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NOTE

REPRESENTATIONAL GAPS, INFORMATION PROCESSING, AND CONFLICT IN FUNCTIONALLY DIVERSE TEAMS

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Functional diversity in teams, while potentially beneficial, increases the likelihood that individual team members will perceive the team's task differently, leading to gaps between teammates' interpretations of what is needed for the team to be successful. These *representational gaps* are likely to create conflict as teammates try to solve what are essentially incompatible problems. Understanding how these general mechanisms work should deepen our understanding of information processing and conflict in diverse teams.

Many have argued that diversity in knowledge and experience in teams should lead to better and more creative solutions (e.g., Kanter, 1988). Yet such gains have not been consistently found (Bettenhausen, 1991; Hambrick, Cho, & Chen, 1996; Milliken & Martins, 1996; Simons, Pelled, & Smith, 1999; Williams & O'Reilly, 1998). These mixed findings have often been explained as information sharing problems, including unwillingness to share information (Bunderson & Sutcliffe, 2002; Lovelace, Shapiro, & Weingart, 2001), the degree to which people feel safe in expressing their viewpoints (Edmonson, 1999), and the tendency of groups to focus on common knowledge (Stasser, 1999; Wittenbaum & Stasser, 1996). Implicit in this literature is that (1) people are *capable* of integrating others' information with little misunderstanding and (2) they would choose to do so. We argue that *representational gaps*—inconsistencies between individuals' definitions of the team's problem—limit both of these processes, making it more difficult for team members to integrate one another's information and increasing the likelihood of conflict.

An example of a representational gap comes from a cross-functional product development team at an auto manufacturer. The team is given a mandate to make a "tough truck." The designer, thinking in terms of styling, conceptualizes "tough" as "powerful looking." The designer then sketches a vehicle with a large grille and large tires, creating a very powerful stance. When seeing this mock-up, an engineer, thinking in terms of functionality and conceptualizing tough as implying durability, is unhappy with the design because it compromises the vehicle's power. Maintaining hauling capacity with large tires implies a need for greater torque output from the engine, adding expense and difficulty to the engineer's part of the problem. When the engineer suggests 16- rather than 20-inch wheels, the designer balks, claiming it makes the vehicle look cartoonish rather than tough.

The representational gap illustrated here involves the conceptualization of "tough." Although the two conceptualizations can coexist (a vehicle can be both powerful looking and durable), resources are often limited and accommodations between alternative perspectives are usually required if the truck is to be built within

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specifications. Such accommodations, we argue, can be difficult to achieve. In the best of situations, the designer may want to help solve the engineer's torque problem by offering solutions that maintain the vehicle theme. However, lacking training in engineering principles, it will be difficult for the designer to propose feasible solutions, as much as it will be difficult for the engineer to know what features will and will not convey the "tough" theme (a design concept). For the engineer to accept the use of 20-inch wheels, she would have to justify the resulting cost of increased torque. Even if cost and benefit could be calculated accurately (how does one quantify the utility of 20-inch wheels?), the designer's and engineer's assessments of the trade-off would likely differ in line with their functional values. If styling (à la design) is assessed as the primary driver of the purchase of a truck, then the benefit of the 20-inch wheels will be greater than if functionality (à la engineering) is the primary driver.

Fundamentally, a representational gap reflects differences between team members' problem definitions that will ultimately affect group problem solving. In this paper we examine representational gaps in detail—their causes, how they affect information processing, how they create conflict, and what can be done to bridge them. We do this by using information processing psychology (Newell & Simon, 1972) to build on the research on shared mental models (SMM; Cannon-Bowers, Salas, & Converse, 1993; Klimoski & Mohammed, 1994), in accordance with the suggestion by Klimoski and Mohammed that the potential of understanding shared cognition "can best be realized if the notion of a group mind is examined relative to what we know about mental representations and cognitive architecture at the level of the individual" (1994: 404). The SMM literature demonstrates the importance of team members holding similar views for team performance (Marks, Sabella, & Burke, 2002; Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000). We hope to advance the theory of SMM by using the notion of the representational gap to shift the focus from what is *shared* among teammates to what is *inconsistent* among them. We argue that inconsistencies in individual cognitive representations are at the heart of many decision-making problems in diverse teams.

