Means versus Ends:
Implications of Process and Outcome Focus for Team Adaptation and Performance

Anita Williams Woolley
Harvard University
awoolley@fas.harvard.edu

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Work on knowledge tasks frequently involves both the redefinition of desired outcomes and the specification of task processes. The relative emphasis that teams place on these issues early in work can lead members to become “outcome-focused” or “process-focused,” with subsequent consequences for performance. This paper develops and explores a theory of how outcome focus and process focus develop in teams. Outcome and process focus were both observed and experimentally manipulated in 90 teams working on an open-ended task. Measures of the teams’ performance as well as members’ ability to adapt their work processes and to identify problems in their work point to an advantage for outcome-focused teams in dynamic environments. Implications for the design and management of knowledge work teams are discussed.

Key words: team adaptation, team performance, action identification, knowledge work
Standard operating procedures have long been used for teams performing repetitive tasks in factories, hospitals, airplanes, and elsewhere. More recently, this emphasis on work process has been extended to knowledge workers engaging in innovative tasks such as software programming or research and development (Adler 2003; Benner and Tushman 2003; Craig 1995; Wheelwright and Clark 1992). Underlying the focus on process is the belief that it will enhance the efficiency and productivity of the knowledge worker (Drucker 1999). At the same time, one of the most robust findings of the literature in industrial and organizational psychology is the positive effect of clear goals on individual and team performance (Locke and Latham 1990; Weldon and Weingart 1993). While the tacit assumption is that the two are complementary, I offer a different point of view.

The conditions present at the beginning of a team’s work can lead a team to become “process-focused” or “outcome-focused.” Process focus in teams is defined as the precedence of work processes over outcomes. A team’s process refers to decisions regarding how members coordinate and combine physical efforts and resources into a shared product (LePine 2005). Team outcomes refer to the intended final products or results of the team’s work. “Precedence” is an important part of the definition of process focus in that it refers both to temporal precedence, or the focus on processes prior to outcomes in organizing work, but also in importance, in that processes are more central to decision-making about work. Thus, process-focused teams begin by defining their work process and anchor on their original plan of action as they move forward with their work. Likewise, teams that are outcome-focused allow outcomes to take precedence over processes, both temporally and in their level of centrality in decision-making. Being focused on one element does not preclude consideration of the other; instead, it is the relative emphasis on each that has significant implications for the focus that evolves and consequences for team performance.

Research on the relationship between goals and task planning suggests a complementary relationship between consideration of processes and outcomes (Earley et al. 1987; Weingart 1992). However, in such studies goals are established by the experimenters at the outset of work as an independent variable, and the relationship of task planning to performance is examined therein. Research
on goal orientation distinguishes between the implicit pursuit of a learning (or skill development) goal versus a performance (or failure avoidance) goal (Diener and Dweck 1978) and the implications for an individual’s responses to challenge and feedback. At the team level, these individual tendencies influence a team’s learning orientation, which is associated with more openness to feedback and improved performance in teams that are struggling (Bunderson and Sutcliffe 2003). While teams with a greater learning orientation may certainly engage in more explicit consideration of either processes or outcomes, this line of work does not examine the effects associated with which element takes precedence in their work.

The present research is concerned with how a focus on outcomes versus processes develops within teams working on open-ended tasks, such as those involved in knowledge work (e.g. Lewis 2004; Quinn 2005). Open-ended tasks are those that do not involve clearly defined outcomes or processes (Gersick 1989; McGrath 1984). Knowledge work seldom involves one single correct result nor one correct process for completion (Quinn 2005) and thus knowledge work teams must define or at least redefine the outcomes and processes of their work for themselves (Hackman 1987; Janz et al. 1997; Quinn 2005; Staw and Boettger 1990). While research has established the importance of events that take place at the beginning of a team’s work together (Ericksen and Dyer 2004; Gersick 1988; Hackman and Wageman 2005) and the benefits of mobilization strategies that privilege content over process (Ericksen and Dyer 2004) this work has not explicitly examined the effects of a team’s focus on processes or outcomes over time. I explore the extent to which a team’s relative emphasis on processes or outcomes endures through their work and has implications for decisions they make as they face challenges in their work. In the next section, I discuss research relevant to the means-end distinction in organizational functioning and individual cognition as well as other work informing hypotheses of the effects of outcome and process focus for team effectiveness. I then present a laboratory study to examine the development of outcome and process focus, their stability in teams over their life, and their effects on team process adaptation and performance.
What versus How: Evidence for a General Process/Outcome Distinction in Human Life

In a variety of settings, a distinction is made between thinking about what we want to accomplish versus how we proceed to accomplish it. Which of these dimensions is given priority is consequential for the action that ensues. For instance, government and military intelligence organizations have been criticized for being too “process-centric,” or driven by their methods of collection. The restructuring of national intelligence agencies is based in part on the ideal of a more objectives-focused, target-centric approach to collection and analysis (e.g. organized around the group or geography of interest) on the assumption that this will make the enterprise more adaptive and agile (Clark 2004). Similarly, the culture of innovation in commercial organizations can be characterized by whether outcomes or processes dominate; organic organizational cultures are more results-oriented and outward facing, whereas mechanistic organizational cultures are more process-oriented, hierarchical and inward facing (Burns and Stalker 1994). Beyond the specific organization for innovation, entrepreneurial scholars argue that as most organizations grow from being small and entrepreneurial to being larger and more bureaucratic, many of their strategic decisions become less driven by external opportunities and more driven by internal processes and the resources already owned or controlled (Stevenson and Jarillo 1991), with implications for their ability to adapt and change.

This means-ends distinction also arises at a much lower level of analysis than social systems: in individual-level cognitive neuroscience. Research in cognitive psychology has shown that different parts of the brain specialize in thinking about “how” (process) versus “what” (outcomes) (Ungerleider and Mishkin 1982). The procedural or “how” pathway (Goodale and Milner 1992) in the brain is particularly important for acquiring and performing skills involving sequences – whether the sequences are serial or abstract, or sensorimotor or cognitive (Squire et al. 1993; Ullman 2004). Meanwhile, the declarative or “what” system (Goodale 2000) underlies the learning, representation, and use of knowledge about facts and events (Ullman and Pierpont 2005). Research on mental imagery and cognitive styles suggests that preference for reasoning in the procedural (“how”) system is slightly negatively correlated with
declarative (“what”) system reasoning, leading to stable individual cognitive styles which can be characterized on this basis (Blajenkova et al. 2006; Kozhevnikov et al. 2005). Taken together, this work suggests that an individual reasoning in a manner that engages one of these subsystems is unlikely to shift easily to the other subsystem, leading them to remain focused on “what” vs. “how” for at least a certain period of time.

*Processes Versus Outcomes and Action Identification in Teams*

The implications of the “what” versus “how” systems of the brain become applicable to team functioning as members are cued by their environment to attend to processes or outcomes, and develop norms about the ways they will deal with these issues in their work together. In complex or ambiguous social situations, members look to one another for cues regarding how to behave in the situation, and follow one another’s lead (Bettenhausen and Murnighan 1985; Hackman 1992). In newly formed teams, initial member commentary can direct other members’ attention to processes or outcomes, stimulating related thoughts and commentary as members follow conversational norms of reciprocity (Burgoon et al. 1993). In ongoing teams or those coming from the same organization or other shared social setting, understandings about standard operating procedures or expected outcomes may be imported from the team’s prior history or social context (e.g., Woolley 2007). Whether self-generated or imported from their context, once the team is anchored on a set of outcomes or processes, they assert a structural influence over decisions the team makes subsequently. For example, a process-focused research group might decide to pursue their work by first establishing a weekly meeting of a determined length with the entire group, and then accomplish whatever outcomes they can within those parameters. In contrast, an outcome-focused group might determine first the objectives they want to accomplish within a particular time frame, and then determine if meetings are necessary, and, if they are, when they should be held and whom should attend. As subsequent decision points about the group’s progress are encountered, I argue that the early pattern of relative emphasis on outcomes and processes is replicated, with the process-focused
group remaining anchored in their weekly meeting and the outcome-focused group remaining anchored in their objectives. In this manner, a team’s outcome and process focus is perpetuated over time.

_Hypothesis 1_: Early cues (e.g., conversations, instructions, expectations) encourage a relative emphasis on process or outcomes that is replicated over time in team’s work.

Process and outcome focus are further perpetuated in a team through their influence on the action identities team members adopt in their work. Work on action identification (Vallacher and Wegner 1987) has shown that individuals can identify actions as low-level specific activities (e.g. “I am designing an advertisement to sell this product”) or in higher-level terms that encompass multiple specific alternative activities for enactment (e.g. “We are generating as much profit from this product as possible”). The level at which people identify their actions is highly influenced by cues provided by the task context (Vallacher et al. 1989). Process-focused team discussion can involve identifying specific tasks and subtasks, the assignment of tasks to members, and the specification of how these activities will be coordinated across people and/or over time. Members come to identify their actions at a low level, reasoning in terms of specific tasks and their own personal role rather than higher-level team goals. In contrast, outcome-focused team discussion centers on identifying desired results of work and the internal or external criteria for success. Normative pressures serve to create uniformity in members’ perceptions and discussion (Sherif 1936), and reinforce and maintain the level of action identification in the team, as members resist discussion that changes the level at which their actions are identified. For instance, a member of a process-focused product development team who questions individual tasks by trying to discuss the higher level meaning of what the team is really trying to accomplish (e.g., “Will advertising increase our profit?”) will be seen as slowing the team down, while a member of an outcome-focused team that tries to get lower-level and tactical (e.g., “Should we hire Michael Jordan as a spokesman?”) will be seen as similarly inappropriate. The cues members give to sanction one another for changing their focus can be subtle, such as ignoring someone’s off-level comment, or can be more direct, as members experience such comments as attempts to change their own personal work (e.g., the team member from Marketing
responds, “If we aren’t going to advertise, why am I on the team?”). In this manner, norms maintain the level of action identification that is dominant in the team, which serves to reinforce the team’s task focus.

*Hypothesis 2*: Actions are identified at a significantly higher level in outcome-focused teams than process-focused teams.

**Outcome Focus, Process Focus, and Their Consequences for Adaptation and Performance**

In considering the discussion leading to an outcome or process focus in a new team, it is important to keep in mind that many teams exhibit a tendency to forego any task discussion whatsoever unless explicitly encouraged (or even mildly coerced) to engage in it (Hackman et al. 1976; Hackman and Wageman 2005; Shure et al. 1962). Given this tendency, either process- or outcome-focused discussion is likely to be beneficial when compared to no organized discussion, since any planning or organized discussion will help teams develop a better shared basis for proceeding with work (Klimoski and Mohammed 1994; Weingart 1992). In contrast, when left to their own devices, teams can become “unfocused” by either failing to have any organized discussion, or else by allowing members to develop different foci which inhibits engagement in shared planning and leads members to work at cross-purposes (Dougherty 1992; Woolley 2007; Woolley et al. 2007, in press). In other instances, teams may begin to discuss the issues necessary for organizing work, but then become distracted by the work itself and instead fall back on “in process planning” (Weingart 1992). In such cases, getting team members to discuss and come to agreement on core issues is likely to yield benefits when compared to no intervention, as getting a team to discuss their work together in any capacity can allow them to be relatively more organized and productive (Hackman et al. 1976).

*Hypothesis 3*: Interventions prompting outcome- or process-focused discussion improve team performance when compared to no intervention.

While interventions to get a team focused on either outcomes or processes can both be beneficial in stable environments when little change is needed, they are likely to yield different effects in dynamic
environments in which it is necessary for teams to respond to unexpected events. The ability of individuals and teams to adapt to changing circumstances is critical to performance in a variety of contexts (Kozlowski et al. 1999; LePine 2005; Pulakos et al. 2000). The types of adaptations a team needs to make can take a variety of forms. Pulakos et al. (2000) identified eight different dimensions of adaptive performance, among them the ability to solve problems creatively, and the ability to deal with changing work situations. Process focus and outcome focus can potentially enhance a team’s ability to adapt, but in slightly different ways.

Clear processes can have significant benefits for the efficiency of work, particularly in situations of membership change (Carley 1992; Levine and Choi 2004; Rao and Argote 1995). When reduced error and high reliability of output are highly desirable, well-established procedural routines can significantly enhance efficiency of work and team performance (Gersick and Hackman 1990). Clear roles and work processes can have significant emotional benefits in reducing stress and uncertainty for team members (Dollard and Winefield 1994; Rizzo et al. 1970; Smith 1957; Sperry 1998). Clearly defined roles can also reduce cognitive burden, freeing up team members to focus only on role-relevant information (Brandon and Hollingshead 2004; Hollingshead 2000; Lewis et al. 2007; Moreland and Argote 2003; Wegner 1987) and generally makes work more efficient (Moreland et al. 1996). Process-focused teams are likely to segment their task into parts associated with member roles, leading them to be well-prepared to reflect on internal processes (Arrow and McGrath 1993) and to make the accommodations needed for membership change, especially if the change has been anticipated (Moreland and Argote 2003). By contrast, outcome-focused teams may not spend enough time specifying how work will be accomplished and devising clearly defined roles, and thus experience process loss as members try to organize themselves while work is in progress (Steiner 1972; Weingart 1992). Membership change will be difficult for outcome-focused teams, since the loss of a person will be associated with gaps in information and responsibility which cannot be easily identified or replaced (cf. Choi and Thompson 2005; Levine and Choi 2004; Lewis et al. 2005). Therefore, I hypothesize that:
**Hypothesis 4:** Process-focused teams outperform outcome-focused teams under conditions of membership change on open-ended, creative tasks.

While process-focused teams will be more effective in adapting to membership change, outcome-focused teams will be better at dealing with task change. Although the low-level action identifications embraced by process-focused team members allow new team members to more easily identify their tasks, low-level action identifications are not as flexible as high-level action identifications for facilitating overall task change. “Maximizing profit” (a high-level action identification) can be accomplished in multiple ways, while “designing an advertisement” (a relatively lower-level action identification) does not lend itself to as many alternative approaches (Vallacher and Wegner 1989). In a team that has defined its work by deconstructing it into a series of specific and/or individual-level tasks, it is difficult for members to identify problems that are not specific to their role or come to agreement on how to address them (Moreland and Levine 1992). In contrast, the discussion of potential outcomes in outcome-focused teams results in members sharing a greater amount of information about the task overall (Kerr & Tindale 2004; Latham, Winter & Locke 1994). The resulting higher level of action identification by members allows outcome-focused teams to identify multiple approaches to accomplishing their desired outcomes; “maximizing profit” can happen many different ways and need not involve advertising at all. As the team encounters difficulties (e.g., “Ad prices have gone sky high!” or “Shipping costs are astronomical!”) an outcome-focused team has a better basis for reframing and changing its approach than does a process-focused team. Thus, outcome-focused teams will exhibit greater flexibility in adapting their performance strategy to changing task conditions. Furthermore, the increased adaptation behavior observed as a result of outcome focus will be mediated by the team’s level of action identification.

