at (a local museum), and many times we would have impromptu visitors show up, like Board Members … and I would have to give an 'impromptu talk' about whatever it was I was doing at the time"	"I was facilitating an anger management group, and my clients didn't seem to be understanding (the) concepts … I switched gears during the group and created a fictitious scenario to demonstrate how people think, feel, and respond differently to the same situation. My clients ended up understanding when I switched my tactics"
"When work looks like it might not get done...being willing to try divvying up the assignments either differently or across more people in combinations that haven't been tried before"	"I'm in sales. I talk to strangers all day and I have to listen to them and react/respond with empathy or quickly grasp their points. They can say all kinds of things so I just have to stay in the flow to respond"
"I mostly use my skills to banter with coworkers but it has improved my communication skills for issues that arise"	"When teaching class, I try to grab onto jokes that are working to keep students on their feet"
"I have been a professional storyteller and teaching artist for almost 20 years. My most successful programs are when I trust myself to make stories up on the spot from a variety of prompts. My decision is to use improvisation almost exclusively in storytelling because the results are always fresh and original."	"I'm a PhD student and when I present my work I have to be prepared to get questions from people who see my work from a different perspective, and I have to try to understand that perspective both to answer their questions and to improve what I'm doing"
"As a college instructor, a large part of my job is listening to and validating my students' ideas while helping to shape them"	"Everyday I have a list of things I'd like to get done, but if a problem arises (like an email I wasn't expecting) I will pause and respond to that email and take steps to resolve the problem"
"Making sense of a project for which clear direction is lacking"	"There are many opportunities to improvise in work with children as well as individuals with severe mental illness; lots of thinking on one's feet"
"I write software for art installations. This means doing quick responses to changing requirements"	"I'm a journalist, so I ask questions on the fly"

“I'm a senior software engineer. I work independently and frequently have to figure out how to do something I've never done before, and often no one else had done it either”	“I teach, so I'm always improvising with students as they ask questions. I constantly integrate current events and try to make parallel examples with things that are happening now”
“Today, I installed a doorbell. I had no instructions nor have I ever installed a doorbell previously. However I have had past experiences working with many electrical devices, I drew off of that knowledge to figure out how to properly wire it”	“I find that when something doesn't work out as planned or a problem arises at work, my mind automatically jumps into improv mode and I think of some out-of-the-box solutions using the information I have about the problem”
“When my coworkers come up with a problem, I ‘yes and’ them into the solution. That is, I listen to what they say and give other ideas to help them fix their problem”	

Table 2

Correlations and Descriptive Statistics Among Field Experiment Measures

	Variable	1	2	3	4	5
1	Improv Performance	–				
2	Perspective-Taking	.28*	–			
3	Team Experience	.19	.22	–		
4	Member Expertise	.15	.41*	.29*	–	
5	Emergent Interdependence	.40**	.26	.10	.23	–
	Minimum	2.80	3.42	0	1.00	1.80
	Maximum	6.50	6.75	2	4.67	2.97
	Mean	4.87	5.67	–	3.38	2.41
	SD	0.91	0.79	–	0.80	0.28

Note. $n = 56$. $^{*}p < .05$ $^{**}p < .01$.

Table 3

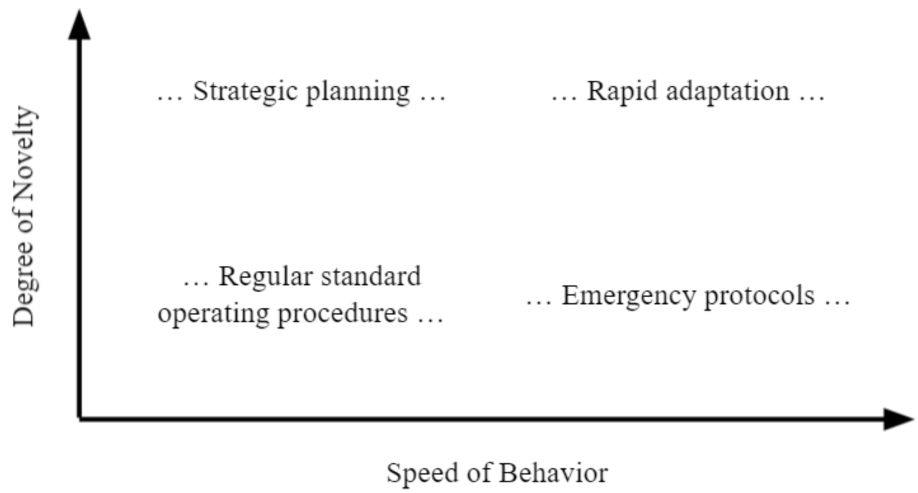
Multiple Membership Model Analyses of Field Experiment Data

Variables	Model 1 (DV: Improv Performance)	Model 2 (DV: Improv Performance)	Model 3 (DV: Emergent Interdependence)
Perspective-Taking	0.31* (0.01, 0.61)	0.33* (0.02, 0.64)	0.08 (-0.02, 0.17)
Member Expertise		0.02 (-0.30, 0.33)	0.03 (-0.06, 0.13)
Perspective-Taking × Member Expertise		0.47* (0.06, 0.87)	0.18** (0.06, 0.30)
Team Experience	0.34 (-0.29, 0.98)	0.34 (-0.28, 0.97)	0.02 (-0.16, 0.21)
Week of Observation	0.03 (-0.11, 0.17)	-0.04 (-0.10, 0.17)	-0.02 (-0.06, 0.02)
Intercept	2.71** (0.87, 4.55)	4.33** (3.58, 5.07)	2.41 (2.19, 2.64)
DIC	141.70	136.70	1.90
Random Components – Variance Estimates			
Level 1	0.74	0.67	0.06
Level 2	0.00	0.00	0.00

Note. $n = 56$. DV = Dependent Variable. 95% confidence intervals in parentheses. $^{*}p < .05$ $^{**}p < .01$.

Figure 1

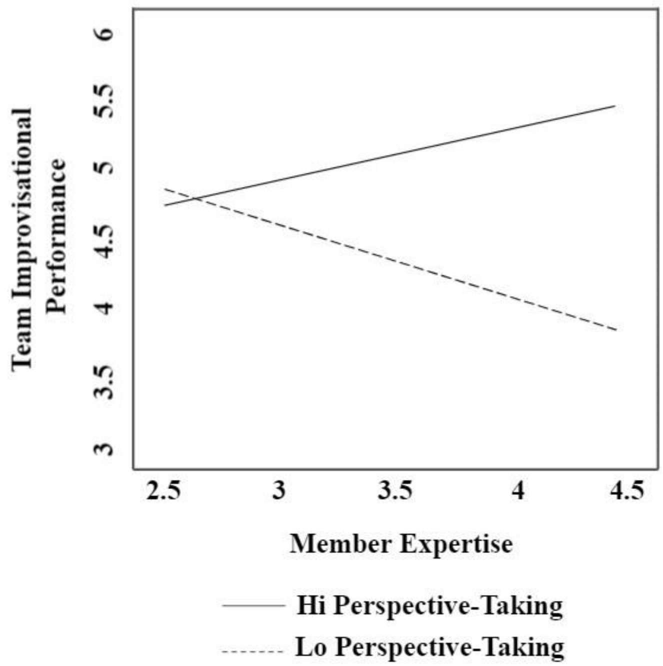
Dimensions of Behavior in Organizations



Note. Rapid adaptation can be understood with regard to two dimensions of behavior. "Rapid" refers to the speed of a behavior; specifically, the amount of time separating the beginning and end of the behavioral process (less time = higher speed). "Adaptation" refers to the degree to which the behavior is a novel reaction to the context (more novel reaction to context = higher adaptation).

Figure 2

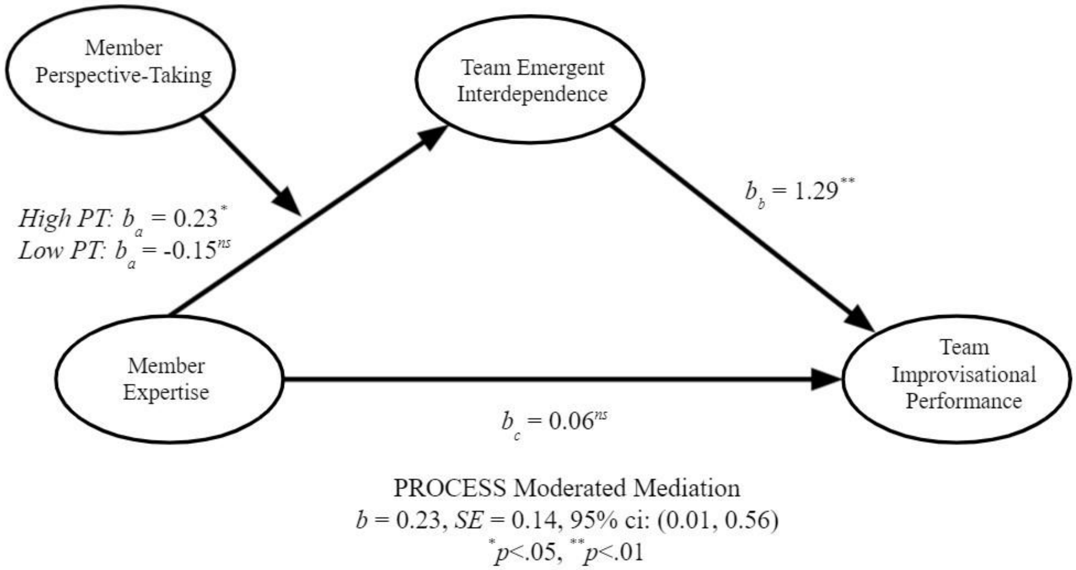
Interaction Effect of Member Perspective-Taking and Member Expertise



Note. Interaction effect of member perspective-taking and member expertise on team improvisational performance.

Figure 3

Interaction Effect of Member Perspective-Taking and Member Expertise on Improvisational Performance via Emergent Interdependence



Appendix A

Open-Ended Survey Questions

- In your performances, how often do you draw upon past ideas, narratives, ready-mades, actions, scenes, etc. that you have utilized in prior improvisational performances, updating them for the current scene? Please briefly explain your response to the previous question.

- What methods, if any, do you use to practice for your improvisational performances? That is, how do you prepare to improvise?

- What are some skills that are important to have when improvising in a team? Ex. delivering jokes, predicting teammates' actions, knowing when to end a scene, etc.

- Which of the skills you mentioned above are you best at?

- Moving outside of the improvisational theater, how often do you improvise in any way in your profession? If possible, please provide a brief example of an improvised action you took or decision you made in your profession.

Appendix B

Note: Teams had the choice of how many members appeared on stage at any given time. In the screenshot on the left, two members are on stage while one is offstage right. In the screenshot on the right, all three members are on stage.

Appendix C

Table A1

OLS Regression Analyses of Field Experiment Data

Variables	Model 1 (DV: Improv Performance)	Model 2 (DV: Improv Performance)	Model 3 (DV: Emergent Interdependence)
Perspective Taking	$0.31^{\dagger}$ (-0.01, 0.63)	$-1.25^{\dagger}$ (-2.73, 0.24)	-0.52^{*} (-0.97, -0.10)
Member Expertise		-2.63^{*} (-5.15, -0.11)	-0.97^{*} (-1.73, -0.22)
Perspective Taking × Member Expertise		0.47^{*} (0.03, 0.90)	0.18^{**} (0.05, 0.31)
Team Experience	0.34 (-0.33, 1.02)	0.34 (-0.33, 1.02)	0.02 (-0.18, 0.23)
Week of Observation	0.03 (-0.11, 0.18)	0.04 (-0.11, 0.18)	-0.02 (-0.06, 0.02)
Intercept	2.71^{**} (0.75, 4.66)	11.35^{**} (2.97, 19.73)	5.27^{**} (2.76, 7.79)
R^2	.10	.18	.22
Overall F	1.97	$2.17^{\dagger}$	2.80^{*}

Note. $n = 56$. DV = Dependent Variable. Unstandardized regression coefficients displayed with 95% confidence intervals in parentheses. $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$.

Chapter 4

An Expert in this Domain or that Domain? The Effects of Advisors' Expertise and Advice Framing on Advisees' Perceptions and Creative Problem-Solving

Benjamin Ostrowski & Anita W. Woolley

Abstract

When solving complex problems, individuals and teams often benefit from receiving advice from outside experts. The domain of advisors' expertise, and the way their advice is communicated, can have an important influence on the degree to which problem solvers see it as credible and make use of it, with implications for their problem-solving performance. Across three studies, advisors with expertise in areas other than the domain of the focal task—complementary expertise advisors—were rated as less impactful, less enjoyable to work with, awarded less prize money, and perceived to have more general expertise but still be less competent than advisors with expertise in the focal task's domain—domain expertise advisors. They were also preferred and chosen over a domain expertise adviser just 9% of the time when given the choice. Despite these differences in preference, participants with complementary expertise advisors consistently performed just as well or better than those with domain expertise advisors. These findings highlight people's tendency to avoid and dislike advisors who might identify new problems or suggest unfamiliar ideas, at the expense of exposure to unique perspectives and, potentially, of creative performance over time.