Representational gaps are a process loss phenomenon (Steiner, 1972) in diverse teams that influence each of the three core processes in group functioning identified by McGrath and Argote (2001): information processing, coordination, and conflict management. Representational gaps degrade information processing by leading to misunderstanding and potential misuse of information. Representational gaps make coordination difficult by creating contradictions in how teammates believe the problem should be solved, leading them to take actions that contradict each other. Finally, when team members interpret the same information differently and view how the problem should be solved differently, the team is likely to experience conflict. In explicating representational gaps, we focus on their influence on information processing; we also consider their subsequent effects on team coordination and conflict.

We also argue that our theory of representational gaps is very generalizable. Representational gaps come from the different knowledge and values that people hold. Although we focus primarily on functional diversity, most types of diversity lead people to have different knowledge and values (Williams & O'Reilly, 1998). Norms and values can vary across local conditions (Cramton, 2001), culture (Hofstede, 1980), and as a result of differences in individual personality (Rokeach, 1979). Thus, representational gaps can even occur in what appear to be homogeneous teams.

REPRESENTATIONAL GAPS DEFINED AND DELINEATED

A representational gap is a group-level phenomenon that arises as a function of the cognition of individuals working together to solve a problem. It is rooted in individual-level *problem representations*—the framework that guides the way an individual solves a particular problem. The representation is "a cognitive structure that corresponds to a given problem . . . constructed by the solver on the basis of domain-related knowledge and its organization" (Chi, Feltovich, & Glaser, 1981: 131). Representations can be distinguished from frames (Putnam & Holmer, 1992) or schemata (Fiske & Linville, 1980) in that representations are constructed for specific problems, whereas frames and schemata are generalized templates used to make sense of large classes of problems. Representations are often created using the perceptual schemata that people hold.

Groups have what we call a "joint representation"—a group-level cognitive structure that corresponds to the group's problem. Like a shared mental model, a joint representation can be seen only by considering the aggregate of individual representations (Cannon-Bowers et al., 1993). It is necessary to view the joint representation as the *union* of all individual representations for two reasons. First, representations arise from perception, and people can only "see though their own eyes." In other words, each individual has only his/her own perception, while others' perceptions (and, hence, problem representations) are not actually experienced. This is not to say that one person cannot affect another's representation; rather, any outside influence is going to have to be encoded through one's own perceptual schemata. Second, since individuals will create representations that they think accurately model the team's task, any part of that representation, shared or unshared, will affect the individual's problem solving. Thus, we use the union as the aggregating function because people cannot fully know others' cognitions, and their personal representations of the team's problem will affect their actions, even if their representation differs from other team members' representations.

Because individuals are limited to perceiving a problem from their own vantage point, internal consistency of the joint representation is difficult to obtain. An individual representation, contained in one person, allows that person to inspect his or her thoughts for consistency and to change them as he or she sees fit. In contrast, the mechanism for comparing representations *across* team members is more difficult to implement and less reliable. The default beliefs of others are difficult to inspect because they are often not verbalized since much of the process of creating a problem representation is based on the automatic application of pattern recognition and matching within a cognitive system that is built over time (Bargh & Ferguson, 2000). Thus, any inconsistencies across these tacit or nonverbalized beliefs can easily go undetected and uncorrected.

One may ask why people on the same team and presumably working toward the same objectives would differ in their problem representations in the first place. Variation among representations is possible because the representations are created from a subset of the task environment (Hinsley, Hayes, & Simon, 1977; Newell & Simon, 1972). The resulting simplified model of the problem provides a framework one can use to guide problem solving without overtaxing one's limited cognitive capacity (Simon, 1979). It is this simplification process that can introduce variation among the cognitive representations of people who look at the same situation but attend to different aspects simply because of individual differences in the knowledge and values they use to encode the problem. Representation gaps occur when the different encodings lead people to create representations that cannot be integrated.

Different Knowledge and Values Create Different Problem Representations

Given a problem, people will look for a way to solve it that capitalizes on the knowledge they already possess. Thus, people will tend to represent a problem in accordance with the knowledge they hold (Dougherty, 1992; Weingart, Cronin, Houser, Cagan, & Vogel, 2005). Knowledge can therefore drive how people categorize a problem and then formulate their problem representation. Dearborn and Simon (1958) demonstrated this when they showed how executives viewed organizational problems from the perspective of their own departments (e.g., finance managers saw a decrease in revenue as stemming from mismanagement of money, whereas marketing managers saw the same decrease in revenue as stemming from poor marketing of the product). Since people rely on their knowledge to function in the world, it logically follows that to solve problems they will represent them in ways that capitalize on the knowledge they hold.