**Hypothesis 5:** Outcome-focused teams outperform process-focused teams under conditions of task change on open-ended, creative tasks

**Hypothesis 6a:** Outcome-focused teams exhibit greater ability to adapt their performance in the course of their work than process-focused teams when working on open-ended, creative tasks.
Hypothesis 6b: Level of members’ action identification mediates the relationship between outcome focus and adaptation.

Figure 1 contains a visual depiction of the model and hypotheses tested in this research.

---Figure 1 here ---

Method

Participants

The experiment was conducted with 90 three-person teams composed of male and female undergraduates who were randomly assigned to one of the six conditions of a 2 (process vs. outcome-focused manipulation) x 3 (midpoint material loss vs. midpoint membership change vs. no midpoint change) or a seventh condition that received no manipulation or midpoint change (the control condition). All participants were either paid or received course credit for their participation and were randomly assigned to one of two teams during each experimental session (within compensation type), which were in turn randomly assigned to conditions. Fifteen teams were all female, 18 teams were all male, and the rest were mixed-gender. There were no systematic differences in performance between the two types of compensation ($F_{(1,89)} = 1.24, p = n.s.$) or on the basis of gender composition ($F_{(2,87)} = .03, p = n.s.$) in the experiment overall. Therefore, all analyses will include both compensation types and all gender compositions together. To foster motivation among all participants and a collective identity for the team (Van der Vegt and Bunderson 2005), a $300 prize was offered to the team with the highest score at the end of the study. This prize was paid at the conclusion of data collection.

Task

Participants were asked to work on a creative, open-ended task together with their team during a one-hour laboratory session. Specifically, they were asked to use a set of building blocks to build a house, garage, and swimming pool, which were scored according to a set of complex scoring criteria including their size, aesthetics, and sturdiness (see Appendix A). The scoring of the task was intentionally complex.
and devised to force trade-offs; teams could not maximize all sources of points simultaneously (much like a product development team usually cannot optimize on both price and performance) and thus needed to redefine the task for themselves and determine their own outcomes and processes. Such a task is very similar to the open-ended tasks typically given to knowledge workers, while not requiring the application of specialized expertise (a distinguishing feature of knowledge work), allowing for the use of ordinary participants in a laboratory.

All teams except those in the control condition received an intervention at the beginning of their work to focus their discussion on outcomes or processes. Half-way through their work, they experienced a membership change or a loss of critical building materials. This allowed for the evaluation of teams’ response to a dynamic task environment in which members and resources can change unexpectedly.

Each team member was given a set of written task instructions, and the team was shown a video detailing the criteria to be used to compute a score for the team’s products. The final structures were scored on the basis of their size, quality (e.g. whether they would hold together when lifted, flipped over and/or dropped), and the inclusion of features that qualified for bonus points (such as extra points for each parking space included in the garage.) There were also some required elements for each of the structures; the roof of the house and garage as well as the floor of the pool had to be made from blue blocks, while the “foundations” of the house and garage had to be built from white blocks. All requirements were spelled out in detail to the teams both in a video presentation and in the written instructions. Full task instructions can be found in Appendix A.

Procedure

Teams worked alone in a private laboratory room set up with a table, three chairs, and a video player. The table in front of each participant was labeled either A, B, or C as a means of identifying which participant to remove in the membership change condition. The seating of each participant in each position was decided randomly, and the placement of these letters on the table was rotated for each
Experimental session. All teams were videotaped with the knowledge and consent of all participants, and conversations were transcribed for the purposes of coding and analysis.

In Condition A (process-focused/no midpoint change), teams were first shown the instructional video for the task. Following the video, teams were instructed to use the next 10 minutes to work on a "Preliminary Task," which served as the process focus manipulation. This was a worksheet that led the team through a discussion of roles and assignments for the task, deciding who would focus on each of the structures as well as brainstorming and assigning what other tasks needed to be done in the course of their work. Teams recorded their decisions on a worksheet that was returned to the experimenter before they began their 40-minute building period. After the teams had worked for 20 minutes, they were given a 20-minute warning. At the 35-minute mark the team was given a 5-minute warning, and at the completion of their work, the experimenter took the structures into an adjacent room to measure and photograph them while the participants individually completed a post-task survey without communicating with their teammates, following which they were debriefed and released.

In Condition B (process-focused/membership change), the first half of the session proceeded exactly as it had in Condition A. After the teams in this condition had worked for 20 minutes, the experimenter entered the room with a fourth participant. She explained that the participant seated in chair “A” was needed to work on something else in the other room, but that this new person was being brought to take his/her place. The team was informed that this new member was familiar with the instructions for the task, but that they needed to fill him/her in on what s/he would work on. The new participant was a bona fide research participant, not a confederate, and had viewed the same instructional videotape as the original team members prior to entering the room. The new member then entered the room and sat in member “A’s” chair, and the former Member A left the room with the experimenter. The remainder of the session was conducted in exactly the same manner as Condition A.

In Condition C (process-focused/material loss), the first half of the session proceeded exactly as it had in Condition A. After 20 minutes, the experimenter entered the room and explained that she needed to take some of the blue blocks. Without additional explanation, she proceeded to remove a specific number
of the team’s blue building blocks, equivalent to one-third of the total they had available. Following removal of the blocks, the team was informed that they had 20 minutes remaining in their building period. The remainder of the session was conducted in exactly the same manner as Condition A.

In Condition D (outcome-focused/no midpoint change) following the instructional video, the team was given a “Preliminary Task” to work on for ten minutes, which comprised the outcome focus manipulation. This was a worksheet which led the team through a review of relative point values for the various structures they were being asked to build, and to encourage them to determine their priorities and desired outcomes for the task by rank ordering the three structures and estimating the points they wanted to earn. Teams recorded information in response to each “step” on the worksheet, and were required to turn in a completed worksheet before they began their 40-minute building period. The remainder of the session was conducted using the same procedure as in Condition A.

In Condition E (outcome-focused/material loss), the first half of the session was conducted exactly as described for Condition D, and the second half (from the midpoint through completion) was conducted identically to Condition C.

In Condition F (control condition) following the instructional video, the teams were given a worksheet directing them to introduce themselves and spend 10 minutes reviewing and discussing the task. No additional directives were given regarding discussion of processes or outcomes. The remainder of the session was conducted using the same procedure as in Condition A.

All participants were debriefed in writing and verbally queried about their observations regarding the experiment at the conclusion of each session. While there was much speculation regarding the reason for invoking a membership change or removing building materials, there was no indication that any team suspected the role of the opening exercise in enhancing or impairing their ability to deal with these obstacles.
Outcome and Process Focus

Measures

Control Condition Focus Measures

Two measures were developed to provide indices of the relative attention to outcomes versus processes over time in the work of the teams in the control condition. The attention the control condition teams gave to these issues is of particular interest in addressing Hypothesis 1, as these teams were not directed to consider task processes or outcomes and, thus, their focus evolved organically.

Attention to Outcomes and Processes*: Three research assistants who were blind to the experimental hypotheses independently viewed the video tapes of the initial ten-minute planning period of each team, and coded the amount of attention that teams gave to each of the following four issues on a 7-point scale, from “no attention at all” to “extensive attention:” (1) scoring and the point values of different building features; (2) implications of different designs for the final score and what the team wanted to build; (3) "nuts and bolts" of how to build the different structures (e.g., specific techniques for connecting layers of blocks, how to satisfy the building codes, etc.); and (4) assignment of member roles and/or allocation of time to each structure. Two additional research assistants watched the five minute period following the temporal midpoint of work for each team and made the same ratings, as this was a time when all teams engaged in some additional discussion of their work, while discussion during all other time periods varied considerably and was minimal for many teams. The first two items were summed to provide an index of the amount of attention given to outcomes, while the sum of the latter two provided an index of attention to process. Raters were trained in the use of the coding instrument as a group by reviewing tapes of pretest teams that were not part of this dataset, then completed their evaluations of the teams in the sample independently. The scales showed acceptable levels of reliability for both outcome focus (ICC1 = .65, \( p < .05 \); ICC2 = .89) and for process focus (ICC1 = .54, \( p < .05 \); ICC2 = .73). Ratings were standardized and then averaged across raters for analysis.

Self-Report Process and Outcome Focus. The survey administered to participants at the conclusion of the teams’ work included scales measuring outcome and process focus. The scales provide
an opportunity to evaluate how members’ conversations throughout work are reflected in their own understanding of the different elements of their task. Specific scale items can be found in Appendix B. Team members’ responses showed acceptable levels of reliability for both process focus (ICC1 = .52, *p* < .05; ICC2 = .77) and outcome focus (ICC1 = .50, *p* < .05; ICC2 = .72) This measure was used to examine the consistency of outcome and process focus in teams over time by relating the scores to observer measures of team focus earlier in work, and also served as a manipulation check of the outcome and process focus exercises in teams receiving those manipulations.

**Observational Measures**

*Action Identification.* Two independent raters viewed the video recordings of the teams working after their initial discussion and during the first half of their work together (prior to any midpoint manipulations) and evaluated the level at which the teams discussed and identified actions. These raters were not involved in evaluating any of the other observational measures in the study. Individual team member comments were evaluated on a scale of 1 to 5 for the extent to which they identified actions at a low level by discussing individual parts of the task relative to their own role and resources, versus discussing higher level team activities. Raters were instructed to be attentive for cues such as the use of personal (“I” vs. “we”) and possessive pronouns (“my” vs. “our”) in discussing parts of the task and the building materials. Raters were trained together but then made their ratings independently. Raters’ evaluations were standardized before being averaged together for each team to prevent the weighting of their contribution to the composite score by the variance in their ratings. The internal-consistency reliability for the observers’ rating of each team’s level of action identification was ICC = .86, *p* < .05. The scale was reversed to aid in interpretation of subsequent analysis, such that a high score corresponds to a high level of action identification.

*Process Adaptation.* Two procedural suggestions were implicit in the design of the task – the correspondence of the number of assigned structures to the number of team members (three), and the provision of interlocking blocks along with the inclusion of a “quality rating” as part of the team’s
outcome and process focus

performance measure. These two factors suggested a work plan in which each structure is built separately, and blocks are hooked together to make the structures as sturdy as possible. However, given the nature of the scoring criteria, plus the inclusion of large plat roof pieces whose bottom connectors were deficient, the optimal solution involved combining the three structures into one to maximize material usage (instead of building them separately), and laying blocks end-to-end rather than interlocking them to maximize structure size (which was much more valuable than structure quality). Both of these adjustments in the team’s approach required an adaptation of the teams’ work process as they discovered these issues and possibilities. Two raters reviewed videos and photographs of the team’s work and coded teams for whether or not they combined structures, and whether or not they used their materials in ways other than interlocking them. A team received a “1” if they made one of these adaptations, a “2” if they made both adaptations, and a “0” if they did neither. The internal-consistency reliability for the observers’ initial rating of each team’s flexibility was $\text{ICC} = .82, p < .05$; all disagreements were discussed and resolved.

Problem Adaptation. While teams in any condition could make the process adaptations described above, another important form of adaptation is that which occurs in response to problems (Pulakos et al. 2000). Thus, another measure of adaptation was used specifically for examining teams losing 1/3 of their critical building materials half-way through their work. The materials that were removed were required for all of the structures, and realization of the difficulty associated with their removal was expected to prompt discussion among team members regarding the allocation of the remaining materials. The five minutes following material removal were coded for both discussion and alteration of strategy in response to this manipulation. A team received a “1” if they merely noted the difficulty but made no significant change and a “2” if they noticed the problem and discussed a change in strategy as a team. If they did neither of these things, they received a “0.” All conversations were coded independently by two research assistants who were blind to experimental condition, and who were not involved in the coding of Process Adaptation. The internal-consistency reliability for the observers’ initial rating of each team’s flexibility was $\text{ICC} = .87, p < .05$; all disagreements were discussed and resolved.
**Task performance.** Teams were asked to build a house, garage, and pool from a set of building blocks provided, and the criteria by which their final product would be scored were explained in detail in the instructional video. Teams earned points (calculated in $US) based on the cumulative value for the size of their structures, their quality (whether it could be lifted, flipped over, and/or dropped without falling apart), and aesthetic appeal. Teams were also assessed penalties for violating any of a number of complex building codes. Teams were not told their score on the task prior to completing any post-task survey measures, and were not given any information about their performance relative to other teams until the study was concluded.

**Results**

Descriptive statistics and intercorrelations for all observational measures can be found in Table 1 for the analysis of control condition teams, and in Table 2 for teams receiving experimental manipulations.

---Tables 1 and 2 here---

**Manipulation Check**

As a check of the focus manipulation, outcome and process focus were evaluated using a post-task survey measure. Teams in the process-focused conditions were significantly higher than those in the outcome-focused condition on the post-task measure of process focus ($M = 5.87, SD = 1.02$ vs. $M = 5.06, SD = 1.10, t(80) = 3.42, p = .0001, \text{one-tailed, Cohen’s } d = .77$) while teams in the outcome-focused condition were higher than process-focused team on the outcome focus measure ($M = 5.05, SD = .61$ vs. $M = 4.80, SD = .66, t(80) = 1.42, p = .08 \text{ one-tailed, Cohen’s } d = .40$). Because the discussion activity was conducted before teams began work on the task and the survey was administered after work was completed, these results are also interpreted as preliminary support for Hypothesis 1, predicting that the early attention teams give to process versus outcome issues is predictive of their ongoing emphasis on these elements as their work progresses.
Process and Outcome Focus Over Time

Figure 2 displays a cross-lag panel analysis to examine Hypothesis 1, predicting that early emphasis on process and outcomes predicts the relative emphasis on each over the course of a team’s work. The teams in the control condition are uniquely suited to such an examination, as they received no external directives to consider outcomes or processes at any point in their work. As shown in Figure 2, attention to outcomes and process at the beginning of work is significantly correlated with the amount of attention given to the same issue at the temporal midpoint, which are in turn correlated with the level of focus on each on the corresponding survey measure at the conclusion of work. Focus on each element is negatively correlated with focus on the other element both at the same and at later time points, supporting the notion that teams do not generally move fluidly back and forth between these categories of issues. Taken together, these findings are interpreted as strong support for the notion that teams develop and sustain a process or outcome focus over the course of their work.

