Organizational Behavior and Human Decision Processes 122 (2013) 92–99

Contents lists available at SciVerse ScienceDirect

Organizational Behavior and Human Decision Processes

journal homepage: www.elsevier.com/locate/obhdp

Do you see what I see? The effect of members' cognitive styles on team processes and errors in task execution

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ARTICLE INFO

Article history:
Received 2 April 2011
Accepted 30 April 2013
Available online 9 June 2013
Accepted by Richard Moreland

Keywords:
Team performance
Cognitive diversity
Cognitive style
Strategic focus
Strategic consensus
Errors

ABSTRACT

This research investigates the effect of members' cognitive styles on team processes that affect errors in execution tasks. In two laboratory studies, we investigated how a team's composition (members' cognitive styles related to object and spatial visualization) affects the team's strategic focus and strategic consensus, and how those affect the team's commission of errors. Study 1, conducted with 70 dyads performing a navigation and identification task, established that teams high in spatial visualization are more process-focused than teams high in object visualization. Process focus, which pertains to a team's attention to the details of conducting a task, is associated with fewer errors. Study 2, conducted with 64 teams performing a building task, established that heterogeneity in cognitive style is negatively associated with the formation of a strategic consensus, which has a direct and mediating relationship with errors.

Introduction

The use of multi-disciplinary and cross-functional teams has risen steeply in organizations because such teams are thought to have the resources required to solve important multi-faceted problems (Bunderson & Sutcliffe, 2003; Hackman, 2002; Wuchty, Jones, & Uzzi, 2007). However, these teams are also susceptible to communication and coordination difficulties and execution failures (Cronin & Weingart, 2007), which makes it important to appreciate the risks associated with such diversity. This is critical in the context of execution tasks, where errors are especially costly.

Recent work in cognitive neuroscience has identified the cognitive styles that characterize individuals working in different occupational and professional domains (Kozhevnikov, Kosslyn, & Shephard, 2005; Kozhevnikov, 2007). A cognitive style is a psychological dimension that represents consistencies in how someone acquires and processes information (Ausburn & Ausburn, 1978; Messick, 1984). Cognitive styles thus provide a way to capture the deep-rooted cognitive differences that exist in functionally-diverse organizational teams. Insights of this kind have been called for often in the groups and teams literature (e.g., Mannix & Neale, 2005; van Knippenberg & Schippers, 2007).

The two studies reported here focus on the implications of team composition and diversity, based on members' cognitive styles, for team process and the commission of errors. In the first study, we explored the effects of cognitive styles on the formation of team strategic focus, and the effect of strategic focus on errors. In the second study, we explored strategic consensus as a mediator of the relationship between team cognitive style diversity and errors. We wanted to understand *how* cognitive styles matter in teams performing execution tasks. To accomplish that goal, we drew on theory and research involving diversity, group processes, and neuroscience.

Theoretical background and hypothesis development

Task context and errors

Task characteristics clearly matter in determining the team processes that are critical for performance (Larson, 2009; McGrath, 1984; Steiner, 1972). McGrath's task circumplex (1984) identifies four task categories that reflect different sets of team interaction processes: generate, choose, negotiate and execute. Generate tasks include creativity tasks, such as brainstorming, that require idea generation. Choose tasks include intellective or problem-solving tasks that require choosing correct answers. Negotiate tasks involve resolving conflicting interests. Finally, execution tasks (such as object assembly) require a high level of coordination, physical movement, or dexterity. Although diverse teams are often good at tasks that benefit from divergent thinking, such as tasks involving the generation of new ideas (Brown & Paulus, 2002), diverse teams might face difficulties in performing execution tasks, which benefit from convergent thinking and require attention to detail.

In execution tasks, adhering to policies, or operating procedures and avoiding errors is often critical for performance. Errors are

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http://dx.doi.org/10.1016/j.obhdp.2013.04.003

unintended deviations from rules, procedures, and policies that can potentially produce adverse organizational outcomes (Goodman et al., 2011). Errors merit research in their own right as an important phenomenon relevant to organizations. However, although references to errors regularly show up in organizational accounts of accidents and other major mishaps (e.g., Starbuck & Farjoun, 2005; Zohar, 2008), errors themselves are rarely the primary topic of interest (Goodman et al., 2011). We have thus chosen to study how group composition (based on cognitive styles) and associated group processes affect the commission of errors in execution tasks.