In addition to knowledge, beliefs about what is beneficial or desirable (i.e., values; see Rokeach, 1973) will also influence how a problem is represented. In contrast to knowledge, which informs what *can* be done, values dictate what *should* be done. For example, Sarasvathy (2001) demonstrated a difference in the value placed on risk between bankers and entrepreneurs. Bankers viewed risk negatively, and risk minimization was therefore an important aspect of any endeavor in which they engaged. Entrepreneurs, however, were not as concerned with risk minimization per se. Instead, they focused on controlling the market (an aspect that bankers valued much less). Value-based beliefs are likely to be adaptive in that they support the achievement of one's objectives; in our present example, minimizing risk was useful for increasing return on investment. However, value-based beliefs are also idiosyncratic to a domain, since they arise, in part, from acculturation via training, rewards, and socialization. Again, in our example, entrepreneurs thought that the level at which risk was shunned by bankers was irrational, reflecting their values.

Thus, even when working on the same problem—for example, to design a "quality" component—the peoples' representations can be quite different. The knowledge that defines what quality is, as well as what one can change to improve quality, is a function of the skills and experience of the individual performing this task. Different values will also lead people to have differing perceptions of why quality is important and how one should rank the aspects of quality in terms of importance. Two people tasked with building a quality component may have very different representations of their collective task when their background knowledge and values differ. These differences become liabilities when they lead the individuals to work against each other in solving their joint problem.

Problem solving involves processing information relevant to the current situation (the problem state) in order to create and select among actions to change the situation (moves) so that it looks more like the desired endpoint (the goal state). Information is *interpreted* and *evaluated* using the problem representation. Interpreting information means determining which implications of the information are relevant for the problem (Bransford & Johnson, 1973; Daft & Weick, 1984; Duimering & Wensley, 2001; Lindsay & Norman, 1977; Nonaka, 1994). For example, information that a bumper design will cost $200 per part can be interpreted as (1) the bumper is too expensive, (2) there is only $450 left for other front fascia components, and (3) the bumper will be high quality—or some combination thereof. In contrast, evaluation is a process of determining *how useful* information will be for satisfying problem objectives (Ohlsson, 1992; Streufert & Nogami, 1992). In the above example, both the information that the bumper will cost $200 and the interpretation that such a cost leaves $450 will be judged of little value for solving the problem of how to make the bumper cheaper. Thus, one's representation guides both the interpretation and evaluation of information. That information, once processed, is used to decide what move to make next. However, when the joint representation has gaps, information processing and subsequent move selection are likely to have coordination problems and conflict.

Representational Gaps Derail Team Information Processing

If one team member is to use another's information, there must be a minimum degree of shared understanding (e.g., at the very least, the receiver's interpretation should not contradict the sender's intended meaning). Representational gaps can degrade this process. Sometimes a concept in one domain has no equivalent in another (e.g., "vehicle theme" for design has no parallel in engineering). Thus, any sophisticated use of that concept by the recipient is unlikely. Other times the words used may be the same, but the nuance may be different (e.g., "trust" as used by economists versus sociologists, "risk and uncertainty" as used by behavioral decision scholars versus managers). In this case it is likely there will be information distortion. The meaning and value intended by the sender may be distorted as the information is assimilated to fit the receiver's problem representation. Note that the representation is unlikely to change to accommodate the new information because the representation is the framework the individual uses to make sense of new information (Hayes & Simon, 1974).

Information integration is difficult, because although all teammates may be highly skilled, intelligent, and familiar with each other, they may not be fluent in each other's domains. When trying to make decisions that require trade-offs across functional areas, these differences in domain expertise could become a major impediment to joint problem solving. Experts and novices have been shown to solve problems differently (Larkin, McDermott, Simon, & Simon, 1980). Novices pay attention to surface features of the problem and try to solve the problem in those terms (e.g., the role of cars and hills when trying to solve a physics problem). In contrast, experts pay attention to deep structural relationships in the problem and try to solve the problem by applying their trained principles (e.g., force on an inclined plane when solving the same physics problem). Similarly, an engineer is likely to see a problem in terms of deep engineering principles, whereas a designer is likely to see the engineering surface features, and vice versa. These differences limit the effectiveness of cross-functional communication, since novices' lack of depth will lower their understanding of the nuances and interrelations between the structural features the expert is trying to describe (or may simply believe to be understood).