---Figure 2 here---

In looking more closely at how the control condition teams worked, it appears that process and outcome focus develop largely through the effect that team members’ early comments have on the attention and subsequent commentary of other team members. For the purposes of comparison, these control condition teams were classified as outcome- or process-focused if they had a consistently higher score on the outcome or process focus measures at all three time periods measured. Five teams were process-focused, three were outcome-focused, and two did not exhibit a clear outcome or process focus according to these criteria. In most of the outcome- and process-focused teams, early comments primed similar comments from other team members in the same domain, and the majority of the conversation followed suit with the early pattern. The following is an example of the very beginning of the conversation in a process-focused team:

C: What do you want to do first?
B: Do you all want to work on the same thing together? Or delegate?
A: Sure
In this example, the team demonstrates a clear preoccupation with how they will conduct work, before having said anything about what they will build. They start discussing how to divide the work among them, how to organize materials, in what order to focus on each element, and the techniques to use for building the structures.

In contrast, outcome-focused teams began their work by focusing on more outcome-related elements of the task, such as understanding scoring guidelines, or exploring the kinds of building materials available and the implications for what they could create. The following outcome-focused team started by discussing strategies for earning the most points for their structure:

B: So the bonus is going to be given to the group that cumulatively, of all the structures, has the highest value . . . the pool has $50 per square foot
A: Six by 12, 12 times 50 is what . . . OK, so the area of two of these, this much, is worth the bonus . . . if we are talking about $20 per square foot, so, relatively, the bonus . . .
B: We could do both (aesthetic bonus and the pool)
A: Maybe we can make one then take it apart and make the next one
B: Is that how it works?
C: That's a question for (the experimenter)
B: I can write that question down
A: OK, what occurred to me is like, blue, seems to be at a premium, because the pool
C: Yeah the pool
A: At the same time, the roof can go over multiple structures
C: (We should build a) tall skinny house

In contrast to the team discussed previously, this team began its conversation by thinking about their outcome – how to maximize the points they could earn. They moved from talking about point values to discussing the design of their structures, with suggestions such as building “A tall skinny house” or...
combining structures by putting the roof over multiple structures (and thus maximizing their points).

Comments about materials or building processes are directly related to the outcome they are creating.

Group norms served to maintain a team’s focus. Sometimes these norms were expressed indirectly, as in the following exchange when Member A kept trying to get the team to think how to maximize points (outcomes; related statements in italics below), while Members B and C ignored him and were more focused on work process:

B: You know what we could do, one of us could do each (structure) ...
C: You want to split up?
A: Well, if we do that we're not going to have all of the pieces to use are we?
B: I don't know
C: Well, that is an interesting thing
A: Well, if we want to use as many pieces as possible in order to get a lot of points 
B: We could kind of divide up, and something could be mostly red, and another thing mostly blue
A: Well my question is do you lose a lot of square footage though
B: I don't know well
C: Well I think it makes sense that we could do one at a time but, let's just say, what do we have, 40 minutes, to do the whole thing? So let's just say we have 30 minutes or ten minutes to do each one.
B: OK, yeah, well that's what I was worried about, coming to 20 minutes or something gets left out

At this point in the discussion, Member A gave up and went along with the plans of B and C. In another group, one member was more overt in her discouragement when another started to stray from the discussion of processes to raise issues related to team outcomes:

B: The thing is, if we want to get things started, how should we start…I mean, should we all start on this house, or should each person take a part?
C: We should coordinate the colors though...
B: Yeah, you want to divvy them up?
A: Oh, you know what we should do? Like the supplies, like put what is the same here and the same here so we could each get to them
C: Do you want to read back the rules?
B: OK, I'll read off the rules -- for the house, $100...
A: You know you shouldn't get really preoccupied with the score until the end. That's something we can add on later
C: Well, yeah, not the score but the rules

In this team, members wanted to talk about the “rules,” which governed the specifics of how they would build their structures, without complicating the discussion with scoring criteria, thus keeping the
team discussion to a fairly low level of action identification. In this instance, Member A acquiesced and the team developed a strong process focus as indicated by all other measures.

*Action Identification, Adaptation, and Performance*

Hypothesis 2 predicts a significantly lower level of action identification among process-focused teams compared to outcome-focused teams. The mean rating for teams on this and all observational and performance measures for the six experimental conditions are displayed in Table 3. A t-test comparing the mean level of action identification demonstrated by outcome-focused versus process-focused teams reveals that the data support this hypothesis: outcome vs. process-focused conditions: $M = -.52$, $SD = .88$ vs. $M = .53$, $SD = .62$; $t (80) = 6.23$, $p < .0001$ two-tailed, Cohen’s $d = 1.39$.

---Table 3 ---

In examining team performance overall, final scores were analyzed using a 2x3 ANOVA to examine the effects of the manipulations on task performance. The results are not significant for the process versus outcome focus manipulation alone ($F (1, 85) = 1.18$, n.s.), but do yield significant results for the midpoint material loss vs. membership change manipulation ($F (2, 85) = 3.40$, $p = .04$, $eta = .25$) and the interaction of focus and midpoint change ($F (2,85) = 3.90$, $p=.02$, $eta = .27$) All additional data analyses were conducted as planned comparisons examining the relationships between the cells of the experimental design that are relevant to each prediction, as recommended by Rosenthal and Rosnow (1991).

Hypothesis 3 predicted that teams receiving either a process- or outcome-focused intervention in the “no change” conditions would perform significantly better than control condition teams not receiving an intervention. A contrast comparing the control condition teams to the outcome- and process-focused/no midpoint change conditions supports this hypothesis: $t (85) = 2.54$, $p = .01$, Cohen’s $d = .55$. In the absence of midpoint difficulty or membership change, there is not a significant difference in the performance of outcome and process-focused teams ($t(85) = .15$, $p = n.s.$). A closer look at specific components of the performance measures provides additional insight into the differences between the
control condition teams and the process- and outcome-focused teams. The third floor of the house was among the most valuable sources of points but the most difficult for teams to attain, since it required working fast to get first and second floors built to provide the basis for higher levels. Only organized and productive teams managed to build higher floors before their time elapsed. Control condition teams added significantly less space higher up than process- or outcome-focused teams: $M = 36.80, SD = 62.20$, versus $M=83.70, SD = 25.68$ for process-focused/no midpoint change teams and $M=70.00, SD = 28.56$ for outcome-focused/no midpoint change teams; $t(85) = 1.98, p=.05$, Cohen’s $d = .43$. This suggests that teams in both conditions receiving an intervention got to work more quickly and worked more efficiently than control condition teams receiving no intervention, which allowed them to get larger structures built within the time allowed.

Hypothesis 4 predicted significantly better performance by process-focused teams than outcome-focused teams under conditions of membership change. As shown in Table 3, the data in this study do not support this hypothesis ($t (18) = 0.12$, n.s.). Hypothesis 5 predicted a performance advantage for the outcome-focused teams in the face of task problems (here introduced by material loss), and was supported. Outcome-focused teams that lost materials at the midpoint earn a higher score overall than process-focused teams ($t (38) = 3.55, p = .005$, Cohen’s $d = 1.15$).

Hypothesis 6a predicted that outcome-focused teams will exhibit significantly greater ability to make process adaptations in their work on the task than process-focused teams overall, which is supported. Outcome-focused teams exhibited significantly more process adaptation overall ($t (80) = 5.91$, $p < .001$, Cohen’s $d = 1.32$) and outcome-focused teams losing materials midway through work exhibited significantly better problem adaptation than process-focused teams ($t (38) = 2.93, p = .009$, Cohen’s $d = 1.38$). Furthermore, mediational analysis confirmed hypothesis 6b, predicting that action identification mediates the effect of task focus on process adaptation within teams experiencing midpoint difficulties. Among these teams, task focus had a significant direct effect on adaptation ($\beta = .25, t (58) = 1.98, p = .05$) as well as a direct effect on action identification ($\beta= .55, t (58) =4.95, p = .001$) where outcome-focused teams exhibited significantly higher action identification than process-focused teams. Action
identification also had a direct effect on adaptation ($\beta = .34$, $t(58) = 2.79$, $p = .007$), and when the effects of the action identification mediator are taken into account, focus no longer has a significant direct effect on adaptation ($\beta = .03$, $t=0.19$, $p=ns$). A Sobel test indicated that the difference between the direct and mediated effects of task focus on adaptation are significant, $z =2.34$, $p<.05$.

Discussion

In teams charged with the open-ended tasks characteristic of knowledge work, the clarification of both task outcomes and work processes often falls to the team itself (Hackman 1987; Janz et al. 1997; Staw and Boettger 1990). While existing work implies a complementary relationship between the work of clarifying outcomes and clarifying processes, this paper offers a different perspective. Early team interactions can send knowledge work teams down a path of anchoring on either task outcomes or work processes at the beginning of work. Because of the cognitive separation of these elements of work, and normative pressures manifested within teams, they do not move fluidly back and forth but remain largely focused on one or the other. The result is the development of an outcome focus or a process focus, in which the focal element takes precedence over the other, with implications for team adaptation and performance.

After observing the consistency of outcome and process focus over the life cycle of a team, I tested a series of hypotheses regarding the effects of outcome and process focus on team adaptation and performance. As predicted, outcome-focused teams exhibited higher levels of action identification, a greater ability to identify problems, and a greater ability to adapt their work processes than process-focused teams. The adaptation of outcome-focused teams appeared to allow them to “do more with less,” as outcome-focused teams losing materials at the midpoint did not score significantly fewer points than the teams that had the benefit of all of their materials for their work. Furthermore, action identification mediated the effects of task focus on adaptation. Prior work on action identification suggests that higher-level action identities facilitate change for individuals who can conceive of multiple means for achieving the higher level goal (Vallacher et al. 1989). That work is consistent with the observations here, where a high level of action identification was associated with greater team process adaptation.
Contrary to predictions, process focus did not improve a team’s ability to deal with member change. Recent research by Lewis and colleagues (2007) suggests a possible explanation by demonstrating that membership change creates inefficient transactive memory processes. While new members generally adapt their specializations to maintain stability in the role structure of the team they join, the team declines in its ability to apply member knowledge efficiently after experiencing a membership change (Lewis et al. 2007). Thus, it is likely that the membership change experienced in the current study impeded teams’ ability to integrate what they had learned in the course of their work to improve their performance, despite the clearly defined roles enjoyed by process-focused teams. In addition, the lower level of action identification exhibited by process-focused teams impeded their ability to adapt in the face of task change, putting them at a disadvantage when losing task materials as well.

Taken together, these findings add a new dimension to what we continue to learn about the importance of events at the beginning of a team’s life (Ericksen and Dyer 2004; Ginnett 1993; Hackman and Wageman 2005). We know from prior work that early events are very influential in a team’s work. The way a team conducts its initial interaction can establish important and lasting norms about how they will function as a team (Bettenhausen and Murnighan 1985; Ginnett 1993). The expansiveness of the decisions they make and the strategies they devise will set them on a trajectory toward high performance or low performance (Ericksen and Dyer 2004). As teams move through their work and experience transitions (Gersick 1988; Okhuysen 2001), whether they are outcome-focused or process-focused will shape the nature of the changes they make. The current study demonstrates that outcome-focused teams much more readily adapted their work process to changing task demands than process-focused teams. In related work, Woolley (2007) observed much greater resistance to a midpoint strategy intervention in field-based consulting teams when they were highly process-focused than when they were not. Thus, the work presented here expands our understanding of the importance of early events by focusing on their implications for a team’s level of outcome- or process-focus and on the differing effects of those foci.

A remaining question for future research is whether teams will almost always be process-focused or outcome-focused, or are there teams out there that can maintain a healthy dual-focus or can (despite
cognitive and normative pressures) shift more fluidly and effectively between foci? Such teams might be in the best position for peak performance. Based on this and related research, one can speculate that truly dual-focused teams would be unusual. Woolley (2007) surveyed student project teams to assess outcome and process focus at the beginning of a semester-long project and found that over three-quarters demonstrated a definitive outcome or process focus. The majority of those without an identifiable focus significantly underperformed the outcome- or process-focused teams, and interview data suggested they were “unfocused” rather than “dual-focused.” The history of distinctions maintained between “means” and “ends” and the neuroscience evidence regarding the cognitive separation of the two argues for a low likelihood that a cohesive team could move fluidly between the two elements very early in their work and define the two simultaneously. Indeed, focus on the two elements was significantly negatively correlated in the content analysis of team planning conversations in the current study. Future research should focus on finding those teams that manage to maintain a healthy, cohesive dual-focus and understand the conditions that allow them to accomplish that. In the meantime, managers and researchers alike are well-advised to understand the tendency of most teams to focus on one or the other, and its implications for team functioning in dynamic environments.

Another remaining question for future research concerns the conditions encouraging an outcome or process focus. While some differences were observed in the levels of outcome and process focus that developed naturally in the control condition, we cannot pinpoint exactly why some groups focused more on one element or the other. Certainly, individual differences could play a role. Future research might focus on examining individuals’ propensities to high or low action identification as an antecedent condition to the development of outcome or process focus, as these propensities have been demonstrated to be stable individual differences (Vallacher and Wegner 1989). Furthermore, while the focus of the current study was exclusively teams working on open-ended tasks, teams working on a task that has a clearly defined, singular goal (“save the patient’s life” or “put out the fire”) or where performance is evaluated based on the quality of the process (e.g., legal proceedings, scientific research) may benefit from process focus in ways not explored here. Finally, factors in the context surrounding the task will
certainly be important. Issues such as how the project is situated in the innovation cycle (Benner and Tushman 2003), how the team launch meeting is conducted (Ericksen and Dyer 2004), and other situational cues regarding the “right way” to conduct work or the importance of attaining certain outcomes will all influence the focus a team adopts and its implications for task performance. Future laboratory and field research can focus on determining the antecedent conditions that will influence these variables.

There are also clear implications of this research for managers interested in structuring and standardizing the processes of teams engaging in knowledge work. While popular team handbooks and existing research underscore the importance of clear team “protocols” and procedures, the subtleties around when and how such tools are introduced is consequential. Managers are advised to pay particular attention to how early team meetings are structured and the relative emphasis on work processes versus outcomes. Teams that begin by reaffirming role and task assignments and project schedules before discussing project objectives are setting themselves up to be process-focused. In contrast, teams that begin work by having an in-depth discussion of what members want to accomplish stand a better chance of reaping the benefits of an outcome focus in a dynamic environment. The distinction between a team launch that leads a team down the path to process focus versus outcome focus is subtle but important to appreciate. A failure to do so can result in the appearance of a smoothly functioning team yielding inexplicably poor results.
References


Kozhevnikov, M., S.M. Kosslyn, J. Shephard. 2005. Spatial versus object visualizers: A new characterization of visual cognitive style. Memory & Cognition 33 710-726.