Giving and receiving advice is a common component of organizational functioning. Because advisors can leverage knowledge and experience to help people overcome challenges or spark new ways of thinking (Arendt et al., 2005; Ter Wal et al., 2020), the full problem-solving process is not commonly undertaken solely by one individual or even one team. More often when people attempt to understand and solve problems, they elicit or are assigned help from people not directly involved with the problem (De Stobbeleir, Ashford, and Buyens, 2011; Harrison and Rouse, 2015; Rouse, 2020). However, the degree to which an advisor is helpful in formulating a solution that effectively solves a problem depends greatly on 1) how useful the advice is and 2) how the person integrates the advice into their work—for example, an advisor could provide excellent feedback that is disregarded, or misguided feedback that is heavily utilized. This research examines the factors that influence both how people select an advisor and how advisor feedback is integrated into people's problem-solving processes.

Outside advisors could be selected for a number of reasons, and depending on the personal or organizational processes that led to their selection, advisors could be experts in the domain of the problem itself (e.g., a marine biology professor called on to advise the reintegration of a species of fish) or experts in a different domain entirely (e.g., a marine biology professor assigned to advise on the construction of a new building on campus; Arendt et al., 2005; Ter Wal et al., 2020). Beyond, but related to, their primary area of expertise (e.g., education field on a resume), advisors differ in the content of the advice they offer (e.g., choice recommendation) and the delivery of that advice (e.g., language tone). Because advice may vary based on advisors' expertise and because people's perceptions of that advice may be influenced by characteristics of the advisor, these factors likely play a key role in how advice is perceived and integrated during the problem-solving process. Eventually, they influence the efficacy of the chosen solution.

Theoretical Background

Domain and Complementary Expertise Advisors Can Both be Beneficial for Problem-Solving

When solving a problem in a given domain, most problem-solvers seek advice from an expert in the same domain with the belief that the closer an advisor's knowledge is to the task at hand, the more beneficial the advice will be. Cognitively, there is reason to believe that domain experts will be highly useful in recognizing potential problems in proposed solutions: they have accumulated large stocks of relevant knowledge from extensive work experience or study, so have the ability to pull examples of similar solutions' successes or failures (Dreyfus and Dreyfus, 2005; Ericsson and Charness, 1994; Hogarth, 2001; Kahneman and Klein, 2009). At the same time, domain experts may overlook potential problems with or uses for a solution because their high level of knowledge and experience could lead them to make assumptions when reviewing familiar situations or to miss threats or opportunities related to adjacent knowledge domains (Dane, 2010; Holyoak, 1991; Lewandowsky and Thomas, 2009). Therefore, while domain experts have the potential to miss certain elements of a problem or solution because of their ingrained assumptions, they are still likely to provide useful advice during the problem-solving process.

But what about advisors with expertise outside of the problem domain? In this research, we examine advisors who have complementary expertise—they possess expertise in adjacent domains that are relevant to the problem though not squarely in the central domain of the problem itself. That is, these complementary advisors possess expertise in areas that are fairly commonly combined with a problem's focal domain in problem-solving (Uzzi et al., 2013), in part because the two areas share a more macro categorization. These categorizations result from abstracting a specific field or idea up, creating a broader category that encompasses more fields, ideas, or sub-categories (Kittur et al., 2019). For example, while biology and chemistry are different fields, they are both natural sciences. Performing arts, however, is not considered a natural science or even a science. Therefore, we would consider an advisor with chemistry expertise solving a biology problem to have complementary expertise, while not considering a performing arts expert to be complementary.[7]

Though complementary advisors may not be viewed as intuitive choices, experts in areas outside of the problem domain can also be useful as advisors in creating effective solutions to problems. Although they do not possess a high level of knowledge in the focal domain and thus may not be able to provide the same advice as a domain expert, these experts' ability to recognize potential alternatives or problems stemming from domains outside of the problem's focal domain may still improve the solution through offering different advice (Ng et al., 2011; Gassman and Zeschky, 2008; Markman et al., 2009). As one example of how outside expertise can provide creative benefit during problem-solving, advisors can suggest novel solutions by using analogies to transfer ideas from one domain to another, such as when origami experts used their expertise to help NASA design aircraft components (Kittur et al., 2019). Therefore, while complementary experts have the potential to miss certain elements of a problem or solution because of their relatively limited experience within the focal domain of the problem, they are still likely to provide useful advice during the problem-solving process.

[7] While fields or ideas could theoretically be perpetually abstracted to the point that everything falls under the same category (e.g., biology, chemistry, and performing arts are all fields of study), we stop this abstraction at a reasonable level by referencing historical combinations across domains (Uzzi et al., 2013).

In sum, both domain expertise advisors and complementary expertise have the potential to benefit problem-solving performance, though their contributions may differ significantly due to their varied backgrounds. Therefore, we predict that the more people integrate advice from advisors in their innovations, the better they will perform—this will be true whether the advisor is a domain expertise expert or a complementary expertise expert.

> *H1: Problem-solvers will perform better the more advice they integrate from their advisors, whether they are domain experts or complementary experts.*

Advisors' Expertise Domains Influence People's Perception and Integration of Advice

But if both types of advisors—domain experts and outside experts—can theoretically provide people uniquely beneficial feedback for understanding and solving problems, what leads people to favor domain expert advisors? In what ways does this tendency impact people's ability to solve problems and attribute influence?

People differ in how they react to advice from advisors, regardless of the content of the advice (Eagly and Chaiken, 1993; Petty and Cacioppo, 1986). For one, people who have created, or even just begun work on, a solution tend to feel a high degree of psychological ownership over that solution, and therefore might be resistant to receiving advice or feedback about it, especially from certain types of advisors (Pierce, Kostova and Dirks, 2001). A key dimension that likely impacts a person's reluctance to integrate advisor opinions is the expertise of the advisor. Advice-seekers may display a knowledge bias (Eagly et al.,1978), wherein they grant domain experts' advice—who hold reputations as highly knowledgeable on the topic—more validity than complementary experts', and thus find the problems they identified or the advice they provide easier to swallow and integrate into the solution (Frewer and Miles, 2003; Thorndike, 1920; Wetzel, Wilson, and Kort, 1980). Moreover, people receiving advice from domain experts are more likely to view these advisors as beneficial to their work, even if complementary experts provided equal objective benefit.

In contrast, complementary experts lack strong signals indicating knowledge in the domain of the problem itself, so their advice may be deemed less valid and therefore cause more discomfort or be more easily dismissed by people (Cook, Marsh, and Hicks, 2003). Such advice, even if potentially useful were it to be integrated into a solution, may chafe people because it feels illogical to receive advice from someone who has less expertise than they do (Frewer and Miles, 2003). Moreover, because of their different field of expertise, non-domain experts' advice may use terminology or jargon unfamiliar to people, further reducing the likelihood of the advice being integrated due to a novelty bias or an inability to judge its usefulness (Harvey and Mueller, 2021; Wang, Veugelers, Stephan, 2017). In fact, because complementary experts are advising across domain boundaries and because their advice is likely to be unfamiliar, these advisors may be perceived as going out of their way to challenge people on their ideas, a perception that limit advice integration—recent work has found that people explaining their problems to others tend to incorporate advice less often when the advisors challenge them on their perceptions of their own thinking or behavior (Behfar, Cronin, and McCarthy, 2020). Therefore, people receiving advice from complementary experts may view these advisors as unhelpful to their work, even if they provided objective benefit.

In sum, similar advice may be perceived quite differently depending on who is providing the advice, thereby influencing how likely it is to be integrated into a final solution and how likely the advisors themselves are to be viewed as beneficial (Eagly and Chaiken, 1993; Petty and Cacioppo, 1986). Therefore, we predict that people will be more likely to integrate domain expert advisors' advice into their solutions, and will perceive domain expert advisors to be more beneficial to their innovations, than complementary expert advisors. Given the theorizing behind Hypothesis 1, this suggests that people's biases against advisors with complementary expertise may limit their ability to generate maximally effective and creative solutions. Even if they do leverage complementary expertise advice en route to success, they may not attribute credit to the correct parties.

> *H2: Problem-solvers will integrate more advice from domain expertise advisors than from complementary expertise advisors.*

> *H3: Problem-solvers will perceive domain expertise advisors to be more beneficial to their innovations than complementary expertise advisors.*

Advisors' Advice Framing Influence People's Perception and Integration of Advice

These ideas—that domain and complementary experts' advice both have the capability to benefit solutions in unique ways, but people utilize complementary experts' advice less often and perceive complementary experts to be less beneficial to their solutions—suggest that many people leave value on the table when seeking advice during problem-solving efforts.

A third factor that may influence a person's perception of an advisor, and therefore their competence in the eyes of the person solving the problem, is the delivery of the advice itself (Bateson, 1972). Given the strong personal connection that the person likely holds with the solution, the presentation of advice—particularly advice that identifies issues with a solution—will likely influence the degree to which the advice is valued and eventually integrated into the final solution (Behfar et al., 2020; Pierce et al., 2001). For one, advice that is provided in a more social, supportive manner (e.g., with greater emphasis on collaboration, including collective goals or processes) may be viewed as more collaborative than adversarial—the advisor is operating in the person's best interest, perhaps as a collaborator. In these cases, advice might be valued more highly and may be more likely to be incorporated into a solution. Conversely, advice provided in a less social and supportive manner (e.g., with clear divisions between problem-solver and advisor that focus less on collaboration) may be perceived as more adversarial—the advisor is working against the person, perhaps as a challenger or competitor (Behfar et al., 2020). Here, advice may be viewed less favorably and be less likely to be used.

Because the relationships outlined here seem plausible, but with limited evidence to draw from to found hypotheses, we take an abductive approach to examining the relationship of advisor language use and advice integration. Specifically, in our data we will test the relationships described above, but we will also explore potential relationships between advice integration and other forms of language used by advisors. We will subsequently formulate and test hypotheses based on our findings.

The Intersection of Advisor Expertise, Perceived Competence, and Advice Framing

Together, the tensions presented here suggest that the relationship between advisor feedback on people's problem-solving efforts and the efficacy of the resulting solutions is nuanced. Purely cognitively, both domain experts and experts in other domains theoretically have the capacity to provide useful advice for people (Dane, 2010). However, to what degree and in which ways this advice is integrated may rely on more social-emotional factors, such as how the person addressing the problem perceives the advisor and how the advisor presents their advice. Examining these factors simultaneously should enhance our understanding regarding under what conditions and in which ways people integrate advice. Such understanding will improve recommendations both for people addressing problems—such as when to seek advice from whom or what mentality to adopt when receiving advice—and for advisors—such as how to present their advice to increase their influence.

This research sets out to disentangle these effects by first conducting a field experiment studying entrepreneurial teams applying to an innovation competition that receive advice on their products from either a team composed of experts in the same domain as the innovation or from a team composed of experts in domains adjacent to that of the innovation. We build on this field experiment with two additional more-focused laboratory experiments in which we directly manipulate the domain of advisors' expertise and the way they present their advice.

Study 1

Method

Research Setting and Participants

As an initial test of our hypotheses, we conducted a field experiment in the context of an innovation competition. The competition was hosted by a conservation-focused technology and innovation company which regularly conducts contests focused on solving different conservation problems (e.g., residential cooling systems that reduce CO^2 emissions). This competition focused on reducing plastic microfiber pollution, seeking innovations that replace existing products (e.g., materials for clothing) or prevent microfiber pollution from existing products (e.g., coating layer for clothing).

The competition was divided into three rounds: the initial round of applications lasting six months, the semi-finalist round lasting two months, and the finalist round lasting one month. Competing innovation teams were to submit an application at the end of each round describing their innovations, which judges used to select teams for the next round. Following the finalist round, five winners were selected. We conducted our study primarily during the semi-finalist round, by the end of which we had collected survey data, qualitative data from teams' working documents, transcripts from team meetings, and judges' scores of teams' products.

Each innovation team was pursuing its own original technology. Examples of solutions to the microfiber pollution problem included a plant-based leather alternative, a sustainable fabric created from the by-products of citrus juice, and renewable yarn derived from kelp. Contest entry guidelines required that all submissions were rated at least at target technology readiness level

(TRL) 4 (out of 9), meaning teams' technologies had been at least validated in a laboratory environment. Because of this, this competition presented a prime opportunity to study the effect of advisor expertise on innovation team success—competing teams' innovations were at a stage where they were moderately developed such that they had a clear vision for their innovation but also early enough to integrate substantial changes and improvements if discovered.

Of the 47 teams that entered the competition, 26 were selected to advance to the semi-finalist round of the competition, with 24 teams electing to participate in this research. Teams ranged in membership from one to five members, with one member as the point person. As part of this research, one "scout team"—a team of advisors external to the innovation team—was assigned to each innovation team. The pool of potential advisors included members of other teams in the competition who were not selected as semi-finalists, as well as individuals who were not involved in the competition but were active in the broader conservation community supporting the competition. We drew from this pool of experts to compose 24 scout teams (including 80 experts: 16 teams of three members and eight teams of four members each). Three scout team participants discontinued before the conclusion of the study, resulting in a total of 77 participating scout team members in our sample. Participants from both innovation teams and scout teams ranged in occupation, including scientists, engineers, marketers, biologists, artists, and so on, and were located all over the world. All communication and collaboration took place via the internet (primarily videoconference and email).

Intervention and Procedure

Our intervention in this study was based on a manipulation of the match between the expertise domains of innovation teams' products with the expertise areas of their advisors. Half of the innovation teams were assigned to work with Domain Expertise scout teams composed of advisors that had expertise in the same domain as their product, while the other half of the innovation teams worked with Complementary Expertise scout teams composed of advisors with relevant expertise but less overlap with the product domain. Identification of the expertise domains of products and advisors is described further below. A visual representation of Study 1's method is presented in Figure 1.