Experts can educate novices, so over time people from one functional area can become facile in other areas. In this way an engineer can develop a more than casual understanding of design principles and concerns. However, it would be overly optimistic to think that a designer could easily educate an engineer to understand design with the same level of sophistication that the designer has gained after years of training and experience. First, this training would occur as people work together, which is an ad hoc, potentially incomplete, kind of training. Moreover, people have their own functions to perform in these teams, so any attention for learning would be left over from that devoted to one's primary task. Learning from others also requires motivation to do so, and when reward structures are in place that do not support such an activity, it is unlikely to occur (e.g., designers have no incentive to stay under budget when that parameter is unrelated to their performance review). Finally, there may be reasons to avoid cross-functional education, since it might homogenize the diverse perspectives of the team, potentially interfering with creativity and innovation.

Shared value systems can aid in the integration of diverse perspectives. However, not all functions or backgrounds are perceived with the same level of legitimacy by others, and so all information is not given equal weighting. Value-driven preferences (rather than objective criteria) may lead people to view some information as more useful than other information. Consider how economists value mathematical modeling whereas psychologists value causal modeling in developing theory. Both approaches provide information regarding the ways human behavior might occur, but the two disciplines value their own approach more highly and infrequently attend to work in the opposing field. Egocentric bias may play a central role in this process (Kruger, 1999). People give importance to information in proportion to its relevance to their own knowledge and values.

In sum, we think about representational gaps as places where information processing between teammates breaks down. For one team member to successfully use others' information, that person must have the tools to process the information. Across a representational gap, the means to properly interpret and evaluate the message may be lacking. For instance, an engineer may hear that "maintaining the vehicle theme is our most important priority" from the designers, but what "maintaining the vehicle theme" means, exactly, is not obvious. Engineers certainly do not understand "theme" with the nuance of people trained or experienced in design. Themes are not in the lexicon of engineering, and so what this implies for the engineer is not clear. Further, even if the engineer understands that "theme" means that components share similar shapes, lines, colors, and materials, he or she (who does not deal in those terms) will have almost no ability to evaluate how this concern should be ranked in comparison to maintaining weight, cost, durability, and ease of manufacturing. What's more, if the engineer wished to make the trade-off, we should expect his or her weightings of importance of the factors to be different from the designer's.

Klimoski and Mohammed (1994) observed that the notion of what is meant by "shared" among mental models requires further development, since expecting teammates to have no unique information is probably too restrictive. In contrast to the SMM literature, which has focused on the sharedness (or similarity) between team members' mental models (Cannon-Bowers et al., 1993; Marks, Zaccaro, & Mathieu, 2000; Mathieu et al., 2000), we focus on the notion of "incompatible" representations to address Klimoski and Mohammed's concern. These constructs differ in that representations can be different (not shared) without being incompatible (or conflicting).

The existence of unshared but compatible representations can be seen in research on specialized teams. Successful teams are often purposely specialized in their knowledge, implying minimal overlap in teammates' representations. For instance, Hutchins (1990) showed how navigational teams on large ships distribute perception of the ship's position across team members as they dock the ship. Levesque, Wilson, and Wholey (2001) found that successful software development teams' mental models *diverge* over time. More generally, transactive memory research (Argote, Gruenfeld, & Naquin, 2001; Liang, Moreland, & Argote, 1995; Moreland, Argote, & Krishnan, 1998; Wegner, 1987) has shown that teams with specialization of knowledge, where there is less common knowledge, are superior in their performance to those without such differentiated knowledge. In all of these examples, although team members are highly differentiated in their representations of the problem, team success implies that their representations are compatible.

To advance theory, we must go beyond merely shifting the focus from similarity to compatibility. We must consider the specific ways in which representations can be (in)compatible. To do this we further develop the definition of a representation and identify specific incompatibilities and their implications for teams.

For a particular problem, the representation (joint or individual) comprises a goal hierarchy, assumptions, elements, and operators (GAEO; Hayes & Simon, 1974; Newell & Simon, 1972). The *goal hierarchy* specifies the objectives that need to be met to solve the problem, as well as their precedence (e.g., the car needs to be affordable but stylish, and the former is most important). The *assumptions* are the general restrictions (e.g., a due date) and preferences (e.g., cheaper is better) taken as "given" (i.e., fundamentally true, requiring no justification). The *elements* are the components of the problem that are changeable (e.g., vehicle theme, profit margin). And the *operators* are the rules for how to transform the elements (e.g., changing vendors enables one to get a component cheaper, reducing overhead).