Table 1

Means, Intercorrelations and Reliability Statistics for Control Condition Observational and Survey Measures

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Beg. Outcome Focus</td>
<td>(.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Midpoint Outcome</td>
<td>.59*</td>
<td>(.90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. End Outcome Focus (Survey)</td>
<td>.31^</td>
<td>.58*</td>
<td>(.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Beg. Process Focus</td>
<td>-.60*</td>
<td>-.63*</td>
<td>-.31</td>
<td>(.90)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Midpoint Process</td>
<td>-.75**</td>
<td>-.47*</td>
<td>-.59*</td>
<td>.74**</td>
<td>(.90)</td>
<td></td>
</tr>
<tr>
<td>6. End Process Focus (Survey)</td>
<td>-.35</td>
<td>-.53*</td>
<td>-.31^</td>
<td>.35^</td>
<td>.44^</td>
<td>(.60)</td>
</tr>
<tr>
<td>Minimum</td>
<td>-1.09</td>
<td>-1.30</td>
<td>2.50</td>
<td>-1.22</td>
<td>-1.31</td>
<td>3.30</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.40</td>
<td>1.25</td>
<td>6.50</td>
<td>1.53</td>
<td>1.62</td>
<td>7.00</td>
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<tr>
<td>Mean</td>
<td>0</td>
<td>0</td>
<td>4.83</td>
<td>0</td>
<td>0</td>
<td>5.25</td>
</tr>
<tr>
<td>SD</td>
<td>1.00</td>
<td>1.00</td>
<td>1.20</td>
<td>1.00</td>
<td>1.00</td>
<td>1.16</td>
</tr>
</tbody>
</table>

Note. Values on diagonal are interrater reliability (ICC) for the measures
^ Correlation is significant at the 0.10 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).
Table 2
Means, Intercorrelations and Reliability Statistics for Observational Measures (N=90)

<table>
<thead>
<tr>
<th></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Process Adaptation</td>
<td>(.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Problem Adaptation</td>
<td>.28*</td>
<td>(.87)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Action Identification</td>
<td>.26**</td>
<td>.16</td>
<td>(.86)</td>
<td></td>
</tr>
<tr>
<td>4. Final Score</td>
<td>.25*</td>
<td>.44**</td>
<td>.22*</td>
<td>--</td>
</tr>
</tbody>
</table>

Minimum         | 0      | 0      | -1.10  | 2,160  |
Maximum         | 2.00   | 2      | 1.69   | 42,480 |
Mean            | 0.54   | 1.15   | 0.00   | 18,076 |
SD              | 0.64   | 0.81   | 1.00   | 7,257  |

Note. Values on diagonal are interrater reliability (ICC) for the measures.
*a Based on the 40 teams that lost materials mid-way through their work
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
^ Correlation is significant at the 0.10 level (2-tailed).
Table 3
Means of Observational and Performance Measures by Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action Ident</th>
<th>Process Adapt</th>
<th>Problem Adapt</th>
<th>Final Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process/No Midpoint Change</td>
<td>M: -0.31&lt;sub&gt;a&lt;/sub&gt;</td>
<td>0.20&lt;sub&gt;a&lt;/sub&gt;</td>
<td></td>
<td>24,611&lt;sub&gt;b&lt;/sub&gt;</td>
</tr>
<tr>
<td>(n=10)</td>
<td>SD: 0.69</td>
<td>0.42</td>
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<td>5,928</td>
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<tr>
<td>Process/Membership Change</td>
<td>M: -0.92&lt;sub&gt;b&lt;/sub&gt;</td>
<td>0.10&lt;sub&gt;a&lt;/sub&gt;</td>
<td></td>
<td>19,386&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>(n=10)</td>
<td>SD: 0.68</td>
<td>0.32</td>
<td></td>
<td>6,479</td>
</tr>
<tr>
<td>Process/Material Loss</td>
<td>M: -0.47&lt;sub&gt;a,b&lt;/sub&gt;</td>
<td>0.35&lt;sub&gt;a&lt;/sub&gt;</td>
<td>.70&lt;sub&gt;a&lt;/sub&gt;</td>
<td>17,091&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>(n=20)</td>
<td>SD: 0.96</td>
<td>0.52</td>
<td>.67</td>
<td>3,196</td>
</tr>
<tr>
<td>Outcome/No Midpoint Change</td>
<td>M: 0.72&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.92&lt;sub&gt;b&lt;/sub&gt;</td>
<td></td>
<td>24,954&lt;sub&gt;b&lt;/sub&gt;</td>
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<tr>
<td>(n=10)</td>
<td>SD: 0.32</td>
<td>0.67</td>
<td></td>
<td>4117</td>
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<tr>
<td>Outcome/Membership Change</td>
<td>M: 0.60&lt;sub&gt;c&lt;/sub&gt;</td>
<td>1.00&lt;sub&gt;b&lt;/sub&gt;</td>
<td></td>
<td>19,058&lt;sub&gt;a&lt;/sub&gt;</td>
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<tr>
<td>(n=10)</td>
<td>SD: 0.80</td>
<td>0.67</td>
<td></td>
<td>6,593</td>
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<tr>
<td>Outcome/Material Loss</td>
<td>M: 0.41&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.90&lt;sub&gt;b&lt;/sub&gt;</td>
<td>1.60&lt;sub&gt;b&lt;/sub&gt;</td>
<td>23,428&lt;sub&gt;b&lt;/sub&gt;</td>
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<tr>
<td>(n=20)</td>
<td>SD: 0.64</td>
<td>0.42</td>
<td>0.70</td>
<td>7,308</td>
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<tr>
<td>Control Condition</td>
<td>M: 0.20&lt;sub&gt;c&lt;/sub&gt;</td>
<td>0.10&lt;sub&gt;a&lt;/sub&gt;</td>
<td></td>
<td>17,982&lt;sub&gt;a&lt;/sub&gt;</td>
</tr>
<tr>
<td>(n=10)</td>
<td>SD: 0.93</td>
<td>0.32</td>
<td></td>
<td>5,732</td>
</tr>
</tbody>
</table>

Note. N = 90 groups. All means in each column which do not share a subscript are significantly different at p < .05, one-tailed.
Figure 1: Model of antecedents and effects of outcome and process focus on team performance
Figure 2: Relationships among ratings of control condition teams' outcome and process focus at beginning, midpoint, and conclusion of work.
APPENDIX A: Task Instructions for Laboratory Teams

THE HOUSE

Square footage (each “knob” is equal to one square foot)
- $10 per square foot on the ground floor
- $20 per square foot on the second floor
- $50 per square foot on subsequent floors

Quality: assessed using the “lift, flip, and drop test”
- no value added for buildings that cannot be lifted without any pieces falling off
- $1000 bonus for buildings that can be lifted
- $1500 bonus for buildings that can be lifted and flipped over
- $2000 bonus for buildings that can be lifted, flipped over, and dropped

Aesthetics: the attractiveness of your building will be assessed according to the following criteria:
- no value added for buildings that are a total eyesore
- $1000 bonus for good use of color
- $1500 bonus for good use of color and symmetry
- $2000 bonus for a “work of art”

Additional Rules:
- The walls separating the individual stories of the house must be least two (2) blocks high.
- Each story of the house must be completely enclosed by a floor and a ceiling for it to count toward the point total. The ceiling of one story can also be considered the floor of the next story.
- The walls around the outside of the house must be two knobs thick.
- There must be a cement foundation (a layer of white Lego bricks) between the house and the ground, though it does not need to be directly touching the ground. This should be the same dimension as the first story of the house, and can, but is not required to, serve as the floor of the first story as well.
- There must be a solid layer of blue blocks between the top of the house and the sky. This should be the same dimension as the top story of the house and can, but is not required to, serve as the roof of the house.

THE GARAGE

Square footage (each “knob” is equal to one square foot): $20 per square foot

Quality: assessed using the “lift, flip, and drop test”
- no value added for buildings that cannot be lifted without any pieces falling off
- $1000 bonus for buildings that can be lifted
- $1500 bonus for buildings that can be lifted and flipped over
- $2000 bonus for buildings that can be lifted, flipped over, and dropped

Aesthetics: the attractiveness of your building will be assessed according to the following criteria:
- no value added for buildings that are a total eyesore
- $1000 bonus for good use of color
- $1500 bonus for good use of color and symmetry
- $2000 bonus for a “work of art”
Car spaces: $2000 for each individual parking space in the garage

- Parking spaces must be at least 20 square feet (knobs) in size and have a door opening that is at least 4 knobs wide and 2 blocks high to qualify for this bonus.

Additional Rules:

- The walls of the garage can be either one knob or two knobs thick.
- There must be a cement foundation (a layer of white Lego bricks) between the garage and the ground, though it does not need to be directly touching the ground. This can, but is not required to, serve as the floor of the garage as well.
- There must be a solid layer of blue blocks between the top of the garage and the sky. This should be the same dimension as the top of the garage and can, but is not required to, serve as the roof of the garage.
- The garage must be completely enclosed on the top, bottom, and sides, except for specified doors.

THE POOL

Square footage (each “knob” is equal to one square foot): $50 per square foot

Aesthetics: the attractiveness of your pool will be assessed according to the following criteria:

- no value added for pools that are a total eyesore
- $1000 bonus for good use of color
- $1500 bonus for good use of color and symmetry
- $2000 bonus for a “work of art”

Additional Rules:

- There must be a diving board included.
- The floor of the pool must be blue.
- The walls around the edge of the pool should only be one knob thick and three blocks high, and should be one solid color (of the designer’s choice) all the way around.

APPENDIX B: Survey items for Outcome and Process Focus Scales

Instructions: In reflecting on your discussions with your team, please indicate on a scale of 1 to 7 (from “Very uncertain” to “Very certain”) the extent to which you discussed and developed clarity or certainty about each of these issues.

Process Focus
- What each of the subtasks are that need to be completed
- How the team should divide its time among the various subtasks
- What you personally are responsible for doing on the project
- When each of the subtasks will be completed

Outcome Focus
- What constitutes a “successful performance” on this task
- What criteria will be used for evaluating the final product
- The relative importance of the different parts of the task to the final score
- What the final output of your team’s work will look like.
Data collection was conducted in two time periods, with 50 teams from all but the “no midpoint change” condition participating in the first data collection phase, and 40 additional teams in the “no midpoint change” and “material loss” conditions participating in the second data collection phase. The $300 prize was offered during each data collection phase to the highest scoring team from among all conditions run during that phase. Since it was unknown a priori which condition would offer the most advantages to the teams, the offering of a single prize during each data collection phase was deemed to be a fair approach to this incentive.

A second measure of attention to processes and outcomes was calculated based on analysis of transcripts of group conversations at the beginning and midpoint. Individual statements were coded for their relevance to group processes or outcomes by two independent raters. The proportion of statements related to each was highly significantly correlated with the more global rating of attention reported here, and thus only the latter is reported here.
Bringing in the Experts:
How Team Composition and Work Strategy Jointly Shape Analytic Effectiveness

Anita Williams Woolley
Margaret E. Gerbasi
Christopher F. Chabris
Stephen M. Kosslyn
J. Richard Hackman

Department of Psychology
Harvard University

In press, *Small Group Research*

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We gratefully acknowledge the research assistance of Jonathon Schuldt, Benjamin Bibler, Abigail Donahue, and Benjamin White. Correspondence concerning this article should be addressed to Anita Williams Woolley, 33 Kirkland St., Cambridge MA 02138. Electronic mail may be sent via internet to anita@post.harvard.edu.
Bringing in the Experts:  
How Team Composition and Work Strategy Jointly Shape Analytic Effectiveness

This study investigates the separate and joint effects of the inclusion of experts and collaborative planning on the performance of analytic teams. Teams either did or did not include members with expert-level task-relevant cognitive abilities, and either did or did not receive an intervention that fostered collaborative planning. Results support our hypothesis that analytic performance requires both task-appropriate expertise and explicit exploration of strategies for optimally using that expertise. Indeed, high expertise in the absence of collaborative strategy planning actually decreased team performance. Teams that received a collaborative planning intervention were more likely to conduct a structured search to narrow their focus on key aspects of the analytic problem, which significantly enhanced their analytic performance. The implications of the findings for the optimal use of team member skills and the development of team performance strategies are discussed.

Keywords: analytic collaboration, team performance, experts, team strategy
Many prominent organizational failures are rooted in flawed analysis of data that are used to guide action. Flawed medical diagnoses, misinterpretation of financial indicators, and biased interpretations of intelligence data can result in ill-advised actions that have unfortunate consequences. In many of these situations, team members from different specialties are asked to work together to integrate multiple sources of information and draw conclusions. In this paper we explore the conditions under which teams whose members are specialists can collaborate effectively to analyze incomplete or unreliable data and use those data to generate trustworthy conclusions about unknown states of affairs.

Analytic work invariably involves both cognitive and social processes. At core, analysis is a cognitive activity. Although analysts often draw on both technological aids and input from others, it ultimately is the human brain that organizes and interprets data to generate an assessment of an event that has happened, is happening, or is likely to happen. But analytic work also is inherently a social process. The lone analyst working in isolation to extract the meaning from a set of data is the exception rather than the rule. Instead, analysts typically draw heavily on the expertise, experience, and insights of their colleagues in developing and testing their conclusions (Hackman & O'Connor, 2004). Nevertheless, research on the cognitive and social aspects of the analytic process heretofore has been carried out as if the two factors are independent. The present research explores the possibility that a robust understanding of the factors that shape analytic performance can be obtained only by examining how cognitive abilities and collaborative planning interventions jointly shape analytic processes and products.

**Bringing in the Experts**

In many fields in which collaborative analysis occurs there is a push for individuals to specialize and develop a high level of expertise in a fairly narrow topic area (Pearson, 1999).
While specialization provides deep knowledge in a given area, it does so at the expense of general knowledge and the ability to notice connections across different knowledge areas (Wagner, 2000). Consequently, multi-faceted real-world problems are best addressed by a combination of generalists and specialists working together in a team. Integrating specialists or “experts” into a team should raise the quality of the team’s product by raising the level of expertise available to the team, but can also create problematic social dynamics which harm team performance. Below we develop two competing hypotheses regarding the effects of integrating experts into a team for collaborative analysis.

Considerable evidence documents that cognitive abilities shape team performance. The general intelligence of members, for example, has been shown to predict a number of team effectiveness criteria (LePine, 2005; Neuman, Wagner, & Christiansen, 1999), as well as team learning (Ellis et al., 2003). The relationship between cognitive ability and performance is particularly strong for tasks that are unfamiliar (Devine & Philips, 2001). Composing teams to include content experts therefore should raise the quality of the team’s product by expanding and deepening the level of knowledge and skill available to the team.