Identifying Problem Domain of Innovation Teams and Matching Advisors. We coded innovation teams' products to identify relevant categories of expertise. For this coding, we used categories from the National Science Foundation's list of doctoral degrees and then, facilitated by discussions with the competition's organizers, expanded to include additional categories more specific to the topic of this innovation competition. We further differentiated the relevant expertise areas for each team's product as either primary or secondary, depending on how central an expertise area was to the product. For example, a plant-based leather alternative that could be sold to customers or businesses might have material development as a primary area and B2B and B2C sales as secondary areas.

To identify the expertise of potential advisors, we administered a survey to all participants, including members of innovation teams and potential scout team members. This survey allowed us to gather demographic information along with areas of expertise for each participant. Participants reported their own expertise in the same categories that were used to code the innovation teams' products.

To assign scout teams, for the *domain expertise condition*, we selected advisors with expertise in areas that were identified as relevant to the team's product, with preference for selecting advisors with expertise in a product's primary areas. In the *complementary expertise condition*, we composed scout teams of members with relevant expertise but in adjacent areas rather than in the primary or secondary expertise categories of the product. In assigning advisors, we assigned 12 innovation teams to scout teams with direct domain expertise, and 12 to scout teams with complementary expertise.

To validate our manipulation of expertise in scout teams, after making scout team assignments we calculated a measure of expertise overlap between innovation teams' products and scout team members. We assigned a value of two to primary expertise areas of products and a value of one to secondary areas. Some products had more areas than others, so this total value differed across teams. If any member of a scout team had expertise in a primary area, they received a value of two; if they had expertise in a secondary area, they received a value of one. We divided the scout team value by the product value to calculate a measure of expertise overlap. We then subtracted this value from one to produce a measure of expertise distance, with a maximum distance of one and a minimum distance of zero. For example, if an innovation team's product had primary expertise areas of material development (two) and textiles (two) and secondary areas of chemistry (one) and B2B sales (one), it would have a value of six. If the scout team had expertise in material development (two), textiles (two), and chemistry (one), it would have a value of five. The expertise distance between innovation team and scout team would be 0.17, as 1 - (5 / 6) = 0.17. Average expertise distance was 0.90 in the complementary expertise condition (i.e., 10% of expertise areas were shared between innovation teams and scout teams) and 0.33 in the domain expertise condition (i.e., 67% of expertise areas were shared between innovation teams and scout teams), indicating the intervention was successful in producing more similar pairings in the domain expertise condition.

Once scout teams were composed, we scheduled launch meetings between each innovation team and its assigned scout team. Due to scheduling difficulties resulting from participants being spread across different time zones, launch meetings were not held simultaneously in all teams and not all members were able to be present for each meeting. However, for each pairing of an innovation team and a scout team, at least one member from each team was present. In addition, one researcher was present at each launch meeting to facilitate the meeting and to convey the goal of the innovation team-scout team collaboration: to help identify problems with the innovation team's product and methods of addressing them.

All launch meetings included an identical agenda and note-taking document provided by the researcher to the teams for use during the meeting and beyond, which included introductions, discussions of expertise, discussions of collaboration techniques. An important element of the launch meeting was deciding how best to collaborate moving forward, at which point the researcher was no longer involved—teams decided among themselves if, when, and how to next meet. We then set teams forth to work on their innovation round application for a two-month period. When all members agreed, we recorded and transcribed launch meetings (19 out of 24 meetings were recorded).

Measures

Advice integration. One of the key elements that innovation teams needed to emphasize in their finalist application was the identification of potential problems (or "risks") in a team's innovation. Specifically, the question was stated as follows: "describe the top three real or perceived risks that may impact the feasibility and long-term viability of your innovation (e.g. technological business/financial, regulatory, consumer behavior) and describe how you plan to mitigate or reduce these three risks." This element was included to show judges that the teams were being realistic in their assessments of their innovations and to facilitate judges ability to assess the long-term viability of the innovations.

In our study, the key deliverable for scout teams was a report they were asked to submit to their innovation team detailing their recommendations for the top three problems facing the innovation team's product. These reports could take any form that the scout team liked—all submitted reports were written documents—and were due one week prior to the finalist round application deadline. Most, but not all, scout teams submitted a final report (18 out of 24 teams submitted a final report).

The key deliverable for the innovation teams was the finalist round application submitted for judge review. This application consisted of a number of questions, including how the company or product has evolved since the teams applied to the competition initially, and the degree to which they addressed the three biggest potential problems with the product. We developed a measure of a scout team's impact on its innovation team's product by measuring the degree of overlap between the problems identified in the scout team's final report and those identified in the innovation team's finalist round application. This was calculated by first distilling scout team final report responses and innovation team finalist application responses (to the question regarding top potential problems to the product) into more abstract categories. To do so, we conducted a first pass of the statements to identify and note the crux of each problem statement, distilling them into phrases (e.g., "scalability of product," "consumer demand," "raw product accessibility"). Next, where these phrases were similar (e.g., "consumer demand concerns" and "lack of interest from certain groups of people"), we compared the original problem statements to determine additional similarities. If these statements were considerably similar, we grouped them into the same category. This procedure produced three problems for scout teams and for innovation teams that could be compared to calculate degree of overlap. If an innovation team used two out of the scout team's three identified problems, they received an overlap score of 0.67. The greater the overlap, the greater the advice integration.

Participants' perceptions of advisors. Once the innovation teams had submitted their applications but, crucially, prior to receiving feedback from judges, we administered all participants from both innovation teams and scout teams a post-collaboration survey. The survey contained items regarding the process of collaboration between the innovation team and the scout team, including how often meetings were held between teams (1 = Never, 6 = Every day) and how often written communication was exchanged (1 = Never, 6 = Every day). Items regarding the satisfaction with the collaboration included the likelihood of participating in a similar collaboration in the future (1 = Very unlikely, 5 = Very likely) and the likelihood of reaching out to the assigned team after the competition had concluded (1 = Very unlikely, 5 = Very likely). Finally, items regarding the outcomes of the collaboration included the perceived impact of the scout team on the innovation team's application (1 = No impact, 7 = Very positive impact), the perceived impact of the scout team on the innovation team's company more broadly (1 = No impact, 7 = Very positive impact), and how much hypothetical prize money the innovation team would award to the scout team (out of $5,000).

Participants' application performance. The host company recruited a panel of seven experts in the domains of the innovations to judge teams' applications. Contest organizers oriented the judges to the basic factors motivating the competition as well as the judging process and scoring system for each of the judging categories, detailed below. To enhance the quality of judging, judges were briefed on common cognitive biases that may be present in judging (language bias, similarity bias, halo effect, confirmation bias, etc.) and provided explicit techniques and additional materials on ways to overcome these biases. Judges were offered an honorarium for their time, and two out of seven accepted the payment.

Judges scored innovation teams' finalist applications on a scale of 0 ("Does not meet the criteria") to 5 ("Exceeds the criteria") in 11 sub-categories composing four broad categories. These broad categories were scalability (an innovation's scalability regarding its demand/customers, competitive advantage, manufacturing, and business model), feasibility (an innovation's feasibility regarding its technology, team, finances, and, focal to this study, the risks facing the innovation), environmental impact (an innovation's overall environmental impact and its relevance to microfibers), and transformational (how revolutionary and novel an innovation is; scored on a 0 ["Does not meet the criteria"] to 10 ["Exceeds the criteria"] scale). Additionally, judges provided written feedback to innovation teams identifying strengths along with general and specific issues, and some also provided written recommendations to be viewed only by competition organizers.

Either three or four judges reviewed each innovation team's finalist application, and each judge reviewed either six or seven applications in total. We standardized each judge's score using the mean and standard deviation of scores given out by that judge across all applications they reviewed. We took the average of these standardized scores across all judges for each application as an innovation team's final judge score. Twelve teams were selected to advance to the finalist round; eventually, five teams were selected as winners. Winning teams received funding to support the continued development of their innovation.

Launch meeting language. We transcribed the recorded launch meetings, and separated innovation team members' and scout team members' speaking turns. We used LIWC textual analysis software (Tausczik and Pennebaker, 2010) to produce measures of word count and language use (e.g., how much social or insight language was used). This was an abductive analysis, so while we focused primarily on examining the categories of social and insight language, all available categories in the default LIWC dictionary were considered.

Results

Hypothesis Testing: Integration of Advisor Ideas and Perception of Advisor Benefit

Because sample size limitations prohibited much significance testing, we report Pearson correlations when reporting associations between variables. When reporting mean differences, we report the means of the standardized values of each comparison group. Correlations and descriptive statistics are reported in Table 1.

We began by comparing the two experimental conditions. Innovation teams from the conditions performed similarly—innovation teams assigned domain expertise advisors received slightly higher judge scores than those assigned complementary expertise advisors on average (0.003 vs. 0.02) and produced one more finalist team (5 vs. 6). However, complementary expertise teams had a wider range of scores—they produced the highest score and four of the top five scores along with the lowest score and three of the bottom five scores (Figure 2). In addition, complementary teams that reached the finalist round scored nearly twice as high on average than domain finalist teams (0.68 vs. 0.36), and the complementary condition produced one more competition winner than the domain condition (3 vs. 2). Given the expertise intervention, the winners from the complementary condition had only a 7% average overlap in expertise, while those from the domain condition had a 94% average overlap.

We then tested Hypothesis 1, which predicted that people would perform better the more advice they integrated from their advisors, regardless of the advisors' expertise. To do so, we investigated the degree to which innovation teams integrated scout team advice into their work. We found that all teams performed better the more overlap there was between problems identified in the scout team's final report and those eventually identified in the innovation team's application. This was true for both innovation teams assigned domain expertise advisors (r = .31) and those assigned complementary expertise advisors (r = .27). These results provided support for Hypothesis 1.

We next tested Hypothesis 2, which predicted that people would integrate more advice from domain expertise advisors than from complementary expertise advisors. Domain expertise advisors integrated slightly more advisor advice into their final applications than did complementary expertise advisors (1.25 out of 3 problems overlapped vs. 1.40 out of 3 problems overlapped). These results provided weak support for Hypothesis 2.

We next tested Hypothesis 3, which predicted that people would perceive domain expertise advisors to be more beneficial to their innovations than complementary expertise advisors. Compared with innovation teams assigned complementary expertise advisors, domain expertise innovation teams reported better collaboration processes (more communication with their scout teams; 0.09 vs. -0.26) and greater enjoyment of the collaboration process (a higher likelihood of participating in a similar collaboration in the future; 0.26 vs. -0.23). In addition, domain innovation teams perceived their scout teams to be more beneficial to their innovations—they reported their scout teams as being more impactful to their finalist application (0.11 vs. -0.10) and they awarded their scout teams nearly $500 more hypothetical prize money than complementary teams ($2,519.91 out of $5,000 vs. $2,086.33 out of $5,000). These results provided support for Hypothesis 3.

Given the similarity across conditions in performance juxtaposed by the difference in satisfaction with collaboration processes, we next compared high-performing (i.e., finalist) and low-performing (i.e., non-finalist) teams in both conditions. We found that domain expertise innovation teams performed better the more they enjoyed their collaboration with their scout teams—compared with non-finalists from the domain expertise condition, finalists from this condition reported their scout teams as having more impact on their application (0.22 vs. 0.02), predicted they were more likely to reach out to their scout teams following the competition (0.49 vs. -0.26), and were more likely to participate in a similar collaboration in the future (0.68 vs. -0.10; Figure 3). These teams appeared to enjoy the help of the scout teams due to their expertise in the domain of their innovation—as one finalist team noted, "(The scout team) gave really great insights and considerations based on their industry experience."

Conversely, complementary expertise innovation teams performed better the *less* they enjoyed their collaboration with their scout teams—compared with non-finalists from the complementary expertise condition, finalists from this condition awarded less prize money to their scout teams ($1,179.00 out of $5,000 vs. $2,305.86 out of $5,000), reported their scout teams as having less impact on their application (-0.48 vs. 0.16), predicted they were less likely to reach out to their scout teams following the competition (-0.52 vs. 0.24), and were less likely to participate in a similar collaboration in the future (-0.98 vs. 0.30). Though they performed well, these teams appeared to be frustrated with the scout teams' lack of expertise in the domain of their innovation—as one finalist team noted, "The Scout Team wasn't composed of experts in our field so their understanding of our technology was limited given the amount of time we had to interact."

Moreover, perceived scout team impact (i.e., a self-report measure) and objective scout team impact (i.e., a measure of identified problem overlap) were positively correlated in the domain expertise condition (r = .45), but negatively correlated in the complementary expertise condition (r = -.58). This suggests that innovation teams in the complementary expertise condition were not aware of how impactful the scout teams were on their work.

In fact, despite not enjoying collaborating with their scout teams, innovation teams assigned complementary expertise advisors performed better the more actual impact the scout teams had on their applications—compared with non-finalists, finalists were more likely to have received a final report from their scout team (80% likelihood vs. 57% likelihood), those final reports had longer word counts (263.20 words vs. 139.29 words), and more of the problems identified in the report were likely to appear in the innovation teams' applications (58% of problems included vs. 25% of problems included; Figure 4). In addition, the scout teams of complementary expertise finalist innovation teams reported receiving more benefit from the collaboration than scout teams of non-finalists (0.72 vs. -0.76).

It appears then that although complementary expertise innovation teams that were selected as finalists found the collaboration frustrating—so much so that they may not have even recognized the impact the scout teams were having on their work—they simultaneously benefited from the scout teams' involvement. Moreover, the scout teams assigned to these innovation teams appeared to benefit greatly from the collaboration experience. One potential explanation of these results is a difference in expectations: while innovation teams receiving feedback from non-expert scout teams may have been disappointed to not be matched with advisors holding expertise in their precise domains, scout teams assigned to products outside of their expertise may have found unexpected gain in learning about cutting edge work that might inform their own individual endeavors.