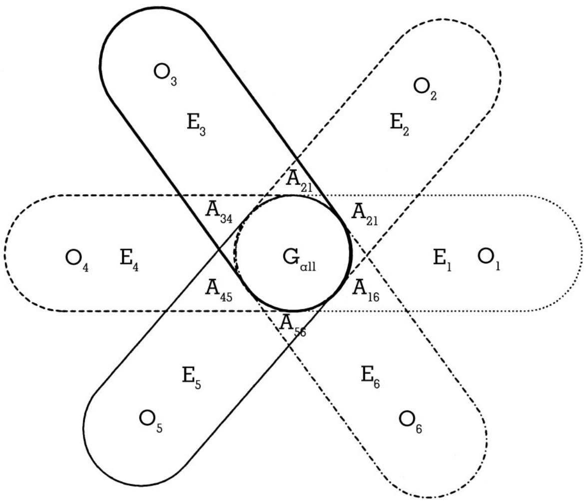
Representational gaps manifest as incompatibilities among the GAEO of a joint representation. Some gaps may be very large—for example, when the difference relates to the overall categorization of the problem (e.g., a sales problem versus a cost reduction problem). Such large-scale differences are likely to encompass many incompatible GAEO (e.g., whether increased sales or reduced overhead is the ultimate goal, whether or not to assume that costs are fixed, whether to use marketing operators to increase sales, whether one should change internal operational elements). Representational gaps will be much smaller when the different perceptions are about a specific issue (e.g., the meaning of market data). Small gaps may encompass just one GAE or O (e.g., designers assume customers do not know what they want until the designers show them, marketers assume the customer knows best).

Incompatible GAEO are problematic because they lead to incompatible interpretation and evaluation of information in relation to the problem, which, in turn, can lead people to select moves (actions taken to solve the problem) different from what their teammates would choose, potentially resulting in coordination problems and conflict. For example, people who hold different *goals* will at some point want to move in contrary directions (e.g., one may want to put more resources toward marketing, while another may think resources are better applied to improving technology). People may make *assumptions* that others do not and can be surprised when others' moves violate their own assumptions (e.g., ignoring a deadline). Finally, people may unintentionally make others' jobs more difficult by applying *operators* that change the *elements* of the problem so that it is now harder to solve (e.g., designers often draw things that engineers believe to be infeasible).

Although incompatibilities within a joint representation pose problems for team coordination and conflict, not all differences among the parts of a representation result in incompatibilities, and only some aspects of representations *must* be shared for teams to function effectively. Figure 1 presents a minimal overlap configuration for a joint representation. While teams may experience more similarity in their joint representation than presented in Figure 1 (depending on task demands and levels of specialization), it is informative to explicate minimal conditions for effective teamwork. We use the GAEO framework as the foundation of this discussion.

The goal hierarchy specifies what the end state of solving the problem should look like. If goal hierarchies differ among team members, it means that teammates are working toward different desired end states. This implies that, to be effective, all teammates should have the same set of team goals in the same order of prece-

FIGURE 1
Dissimilar But Compatible Joint Representation



Note: Ovals represent each individual's representation. Operators (O) and elements (E) are unique to individuals, assumptions (A) are shared between those for whom they matter, and goal hierarchy (G) is shared by all.

dence (Figure 1, "G"). When interdependent team members have the same goal state in mind, it is easier for them to agree on the relevance and importance of information. For example, team members will agree that information about consumer preferences for a competitor's product is important if they concur that the goal of gaining market share dominates the goal of increasing return on investment. Additionally, when interpretations and evaluations of information are different for other reasons (i.e., different AEO; see below), people will be more willing to synthesize their disparate knowledge when they are looking to move toward the same end state.

Assumptions serve as the background information taken as "given" for the problem. Assumptions, therefore, need to be aligned for the same reason goals do—so that people make consistent interpretations and evaluations of information. Yet, unlike goals, assumptions may not affect all teammates; many assumptions are only relevant to a subset of the team's problem (Figure 1, "A"). For example, the assumption of the importance of a deadline is only relevant to those whose tasks relate to that deadline.

The elements name the aspects of the problem that people can change to get to a solution. Unlike goals and assumptions, elements do not need to be shared at all (Figure 1, "E"). One team member can see the problem in terms of gears and leverage while another can see it in terms of lines and theme without any inherent conflict because elements are cognitive symbols for objects or concepts in the world that rarely preclude other symbol systems (e.g., parsing a task environment in terms of cost per unit does not preclude parsing it in terms of labor rate or defect rate). Elements function much like language, providing a coherent system with which to describe components of the task and implying relationships among them. Thus, unshared elements across team members present the same problem as unshared language—interference with the transmission of meaning both explicitly and implicitly.