“Experts” earn their title by possessing an appreciably higher level of knowledge or skill than the average person (Ericsson & Lehmann, 1996; Patel, Groen, & Arocha, 1990). An individual’s expertise can be the result of training and experience, or may be a function of the cognitive or physical abilities of the individual or some combination thereof (Ericsson, 2005; Volmer, 2006). Because a person's cognitive abilities are particularly germane to analytic work, we focus on them in the present research. Specifically, we take advantage of recent advances in cognitive neuroscience that offer the possibility of using brain-based measures to assess members' cognitive abilities (Cabeza & Nyberg, 2000; Kosslyn, 1994; Kozhevnikov, Kosslyn, &
Shephard, 2005). Analytic teams that include experts with strong task-relevant abilities have greater potential to perform well compared to teams without experts.

*Hypothesis 1a:* Teams including task-relevant cognitive experts will outperform teams without experts on analytic tasks.

While experts can provide a depth of information that the team would not have otherwise, integrating experts into a team of generalists can also create problematic social dynamics. Research on team diversity suggests that bringing together teams of members from different social categories creates significant difficulties for collaboration (Bunderson & Sutcliffe, 2002; Caruso & Woolley, in press; Dahlin, Weingart, & Hinds, 2005; Jehn, Northcraft, & Neale, 1999; Thomas-Hunt, Ogden, & Neale, 2003). Even in the absence of social categories, designating particular team members “experts” can evoke status dynamics that will override any benefits associated with the higher overall ability of the team. Teams have a demonstrated tendency to defer to expert members (Baumann & Bonner, 2004) and sometimes misweight member contributions on the basis of status considerations where the opinions of higher status members carry more weight than is warranted by their domain of expertise (Hackman & Morris, 1983; Littlepage, Robison, & Reddington, 1997). Thus, teams that are cognitively or educationally diverse may fail to effectively integrate their information (Caruso & Woolley, in press; Cronin & Weingart, 2007; Dahlin et al., 2005; Dougherty, 1992). This problem may be exacerbated by the assignment of experts to particular roles in advance of their work together, leading members to segment the problem and identify certain elements as “their” part (Moreland & Levine, 1992; Woolley, in press). On a highly interdependent, collaborative task, such dynamics can result in a situation opposite to the one described above, where teams including experts demonstrate a less integrated analytic product and underperform teams without experts.
Hypothesis 1b: Teams including task-relevant experts will demonstrate less analytic integration and underperform teams without experts on analytic tasks.

Expertise and Collaboration

Analytic work involves multiple steps, about which considerable research has been done—recognition of the situation in need of assessment (Bazerman, in press; Chugh & Bazerman, in press; Moreland & Levine, 1992), definition of the problem (Fiore & Schooler, 2004), creation or selection of the information to be considered (Heuer, 1999), pooling knowledge and coordinating members' inputs (Faraj & Sproull, 2000), and decision-making about analytic conclusions (Davis, 1996; Kerr & Tindale, 2004). The growing literature on team analytic performance is pessimistic about how well teams accomplish these functions. For example, teams tend to combine information ineffectively, omitting pieces of critical information (Henry, 1995); they focus too much on shared information (Stasser, Stewart, & Wittenbaum, 1995); and they do not coordinate expertise well, often giving specific members' contributions more or less weight than is warranted by their actual abilities (Bottger & Yetton, 1988; Hackman & Morris, 1983; Hackman & Wageman, 2005).

These dysfunctions can be overcome when members of well-designed teams collaborate to formulate and implement a performance strategy that is uniquely suited to task and situational requirements (Hackman, Brousseau, & Weiss, 1976; Okhuysen, 2001; Okhuysen & Eisenhardt, 2002; Woolley, 1998; Woolley et al., 2007). Competent team collaboration about work strategy rarely occurs spontaneously, however (Hackman, 2002). Therefore, an intervention usually is required to induce members to engage in explicit discussions about how they will carry out their collaborative work and, importantly, how they will capture and use well the contributions of individual members who have special task expertise.
Even well-designed and competently administered strategy-planning interventions encouraging team collaboration cannot compensate for the absence of task-critical member capabilities: Only teams whose membership includes individuals with ample task-relevant expertise will be helped by them. A recent study of dyads performing a task that required members to navigate a virtual maze and identify repeated instances of complex objects illustrates this point (Woolley et al., 2007). The task required two specific abilities: skill at navigation (spatial ability) and skill at storing images of complex forms (object memory ability). Both of these abilities reflect the operation of distinct neural systems (Kozhevnikov et al., 2005). One member of each team was assigned to navigate, and one to "tag" repetitions of forms. Teams were composed of members who were either strong or weak on each of the two abilities and, after completing work on the first maze, were given the opportunity to converse about how they were working together. These conversations about work strategy enhanced team performance only when the dyad contained both forms of task-relevant expertise necessary for the task, but members had been assigned to roles that were incongruent with their abilities (i.e., the person with high spatial ability was assigned to memorize shapes, or the person with high object ability was assigned to the navigation task). Conversation actually impaired performance when the dyad lacked one of the two expertises necessary for work on the task. We hypothesize, therefore, that both ability composition and an intervention to help members use the team's expertise well are required for effective performance. Specifically:

Hypothesis 2: The interaction of team expertise composition and an intervention that fosters collaborative planning more strongly predicts team performance than does the intervention alone.
Team Analytic Process

Good team processes do not invariably lead to good analytic performance. Sometimes exogenous factors, such as critical missing data of which members could not possibly be aware, can result in fine analytic processes generating a wholly wrong conclusion. Other times, a team with terrible processes reaches a correct conclusion for all the wrong reasons. For these reasons, research on team decision-making often employs process criteria of effectiveness (Hackman, 1987; Janis & Mann, 1977). That is, teams are assessed on how well they go about their work, on the assumption that good processes generally yield good outcomes, although not necessarily in any particular instance. By assessing the quality of team analytic processes, researchers can reduce the chances that luck or exogenous factors will muddy the assessment of a team's analytic performance.

Research has identified a number of strategies for improving analytic processes. To overcome memory limitations and fend off biases, for example, analysts are advised to decompose the analytic task into smaller components (Heuer, 1999). To avoid becoming overwhelmed by large quantities of data, they are advised to redefine the analytic task as a series of sub-problems that are more amenable to solution than is the over-arching task (cf., Newell & Simon, 1972). Other recommended strategies include the use of analogies for identifying the similarities between a current problem and one previously analyzed, and role-playing the behavior of a target group to improve predictions over those generated by unaided judgment (Armstrong, 2001; Green, 2002).

A critical challenge for teams performing analytic work is to find ways to extract, organize, and integrate all the potentially relevant information that is known to some, but not all, team members. Research evidence affirms that coordinating member knowledge and expertise is
critical to success for knowledge tasks (Faraj & Sproull, 2000), but the difficulty of doing that increases directly with the size of the team and the scope of its task. In the absence of an effective strategy for dealing with this challenge, an analytic team may fall victim to a number of problems: (a) members may not raise for collective consideration unique information that only they have (Stasser et al., 1995); (b) so much information may find its way to the collective table that members become overwhelmed and cannot assess what the data mean (e.g. Mintzberg, Raisinghani, & Theoret, 1976; Yen, Fan, Sun, Hanratty, & Dumer, 2006); or (c) members may not notice links or associations among independent facts that could provoke original ideas or stimulate fresh thinking (Okhuysen & Eisenhardt, 2002).

To overcome these problems, an analytic team requires some systematic means of structuring its search for data and for evaluating the evidence the team unearths. In analytic work, certain variables usually can be assessed sooner and more reliably than others and then used to structure follow-on searches for other evidence. A murder investigation team, for example, needs to identify the weapon used, the perpetrator, and the motive. In many cases, the weapon can be determined more readily than the other elements, both because there are fewer possibilities and because information obtained about it is likely to be reasonably trustworthy. Because certain people and certain motives will fit better with some weapons than with others, identification of the weapon can inform and constrain subsequent data-gathering about possible perpetrators and motives. This iterative process can continue until a coherent story emerges, at which point additional analytic strategies, such as testing alternative hypotheses and trying out structured analogies, can be used to protect against confirmation biases and to explore the merits of various alternative story lines.
The same logic holds for analytic teams. Analytic performance should be enhanced when teams initially engage in structured searches that focus on factors that have relatively low variance and high certainty, and then use what is learned about those factors to narrow the assessment of higher variance and less reliable factors. Furthermore, collaborative planning interventions will raise the probability of teams’ using structured search strategies by helping them surface the information that all members hold, and identify the variables that can be determined most reliably. Doing so can help teams avoid the under-weighting of information held by non-expert members, and to collectively organize their analysis so that all relevant information is integrated.

*Hypothesis 3*: Teams that engage in structured searches generate more valid analytic conclusions than do teams whose analytic processes are unstructured.

*Hypothesis 4*: Collaborative planning interventions increase the chance that teams will engage in structured search.

**Method**

We tested the research hypotheses in an experimental study of four-person teams that performed a partial analog intelligence analysis task. The task required members to assess and integrate diverse kinds of data to determine what suspected terrorists were planning. Two factors were experimentally manipulated: (a) team composition (experts vs. no experts), and (b) collaborative planning intervention (presence vs. absence of guidance about ways to use member resources well). An additional cell was appended to this 2x2 design for control purposes; all teams in this cell included experts that were explicitly assigned to roles that optimized the match between their abilities and their task responsibilities. Performance measures included both the
objective accuracy of each team's analysis and independent assessments of the quality of their reasoning.

Participants

A sample of 1,692 Boston-area students and residents were recruited on an Internet bulletin board for preliminary screening of cognitive abilities, and were given a $10 gift certificate from an online retailer as compensation. Of these participants, 204 (51 four-person groups) were selected to take part in the experiment, based on their scores on the screening tests. Those selected for the experiment were paid an additional $25 for participating. Sixty-three percent of the participants were female; participant age ranged from 18 to 59 ($M = 27$, $SD = 8.7$) and all were college students or graduates.

Task

The task required four-person teams to “crack a terrorist plot” by correctly identifying within 45 minutes three guilty individuals from a pool of 10 suspects, one target building from five potential locations, and the terrorists’ planned activities. Four types of evidence were provided which are described in more detail below. The evidence was available to the teams on four eMac computers, each of which was loaded with brief biographical sketches of all the suspects and one of the four types of evidence.

The task was structured so that obtaining the correct answer required both accurate analysis of each set of evidence and integration across the four different kinds of evidence. Both the setup of the experimental room and the large quantity of available evidence encouraged groups to spend some time working on their individual computers to analyze a single type of evidence before coming together to discuss and draw conclusions about what they had learned.
Materials

Four types of evidence were supplied to help the teams determine the terrorists’ plans: (a) degraded security camera photos, (b) surveillance video footage without audio, (c) a codeword-based email set, and (d) reconnaissance photos and building plans. Figure 1 contains examples of each type of evidence.

The degraded security camera photos were supplied from each of the five suspected plot locations. Photos of five of the ten suspects were mixed in with 10 distracter photos from each location, and participants were instructed to determine which of the ten suspects appeared at each of the five locations, with the implication that the guilty suspects would have all visited the targeted building. Surveillance video footage of each suspect leaving a hazardous materials laboratory where critical chemicals were stolen provided additional information for participants to use to determine who “looked guilty” as they departed. Codeword-based emails exchanged between the suspects were supplied to provide details of the plot itself. Finally, reconnaissance photos, found on a PDA suspects purportedly had lost, could be matched up to building plans to reveal the probable location of the plot.

Two of the four types of evidence, the email evidence and the security camera photo evidence, were specially designed to require specific cognitive abilities for successful analysis. Analysis of the emails was constrained by limiting participants to a single viewing of numerous code words used in the emails. Furthermore, they were not permitted to write down the codes. These restrictions increased the degree to which strong verbal memory was required to analyze the e-mail evidence. Analysis of the security camera photos was made difficult by degrading the quality of the photos and increasing their graininess. This increased the degree to which face
recognition ability was required to analyze the security camera data. Pretest data affirmed that participants' verbal memory (assessed by a paired associates memory test, described below) and their ability to recognize faces were significantly correlated with their ability to correctly analyze the email and security camera photo evidence ($r = .48, p < .001$ and $r = .47, p = .013$, respectively). Meanwhile, video surveillance footage and building plan layouts were pretested to insure that accurate analysis of them was challenging but achievable by most participants.

**Measures of Cognitive Abilities**

The two cognitive abilities used in selecting experts --verbal memory and face recognition ability--were assessed using a paired associates memory task and the Cambridge Face Memory Test (CFMT, Duchaine & Nakayama, 2006), respectively.

**Verbal Memory (VM).** The paired associates task required respondents to remember the pairings of nouns from a list of 25 pairs. The test was constructed using Paivio, Yuille, and Madigan’s (Paivio, Yuille, & Madigan, 1968) norms for concreteness and imagery of nouns. One hundred nouns were tested, each of which had a concreteness rating less than 2.5 on a scale from 1 (most abstract) to 7 (most concrete). All nouns tested had frequency ratings higher than 3 per million. We used these words to create two 25-item lists of pairs, and also used latent semantic analysis matrices to minimize the semantic relatedness of cues and targets in each list (Howard & Kahana, 2002). The average latent semantic association in list 1 was .078; for list 2 it was .086.

The paired associates lists were pretested online by 127 participants. Performance on the two lists was significantly correlated ($r = .67, p < .001$). List 1, which was slightly more difficult

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1 The lists were shown for six seconds first in a learning phase, followed by a 10-minute distracter task, followed by the four-alternative multiple-choice recognition trials for the words. List 1 was always completed first so that any
than List 2 ($M=.49, SD=.22$; and $M=.58, SD=.26$, respectively), was chosen for use in screening participants.

**Face recognition (FR).** The CFMT requires respondents to examine a set of target faces and then to recognize the targets among sets of distracter faces of increasing graininess. Although the present implementation of the test was adapted for online use using Psyscope-FL, all stimuli and timings were identical to those used by Duchaine and Nakayama (2006). The scores of the 127 pretest participants ($M=.77, SD=.14$) were comparable to those previously obtained by Duchaine and Nakayama.

**Screening and selection.** We developed eligibility criteria for participation in the experimental study based on the performance of the 127 pretest participants, and applied them to the 1,692 individuals who were screened. “Excellent” performance was set at the 90th percentile (FR score >.93, VM score >.76); “good” performance was set as between the 66th and the 33rd percentiles (.71 < FR score <.85, .32 < VM score <.52); and “fair” performance was set as below the 33rd percentile (FR score < .71, VM score <.32). Performance falling between the 66th and 90th percentiles was considered “null.”