Supplemental Analyses and Discussion: Advice Framing in Launch Meetings

Digging deeper into how scout teams' ideas were conveyed to innovation teams, we next analyzed transcripts of the first meeting between the teams, which took place an average of two months prior to the application deadline. We found that an important factor in predicting the eventual integration of scout team ideas into innovation team applications was the amount of insight language used in the launch meeting discussions, even when controlling for the total amount of speaking in the launch meetings—all correlations reported below control for total speaking amount. Insight language, a subset of the cognitive mechanisms category in the LIWC dictionary, indicates attempts to develop understanding of a concept, person, or thing, and is evidenced by words such as “think,” “know,” and “consider.” Innovation teams across conditions that held meetings that contained more insight language were more likely to eventually integrate scout team ideas into their application ($r = .29$), and this effect was especially strong in the complementary expertise condition ($r = .59$). However, in line with the analyses presented above, more insight language had differing effects on the innovation teams’ enjoyment of the collaboration, leading to a higher likelihood of participating again in the future in the domain condition ($r = .65$), but a lower likelihood in the complementary expertise condition ($r = -.34$).

Rather than being a product of either the innovation team or the scout team’s behavior, it may well have been the specific interactions of these innovation teams and scout teams that spurred the generation of insight. For example, we found that insight language was highly correlated with social language that makes reference to others, evidenced by words such as “they,” “us,” “talk,” and “friends” ($r = .77$). Moreover, compared with non-finalist teams, both finalist innovation teams and finalist scout teams used more of this social language (innovation teams: 0.15 vs. -0.16; scout teams: 0.17 vs. -0.19) and insight language (innovation teams: 0.15 vs. -0.17; scout teams: 0.33 vs. -0.36) during their launch meetings.

While not causational, these relationships tentatively suggest a pathway operating in both conditions that might partially explain why some scout teams’ ideas were integrated into applications more than others’: when the teams met initially, the social atmosphere may have facilitated the sharing of ideas that scout teams eventually detailed in their final reports and that innovation teams integrated into their applications, boosting performance.

These characteristics of the launch discussion may have been particularly important in the complementary expertise condition. Theoretically, non-expert ideas had the highest potential to improve innovation team performance because of their novelty, so discussions that facilitated the sharing of these ideas may have been most beneficial. To this point, in the complementary condition, social language was strongly associated with the use of insight language (r = .88) and the eventual integration of scout team ideas (r = .67).

However, a key difference regarding this pathway between conditions was that innovation teams in the domain expertise condition enjoyed the process far more than those in the complementary expertise condition. The social, authentic, and insightful language used in launch meetings may have contributed to the dissatisfaction of complementary innovation teams, despite these characteristics typically producing positive relationships. These teams may have chafed at the presentation of potential problems with their products from non-experts, helpful as the ideas themselves may have been. Therefore, while complementary innovation teams may have reaped the benefits of non-expert advisors during this particular portion of this project, they may select out of such opportunities in the future, potentially at the expense of their performance on similar projects.

These analyses may also indicate why complementary expertise teams produced a wider range of scores that included higher highs and lower lows than domain expertise teams. While domain expertise teams collaborated more smoothly, the innovation teams had less to gain from the scout teams due to their overlapping expertise, resulting in incremental gains and performances clumped around the mean. In contrast, complementary expertise teams had more to gain from their scout teams, but in only some cases were these larger gains realized—in other cases, the collaboration did not produce any utility. The result of these dynamics was a higher average score from domain expertise teams, but the highest and lowest scores from complementary expertise teams.

Discussion

The findings of this field experiment suggest that scout team input, whether posited in the launch meeting with innovation teams, in the final report deliverable, or somewhere else along the collaboration timeline, was generally beneficial for innovation team performance. In particular, innovation teams received higher judge scores the more they integrated the problems identified in scout teams' final reports into their final applications.

This effect was especially strong in the complementary expertise condition, possibly because complementary advisors' outside ideas were more likely to be novel to the innovation team. That is, while scout teams still provided fresh sets of eyes to innovation teams with similar expertise, they may have provided particularly novel ideas to innovation teams with different expertise. To judges, incorporating these diverse ideas likely displayed highly developed applications that considered more perspectives, signaling a company with a more thorough business plan and a higher likelihood of entrepreneurial success.

However, the gathering and integration of scout team ideas appeared to be far more enjoyable for innovation teams when the scout teams were aligned with their expertise. When they were not, innovation teams strongly indicated that their scout teams did not impact their work very much and that they would opt out of a similar experience in the future. This suggests that even when working with advisors in adjacent domains objectively improves performance, people may not realize this improvement and may choose to avoid such beneficial collaborations in the future.

Overall, evidence in a number of studies is beginning to show that incorporating only people with a high level of expertise in the domain of a project is not always the most beneficial for a project, particularly a creative one. Much of this work has shown the merits of incorporating outside perspectives into creative work. However, this is much easier said than done in settings outside of experiments, where interventions can be implemented. Even if the takeaway of extant research is that non-experts' new perspectives can be beneficial for generating new ideas and identifying hidden problems, it appears many expert people or teams will be resistant to integrate those novel perspectives. And even if a team does integrate them during one particular project, we see evidence in this study 1) that the team may not recognize the benefit of those perspectives in the moment and 2) that they may select out of opportunities to be exposed to those perspectives in the future.

Study 2

Given the findings from the field in Study 1, we designed a laboratory experiment to test the resulting ideas in a more controlled environment. In particular, we were interested in more closely examining the conditions under which people enjoy and find competent advisors from backgrounds adjacent to the focal task. Moreover, we looked to further investigate the association found in Study 1 that advisors had more influence when they used more social and insight language. Therefore, in Study 2, we manipulated whether participants received a domain or complementary advisor when undertaking a creative design task, and also whether those advisors used a high or low amount of social and insight language when offering their recommendations. In Hypothesis 2, we predicted that people would perceive domain expertise advisors to provide more benefit than complementary expertise advisors—here, we drill down further, and predict that participants will judge domain expertise advisors as more competent than complementary expertise advisors. Moreover, we predict that the effect described in

Hypothesis 3—that participants assigned domain expertise advisors will integrate more advice into their designs—will weaken the more social and insight language that complementary advisors used to state their advice.

> *H4: Problem-solvers with domain expertise advisors will perceive their advisors to be more competent than those with complementary expertise advisors.*

> *H5: When complementary expertise advisors use social and insight language to state their advice, problem-solvers will integrate advice from domain and complementary expertise advisors to similar degrees.*

Method

Participants and Procedure

We recruited 79 participants (27% female, M_{age} = 20.4 years) from a study pool drawing from a university in the mid-Atlantic United States and its surrounding area to participate in a laboratory experiment. Participants' expertise was randomly distributed given the random sampling method used to recruit participants. Participants received course credit for participating.

The experiment used a 2 x 2 design (domain vs. complementary expertise crossed by strong vs. weak use of social and insight language), and participants were randomly assigned to one of four conditions. All participants were informed that they were hired by a client company as a consultant and tasked with designing a new aircraft vehicle for the company. Specifically, participants were asked to make design decisions for each of four categories of the aircraft: insulation system, nose or tail additions, landing gear, and cargo hold. Each category had four distinct choices from which participants were asked to choose (e.g., "Water circulation system in walls," "Heat radiation tail flaps"; see Appendix A).

To help with their task, participants were informed that they were assigned an expert advisor and were provided a short resume. There were two possible advisors: one had expertise in the focal task of aircraft design, evidenced by an advanced degree in engineering and work experience in the field of engineering listed on their resume, while the other advisor had expertise in biology, an adjacent subject area. Other than these differences in expertise, both advisors were described as graduating with a PhD in the same year (2002), having the same number of years of experience (22), and listed with the same gender neutral name (M. Williams; see Appendix B).

Once participants read about their advisors, they were asked to make selections for each of the four aircraft categories. For each category, the advisor provided a written recommendation. While advisors always recommended the same option, the delivery of their recommendation varied by condition: some advisors used high social and insight language, as evidenced by higher usage of words such as "we," "talk," "consider," and "think," while others did not, instead using more words such as "you" and "should." While word choice differed between conditions, the recommendation paragraphs themselves were kept identical in all other ways, and thus were very similar in wordcount (see Appendix C). Finally, participants completed a series of survey questions about their experience working with their advisor, including their perceptions of the advisor's expertise, warmth, and competence, and about the participant's demographics.

Measures

Creativity. Each of the four categories of aircraft decisions had four options. Each of the four options was assigned a value—high or low—on both novelty and usefulness (Amabile, 1983). The choice recommended by the advisor was assigned high on both scales, one choice was high usefulness and low novelty, one was the opposite, and the final choice was low on both. For example, for the category of landing gear, "hard edge with malleable pad landing gear" was high/high because it is unique but also has utility, "multiple wheels with rotating sockets" was low/high, “cushion-based landing mechanism” was high/low, and “nose bumper and extreme braking system” was low/low. These scores were totaled across the participant’s four choices, resulting in overall novelty, usefulness, and, as the sum of the two, creativity.

Advice integration. For each category of aircraft decision, participants’ choices were coded as 1 if they selected the choice recommended by their advisor, and 0 otherwise. The total across the four categories was the degree to which the participant integrated the advisor’s advice.

Perceived advisor influence. Following task work, all participants were asked to rate how impactful their advisor was to their vehicle design choices (1 = “Not at all impactful”, 5 = “Extremely impactful”).

Perceived expertise. Following task work, all participants were asked to judge their advisor’s level of expertise in the areas of engineering, biology, and psychology. This also served as a manipulation check, as domain advisors were rated as having significantly greater expertise in engineering ($B = 0.38$, $p < .01$), while complementary advisors were rated as having significantly greater expertise in biology ($B = -0.68$, $p < .01$).

Perceived competence. All participants were also asked to rate their advisor’s level of general competence using a 5-item measure of competence (adapted from Fiske et al. [1999] and Eckes [2002]). The scale uses specific items asking participants to state their perceived efficiency, capability, competence, intelligence, and cleverness.

Results

Correlations and descriptive statistics are reported in Table 2. We found support for Hypothesis 1—controlling for language use, participants performed better the more advice they integrated into their innovations ($B = 2.50$, $p < .01$; Table 3, Model 3), both when they were assigned a domain expertise advisor ($B = 2.42$, $p < .01$) and when they were assigned a complementary advisor ($B = 2.49$, $p < .01$).

In testing Hypothesis 2, which predicted that people would integrate more advice from domain expertise advisors than from complementary expertise advisors, we found an effect in the opposite direction. Controlling for condition, participants integrated more advice from their advisors when they were assigned a complementary advisor than when they had a domain advisor (B = -0.13, $p < .05$; Table 3, Model 1). This in turn resulted in greater design creativity (b = -0.42, SE = 0.20, 95% CI [-0.81, -0.03]).

In testing Hypothesis 3, we found that complementary expertise advisors were not perceived to be significantly less influential on participants (M_{infl} = 4.00) than domain expertise advisors (M_{infl} = 3.78; B = 0.22, $p < .18$; Table 3, Model 5), though the mean difference was in the predicted direction. However, we found that complementary expertise advisors were perceived to be significantly less competent (M_{comp} = 18.24) than domain expertise advisors (M_{comp} = 19.95; B = 0.27, $p < .02$; Table 3, Model 4), providing support for Hypothesis 4.

Simultaneously, complementary expertise advisors were judged to have significantly more overall expertise (M_{ovr} = 3.29) than domain expertise advisors (M_{ovr} = 2.91; B = -0.39, $p <$ .02; Table 3, Model 6). Specifically, while complementary advisors were judged to have the nearly the same amount of biology expertise (M_{bio} = 4.27) as domain advisors had engineering expertise (M_{eng} = 4.30), complementary advisors were judged to have more engineering expertise (M_{eng} = 3.51) than domain advisors were judged to have biology expertise (M_{bio} = 2.51). This difference in perceived general expertise may serve to explain the greater integration of advice by participants assigned complementary expertise advisors described above.

In testing Hypothesis 5, no differences were found as a result of the language use intervention (Table 3, Model 1).

Study 2 Discussion

As in Study 1, we observed in Study 2 that complementary expertise advisors enhanced solution creativity while also being evaluated as less competent despite higher aggregate ratings of competence in different areas of expertise—participants judged domain advisors to have high expertise in engineering and low expertise in biology, while they judged complementary advisors to have high expertise in biology and moderate expertise in engineering, resulting in higher rating of expertise in aggregate.

The lack of effect associated with advisor insight language could be due to a manipulation that was too weak. One potential reason is that, in contrast to the advisors in Study 2, the advisors in the Study were communicating recommendations solely via text. It may be that hearing and seeing an advisor using high levels of insight and social language will have a bigger impact. In addition, in both Study 1 and Study 2, participants were not given a choice of which advisor they wanted to work with, and so in Study 3 we wanted to test the effects of expertise and language on advisor choice and use of advice.

Study 3

In following up on Study 2, we wanted to both test a stronger manipulation of the effect of social and insight language as well as testing the effect of this language on how people choose their advisors. Based on Study 1, which found that advice offered using more social and insight language was more likely to be integrated into a final deliverable, we predicted that participants would be more likely to select domain expertise advisors overall, but that complementary expertise advisors using high social and insight language would result in a higher rate of selection compared to complementary advisors not using social or insight language. While people tend to prefer to receive advice from experts in the field of a problem, we suggest that the presentation of advice from experts in other fields may allow people to realize the benefit of these adjacent experts.