Many have studied the influence of language on thought and understanding (see Gentner & Goldin-Meadow, 2003) using national language to illustrate the effects on thinking. Yet different systems of elements should operate similarly because they operate using the same cognitive mechanisms to derive meaning. For example, when a top management team composed of diverse specialists discusses corporate strategy, a member from marketing may evaluate a strategy that is stated in terms of financial elements as weak because the elements imply connections and nuance that the marketing person does not see.

The operators are the rules for how to transform the elements in order to solve the problem; they are "if/then" rules that take information as the "if" input and extract the "then" implication based on one's knowledge of how the rule works. Much like elements, operators cannot themselves be in conflict (engineering operators are neither consistent nor inconsistent with design operators) so they also do not need to be shared (Figure 1, "O"). Yet since operators are the rules one uses to decide what information means and how to use it, when teammates apply different operators to the same information, the interpretation and evaluation that results will also be different (and potentially in conflict).

Figure 1 illustrates the minimum overlap of GAEO needed for effective group functioning. First, all group members need to hold the same goal hierarchies. Second, group members with the power to violate each other's assumptions need to hold similar assumptions. Finally, group members are free to hold their own elements and operators, and if the assumptions and goals are aligned when people execute operators and reconfigure elements, these moves should not create problems in coordination and conflict.

What qualifies as "incompatible" can change across GAEO. With goal hierarchies, anything less than identical will likely be incompatible, but, moving from assumptions to operators and elements, incompatibilities can become further removed from the specific AEO. That is, assumptions can conflict indirectly (designers assume that only designers can create style trends, which implies an assumption that focus groups are not useful for creating style trends; this is incompatible with marketers, who assume that focus groups are useful in this capacity). Operators and elements may conflict only after they have been applied to the state of the problem (e.g., using an operator breaks apart elements in a way that goes against one's assumptions). The complexity of where and how incompatibility exists among representations suggests that we need to develop theory that allows us to consider how incompatibilities among the GAEO differentially affect team information processing, coordination, and conflict.

Research also needs to consider how the task and organizational environments influence the "optimal" level of overlap of GAEO within the joint representation. Teams that require their members to be interchangeable—for example, infantry in a particular unit of the military—should have complete similarity (i.e., all team members should share the same GAEO). In these teams any individual may be called on to do any of the jobs of the other individuals; thus, they must all have similar skills (operators). Because group members must be able to adapt quickly and in concert to changes in the environment, they must also have similar representations (i.e., see the same elements, have the same goals, and make the same assumptions) that lead them to similar evaluations.

At a minimum, our theory suggests that incompatibilities in GAEO (i.e., a representational gap) make it difficult for members of functionally diverse teams to capitalize on each other's unique knowledge. However, when people process information differently, they will also want to solve the problem differently. The function of processed information is to guide the moves people make. Inconsistently processed information can mean that teammates will work against each other and misunderstand each other, which, in turn, implies that there is also likely to be conflict over what the team does, as well as what information implies.

REPRESENTATIONAL GAPS AND THEIR EFFECT ON COORDINATION AND CONFLICT

Representational gaps cause problems for people working together because (1) they increase the misunderstanding and misuse of information, (2) they decrease coordination both explicitly and implicitly, and (3) they lead to conflict that can be more detrimental than positive. As discussed above, representational gaps interfere with team information processing, making it much more difficult to develop the shared understanding that allows groups to communicate efficiently and effectively. These gaps result in problems of coordination and conflict.

Coordination problems can be distinguished from conflict by focusing on action versus disagreement. Coordination problems occur when one team member's actions/moves work against, contradict, or interfere with another's. Conflict focuses on disagreements about what actions *should* be taken. These disagreements could be about how to interpret information (information conflict) or what moves should be taken (move conflict). We discuss the implications of representational gaps for each.

Coordination

In building our theory we have alluded to problems with coordination. Coordination errors can occur when team members have misunderstandings because they hold different GAEO. Different interpretations of information can cause people to make moves that work against others' actions. For example, information that customer satisfaction ratings are down could be interpreted in terms of problems with product quality or customer service—each implying the need for different remedies. Even when people interpret information similarly, they may value it differently, with the result that they make moves that undo others' efforts or make the problem harder for their teammates. Imagine a situation in which one team member cares that a deadline might not be met whereas another does not. Differential pacing of work across the two team members could result in substantial coordination problems. Coordination problems are especially likely when people have different goal hierarchies, since they will be looking to move toward different end states.