Group composition and cognitive style

The information processing perspective argues that a broader range of task-relevant knowledge, skills, and abilities provides a team with a larger pool of resources for dealing with non-routine problems (van Knippenberg & Schippers, 2007; Williams & O'Reilly, 1998). Such resources generally pertain to the deep-level psychological characteristics of team members (Harrison, Price, & Bell, 1998; Jackson, May, & Whitney, 1995; Moreland & Levine, 1992a). These include, but are not limited to, perspectives, training, and cognitive styles. Psychologists have been engaged in research on cognitive styles and individual performance for many decades (Sternberg & Grigorenko, 1997), dating back to Jung (1923), and several different dimensions have been identified, including reflection–impulsivity (Kagan, 1958), field dependence–independence (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962), adaptation–innovation (Kirton, 1976), and verbalization-visualization. We focus on the verbalizer–visualizer cognitive style, which is closely associated with the educational and functional areas in which many people choose to specialize (Kozhevnikov, 2007).

Recent work on the verbalizer–visualizer distinction has further differentiated "visualization" on the basis of two imagery subsystems—object and spatial—that are anatomically and neurologically distinct (Goodale & Milner, 1992; Kosslyn, Ganis, & Thompson, 2001; Levine, Warach, & Farah, 1985). Object imagery refers to representations of the literal appearance of individual objects, in terms of their precise form, size, shape, color and brightness. Spatial imagery refers to relatively abstract representations of the spatial relations among objects, parts of objects, locations of objects in space, movements of objects and object parts, and other complex spatial transformations (Kozhevnikov et al., 2005; Reisberg, Culver, Heuer, & Fischman, 1986). Individuals high in object visualization encode and process an image holistically, as a single perceptual unit, whereas individuals high in spatial visualization generate and process images analytically, part by part (Kozhevnikov et al., 2005).

When solving mathematical word problems, strong object visualizers rely on pictorial images of the objects themselves, rather than on the relations among the objects. In contrast, strong spatial visualizers rely on schematic diagrams that depict the spatial relations of objects to each other (Hegarty & Kozhevnikov, 1999). For example, when thinking of a building, an individual high in object visualization will usually form a clear and bright mental picture of the building, but an individual high in spatial visualization will usually imagine the building's blueprint (Blazenkova & Kozhevnikov, 2008). Kozhevnikov (2007) found that scientists tend to be stronger spatial visualizers, but artists tend to be stronger object visualizers.

Research on how diversity in members' cognitive styles can influence team performance has appeared in the teams' literature (see Caruso & Woolley, 2008, for a review), but has not yet fully examined the impact of cognitive styles on collaboration, much less the mechanisms by which they actually enhance or inhibit team performance. Because cognitive styles represent distinct ways in which individuals encode and process information, individuals with different cognitive styles are likely to approach work differently, influencing how teams go about their work.

Strategic focus

A team's strategy is a framework for guiding members' attention to key priorities and activities. One can often infer a team's strategy by looking for patterns in important decisions (Ericksen & Dyer, 2004; Hackman, 1987; Hambrick, 1981). Levine, Higgins, and Choi (2000) argue that prior to developing a shared reality about the best solution to a problem a group must first develop a shared reality about the best means for solving that problem. These means, or strategic foci, influence critical aspects of the problem-solving process, including what information is attended to, how that information is weighted and integrated, and which members exert influence. All of these can affect the group's final solution. They can also have long-lasting effects on how individual members and the group as a whole respond to subsequent problems (Levine et al., 2000; Moreland & Levine, 1992b).

One dimension along which a team's strategic focus can be conceptualized is *process focus*. A team's level of process focus is determined by the importance that members place on identifying specific sub-tasks that need to be completed, the resources available for doing so, and the coordination of sub-tasks and resources among members and over time (Woolley, 2009a). Although process focus in teams can be manipulated situationally (e.g., Woolley, 2009a, 2009b), it can also be heavily influenced by the work style predilections of members, as shaped by their cognitive styles. As noted earlier, strong object visualizers process information holistically and identify global properties of objects, whereas strong spatial visualizers process information analytically and part by part, using spatial relations to arrange and analyze components (Kozhevnikov, 2007). By extension, we expect that strong spatial visualizers (as compared to strong object visualizers) will exhibit greater tendency toward the granular, detail-oriented thinking associated with process focus, leading to a higher level of process focus in the teams whose members are strong in spatial visualization.