Respondents were eligible for the experimental portion of the study as “non-experts” if they either received a “fair” or “good” score on both tasks. “Null” participants falling between the 66th and 90th percentiles were excluded in order to maximize the ability distinction between “experts” and “non-experts.” Those who received an “excellent” score on one task and a “fair” or “good” score on the other task were considered experts in the domain in which they received interference would not vary across participants. Word pairs were shown in a random order that was fixed across participants. Each target word appeared four times, once as the correct choice, and three times as a distracter. Thus, the task was very difficult; chance performance was 25%.
the “excellent” score. Of the 1,692 people completing the screening, 112 (6.6%) qualified as FR experts, 120 (7%) as VM experts, and 789 (47%) as non-experts. Among the remaining 671 respondents, 37 (2%) received “excellent” scores on both tasks, and the rest (37%) had a score on either or both tasks that fell between “good” and “excellent” and were not invited to participate in the experiment.

**Experimental Conditions and Procedure**

We manipulated team composition by constructing either (a) “special ability” teams consisting of one verbal memory (VM) expert, one face recognition (FR) expert, and two non-experts, or (b) “average-ability” teams consisting of four non-experts.

The collaborative planning intervention was manipulated by either (a) requiring teams to discuss explicitly who would be responsible for which type of evidence, and to plan how they would integrate the various types of evidence to determine who the terrorists were and what they were planning, or (b) allowing members to launch immediately into their work on the task. Specifically, teams receiving the collaborative planning intervention were given a worksheet that delineated the steps of the planning exercise, and the investigator started a ten-minute Quicktime presentation that guided the teams through those steps. The exercise required members to collectively review the types of evidence they were provided, relate the evidence to components of the problem solution (e.g. suspects, location, or plot), review member abilities and their relationship to the types of analyses that were involved, and then plan their approach to their analysis. Completion of the exercise occurred during the team’s work time, thus these teams had 10 minutes less than others to spend on the task itself.

Fifty-one teams were assigned to five experimental conditions, as follows: 20 teams received the collaborative planning intervention (10 expert, 10 average-ability), and 21 teams
received no intervention (10 expert, 11 average-ability). As a control condition, ten additional expert teams were assigned to roles that were specifically appropriate for their measured abilities (the "assign" condition) but did not receive any additional planning guidance.

Once all team members had arrived at the laboratory, they were shown a six-minute Quicktime presentation describing the terrorist scenario, the evidence that was available, and suggestions about how they might use their time (specifically, 30 minutes for organization and individual evidence analysis, followed by 15 minutes for discussion and integration). The investigator then gave each member of the team his or her personal ability report based on the online screening. Participants learned whether they were "fair," “good,” or “excellent” for each of the two key abilities--word pair memory and face recognition ability. Teams were encouraged to share their scores with each other in determining how to divide up their work, at which time the “expert” members (when present) were revealed. All teams correctly assigned expert members to the appropriate roles.

Teams were given time warnings when 15 minutes and 5 minutes remained. When time had elapsed, the investigator collected the answer sheet from the team, and gave them a post-session questionnaire to complete. They then were debriefed, thanked, and dismissed.

**Outcome Measures**

Team performance was assessed using three measures: (a) the correctness of the team's final solution, (b) the analytic integration evident in its final solution, and (c) the quality of its analytic process, as indicated by the teams’ use of structured search.

**Correctness.** Each team was given a single score for their final solution to the plot. This score combined a suspect score, a building score, and a plot score. The suspect score was the number of suspects the team correctly identified as terrorists. The building score was whether or
not the team correctly identified the building that was the suspects' target. Teams were given full credit for selecting the target building and half credit for selecting the building that suspects visited and discussed in the emails but were using as a decoy for the real target. The plot score was a weighted total of the correct plot elements the team identified. Pretests indicated that the plot elements varied in difficulty due to the number of times they were mentioned in the email and the number of codewords needing translation in discerning their details. In analysis, these plot elements were weighted for the difficulty of their determination, as follows. Three easy-to-detect elements were assigned a weight of 1.0, three moderately difficult plot elements were assigned a weight of 2.0, three hard-to-detect plot elements were assigned a weight of 3.0, and four commonly but incorrectly identified plot elements were given a weight of -.75. Two judges independently read and scored the plot descriptions for each team; the inter-rater reliability of the judges’ ratings was .98. The few discrepancies in their evaluations were discussed and resolved. The suspect, building, and plot scores were then z-scored and summed to form the overall correctness score.

**Analytic integration.** The analytic integration score assessed whether a team’s answer was internally consistent. Teams were given credit for “integration” by selecting suspects that had appeared in the security camera photos at the building the team selected as the target, regardless of whether the suspects or target selected were part of the correct solution. Similarly, they were given credit for the number of plot elements they listed that were consistent with their selected building target. Because these elements of the solution were typically determined by

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2 The weight for incorrect elements was devised so that it perfectly balanced with the score that teams could receive for the three easiest plot elements, which made it possible to distinguish between teams that were indiscriminately writing down everything they could think of from those who were carefully filtering all of the information.
different team members, integration of these solutions indicates integration of the work of the
team. The suspect and plot consistency scores standardized and combined to form the analytic
integration measure.

**Structured search.** Finally, the identification of the building target was the most tightly
constrained of all possible subtasks (1 out of 5 possible building sites, versus 120 possible
combinations of 3 in the suspect pool of ten, and an almost unlimited number of details that
could be speculated about the plot) and the most reliable information (three sources, one of
which required no special ability to analyze). Therefore, the optimum analytic process was to
identify the building target first, and then use the solution to that subtask to structure and
constrain analyses of the suspect and plot information. In teams including experts, this approach
presented an additional challenge; the clearest piece of information regarding the building target
was held by a non-expert member, requiring expert members to defer to the non-expert in order
for this optimal strategy to take shape. Two judges independently reviewed the videotape of each
team’s 15-minute discussion period to determine whether the team structured its analysis in this
way. Specifically, teams were assigned a score of 1 if they identified the building target first,
and 0 if they did not. The inter-rater reliability of the judges’ ratings was .85; the few
discrepancies in judgment were resolved by a third independent judge.

**Results**

Table 1 displays standard deviations and comparisons of means by condition, and Figure
2 displays the mean performance score by condition. Focused contrasts are used to test all
directional predictions. Hypothesis 1a and 1b state opposite predictions regarding the effects of
experts on team performance, and the prediction regarding the negative effect of expert presence
on team analytic performance is partially supported. Team performance was measured both in
terms of the correctness of team analytic conclusions, as well as the level of analytic integration evident in their work. A one-way ANOVA comparing conditions was significant for analytic integration ($F(4,46) = 3.41, p=.05$) but not for the overall correctness of teams’ conclusions ($F(4, 46) = .945, p = .447$). A focused contrast comparing the analytic integration of teams with experts and no planning intervention to teams without experts was significant ($t(46) = 1.62, p=.05$, one-tailed, $d=.46$), supporting the prediction that teams including experts would demonstrate less analytic integration, whether they were externally assigned to roles or assigned by the team members themselves. Hypothesis 2, regarding the interactive effects of expertise and collaborative planning intervention, is supported. Teams including experts that receive a collaborative planning intervention perform significantly better than teams with experts without an intervention, both in terms of the correctness of their answer ($t(46) = 1.89, p=.03$, one-tailed, $d=.56$) and their level of analytic integration ($t(46) = 2.48, p=.008$, one-tailed, $d=.73$). Finally, Hypothesis 3, predicting that structured search leads to better analytic performance, and Hypothesis 4 predicting that teams receiving a collaborative planning intervention will be more likely to engage in a structured search, were also supported. Teams that structured their search by solving the location first performed significantly better than those that did not ($t(38) = 3.35, p=.002$), and those receiving a collaborative planning intervention were significantly more likely to structure their search in this way: 40% of intervention (CI: 19%, 64%) versus 14% of non-intervention (CI: 3%, 36%), $\chi^2(1, N = 41) = 3.45, p=.03$, one-tailed.

**Conclusion and Discussion**

The present findings suggest that team analytic work is accomplished most effectively when teams include task-relevant experts and the team explicitly explores strategies for coordinating and integrating members' work.
Even smart teams are poor at processing and analyzing information when members do not use appropriate coordination and integration strategies. Previous research has shown that such strategy discussions rarely happen in the absence of a leadership or instructional intervention (Hackman, Brousseau & Weiss, 1976). The present findings affirm that conclusion and further suggest that such interventions are especially important for teams including expert members. Teams including experts that did not receive the collaborative planning intervention performed worse than other teams, whether they were assigned to their roles or assigned by the members themselves, raising the perverse possibility that the presence of expert members may actually decrease team effectiveness if members are not helped to use the experts' special talents. Because analytic teams almost always consist of members who bring a diversity of expertise and experience to the work, further research on the factors that can increase such teams' ability to recognize and use well these resources is needed.

One of the benefits of collaborative planning, we found, was that it resulted in members using a structured rather than a haphazard search through the available evidence. For many analytic tasks, resolution of uncertainty about certain questions early in the analytic process radically constrains the scope of what must be dealt with subsequently--and thereby reduces considerably analysts' data processing load. If, for example, anti-terrorism analysts can determine the specific geographical area in which a terrorist activity is being planned, then they can focus mainly on data relevant to that area and not spread their analytic resources across all possible areas. Structured analysis is particularly valuable for analyses conducted by teams, since team analytic tasks almost always are broader in scope than those assigned to individuals, and therefore pose a greater risk that analysts will be overwhelmed by the sheer quantity of the information to be processed. We found that teams that conducted a structured search through the
available evidence, which in almost all cases were those that had received the coordination planning intervention, did indeed perform better than those that gave the same priority to all aspects of the overall task in the early stages of their work. This finding is significant for the current task, since the piece of information that the analyses needed to be structured around and subordinated to was held by a non-expert member of the team. We found that expert teams not receiving a collaborative planning intervention helping them to weight member inputs appropriately were less likely to structure their analyses effectively in this kind of situation.

In summary, there appear to be two important benefits of the coordination planning intervention. One, to increase members' awareness of their teammates' task-relevant expertise and experience, and thereby to increase the team's chances of fully using members' contributions. And two, to increase the degree to which all members, as a consequence of working through the steps in the intervention together, come to appropriately structure their work and weight their expertise such that all members can contribute to the team’s collective task. Further research on these secondary effects of strategy-planning interventions could both increase basic understanding of work team processes and be of considerable practical use in guiding those who create and lead task-performing teams.
References


Table 1
Mean Performance Scores by Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Correctness</th>
<th>Analytic Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assign</td>
<td>M</td>
<td>-0.26a,b</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>1.83</td>
</tr>
<tr>
<td>No Experts/No Planning Intervention</td>
<td>M</td>
<td>-0.02b</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.37</td>
</tr>
<tr>
<td>No Experts/Planning Intervention</td>
<td>M</td>
<td>0.04b</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.13</td>
</tr>
<tr>
<td>Expert Members/No Planning Intervention</td>
<td>M</td>
<td>-0.80a</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.03</td>
</tr>
<tr>
<td>Expert Members/Planning Intervention</td>
<td>M</td>
<td>1.04c</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.47</td>
</tr>
<tr>
<td>TOTAL</td>
<td>M</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2.18</td>
</tr>
</tbody>
</table>

*Note.* Means in the same column that do not share subscripts differ at $p < .05$, one-tailed.
Hey:

The environmental guy is going to take you to an artist in southie, a Bug Dust specialist make you blend right in with the people. I will lay the crabs in their bedding myself right across from Hassal’s. Earthy can take annexia while we all work Islam Incorporated together - capiche?

**Code Words:**

- Bug Dust = Diversions
- People = Boston Police
- Crabs = Explosives
- Hassal’s = Federal Reserve Bank
- Annexia = HazMat Lab
- Islam Incorporated = MIT

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**Figure 1a. Sample of encrypted email**

**Figure 1b. Sample degraded security camera photos**
Figure 1c. Screen shot of security camera footage of suspect

Figure 1d. Sample photographs and blueprints used to determine route through building
Figure 2. Mean correctness and analytic integration scores by condition
To reap the value in diverse teams, leaders may try to manipulate structural interdependence – through task design – to foster synergistic collaboration. However, ambiguity about the nature and appropriate intersections of members’ unique and valuable cognitive perspectives can make it difficult to fully anticipate collaborative activity in task design. Here, teams need emergent interdependence – members must develop the desire and expectation to work interdependently for the benefit of the work. We therefore present a model of how leaders can promote emergent interdependence for diverse team success, identifying key antecedents and discussing psychological safety as a condition which can enhance their efforts.
In our increasingly interconnected world, the integration of knowledge from a wide range of perspectives has become essential to the solution of many social and organizational problems. With terrorists from different nations and religions banding together on the everywhere-and-nowhere ground of the World-Wide Web, concerned governments must synthesize knowledge of culture, religion, and technology to effectively protect their citizens. Similarly, medical doctors are no longer the only relevant participants in medical diagnosis and treatment – these activities increasingly demand the attention of experts in diverse fields, ranging from school administration (for Attention Deficit Disorder) to interior design (for Seasonal Affective Disorder). Everyday commerce is no less complex, with both process and product innovation becoming more dependent on input from technological specialists as well as from humanists and businesspeople who understand how technologies are likely to be used. Across industries, societies, and nations, progress demands effective collaboration between people with diverse task-relevant experiences, viewpoints, and knowledge.

To meet this demand, progressive changes in societal structure and values are bringing task-relevant diversity into the workplace. Where the unique historical and social perspectives of different demographic groups (e.g., ethnic groups, gender groups) are task-relevant, advances in fair hiring practices are helping ensure that group members are given the opportunity to productively contribute. Where different forms of learned expertise are key, cross-functional teams are becoming ever more popular. Still, it is not enough to merely bring people with diverse perspectives into contact, or even onto the same work team. Where a final product demands integrated thought from diverse contributors, effective collaboration requires a higher level of interdependence among team members. Whether diverse in social category membership, occupational training, or other background characteristics, the performance benefits of diversity
are generally expected to arise from *exchanging the different task-relevant information or perspectives* those background characteristics afford their possessors (see Jehn, Northcraft, & Neale, 1999). In particular, superior performance often depends critically on the extent to which team members learn from each other’s varied perspectives, as well as on the vigorous and interactive processing of task-relevant information (Thompson, 1967; Wageman, 1995). Decades of research in both the laboratory and field have shown that such collaboration can help teams of people with diverse knowledge and perspective excel in creative thinking and complex problem-solving (Mannix & Neale, 2005).

To some extent, managers of cognitively diverse teams can stimulate collaborative behaviors by using the robust influence of task structure – that is, by manipulating things like task technology, responsibilities, or rewards to create structural interdependencies among members that promote collaboration. However, the tasks for which organizations often select diverse teams can make it difficult to foster necessary levels of collaboration through structural interdependence alone. Because diverse teams are prized for their insight and innovative capabilities, they are often best suited to those tasks that are difficult to understand, circumscribe, or link to extant processes and solutions. Indeed, organizations often convene diverse teams specifically to produce unpredictable intersections of unfamiliar member perspectives in response to confusing and complex problems. In this environment of layered uncertainties, many elements of task structure—like collaborative process instructions and activity assignments—will require more detailed knowledge and insight than managers will have when designing a diverse team’s tasks. In these instances, managers need diverse teams to exhibit *emergent interdependence* – that is, they need team members to develop the expectation to
voluntarily share and process task-relevant information with one another in conducting the team’s work.