H6a: Problem-solvers will be more likely to choose a domain expertise advisor than a complementary expertise advisor.

H6b: When complementary expertise advisors use social and insight language, the effect predicted in Hypothesis 6a will be weakened.

Method

Participants and Procedure

We recruited 87 participants (40% female, M_{age} = 36.7 years) from the Prolific platform to participate in a laboratory experiment. The experiment used a 2 x 2 design—advisors' salient expertise differed, and their introductory language varied in degree of social and insight language used. Participants were randomly assigned to one of four conditions. All participants were compensated $8.

The task was the same as in Study 2, and advisors' backgrounds were the same as in Study 2. However, in this study, participants were informed that they were given the choice of two expert advisors, and shown a short introduction from both. The introductions varied in whether they contained high or low social and insight language as evidenced by higher or lower usage of words such as "we," "talk," "consider," and "think" (Appendix D).

Once participants selected their advisors, they were asked to make selections for each of the four aircraft categories. As in Study 2, for each category, the advisor provided a written recommendation, and advisors always recommended the same choice, this time in identical language (Appendix E). Finally, participants completed a series of survey questions about their experience working with their advisor, including their perceptions of the advisor's expertise, warmth, and competence, and about the participant's demographics.

Measures

Creativity, advice integration, perceived competence, and perceived expertise were all measured the same as in Study 2. Again, perceived competence also served as a manipulation check, as domain advisors were rated as having significantly greater expertise in engineering ($B = 0.38$, $p < .01$), while complementary advisors were rated as having significantly greater expertise in biology ($B = -0.42$, $p < .01$).

Results

Correlations and descriptive statistics are reported in Table 4. We found support for Hypothesis 1—participants performed better the more advice they integrated into their innovations ($B = 1.18$, $p < .01$; Table 5, Model 1), both when they selected a domain expertise advisor ($B = 1.18$, $p < .01$) and a complementary advisor ($B = 1.26$, $p < .01$).

Testing Hypothesis 2, we found no significant differences in the degree to which participants integrated their advisor's advice into their design across conditions while controlling for advisor choice (Table 5, Model 2). We also did not find support for Hypothesis 4—controlling for social and insight language use, chosen domain expertise advisors ($M_{comp} = 19.15$) were not perceived to be more competent than chosen complementary advisors ($M_{comp} = 19.00$; Table 5, Model 3).

Because Hypothesis 5 was not relevant for this study, we continued by testing Hypothesis 6a, and found support—when given the choice, the vast majority of participants (90.8%) selected the domain advisor to help them with their task over the complementary advisor (9.2%). We did not find support for Hypothesis 6b—the type of language used in the advisors' introductions had no effect on the selection of advisors (Table 6, Model 1).

However, mediation analyses shed some light on the reasons why participants selected one advisor over the other and revealed that the reasons participants integrated advice differed based on which advisor was chosen. Choosing a domain advisor—as opposed to choosing a complementary advisor—resulted in a chain reaction stemming from higher perceived advisor engineering expertise, to higher perceived advisor competence, to greater integration of advice, and finally to greater design creativity; Figure 5). In contrast, choosing a complementary advisor—as opposed to choosing a domain advisor—resulted in higher perceived advisor biology expertise, which led to higher perceived advisor competence, greater integration of advice, and greater design creativity (Figure 5).

Discussion

We conducted this experiment to test a stronger manipulation of advisor insight language, as well as an additional hypothesis predicting that when faced with a decision on a technical innovation task, participants would select an advisor with more domain expertise than one with more complementary expertise. Consistent with predictions, participants overwhelmingly selected domain advisors when given the chance. However, when complementary advisors were selected, they were viewed as competent, and their advice was integrated *because* they held expertise in a domain other than the focal domain of the task. Across all three studies, this small group of participants was the first to view complementary advisors in a fully positive light. As in Studies 1 and 2, collaboration with complementary advisors did not harm performance.

General Discussion

The research detailed here involving both field and lab experiments presents findings that suggest that problem-solvers 1) have a strong tendency to prefer advisors with expertise in the primary domain of the focal task to advise them in identifying and solving problems in their creative projects, and 2) if assigned an advisor with expertise in a different domain, they have a tendency to believe the advisors was less helpful or less competent during their collaboration. These observations are consistent with recent research highlighting people's tendency to prefer advisors who do not often challenge them on ideas or problem that they have, despite the problem-solving utility these challenging advisors have (Behfar et al., 2020). Simultaneously, the latter finding is further contextualized by the fact that there was little evidence found across three studies that projects with complementary expertise advisors performed any worse than those with domain expertise advisors.

In fact, there was more, albeit minimal, evidence suggesting that projects with complementary advisors received a performance boost. But there are theoretical reasons that people may incur future benefits from selecting a more diverse set of advisors over time to help them identify and solve problems. It is well established that exposure to diverse perspectives and ideas can benefit creative idea generation (e.g., However et al., 2012), suggesting that projects that employ advisors with diverse expertise may gain creative advantages over time. Moreover, creators working on a task are more likely to have overlapping or even redundant expertise if they select only to collaborate with advisors with expertise in the domain of the task. So, on any given project, the differences in creative performance may not be apparent, but over time, as people continue to select out of experiences with complementary advisors, the novelty of their ideas may begin to decline.

In addition, there are contextual conditions under which collaboration with complementary expertise advisors may prove more beneficial than with more domain advisors. Advisors with expertise in areas adjacent to the focal domain of the task are more likely to be able to identify problems that could occur as a result of factors beyond the focal domain or to identify additional uses for an idea beyond that domain. For example, a person working on an engineering problem being advised by a biologist might benefit because the biologist might recognize that the engineer's product could act as a solution to a difficult problem in biology.

This type of domain crossover is characteristic of many creative ideas, as evidenced by sub-fields such as analogical thinking, where an idea from one domain is used to solve a problem in another (Kittur et al., 2019). Therefore, in contexts where creators are open to longer-term collaborations with advisors—rather than shorter-term projects more focused on singular objectives—working with complementary expertise advisors may prove to be a more fruitful endeavor.

Complementary expertise advisors are also more likely to be beneficial in projects that call for high levels of novelty in their products. In the case that a team of creators is tasked with a highly specific goal or where efficiency is understood to take precedence over novelty, a domain expertise advisor—specifically one with overlapping but additional knowledge—may be best. But in cases where goals are open-ended and the focal problem at hand has not been solidified, complementary advisors may be of great use in injecting diverse perspectives and stimulating new ideas.

In sum, advisors are both problem identifiers and problem-solvers—when a person collaborates with an advisor, advisors are tasked with pointing out threats and opportunities, and often with suggesting methods of mitigating or realizing them. As problem-solvers approach uncertain projects where understanding the problem at hand is key, the degree to which an advisor is helpful or harmful in crafting an effective problem and solution likely depends on multiple factors. An important factor identified by these studies is the relation of the expertise of the advisor to the focal domain of the task, in part because this relationship influences how the problem-solver perceives the advisor.

Limitations and Future Directions

Naturally, this research is not without limitations, which provide opportunities for future work. For example, one of the goals of Studies 2 and 3 was to further investigate the finding in

Study 1 that advisors who used more social and insight language were more influential in their advising. However, two separate experimental paradigms with varying interventions were unable to uncover any effect of language use on integration of advice. This lack of perceptible effect could be for several reasons: the finding in Study 1 was spurious, the manipulations in the subsequent studies were implemented ineffectively, or the contexts differed in some way between studies that altered the presence of the effect. Future research could seek additional ways for advisors to tailor their advice—particularly advice having to do with the identification of problems—to promote integration by advisees. Given the evidence in this research package that integrating advisor feedback benefits creative performance across the board, this research will likely be beneficial for all parties.

An additional limitation pertaining primarily to the two laboratory experiments is that in both, domain advisors were engineering experts and complementary advisors were biology experts. This was a conscious decision made to reduce disparities between experiments so as to facilitate the comparison of results, but comes with the limitation that domain and complementary categories were not represented by additional domains. Future research could confirm these effects apply to domains beyond those utilized here.

Finally, in both laboratory experiments, the content of the advisor's feedback was held constant. An extension of this work would include manipulating the content of the feedback itself, particularly such that it was aligned with the expertise of the advisor (e.g., a biology expert provides a biology-related perspective on an engineering problem). Doing so would continue to home in on how precisely different advisors impact solutions, and therefore what specific benefits those who turn down advice are missing out on.

Tables and Figures

Table 1

Correlations and Descriptive Statistics (Study 1)

	Variable	1	2	3	4	5	6	7
1	Judge scores	–						
2	Identified problem overlap	.27	–					
3	Perceived scout team impact	-.43*	.24	–				
4	Scout team final report	-.11	.58*	.26	–			
5	Final report word count	.11	.58*	.32	.63**	–		
6	Prize awarded to scout teams	-.26	.11	.68**	.31	.03	–	
7	Future participation (innovation team)	-.30	.12	.67**	.08	.19	.51*	–
	Minimum	-1.15	0	1	0	0	0	1
	Maximum	1.02	3	7	1	784	5000	5
	Mean	0.01	1.00	3.96	0.75	269.79	2293.70	3.78
	SD	0.59	1.02	2.01	0.44	254.43	1892.71	1.20

Note. $n = 24$. $^{*}p < .05$ $^{**}p < .01$.

Table 2

Correlations and Descriptive Statistics (Study 2)

	Variable	1	2	3	4	5	6	7	8	9
1	Creativity	–								
2	Novelty	.84**	–							
3	Usefulness	.81**	.36*	–						
4	Advice integration	.93**	.80**	.74**	–					
5	Advisor engineering expertise	.01	.07	-.06	-.02	–				
6	Advisor biology expertise	.22	.25*	.12	.17	-.22	–			
7	Total expertise	.15	.22	.02	.09	.45**	.68**	–		
8	Advisor competence	.15	.26*	-.02	.16	.36**	.08	.31**	–	
9	Perceived advisor influence	.33**	.37**	.17	.62**	.25*	.07	.22	.60**	–
	Minimum	1	1	0	0	1	1	1.67	10	2
	Maximum	4	4	4	1	5	5	5	25	5
	Mean	2.94	2.82	3.06	0.58	3.88	3.44	3.11	19.05	3.88
	SD	0.78	0.98	0.92	0.29	1.03	1.31	0.73	3.15	0.70

Note. $n = 78$. $^{*}p < .05$ $^{**}p < .01$.

Table 3

Regression Analyses (Study 2)

Variables	Model 1 (DV: Advice Integration)	Model 2 (DV: Creativity)	Model 3 (DV: Creativity)	Model 4 (DV: Advisor Competence)	Model 5 (DV: Perceived Advisor Influence)	Model 6 (DV: Perceived Advisor Expertise)
Advisor Expertise (0 = Complementary, 1 = Domain)	-0.13^{*} (-0.26, -0.003)	-0.38^{*} (-0.72, -0.03)	-0.47 (-0.18, 0.09)	1.70^{*} (0.32, 3.09)	0.22 (-0.10, 0.54)	-0.39^{*} (-0.70, -0.08)
Social/Insight Language (0 = Low, 1 = High)	-0.06 (-0.19, 0.07)	-0.16 (-0.50, 0.19)	-0.01 (-0.14, 0.13)	0.01 (-1.38, 1.39)	-0.03 (-0.35, -0.29)	$0.28^{\dagger}$ (-0.03, 0.60)
Intercept	0.68^{**} (0.57, 0.78)	3.20^{**} (2.91, 3.49)	1.51^{**} (1.32, 1.70)	18.24^{**} (17.07, 19.41)	3.80^{**} (3.53, 4.06)	3.15^{**} (2.89, 3.42)
R^2	.06	.07	.87	.07	.03	.11
Overall F	$2.58^{\dagger}$	$2.81^{\dagger}$	166.54^{**}	$3.00^{\dagger}$	0.97	4.58^{*}

Note. $n = 79$. DV = Dependent Variable. 95% confidence intervals in parentheses. $^{*}p < .05$ $^{**}p < .01$ $^{\dagger}p < .10$.

Table 4

Correlations and Descriptive Statistics (Study 3)

	Variable	1	2	3	4	5	6	7	8
1	Creativity	–							
2	Novelty	$.84^{**}$	–						
3	Usefulness	$.82^{**}$	$.37^{**}$	–					
4	Advice integration	$.94^{**}$	$.82^{**}$	$.74^{**}$	–				
5	Advisor engineering expertise	$.32^{**}$	$.26^{*}$	$.26^{*}$	$.35^{**}$	–			
6	Advisor biology expertise	.07	.05	.07	.09	-.17	–		
7	Total expertise	$.24^{*}$	.20	$.24^{*}$	$.24^{*}$	$.25^{*}$	$.86^{**}$	–	
8	Advisor competence	$.48^{**}$	$.34^{*}$	$.45^{**}$	$.52^{**}$	$.55^{**}$	.19	$.44^{**}$	–
	Minimum	1	0	1	0	2	1	1.67	10
	Maximum	4	4	4	1	5	5	4.33	25
	Mean	3.07	2.97	3.17	0.61	4.29	1.89	2.57	19.14
	SD	0.74	0.92	0.88	0.30	0.81	1.23	0.66	3.69

Note. $n = 87$. $^{*}p < .05$ $^{**}p < .01$.