Conflict

Differentiating between information conflict and move conflict recognizes that conflicts can occur at different levels of abstraction. Information conflict is more abstract, since team members present their different perspectives on the meaning of information; move conflict is more concrete, relating to what actions should be taken by members of the team. Either type of conflict can be driven by a representational gap, and when it is, the conflict can be difficult to identify and resolve.

When a representational gap is the cause of information conflict, it reflects a difference in the evaluation and interpretation of the information itself. The conflict will surface over what the information means and how useful it is for solving the problem. The information conflict can be specific (e.g., conflict over the implications of an assumption about wear and tear) or more general to the problem-solving process (e.g., debate over the usefulness of a schedule for keeping the team on track), or it can relate to the GAEO themselves (e.g., is price more important than functionality in purchase behavior?). Regardless of the generality, the source of the information conflict in this example is a representational gap over what drives vehicle purchase (price versus features).

When a representational gap is the cause of move conflict, it usually reflects an underlying difference in the evaluation and interpretation of the information supporting that move (i.e., underlying information conflict). For example, two may disagree about whether adding a feature to the vehicle is the right move, but this disagreement is a result of responding to different information as relevant (what adding the feature does to price versus ease of use) and/or evaluating the information differently (whether it is more important to keep costs low or add functionality). Since the interpretation of information informs the moves team members make, the interpretation of the information is the cause of the conflict; the move is merely symptomatic. Note that move conflict does not necessarily imply a representational gap. Two people might view the problem similarly, as well as the supporting information, but may favor different strategies or tactics for solving the problem.

In that information conflict is expected to be at the root of move conflict and coordination problems in teams with representational gaps, the source of the conflict (incompatible GAEO) is often difficult to diagnose because it is relatively unobservable. It may not occur to a person to ask if other team members are making the same assumptions. As Dougherty (1992) notes in her research on the problems of working across functional areas, people do not generate conflict maliciously or because they ignore the needs of others; rather, they "gloss over the concerns of others and tend not to appreciate their complexities" (1992: 189). People can also mistakenly attribute the move conflict to their teammate's insufficient concern for their perspective, rather than a fundamental difference in problem definition as a result of functional diversity; this would simply be an instance of an attribution error (Baron, 1985; Kelley & Michela, 1980).

In that conflict stemming from representational gaps is difficult to identify and resolve, it may not be surprising that task conflict—conflict over what the team must do to perform a task or solve a problem (Jehn, 1995)—has been found to be negatively related to team performance across a variety of studies (De Dreu & Weingart, 2003). In some studies task conflict has been shown to be beneficial to teams because it allows them to explore and integrate multiple perspectives (e.g., Amason & Schweiger, 1997; Jehn, 1995). Representational gaps derail the beneficial effect of task conflict and make resolving it difficult, because the mechanism for both exploration and resolution—sharing information to increase understanding—is derailed. Subgroups can voice their issues and concerns, but the receivers are limited in their ability to respond to this information. Diverse team members may have some understanding of what others ask for, but this is often the understanding of a novice. Moreover, people may simply not value what others offer as much as they value their own perspective, and so the motivation to use others' information may be lower than the motivation to use one's own. Over time, as people share information but only encounter more conflict over the use of that information, frustration can build, which can turn into relationship conflict (De Dreu & Weingart, 2003; Simons & Peterson, 2000).

Closing Representational Gaps

Assuming that representational gaps cause problems raises the question of how to close or bridge them. Central to bridging a gap is creating some degree of shared understanding so that people can translate others' knowledge bases; this problem is primarily cognitive. Expanding people's representations so that they include the capabilities and concerns of others (i.e., increasing similarity) may just be a matter of education—teaching enough functional knowledge to those with different backgrounds to allow for shared understanding. However, when representations are incompatible, integrating knowledge bases becomes trickier, since teammates may need to change their GAEOs.

The research on schemas (e.g., Fiske & Linville, 1980) may provide insight into the cognitive process of accommodation (changing one's framework for interpreting the environment in response to novel information). Weick (1996) has also discussed this problem in terms of getting people to eschew their standard practices and approach so they can adaptively respond in contexts that cannot be handled by their standard operating procedures. Finally, since insight is associated with changes in cognitive representations (Ohlsson, 1992), the literature on insight may be helpful as well. Certainly, the goal would not be to homogenize team members' representations. The goal should not be to reduce the diversity of perspectives that these teams were created to capitalize on but, rather, to engender enough understanding to facilitate communication and accurate interpretation. The question of how to bridge gaps without decreasing divergent thinking will be challenging.