Though emergent interdependence is gaining research attention (see Wageman & Gordon, 2005), the literature is not yet sufficient to explain how emergent interdependence relates to diverse team performance, how managers can promote it, nor how it may be influenced by other team variables. In this chapter, we expand on existing theory and research to address these issues. We begin by clarifying our cognitive focus in using the term “diversity”, and discuss links between cognitive diversity and other well-known forms of diversity (e.g., social category diversity, functional diversity). We then present a model of the role emergent interdependence can play alongside structural interdependence in facilitating collaboration and success in cognitively diverse teams. Following that, we identify the cognitive, emotional, and behavioral factors that we believe can, independently and in interaction, promote emergent interdependence. We conclude the chapter by discussing the implications of our model and by suggesting future directions for research and practice.

**Team Diversity – A Cognitive Focus**

In this chapter, we focus on cognitively diverse teams—teams whose members possess inherent or acquired differences in beliefs, attitudes, perceptions of, and approaches to entities in the world. For decades, research on heterogeneity in small groups has suggested these kinds of cognitive differences among team play a critical role in facilitating performance when tasks require high levels of creativity or complex thought (Hoffman, 1959; Hoffman & Maier, 1961; Triandis, Hall, & Ewen, 1965). With exposure to and engagement with their teammates’ unfamiliar knowledge, understandings of the task, or approaches to work, team members can experience constructive task conflict which helps them to innovate and to generate useful task-
relevant insights (e.g., Damon, 1991; Levine, Resnick, and Higgins, 1993). Indeed, the bulk of the support for the “optimistic” view of diversity as benefiting team performance comes from research concentrating on these kinds of cognitive interpersonal differences (i.e., in functional expertise, skill, or information; Mannix & Neale, 2005; Williams and O’Reilly, 1998).

Literature often links differences in individual cognitions to differences in individuals’ social identities (e.g., as members of ethnic groups or occupational fields). This link is not unreasonable, because cognitive differences often influence, and are influenced by the group identities people experience in their lives. For example, individuals with certain cognitive beliefs or tendencies might systematically tend to seek admission to certain universities or membership in related occupational identity groups. Conversely, membership in different cultural, social, and occupational identity groups often entails exposure to different “thought worlds” (Dougherty, 1992; Fleck, 1979)—pools of knowledge and systems of meaning—which can shape members’ perceptions of issues (Dearborn & Simon, 1958; Walsh, 1988), cognitive orientations to goals, time, and formality (Lawrence & Lorsch, 1986), and methods or procedures for approaching work (Dougherty, 1992). However, the tradition of using social identity diversity as a proxy for cognitive diversity reinforces the notion that the latter is the most direct source of diversity’s value.

Of course, diversity in social category membership, in functional background, or in any other identity group membership can, in and of themselves, inspire intergroup dynamics that have significant implications for team functioning. Research has shown that such identity group diversity can, for example, thus influence performance by aiding or impeding diverse team members in discovering, accepting, and effectively utilizing their cognitive differences (e.g., Phillips, Northcraft, & Neale, 2006; Phillips & Loyd, 2006). Even in these situations however, it
is fundamentally the existence and use of members’ cognitive diversity that remains the most proximal facilitator of performance. Indeed, little or no theory suggests that social identity diversity will improve team performance except insofar as that team also possesses “deep-level” differences in information, perspective, or other cognitions that can produce constructive task conflict (Damon, 1991; Harrison, Price, and Bell, 1998; Hoffman, Harburg, & Maier, 1962; Jehn et al., 1999; Levine, Resnick, & Higgins, 1993).

We therefore focus our model and this chapter on cognitively diverse teams and the dynamics that can help to improve their collaborative performance, acknowledging that the sources of their cognitive diversity (e.g., diversity of racial background or cultural experience) may, in some cases, moderate the relationships we propose. By defining cognitive diversity broadly (to capture both inherent and acquired differences in cognition), we hope to capture as completely as possible the myriad differences in perspective that might impact team members’ styles or quality of work. This means that we concern ourselves with cognitive differences that might stem, as described earlier, from membership in various social identity groups, but it also means that we attend to cognitive tendencies and abilities that are shaped by inherent, brain-based individual differences.

Work in cognitive neuroscience documents that individuals can differ markedly in how well specific brain systems function – and that such differences in brain function predict differences in their performance on related tasks. For example, cognitive neuroscientists have found distinct neurological differences between “verbalizers” (those who tend to reason through problems using verbal strategies), “object visualizers” (those who tend use object shape and color information) and “spatial visualizers” (those who tend to use spatial relations between objects) (Kozhevnikov, Kosslyn, & Shephard, 2005. These brain-based cognitive differences are
directly relevant to the perceptions and approaches individuals in these three categories are likely to bring to any organizational task involving verbal communication (e.g., within a work team or to outsiders), the creation or use of organizational objects (e.g., manipulating product prototypes), or the navigation of organizational space (e.g., to locate project resources in the work environment). We believe that brain-based cognitive differences with these kinds of organizational implications constitute an organizationally significant form of cognitive diversity, alongside previously studied forms like differences in task approaches (e.g., Brehmer, 1976) in attention to information (e.g., Hammond, Todd, & Wilkins, 1966), and in underlying task assumptions, preferences, and belief structures (e.g., Glick, Miller, & Huber, 1993; Markóczy, 1997; Miller, Burke, & Glick, 1998; Walsh, 1988).

In order to capture some of the breadth of the cognitive diversity construct, our model and discussion of supporting research utilize cognitive diversity both as proxied by occupational identity and as measured by cognitive tests. Doing so allows us to explore not only the collaborative challenges presented by cognitive differences per se, but also to begin to look at how those challenges can be compounded by issues related to the group identities that are associated with those cognitive differences.

Furthermore, because we hope to address work teams most directly with this chapter, our model focuses on those cognitive differences which have direct relationships to team tasks, task resources, and task approaches. As mentioned earlier, cognitive diversity is expected to produce its performance benefits primarily through constructive task conflict, something task-irrelevant cognitive differences have little chance of generating. However, as we discuss in our next section, neither the mere presence of task-relevant cognitive diversity nor collaboration among cognitively diverse teammates necessarily improves performance.
When Can Diverse Teams Benefit Most From Collaboration?

All too frequently, diverse teams fail to derive value from collaboration (Guzzo & Dickson, 1996; Milliken & Martins, 1996; Pelled, Eisenhardt, & Xin, 1999). Though collaboration is undoubtedly beneficial for many tasks, it is easy to fall into the trap of viewing it like one views friendship – one can never have too much of a good thing. Moreover, because diverse teams are particularly prone to low levels of collaboration (Dahlin, Weingart & Hinds, 2005), it is easy to infer that better collaboration would improve performance. If these assumptions are incorrect, however, then the time and energy devoted to getting cognitively diverse teams to collaborate more may be wasted.

Research conducted by Woolley and colleagues (2007b) investigated these assumptions in a study of the relationships among team composition, collaboration, and performance. The researchers composed dyadic teams by selecting pairs of participants who each predominantly exhibited one of two cognitive abilities: object recognition (the ability to accurately encode and recall object features) or spatial visualization (the ability to encode and use spatial relationships between objects). Each dyad was asked to navigate a computer-based maze consisting of a long, winding corridor with many branching hallways populated by complex and unfamiliar objects called “greebles” (Gauthier & Tarr, 1997). Because the team reward (and participants’ compensation) depended on both accurate recognition of greeble pairs as well as on efficient maze navigation, members facile with object processing as well as those skilled in spatial navigation were essential to task success.

Three types of dyads were constructed to perform the task. The “congruent” dyads were “functionally aligned” (Owens, Mannix, & Neale, 1998), containing one object visualizer and one spatial visualizer, each assigned from the outset to expertise-appropriate roles (object marker
and maze navigator, respectively). In the “incongruent,” functionally-misaligned dyads, participants were assigned in the opposite fashion, to expertise-inappropriate roles (object visualizers had to be maze navigators, and spatial visualizers had to be object markers). In a third condition, dyads were homogeneous in that both members shared only one type of expertise. While all participants were required to physically execute their assigned role (e.g. they could not “swap” roles), participants were free to engage in supplementary, spontaneous verbal collaboration to try to work more effectively.

Congruent teams (which put teammates into structural roles that explicitly elicited their differing cognitive “expertise”) significantly out-performed both incongruent and homogenous teams, regardless of the amount of spontaneous collaboration they exhibited. Collaboration had little additional value to offer to these teams – with appropriate role assignments already predetermined and a task that did not require collaboration for effective execution, the value of collaboration was redundant. The most positive impact of collaboration came instead in the incongruent teams, where the diverse team members were expressly assigned to suboptimal roles. Working together closely allowed these functionally misaligned teams to compensate for the structural flaw in their work assignments by redistributing their expertise through spontaneous, collaborative communication. In contrast, collaboration was negatively related to performance in homogenous dyads. In this instance, the dyads lacked the necessary skills for carrying out the task – skills that no amount of collaborative communication could produce. Instead, discussion served as more of a distraction from work than facilitator of it.

Taken together, these results suggest that collaboration is most beneficial for cognitively diverse teams when the member’s potential contributions, the appropriate application of those contributions, or the complementarities between members’ contributions are ambiguous or
cannot be fully anticipated. For these teams, collaboration is necessary to transfer and apply members’ knowledge and skill appropriately as work progresses.

*Proposition 1: Collaboration benefits the performance of teams with task-appropriate cognitive diversity when the nature and appropriate use of members’ diverse cognitive resources are ambiguous or misunderstood.*

Of course, even if managers are good about seeking collaboration for their teams only when it is likely to be beneficial, merely hoping that team members will behave collaboratively will not make it so. In the next section, we discuss emergent interdependence—as an understudied complement to the widely recognized power of structural interdependence to promote collaborative behavior.

**Facilitating Collaboration through Emergent Interdependence**

No diverse team can be a “real team” unless its members are interdependent on one another for the achievement of some common goal (Hackman, 2002). Still, the extent to which interdependence generates actual collaboration among diverse team members can vary widely (Wageman, 1995; Wageman et al., 2005). We believe that two key factors contribute significantly to this variance: the level of *structural* interdependence incorporated into the team’s work, and the level of complementary *emergent* interdependence that evolves as the diverse team performs its tasks.

---Figure 1 here ----

*The established role of structural interdependence*

A substantial body of literature indicates that a diverse team’s level of collaboration – that is, the interdependence team members actually exhibit during work – will be both directly and indirectly affected by the structural interdependence of their work (e.g., Miller & Hamblin,
Structural interdependence refers to elements outside the individual and his/her behavior—that is, features of the context—that define a relationship between entities (diverse coworkers, for our purposes) such that one affects and is affected by the other (Wageman, 2001b). Structural interdependence can be further differentiated into two forms—"task interdependence" and "outcome interdependence." Task interdependence refers to features of the task—such as resource allocations, role definitions, and task requirements—that require multiple individuals to work together to achieve performance success. Outcome interdependence refers to the degree to which significant consequences of work are both shared by team members and contingent on collective performance of the task(s). When structural interdependence on one or both of these dimensions is low, members of diverse task-performing teams are likely to encounter relatively little difficulty in conducting their work independently of one another. For tasks with high structural interdependence, however, collaborative patterns of work are facilitated, and any pursuit of independent work must overcome pressures inherent in the task design to work with each other.

Consider an edited book, with sections contributed by authors from diverse disciplines, as an example of a diverse team task with low structural interdependence. Each author is not required to seek material from or interaction with the other authors to perform his or her own work, and his or her “reward” (in terms of compensation, recognition, etc.) depends little, if at all, on the work of the others. An author in this situation is likely to experience nearly complete freedom to write his or her chapter independently, and to receive little or no unsolicited help in seeking collaboration with other authors. A contrasting example with high structural interdependence would be a co-authored book intended to reflect the integrated knowledge of authors from different disciplines, where those authors will be collectively credited (or
condemned) for the book’s quality. In this situation, it would be awkward (at the very least) for any of the contributing authors to attempt writing the book independently, whereas attempts to work with his or her coauthors would likely be expected and mutually facilitated by those involved. Consistent with this view, both field and laboratory studies have shown that tasks designed with high structural interdependence do promote more collaborative behaviors—communication, helping, and information sharing—than those with low structural interdependence (Johnson, 1973; Johnson & Johnson, 1989; Wageman, 1995; Wageman et al., 1997).

When a team leader can anticipate which aspects of a diverse team’s work benefit from collaboration, the appropriate occasions on which collaboration should occur, and who should participate in the collaboration, it should be relatively straightforward to design work with appropriate structural interdependence to promote collaboration as desired. Take a production team where it is clear that collaboration is only desirable when planning transitions between individual, specialized phases of production. Assume that it is understood that the collaborative planning sessions need only occur when a new product is introduced to the system, and that the specialists involved in the transition are the only ones with the relevant knowledge to contribute to those sessions. Many elements of task structure can be used to induce these team members to collaborate. To name just a few, a manager can manipulate the definition of the task (e.g., largely sequential independent work, punctuated by supervised partnered collaboration), the rules of the task (e.g., members are expected to jointly produce and submit transition plans), or the task rewards (e.g., members are rewarded for the performance of their section of the production process—their own station as well as the stations of those who transition to and from their own).
For many diverse team tasks, however, it is difficult to identify just what a desirable pattern of collaboration specifically entails, weakening a manager’s ability to design an appropriately interdependent task structure. This is particularly the case for diverse teams in the growing domain of knowledge work, like intelligence analysis, consulting, customer service, or product development teams (Hackman, 2002; Quinn, 2005; Wageman, 1995). While it might be clear that some kind of collaboration among the cognitively diverse team members could be beneficial, pressures for dynamic, responsive, and innovative work in these domains can make it difficult to determine in advance what aspects of work (e.g., idea generation, option evaluation, decision making) most benefit from collaboration and when those activities should occur. In addition, managers of cross-disciplinary and cross-functional teams may find themselves unfamiliar with the specific knowledge and perspective each team member can contribute, making it difficult to design a task structure that matches each member to the collaborative roles and activities for which he or she is best suited.