Table 5

Regression Analyses (Study 3)

Variables	Model 1 (DV: Creativity)	Model 2 (DV: Advice Integration)	Model 3 (DV: Advisor Competence)
Social/Insight Language Condition	-0.05 (-0.15, 0.05)	4.41 (*F* = 1.05)	-0.47 (-1.20, 0.26)
Advisor Choice (0 = Complementary, 1 = Domain)	-0.06 (-0.43, 0.32)	1.16 (*F* = 0.83)	-0.07 (-2.82, 2.68)
Advice Integration	1.18^{**} (1.09, 1.27)		
Intercept	3.42^{**} (2.93, 3.91)	150.07^{**} (*F* = 106.69)	20.35^{**} (17.01, 23.69)
R^2	.89	.05	.02
Overall F	225.89^{**}	1.12	0.83

Note. $n = 87$. DV = Dependent Variable. 95% confidence intervals in parentheses. Model 2 is a univariate Generalized Linear Model, which includes *F* values in parentheses instead of confidence intervals. $^{*}p < .05$ $^{**}p < .01$ $^{\dagger}p < .10$.

Table 6

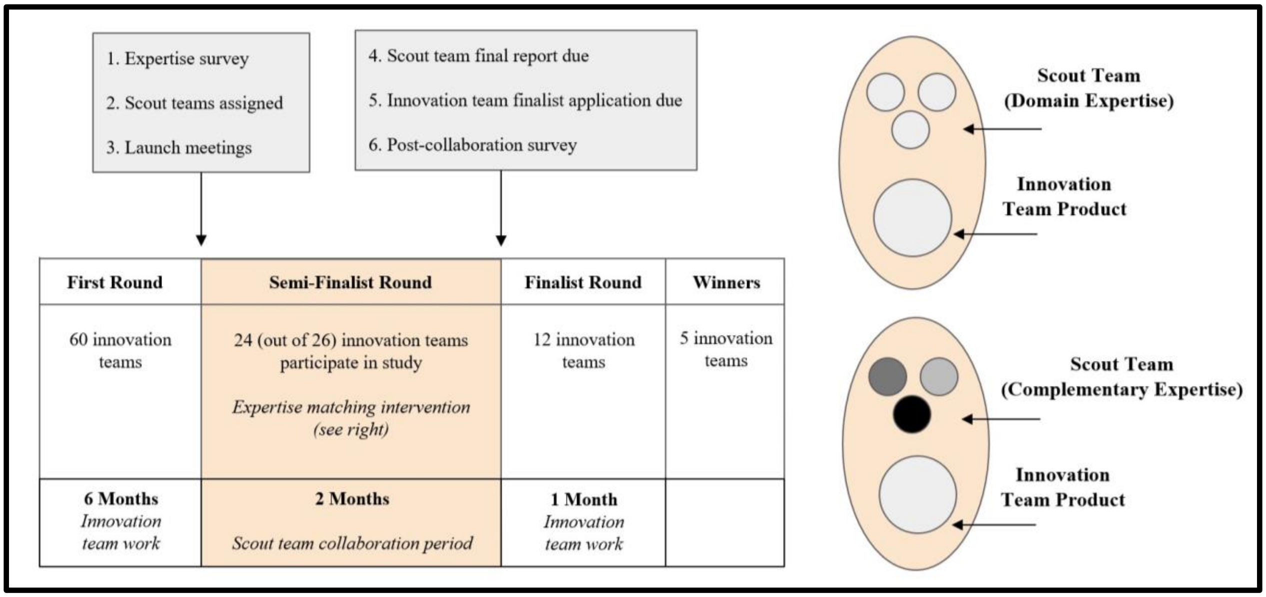
Logistic Regression Analyses (Study 3)

Social/Insight Language Conditions	Model 1 (DV: Advisor Selection, 0 = Complementary Expertise, 1 = Domain Expertise)
1. (Domain Expertise = High, Complementary Expertise = High)	0.63 (0.97)
2. (Domain Expertise = High, Complementary Expertise = Low)	19.53 (8380.81)
3. (Domain Expertise = Low, Complementary Expertise = High)	0.22 (0.88)
Intercept	1.67^{**} (0.63)
Cox and Snell R^2	.06

Note. n = 87. DV = Dependent Variable. Standard Errors in parentheses. The reference category is condition 4 (Domain Expertise = Low, Complementary Expertise = Low). $^{*}p < .05$ $^{**}p < .01$ $^{\dagger}p < .10$.

Figure 1

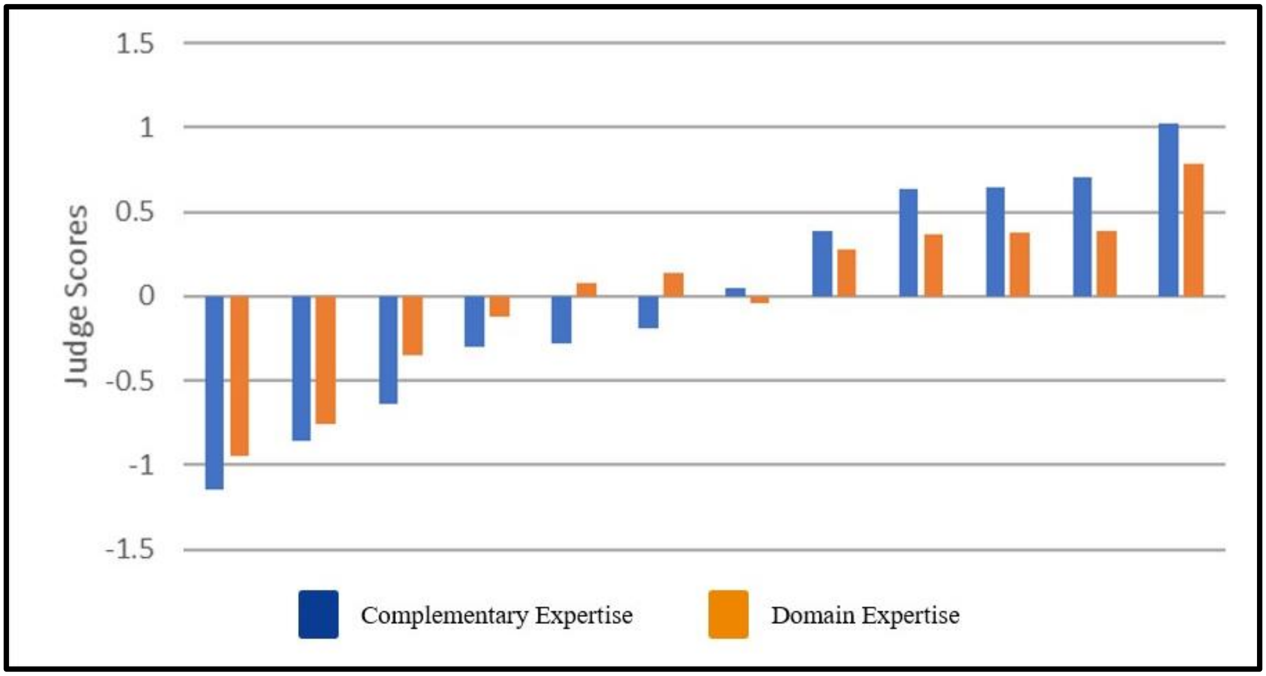
Overview of Field Experiment Data Collection Procedure



Note. Description of Study 1's field experimental procedure.

Figure 2

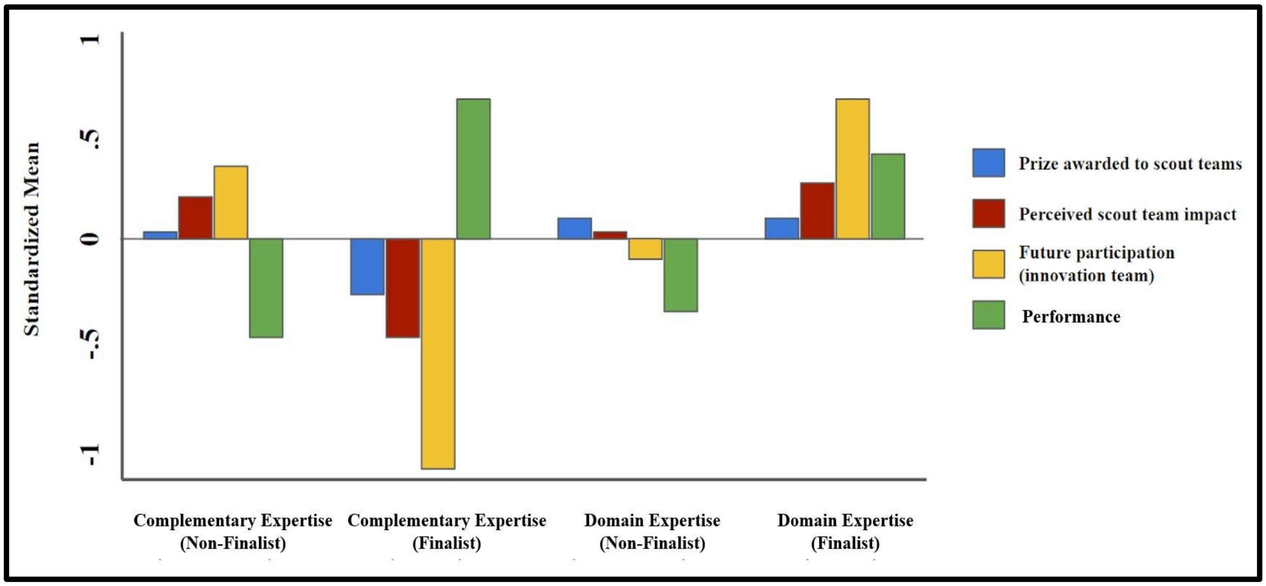
Field Experiment Team Performance Scores by Condition



Note. Each innovation team score from Study 1 graphed in ascending order according to judge score, separated by condition (12 teams in each condition; complementary expertise scout team vs. domain expertise scout team).

Figure 3

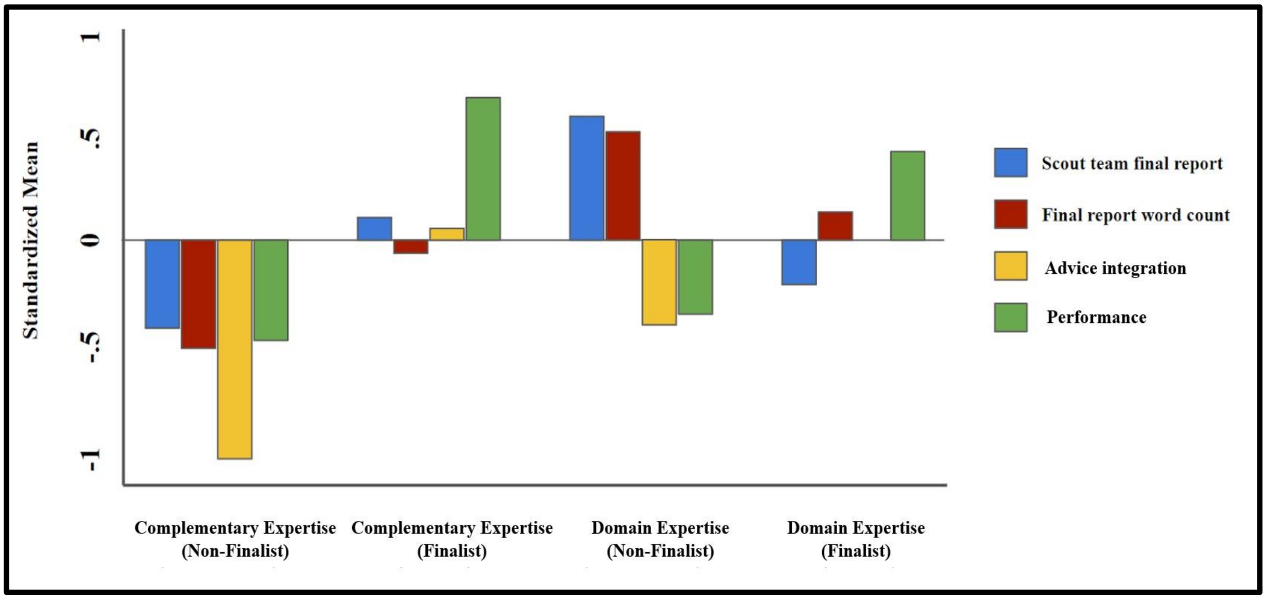
Team Performance Scores and Rating of Experience with Advisors by Condition



Note. Twenty-four total teams, 12 in each condition. Complementary expertise condition: seven non-finalists, five finalists. Domain expertise condition: six non-finalists, six finalists. Measures of judge scores and of enjoyment of the collaboration process with scout team experts from Study 1 separated by whether the scout teams had similar or different expertise and whether the innovation team advanced to the finalist round.