Beyond understanding the pure cognitive difficulties of getting people to align their GAEO, research needs to determine the role of motivation to learn and/or change. Team leaders/ organizations must motivate teammates to *try* to understand each other. Without adequate motivation, information will be rejected if the source is viewed negatively (Fox & Irwin, 1998; Hovland & Weiss, 1951).

Much of the work on minority influence would be relevant to understanding how dissent, especially when coming from a subset or low-power group, changes the dominant viewpoint (e.g., Forgas & Williams, 2001; Levine & Russo, 1987; Maass, West, & Cialdini, 1987). Also relevant is the work on persuasion that shows that one's attitude toward a source of an argument will influence the persuasiveness of that argument (Petty, Schumann, Richman, & Strathman, 1993; Sharma, 1999). Factors like psychological safety within the team (Edmonson, 1999) or willingness to engage in learning behaviors (Bunderson & Sutcliffe, 2003) will also play an important role. The common theme among these ideas is that the thoughts and feelings one has about another teammate will bias the view of the information coming from that teammate. One could easily apply much of the work on social cognition, but it would be the other person's ideas or perspectives instead of that person him or herself that is the object of assessment (Bodenhausen, Macrae, & Hugenberg, 2003; Chatman & von Hippel, 2001; Cohen, 2003).

Extensions

The mechanisms and paths through which representational gaps work should inform theory on diversity, conflict, and shared cognition, as well as address some specific conundrums in each domain. In particular, discussing how team members' task representations can differ will address the question of how much knowledge needs to be shared among team members for the team to be functional, a question relevant to the research on group cognition and SMM (Cannon-Bowers et al., 1993; Klimoski & Mohammed, 1994). Understanding how people's representations affect their ability to use the unique information of others will illuminate a reason why diverse teams fail to optimally use the team's knowledge, a puzzle to many researchers who study diversity (Dahlin, Weingart, & Hinds, 2005; Milliken & Martins, 1996; Williams & O'Reilly, 1998). Finally, understanding the nature of the conflict created by representational gaps will provide reasons why task conflict (which is what representational gaps create) is generally not helpful for teams (De Dreu & Weingart, 2003), despite the widely held belief that it should be (e.g., Amason & Schweiger, 1997; Simons & Peterson, 2000; Van de Vliert & De Dreu, 1994).

We present this theory of representational gaps in the context of multifunctional teams. However, representational gap–based conflict can happen whenever people with different backgrounds come together to solve a problem. All kinds of diversity can lead people to have different knowledge and values. A large body of literature on demographic diversity supports this conclusion (Williams & O'Reilly, 1998). Age group and culture (both organizational and national) are likely to affect one's knowledge and values. For example, someone from IBM, where the culture is well-structured and conservative, will approach software development very differently than someone from Microsoft, which is known for having a more free-flowing and open environment. Similarly, we would expect the Japanese to conceive of social interaction very differently than Americans. Yet there may be also smaller groupings that produce similar discrepancies between people's knowledge and values. Cramton (2001) has described how local conditions of people in geographically distributed teams can beget different perceptions of norms (e.g., people take public transportation) and day-to-day functioning (e.g., it was snowing in Finland so team members were late to work).

Representational gaps may also occur in what appear to be homogeneous teams. People often have different fundamental beliefs because they have different personalities (e.g., cognitive style; see Tetlock, 2000) and life experiences. The mechanisms that create representational gaps are general to people (all people draw on their knowledge and values to make sense of the world and solve the problems they are given). However, representational gaps based on personality may be even harder to find than those that occur between people from different social categories, because people within similar social categories have more reason to believe they should think similarly (Williams, Mannix, Neale, & Gruenfeld, 2004).

Representational gaps create process losses in teams that can undermine both creativity and basic effectiveness. Research needs to be done on how to either close or bridge these gaps in such a way that preserves the diversity of knowledge for which teams are created but makes integration among these perspectives possible. In understanding how to deal with representational gaps, we are likely to advance our understanding of information processing and conflict in diverse teams. Although we have focused on functional diversity, many of the issues we have highlighted should generalize to other types of diversity (e.g., cultural). Since teams are often the basic work unit, and since people have to work with others from different backgrounds, understanding representational gaps should help teams work better together as well.

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