The nature and role of emergent interdependence

In situations where ideal patterns of collaboration are hard to predict, it can be helpful to recognize that structural interdependence need not be the sole determinant of actual collaborative activity in a diverse team. In fact, research has shown that different teams working on structurally equivalent tasks can exhibit widely varying levels of collaborative behavior (e.g., Franz 1998, Hackman and O’Connor 2004, Stewart and Barrick 2000, van der Vegt et al. 1999). To help understand how this variance in actual collaborative activity can arise from the same task structure, we suggest that it is important to examine the role of emergent interdependence (see Wageman & Gordon, 2005). Emergent interdependence refers to the extent to which members expect to voluntarily share and process task-relevant information with one another in
conducting their work. This does not refer to members’ recognition of any task demands that “force” them to work with one another. Instead, emergent interdependence is the extent to which team members seek and anticipate voluntary, noncompulsory, task-focused interaction with their teammates as a way of accomplishing work. We propose that emergent interdependence can be a substantial facilitator of collaborative behavior in diverse teams, especially where ambiguities of the work situation limit the influence of the task’s structural interdependence.

Wageman and Gordon (2005) have provided evidence consistent with this idea. In a study of 39 project teams, they found that egalitarian teams—those with a shared desire to have each team member evaluated solely and equally by the quality of their team’s collective work—exhibited more collaboration than teams whose members preferred to be evaluated individually. While members’ expectations for work process were not explicitly measured, the former teams’ preference for outcome interdependence implies that they anticipated an interdependent work experience that would involve significant collaboration—a state we would characterize as high emergent interdependence, and which we would expect to account for their higher levels of actual collaboration. Similarly, we suggest that the latter teams’ individualistic orientations imply an expectation of independent work process that we would describe as low emergent interdependence and expect to explain the lower levels of actual collaborative behavior.

Proposition 2a: Emergent interdependence will foster collaborative behavior.

We also propose that emergent interdependence and structural interdependence are mutually reinforcing; the structural features of a diverse team’s work environment can aid the development of emergent interdependence, while the desires and expectations members have for interdependent work processes can lead them to strengthen the explicit structural interdependence of their tasks. Therefore, emergent interdependence may indirectly promote
collaboration in diverse teams by enhancing structural interdependence, or may itself be 

enhanced in directly promoting collaboration by stronger structural interdependencies.

Proposition 2b: Emergent interdependence and structural interdependence are mutually 

reinforcing, such that each tends to lead to higher levels of the other.

Understanding that emergent interdependence can be an important facilitator of 
collaboration in cognitively diverse teams, the question remains as to how emergent 
interdependence itself can be promoted. The Wageman and Gordon (2005) study discussed 
earlier suggests that, to the extent that managers can select team members based on their personal 
values, such selection can be used to set up teams which are predisposed to develop different 
levels of emergent interdependence and collaboration\(^1\). However, team leaders are generally 
unable or unwilling to select team members on the basis of personal values. They must instead 
look to the social context to create conditions that encourage the development of emergent 
interdependence. In the next section, we consider cognitive, emotional, and behavioral 
conditions that can promote emergent interdependence in diverse teams and thereby contribute to 
beneficial patterns of collaboration.

Creating Conditions That Promote Emergent Interdependence

Assuming a diverse team will be working in a situation in which emergent interdependence is 
likely to be beneficial, how can leaders encourage it to best effect? Leaders can take many 
actions that will “plant the seeds” for emergent interdependence (Edmondson & Woolley, 2003; 
Hackman, 2002). Just as work design sets the stage for a particular level of structural

\(^1\) In the Wageman & Gordon (2005) study, this is most clearly shown for teams whose members share a 
preference for or against interdependent outcomes – teams whose members share a split preference for 
interdependent and independent evaluation, as well as teams whose members do not share preferences exhibit 
inconsistent patterns of collaboration, and generally perform poorly.
interdependence (Wageman, 2001a), we propose here some specific cognitive, emotional, and behavioral conditions that leaders can put in place to encourage emergent interdependence. These include the ways that the task and members’ expertise are framed and understood by the team, the structuring of early behavioral interactions, and the creation of a climate of psychological safety that allows the other interventions to take root and grow.

**Task Framing**

The way diverse team members understand their work – the way the problem is defined (Cronin & Weingart, 2007; Fiore, 2001), the focus of their early task discussions and interactions (Woolley, in press), and the ways that they understand the roles of fellow team members (Hollingshead, 2000; Moreland, Argote, & Krishnan, 1996) can all have a profound influence on collaboration. As Wageman and Gordon (2005) note, even when the objective structures of various tasks are exogenously determined, managers can use task descriptions and instructions to alter the framing of the task for team members—that is, to emphasize or downplay opportunities, constraints, and goals that guide team members in subjectively interpreting those objective demands. Ultimately, both objective and subjective conceptions of the task will influence diverse team members in selecting, evaluating, and refining their strategies for work and collaboration (Hackman, 2002; Wageman et al., 2005), but it is the flexibility of subjective task perceptions that managers of cognitively diverse teams can most easily exploit.

Accordingly, Caruso (2007) conducted a study of task framing to explore its effects on emergent interdependence and collaboration in cognitively diverse teams. Specifically, the study explored the possibility that leaders can guide teams toward emergent interdependence by simply framing their team tasks as relatively high (rather than low) in interdependence.
Seventy-eight participants with careers in the fields of art, engineering, or “verbal analysis” (e.g. law, journalism, or analytical reading and writing) worked in 3-person teams to build three structures together from Lego® building blocks. Scoring criteria were designed such that one structure required a high level of attention to physical and structural stability, another required special attention to aesthetic criteria, and the third demanded compliance with an exceptionally dense and complex description of building codes—but all structures contributed equally to the overall score and all demanded some degree of attention to each kind of constraint.

Task framing was manipulated by exposing each team to subtle cues in the initial team instructions and setup activities. Groups in one condition received cues that emphasized an understanding of the work as highly interdependent, while others received cues that reflected an understanding of the work as less so—more as loosely coordinated independent work. An example of these contrasting presentations can be seen in the description of the performance bonus offered for the task. Participants in the high interdependence condition were told that the bonus was “$150 for the team that scores the highest, to be divided equally among members,” while participants in the low interdependence condition were told that the bonus was “$50 for each member of the team that scores the highest.”

Consistent with expectations, teams receiving a high interdependence task frame exhibited attitudes indicating higher emergent interdependence, as well as higher levels of actual collaborative behavior. These results suggest that task framing can be effectively manipulated by managers to promote emergent interdependence.

Unexpectedly, however, a separate critical insight emerged from this study. Higher levels of collaboration did not translate into better task performance for these occupationally- and cognitively-diverse teams. Analysis of individual-level experience measures helped explain
why: members of different occupational groups responded differently to the manipulation. Specifically, engineers responded to the manipulation of interdependence in a direction precisely opposite to both of their coworkers. When working on more interdependent teams, visual artists and verbal analysts reported more positive experiences of their work and more positive impressions of their coworkers. Engineers exhibited the opposite set of reactions, however, experiencing more negative reactions to interdependent work than to independent work. This pattern of results suggests that although task framing might be successful in promoting emergent interdependence and consequent collaboration, team members from different backgrounds might experience that collaboration in different ways, altering the personal or performance benefits they can derive from it. Perhaps a heightened and potentially exaggerated sense of authority intensified the engineers’ focus on their own unique expertise for “construction” tasks, making interaction and information exchange with others seem burdensome and frustrating. The quality of engineers’ collaborative contributions appears to have suffered as a consequence, which undermined the potential benefit of the collaboration for this team task.

This study demonstrates that managers can effectively utilize task framing to promote emergent interdependence in cognitively diverse teams, yet also cautions managers to not ignore the potentially counteractive influences of the social identities from which the cognitive differences stem.

*Proposition 3: Framing a team task as highly interdependent increases the level of emergent interdependence that emerges.*

*Early Interactions and Structuration*

Wageman and Gordon (2005) discussed emergent interdependence from the structurationist perspective—that is, as evolving from the patterned, consensual behavior of
individual actors (Poole & DeSanctis, 1992). They argued that such behavioral patterns can be driven by a variety of antecedents, such as shared perceptions of situational contingencies, learned work strategies, and shared values. Over time, the patterned behavior of groups becomes normative, and processes solidify into structure (Perlow, Gittell, & Katz, 2004). Much in the same way that one’s own emotional expressions can lead one to surmise one’s feelings (Tamir, Robinson, Clore, Martin, & Whitaker, 2004), or the observation of positive performance can lead to notions of self-efficacy that fuel further performance (Lindsley, Brass, & Thomas, 1995), teams that begin their work by receiving a nudge toward more collaborative behavior may be more prone to developing positive expectations regarding ongoing collaborative work. Consistent with the growing body of research on the importance of beginnings in teams (Ericksen & Dyer, 2004; Hackman & Wageman, 2005; Woolley, in press), a team’s early life is an important time for creating behavioral patterns to support emergent interdependence.

In a study to examine the importance of early behavioral interventions for encouraging emergent interdependence in teams, 204 individuals were recruited to participate in 51 four-person teams charged with analyzing information to crack a fictional terrorist plot (Woolley et al., in press). The task required each team to identify the planned terrorist activities, the guilty suspects, and the location of the planned activity from a list of possibilities. Teams were supplied with four types of evidence to examine in solving the plot, two of which required a high level of specific skill in order to be effectively analyzed. Cognitively diverse, high-ability teams contained two members who had each demonstrated high levels of task-relevant ability working with two participants of average ability, while homogenous, average-ability teams were composed of four members with average scores on the same measures.
Structural interdependence was present in the task because solving the problem required integration across analyses of the different kinds of evidence. This integration could be minimal, involving only last-minute comparison and assimilation of separate analyses conducted by each team member. More substantial integration was also possible, if members chose to consult and collaborate on analyses throughout interaction. Early team interactions were manipulated through a pre-task team intervention. Teams receiving an emergent interdependence intervention were prompted to plan for work on the task by discussing several factors that would facilitate an interactive, collaborative work pattern: members’ abilities, assignment to appropriate roles, and possible intersections among different members’ work activities. Teams who did not receive this intervention received no external prompts or guidance about how to coordinate the work.

Results showed that the emergent interdependence intervention significantly enhanced performance for diverse teams, but had little effect on performance for homogeneous teams. These effects were observed both for measures of the correctness of the teams’ solutions overall, and for measures of the integration of their solutions (e.g. the guilty suspects they chose were seen at the building they identified, etc.). Cognitively diverse teams that received the intervention significantly outperformed the other teams, whereas those that did not receive the intervention underperformed all other teams, despite having more “in-house” expertise than the homogeneous teams. Moreover, pair-wise comparisons of the performance scores by condition indicate that the intervention helped diverse teams significantly more than homogenous teams, suggesting strong combined effects for cognitive diversity and intervention. In other words, emergent interdependence had the greatest impact on diverse (as opposed to homogeneous) teams, helping members to determine appropriate work roles and interact across roles as necessary to exchange the unique task-relevant perspectives and cognitive abilities they possessed.
Proposition 4: Early behavioral patterns characterized by collaboration fuel team members’ expectations of ongoing collaboration, producing higher levels of emergent interdependence.

Psychological Safety

In addition to the conditions that cue a particular understanding of task interdependence or encourage initial behaviors that evolve into collaborative interaction patterns, the emotional climate within the team can set a tone that is more or less conducive to emergent interdependence. A particularly important element of the climate for this purpose is psychological safety. Psychological safety is defined as a shared belief that the team is safe for interpersonal risk taking (Edmondson, 1999). Members of psychologically safe teams are better able to admit to mistakes and ask for help from fellow team members, making it easier for them to seek collaboration with their teammates. Moreover, studies suggest that psychological safety and trust are associated with individuals’ propensity to reveal what they know and can offer to the team (Mayer, Davis, & Schoorman, 1995), a process that is critical to effective creative collaboration in diverse teams (Polzer, Milton, & Swann, 2002).

Edmondson and Woolley (2003) examined the implications of interpersonal climate for an organizational learning intervention designed to enhance collaboration in local work units at a large electronics manufacturing firm. Managers and subordinates were encouraged to engage in dialogue regularly to identify areas for shared improvement projects. Company leaders rolled out the dialogue program company-wide, and provided ample resources and support to encourage participation by all. Work units throughout the organization engaged in the same “launch” process to get them off to a good start. However, within six months of the launch, program leaders observed significant variance across work units in the extent to which different
groups engaged in and benefited from the process. Survey and interview data from a cross-section of the organization revealed that local units varied significantly in psychological safety, which significantly moderated members’ receptiveness to the program’s efforts. Higher levels of psychological safety enhanced the success of program efforts to promote collaboration (Edmondson & Woolley, 2003). By lowering the potential risks and anticipated costs associated with collaboration, psychological safety made it easier for people to develop desires and expectations for interdependent work in the presence of other cues for emergent interdependence.

Proposition 5: Psychological safety enhances the positive influences of task framing and structuration on emergent interdependence.

Implications

Our model of the role emergent interdependence plays (alongside structural interdependence) in promoting diverse team success offers important implications both for researchers and managers of diverse teams. First, this chapter contributes to the literature on interdependence in teams by identifying conditions under which emergent interdependence is particularly likely to benefit and, sometimes, hinder the performance of diverse teams. Our theory and supporting research suggests that emergent interdependence is likely to have the greatest impact on team performance when cognitively diverse teams face minimally defined tasks and role responsibilities. In these situations, which are characteristic of the analytical or knowledge work done by consulting, intelligence, or product development teams, team members must define roles and determine interaction patterns themselves. The knowledge, perspectives, and abilities necessary to perform the task may only be understood at a broad level, leaving team members to identify for themselves particular uses for the specific cognitive resources that each
member has to contribute. In such ambiguous and uncertain situations, emergent interdependence may be the only way for teams to offset their structural inadequacies and get themselves on a productive track.

Based on prior research, we proposed a number of conditions that leaders of teams can put in place to foster emergent interdependence in teams. First, it is clear that teams need to view their task as interdependent, and concerns derived from social identity group membership must be managed such that the interdependence is experienced as worthwhile. Second, the behavioral patterns that are established at the beginning of work can create a self-reinforcing cycle and help a team evolve toward or away from emergent interdependence, which is particularly important for cognitively diverse teams that need to integrate their work to produce effective results. And, finally, factors promoting emergent interdependence can be either cultivated or inhibited by psychological safety, which both allows team members to reveal their uniquely held skills and abilities and lowers the risks team members perceive to collaboration. Attending to these cognitive, behavioral, and emotional conditions that foster emergent interdependence will enable leaders to better realize the possibility of high quality collaboration in cognitively diverse teams.
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References


Kozhevnikov, M., Kosslyn, S. M., & Shephard, J. 2005. Spatial versus object visualizers: A new characterization of visual cognitive style. *Memory & Cognition*, 33: 710-726.


Figure 1: Conceptual model of relationships between structural interdependence, emergent interdependence, collaboration, and performance in cognitively diverse teams, with antecedent conditions and psychological safety as a moderator.