Figure 4

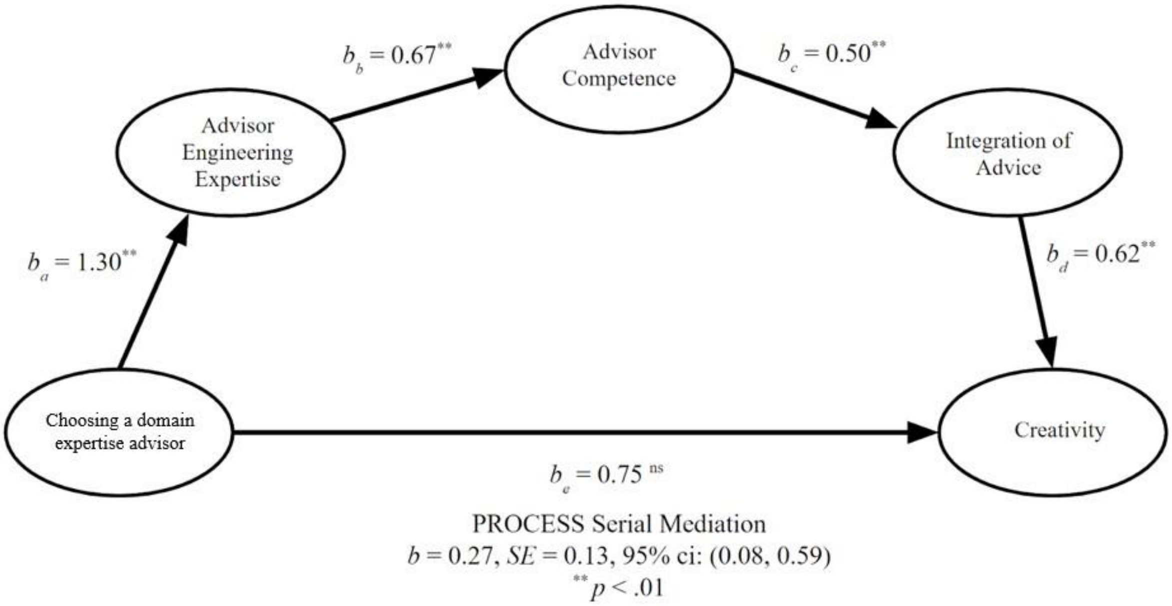
Team Performance Scores and Integration of Advisor Ideas by Condition



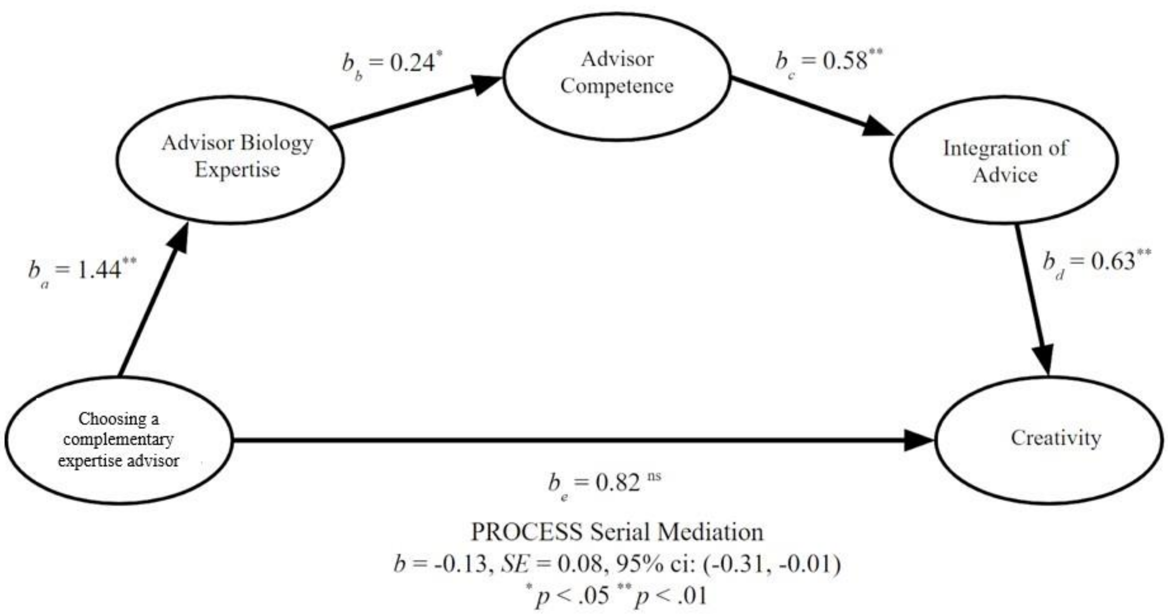
Note. Twenty-four total teams, 12 in each condition. Complementary expertise condition: seven non-finalists, five finalists. Domain expertise condition: six non-finalists, six finalists. Measures of judge scores and of integration of scout team ideas from Study 1 separated by whether the scout teams had similar or different expertise and whether the innovation team advanced to the finalist round.

Figure 5

Effect of Choosing a Domain Expertise Advisor on Creativity (Study 3, n = 87)



Effect of Choosing a Complementary Expertise Advisor on Creativity (Study 3, n = 87)



Appendix A (Study 2)

Vehicle Component Response Options

1. How should we design the insulation system for the vehicle?

- Water circulation system in walls.
- Aluminum layers in walls.
- Stone layers in walls.
- Soft cellulose cushion in walls.

2. What additions should we make to the nose or tail of the vehicle?

- Heat resistant nose shield.
- Breakaway nose guard.
- Heat radiation tail flaps.
- Tail breakaway pod.

3. How should we design the landing gear of the vehicle?

- Hard edge/malleable pad landing gear.
- Multiple wheels with rotating sockets.
- Cushion-based deployable landing mechanism.
- Nose bumper and extreme braking system.

4. How should we design the cargo hold of the vehicle?

- Spiral shelving system in room running the length of the vehicle.
- High-ceiling room running the length of the vehicle.
- Detachable containers on the belly of the vehicle.
- High-ceiling room at the rear of the vehicle.

Appendix B (Study 2)

Domain Advisor Introduction

To help you design the aircraft, FlyTech has assigned you an adviser who has some suggestions for your design. Information on your adviser is below:

- M. Williams.
- PhD in Engineering, 2002.
- 6 years experience designing aircraft at IntraFlight, LLC.
- 14 years experience designing and testing air and ground vehicles at Global Aerospace, Inc.
- Teaches course in aerospace engineering at a local university.

Complementary Advisor Introduction

To help you design the aircraft, FlyTech has provided an adviser who has some suggestions for your design. Information on your adviser is below:

- M. Williams.
- PhD in Biology, 2002.
- 6 years experience researching ecological adaptation at LifeGen, LLC.
- 14 years experience leading the adaptation research group at Global Bio Labs, Inc.
- Teaches course in evolutionary biology at a local university.

Appendix C (Study 2)

Advisor Suggestions and Reasoning

1. How should we design the insulation system for the vehicle?

High social and insight language (same for domain and complementary expertise advisors)

Our team worked on a project with water-based insulation systems once. We could consider building a water circulation system to insulate the walls, because that would increase the vehicle's low temperature thresholds. However, we should know that this would also decrease the vehicle’s high temperature threshold.

Low social and insight language (same for domain and complementary expertise advisors)

I once worked on a project with water-based insulation systems. You could build a water circulation system to insulate the walls, because that would increase the vehicle's low temperature thresholds. However, you should know that this would also decrease the vehicle’s high temperature threshold.

2. What additions should we make to the nose or tail of the vehicle?

High social and insight language (same for domain and complementary expertise advisors)

A good friend of ours specializes in shield mechanisms. We could consider a shield mechanism on the vehicle's nose, which can increase the vehicle's high temperature threshold. Something we should think about though is that it would increase the vehicle's weight.

Low social and insight language (same for domain and complementary expertise advisors)

Another engineer I know of specializes in shield mechanisms. You could build a shield mechanism on the vehicle's nose, which can increase the vehicle's high temperature threshold. Though this would increase the vehicle's weight.

3. How should we design the landing gear of the vehicle?

High social and insight language (same for domain and complementary expertise advisors)

A colleague of ours thought up an airplane that uses landing gear with hard edges and malleable pads to allow it to land on uneven surfaces. We could think about adding that to the design of this vehicle, although it could reduce the vehicle's top speed.

Low social and insight language (same for domain and complementary expertise advisors)

Another engineer I know of built an airplane that uses landing gear with hard edges and malleable pads to allow it to land on uneven surfaces. You could add that to the design of this vehicle, although it could reduce the vehicle's top speed.

4. How should we design the cargo hold of the vehicle?

High social and insight language (same for domain and complementary expertise advisors)

On a recent project, our team designed a spiral shelving system for increasing cargo space in a similar vehicle. We could think about using that here, though it would increase the vehicle's weight.

Low social and insight language (same for domain and complementary expertise advisors)

On a recent project, I designed a spiral shelving system for increasing cargo space in a similar vehicle. You could use that here, though it would increase the vehicle's weight.

Appendix D (Study 3)

Advisor Introductions

Domain Advisor Introduction, High Social and Insight Language

Hello! I'm Dr. Williams, and I know that working together, we can design an effective vehicle. We have thoroughly reviewed FlyTech's requests, and considered a number of potential avenues for us to pursue. I received my PhD in Engineering in 2002 and have over 20 years of experience in the field—I am here to support you in any way that I can as teammates, and am confident that our collaborative relationship will produce great insights.

Domain Advisor Introduction, Low Social and Insight Language

Hello, I'm Dr. Williams. You are completely prepared to begin your project designing FlyTech's vehicle, and you should be able to satisfy the client's needs to build an effective final product. I received my PhD in Engineering in 2002 and have over 20 years of experience in the field. Based on the company's clear guidelines, I have provided advice that will help make your project a winner.

Complementary Advisor Introduction, High Social and Insight Language

Hello! I'm Dr. Stevens—we should be very excited to get started on our design for FlyTech. We've considered the client's parameters and thought deeply about how we should proceed. I received my PhD in Biology in 2002 and have worked in the field for over 20 years, and I know that if you and I work together as teammates, thinking hard about our best decisions, then our collaboration will definitely be a success.

Complementary Advisor Introduction, Low Social and Insight Language

Hello, I'm Dr. Stevens—you should be very excited to get started on your design for FlyTech. If you work hard on this project and you apply yourself, then your design will definitely be a success. I received my PhD in Biology in 2002, have over 20 years of experience in the field, know the client's parameters, and I have advice regarding how you should proceed on your project.

Chapter 5

General Discussion

As a result of global trends representing increased complexity and speed of work, modern organizational teams are more commonly facing contexts where they are tasked with understanding and solving a complicated problem in a short period of time while having access to advice from experts in various domains. In this dissertation, I seek to develop enhanced understandings of how organizational teams understand the problems they solve and how they leverage internal expertise from team members and external expertise from outside advisors to solve them.

Chapter 2 began my examination of these concepts by conducting a qualitative field experiment with teams composed explicitly to formulate a focal problem from a set of broad, unrestrictive parameters. This first empirical study allowed for detailed examination of the team problem formulation process through the analysis of rich, qualitative data, providing evidence for the iterative collective processes that drive teams to define more concrete, present-focused or more abstract, future-focused problems.

This study is useful as a first step in examining the complex dynamics of how team member expertise influences problem formulation, and will hopefully be able to act as a springboard for future research to develop additional hypotheses and refine the theory laid out at the chapter's conclusion. In particular, that additional work can hopefully employ more quantitative methods to test the efficacy of the iterative theory in which individual member cognition processes of how to perceive the problem influence how the team itself interacts and how those interaction patterns solidify into social norms that guide cognition. If further evidence is found for this process, interventions can be designed to target different aspects of the process (i.e., individual cognition, team interaction, or social norms) depending on the context of the team's task. For example, additional quantitative research would be especially useful to the end of determining when teams should direct their attention to a problem's current state versus its desired state. For one, it seems reasonable that when a team is striving for a highly creative, disruptive solution (e.g., when tasked with designing a groundbreaking new product or service), that teams would want to focus on a desired state so as not to be restricted by any assumptions or notions about the present. Conversely, teams tasked with finding a satisfactory solution to a problem (e.g., a flaw in a product has been discovered that must be patched or relaced as soon as possible) may perform best when they focus on a problem's current state, determining what precisely is wrong and how to best fix it. In addition, answering questions regarding other types of problem-solving goals or which focus certain types of teams or individuals naturally adopt will further this line of research.

Next, Chapter 3 focused on the time-pressured aspect described above by employing a field experiment to study how teams make rapid adjustments to their coordinated behavior based on evolving understandings of the focal problem. This study revealed that certain teams—in this case, those composed of members high in perspective-taking—are able to capitalize on their members' expertise by tailoring the problems they solve to their members' preferences and abilities.

To study true rapid adaptation, I studied participants in a context—improv theatre—where the task's goal was as broad as possible: create a funny show. In this context, with no time or space to explicitly plan behavior with teammates, teams had to rely on other skills or abilities—individual perspective-taking, for one—to coordinate their behavior. This context may be similar to those faced by emergency response teams who enter crisis situations knowing they will be unprepared and must coordinate on the fly, often non-verbally, to succeed in their missions. But beyond these more extreme, non-traditional contexts, future research that could conduct similar studies in more traditional organizational contexts would be beneficial in developing interventions that could be employed across many types of organizations, or perhaps even regardless of task (e.g., perspective-taking interventions en route to time-pressured meetings, presentations, or other events). Moreover, the translation of team member expertise into performance is a topic that will likely benefit from more research for many years to come given global trends toward 1) heavier reliance on teams to solve problems and 2) increasingly specialized expertise in individuals. As more teams composed of deep experts in disparate fields are assigned tasks with tight timeframes, the importance increases of understanding how teams can coordinate to capitalize on that expertise to generate quick solutions to evolving problems. Training perspective-taking in these teams appears to be important given the findings of my study, but undercovering additional methods of achieving this goal will be crucial.

Finally, Chapter 4 examined the role of advisors of either domain or complementary expertise in how teams of innovators understand and develop solutions to problems, presenting three experiments, one in the field and two in the laboratory. These experiments revealed that problem-solvers value advice from experts in the realm of the problem they are solving much more than advice from experts in outside realms, despite both types of advisors having the capacity to enhance performance in unique ways.

However, across Chapter 4's three studies, a key inconsistency emerged regarding the impact of language used by advisors on problem-solvers' perceptions and behaviors. Specifically, Study 1, a field study of a global innovation contest, found that when advisors used more social and insightful language in their introductions to problem-solvers, their advice was more regularly integrated into solutions, benefiting performance. However, Studies 2 and 3, conducted in laboratory settings with interventions manipulating social and insightful language, found no effect of advisor language on participants' attitudes or behavior. There are a number of potential reasons for this, both methodological and theoretical. Many of the methodological concerns are presented in the discussion of Chapter 4, including that the effect of language use was found in Study 1 where language was not manipulated, meaning the observed correlations could have possibly been related to an unmeasured variable. However, other differences in context between the studies could shed light on the conditions under which social and insight language use is influential on problem-solvers, and the conditions under which it is not. These theories could help indicate next steps for research to turn for answers to this question.

Two primary differences between contexts are 1) the level of ownership problem solvers had in relation to the solution they were pursuing; and 2) problem solvers' expertise in the field of the problem. In the field experiment, participants were entrepreneurial teams who had spent much time and money learning about their field and building their products. By contrast, participants in the lab experiments were new to the task and, in most cases, were not experts in the domain of the problem. These differences may well have impacted which factors participants were influenced by when listening to advisors.

Due to the high personal and sometimes financial stakes of their decisions, problem solvers who feel great psychological ownership over a product in a domain in which they have expertise are likely to heavily scrutinize advisors, particularly when the advice is about flaws with their ideas. Psychological ownership is likely to make problem solvers hesitant to heed advice from just anyone for fear of losing their significant investment of time and effort, while domain expertise allows them to recognize whether or not the advisor possesses knowledge that they need to improve their idea. Therefore, in their evaluation of their advisors and their decision of whether or not to trust the advice, they may pay keen attention not only to characteristics such as advisors' salient expertise domains—for they may not feel an advisor's credentials are a perfect representation of the advisor's expertise—but also to how they behave and speak (Hur et al., 2020). Thus, in contexts like the field experiment in Study 1, the language used by advisors may be influential in instilling trust in problem solvers—specifically, evidence presented here suggests that expert problem-solvers who feel a high level of ownership are drawn to advisors using social and insight language. This type of language might make it clear to problem solvers that 1) advisors are working in collaboration with them and invested in their success; and 2) that advisors are equipped to provide insights that will be helpful for developing the idea, regardless of the advisors' expertise. More precise mechanisms behind these theorized relationships should be explored in future research.

In contrast, in lab contexts, where participants feel less ownership over an idea and who possess limited knowledge of the domain of the problem, problem solvers may rely much more heavily on salient signals of expertise when deciding whether or not to listen to advisors. With less personal investment, participants will likely be more willing to trust outside advisors and their advice because the costs of a poor decision are low, and with less domain knowledge, they will be more likely to assume an advisor's credentials are clear indicators of their expertise. Therefore, when deciding how to incorporate advice, these participants are likely to weight factors such as education or experience far above language use, which could explain why effects of language use were harder to detect in laboratory experiments. Again, while the evidence supports the theory that the use of advisor language plays a lesser role when participants feel less ownership or possess less expertise, there are also methodological differences between studies that could explain the difference in findings. Therefore, further research is necessary to disentangle the causal factors of the observed results.

Linking the Empirical Chapters Together

These empirical chapters examine three key components of problem-solving that are particularly relevant in modern organizational life, which is characterized by complex, ill-structured problems (Chapter 2), evolving circumstances with tight timelines (Chapter 3), and increasing use of expert advisors during work (Chapter 4). Taken together, this package presents a picture of some of the most pertinent obstacles facing organizational teams in the mid-21st century, and strives to provide understanding as to how those obstacles influence problem-solving attitudes, processes, and outcomes.

A primary theme linking these three empirical chapters—and the obstacles they each focus on—is the way problem-solving teams understand the problems they are solving. Though problem-solving has been a popular research topic for decades, the vast majority of this work has focused on understanding and improving how people solve stable, well-defined problems. This is vital work, but it has resulted in a limited understanding of how problems come to be stable and well-defined. Given the various global contextual changes described previously that result in hyper-complex problems with hazy parameters, the understanding of how people—and teams of people in particular—define problems is growing in relevance. Thus, as filling the gap in problem-solving research becomes more relevant over time, this dissertation strives to address this gap through examining the formulation of problems from three different angles.

To this end, Chapter 2 takes a baseline approach, asking which factors influence how teams settle on definitions of problems given minimal restrictions, and how their expertise influences these definitions. This work provides rich data that may be used to develop theories of problem formulation at the team level to guide future research, such as the iterative model outlined in Chapter 2. Then, Chapter 3 examines the formulation of team problems in a different context—extreme time pressure. As advancing technology speeds up modern organizational life, problem contexts evolve faster and faster, meaning problem-solving teams must grapple with the issue of defining ill-structured problems that continues to change. This work provides insight into how teams can formulate problems on the fly while still capitalizing on their expertise. Finally, Chapter 4 expands the relevant problem-solving unit by examining how expert advisors impact how problem-solvers understand and solve the problems they are facing. In a world where, due to growing complexity of problems, problem-solving is rarely undertaken solely by one person or team, this work enhances our understanding of how problem-solvers come to understand the problem they are facing as a function of how they perceive their advisors.

Overall, the hope with this research is that a better understanding of the obstacles facing problem-solving teams and their impact, particularly regarding problem formulation, can be used to construct effective interventions that may be implemented in modern organizations to create positive change.

Theoretical Contributions, Future Directions, and Practical Recommendations

The research in this dissertation makes a number of theoretical contributions that suggest directions for future research, particularly in the realms of problem-solving, creativity, and adaptation. In addition, these takeaways suggest implications for the management of teams likely to face problems with uncertain parameters, especially when under time pressure or with the option to seek advice from outside experts.

Problem-Solving

Decades of behavioral science research have been dedicated to understanding how people solve problems (Newell and Simon, 1972). More recently, focus has expanded to include not only the solving of a defined problem, but the defining of the problem itself, and the role this process has in which solutions are generated and selected (Cromwell et al., 2018; Cronin and Loewenstein, 2018; Harvey and Kou, 2013; Reiter-Palmon et al., 1997). This shift is particularly important in the context of team problem-solving, given the increasing reliance of organizations on teams to perform work (Argote, 2012; Kozlowski and Ilgen, 2006; Reiter-Palmon and Murugavel, 2018), along with the ample evidence that teams often underperform despite the presence of adequate expertise (Cronin and Weingart, 2007; Diehl and Stroebe, 1987; Kozlowski and Bell, 2003; Woolley et al., 2008). This research has tended to emphasize the solution-seeking or solution-implementing issues that inhibit teams from capitalizing on their expertise (e.g., Coursey et al., 2019; Diehl and Stroebe, 1987; Woolley et al., 2008). However, the stem of many of these behaviors may reside even earlier in the problem-solving process: in how teams formulate the problems that they go on to solve. The research presented in this dissertation builds, first and foremost, upon the idea that understanding the problem formulation process has potential to help researchers and practitioners improve organizational problem-solving, especially at the team level.

Across three chapters, this dissertation demonstrates the variance in how well problems are solved and how highly solutions are valued that can occur as a result of how the problem formulation process is undertaken, who is undertaking it, and what problem definition it produces. Moreover, the interventions implemented in these studies both shed light on the underlying processes of how teams formulate problems and suggest pathways of facilitating teams in the problem formulation process. For example, Chapter 2 demonstrated that focusing an expert team's attention on different aspects of the problem it is formulating (here, the current state or desired state) can systematically impact the definition of the problem that is ultimately formulated. These results support the idea that problem-solving outcomes can be influenced by slight changes in framing at the very beginning of the problem-solving process, opening the door for the development of additional beneficial problem formulation interventions. In addition, Chapter 4 demonstrated that when advisors introduce new perspectives on problems to teams of innovators, ideas become better developed, more robust, and more valuable. These findings highlight that a key point of influence for advisors in these contexts is in how people perceive the problem they are solving—specifically, advisors appear to help people attend to a larger set of a problem's facets, thereby helping them build a more comprehensive solution.

The result presented here is a jumping-off point for future research—it displays that certain types of interventions can be useful in enhancing our understanding of problem-solving and in improving problem-solving performance, but it only scratches the surface of the potential forms of intervention that could be useful. For one, researchers could examine other interventions in the problem formulation process that vary in their objective, and thus their content and timing. For example, Chapter 2 found that nudging teams to focus on the desired state of the problem tended to facilitate the generation of highly creative problems borne from combined knowledge domains and suited to teams' expertise. How might interventions be designed to facilitate the generation of other types of problems (e.g., simplest forms of problems) that are best suited to the context's constraints?

Creativity

In certain aspects, the problem-solving and creativity literatures are closely related (Cronin and Lowenstein, 2018; Reiter-Palmon and Murugavel, 2018). For example, novel solutions are often generated as a result of viewing a common problem from a new perspective. In fact, many prominent examples of highly creative solutions involve converting an idea from one domain into another, thereby generating a new combination of knowledge that is both highly novel and highly useful (e.g., use of origami techniques in space vehicle construction; Kittur et al., 2019). Though the winning examples of this possibility are striking, more often people face the classic tradeoff between novelty and usefulness when they attempt to generate new solutions by adopting different perspectives to problems (Amabile, 1982). For example, when current solutions to a problem centered in domain X are lacking novelty, an expert in domain Y might be brought in to provide a unique perspective. The resulting solution might very well be novel because of the unique combination of expertise, but it may not be useful due to violation of certain rules, regulations, or other parameters that the non-domain expert is unfamiliar with (Dane, 2010).

This dissertation builds upon new research conducted on creativity, diversity, and analogical thinking (Cromwell et al., 2018; Cronin and Lowenstein, 2018; Cronin and Weingart, 2007; Kittur et al., 2019) to extend understanding of the conditions that allow problem formulation to result in both novel and useful problem definitions and, subsequently, solutions with those same characteristics. For example, Chapter 2 revealed the influence that shifts in attention during problem formulation can have on how novel and how useful problem definitions are, along with highlighting the importance of goals in the evaluation of problem definitions, particularly the interpretation of usefulness. The findings suggested that directing attention primarily to a problem's desired state results in more novel problem definitions that imagine new futures while still being useful because they are suited to the expertises of the team's members. And while directing attention to the current state resulted in less novel problem definitions that were less suited to members' expertises, those definitions may be useful in a different sense in that they were deeply rooted in characteristics of the present context. In addition, Chapter 4 finds that domain experts are less likely to enjoy receiving and integrating advice from complementary experts who identify potential problems with a project, suggesting that expertise in a particular topic area can cause people to resist outside perspectives that help them formulate more robust problems and therefore more robust solutions.

Future research should continue to examine how a team's goals influence the value of the problem it defines. A better understanding of what type of problem a team desires (simple, novel, etc.) and which processes nudge teams to generate these types of problems would shed light on the links between problem formulation and creativity and would facilitate recommendations for people looking to formulate useful problem definitions.

Adaptation

This dissertation also informs the literature on adaptation. There are some problems that teams expect to face in their work. To prepare for these, organizations build routines and protocols to respond to common problems that may arise during a team's lifespan (March and Simon, 1958; Cyert and March, 1963; Nelson and Winter, 1982). Other problems, however, crop up unexpectedly, and require adaptation (Burke et al. 2006; Christian et al. 2017). As evidenced throughout this dissertation, how a team formulates an unexpected problem that arises can have a large impact on how well the team addresses the problem and how well it performs its work.

This dissertation integrates research on expertise as sources of both rigidity and flexibility in adaptation and problem-solving (Baker et al. 2003; Dane, 2010; Feldman, 2000; Gilbert, 2005; Hannan and Freeman, 1983), and reconciles tensions between these competing forces by examining them through the lens of problem formulation. Specifically, it finds that expertise does not consistently facilitate the formulation of novel and useful problems, and has the potential to even reduce the novelty of problems. This suggests that one mechanism between expertise and creative performance involves problem formulation, which would help to explain the inconsistent effects of expertise on creativity. Moreover, this research sheds light on the conditions under which expertise does facilitate the formulation of novel and useful problems, suggesting directions for beneficial interventions for teams facing adaptive contexts in practice. For example, Chapter 3 reveals that perspective-taking plays a key role in whether expertise is beneficial or detrimental in teams adapting under time pressure. Specifically, it shows how prosocially formulating problems from uncertain contexts can result in creative problem-solving because team members help to place each other in situations where they can solve problems specifically suited to their strengths. When perspective-taking is not employed during this rapid adaptation, teams are not well-suited to solve the problems they have defined, thereby misusing their expertise and performing poorly.

Given the findings of the research presented here, the connections between problem formulation and adaptation will be fruitful areas for future research. As the speed and complexity of organizational life continues to increase, adaptation is likely to only become a more relevant ability, with the best organizations being those composed of teams that can adapt rapidly and effectively to evolving contexts (Burke et al. 2006; Christian et al. 2017; De Smet et al. 2020; Kozlowski and Bell 2003; Moorman and Miner 1998). If how teams formulate problems can influence how well they make use of available expertise and resources, then research dedicated to understanding these processes and designing effective interventions will be highly beneficial. A future where organizational teams are trained to quickly formulate problems in accordance with both the context and their strengths may be a future where such teams are able to perform well under even the most challenging circumstances. Such research would have particular benefit for crisis teams, including first responders and those in healthcare organizations.

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