Hypothesis 1. Spatial visualization will be a more positive predictor than object visualization of process focus in teams.

A process focus engenders attention to the details of conducting work on a task. Such attention should be especially beneficial in the context of execution tasks, which are heavily dependent on pre-specified standards, such as rules, procedures, and policies. Deviating from these standards (errors) will be more common in teams that are not attentive to details and process. So, we predict that the more process-focused a team is, the less likely it is to commit errors.

Hypothesis 2. Process focus in teams will be negatively associated with errors in an execution task.

Strategic consensus

A team's strategic focus is important for the successful execution of a task, but so is whether team members see the priorities of their work similarly (Gurtner, Tschan, Semmer, & Nagele, 2007). Strategic consensus is the shared understanding of strategic priorities among members of an interacting group or organization (adapted from Floyd & Wooldridge, 1992; Kellermanns, Walter, Lechner, & Floyd, 2005). Strategic consensus reflects whether team members are "on the same page" about important task elements and about how work will be conducted. Strategic consensus is an important factor in top management teams, and should be important in other work teams as well.

Similarities among group members lead to higher levels of cohesiveness, conformity, and consensus (Kellermanns et al., 2005); even without much communication on a particular issue, individuals who share a common background and set of experiences may come to see things in similar ways (Hambrick & Mason, 1984). So, it is not surprising that diversity has a negative impact on strategic consensus (Knight et al., 1999; Priem, 1990), though the reasons for that impact are not well understood. We contend that heterogeneity in cognitive styles is an important factor influencing the difficulty of reaching strategic consensus. Individuals with different cognitive styles literally see the world differently, and thus start in different places with regard to the kinds of details they believe should be prioritized when planning work. Consequently, heterogeneity in cognitive style creates discrepancies in members' understanding of the team's strategic focus, resulting in weak strategic consensus.

Hypothesis 3. Team heterogeneity in members' cognitive styles will be negatively associated with strategic consensus.

Strategies can only be successfully executed when members are acting on a common set of priorities (Floyd & Wooldridge, 1992). Strategic consensus facilitates the implementation of a group's strategic decisions (Amason, 1996); higher degrees of strategic consensus are associated with greater coordination and cooperation in the implementation of strategy, and with better organizational performance (Kellermanns et al., 2005). Hence, for successful execution that involves fewer errors, teams must come to a shared understanding of what constitutes their final strategy.

It can be argued that consensus plays a different role in performance depending on what stage of the decision-making process a group is in (e.g., Mintzberg, Raisinghani, & Theoret, 1976; Zeleny, 1982). Although consensus during the problem-framing and brainstorming phases might decrease the number of strategies a team considers, and weaken team creativity as a result, consensus during the execution stage will enable the group to coordinate members' activities so that they can perform as a single unit. In general, being on the same page about a poor strategy is likely to be detrimental. However, we argue that the coordination losses associated with low strategic consensus can be even worse, particularly in a context where execution is important and errors are costly. As hypothesized previously, we expect that a team process focus will be associated with fewer errors (H2) and further predict that greater consensus around process focus will result in fewer errors.

Hypothesis 4. Strategic consensus in teams will be negatively associated with errors in an execution task.

Strategic consensus is probably the main vehicle through which team heterogeneity in cognitive styles leads to errors. In other words, differences in members' cognitive styles lead to low strategic consensus, which in turn produces coordination lapses – key details are missed, and errors are committed. Thus, we predict that strategic consensus will mediate the relationship between cognitive style heterogeneity and commission of errors.

Hypothesis 5. Strategic consensus will mediate the relationship between team heterogeneity in cognitive style and errors in an execution task.

Overview of studies

The objectives of the first study were to test the effects of team members' cognitive styles on the level of process focus that teams develop, and the effects of process focus on errors (Hypotheses 1 and 2). Study 2 examines the effects of cognitive style heterogeneity on strategic consensus (Hypothesis 3) and the direct and mediating effects of strategic consensus on errors (Hypotheses 4 and 5).

Study 1

Method

Participants

The sample consisted of 70 dyads. Thirty dyads were diverse (one member was high in object visualization and low in spatial visualization, whereas the other member was high in spatial visualization and low in object visualization), 20 dyads were homogenous in one way (both members were high in spatial visualization and low in object visualization), and 20 dyads were homogeneous in the other way (both members were high in object visualization and low in spatial visualization).[1]

Individuals from the general population were recruited for the study through online and paper advertisements. An online prescreening was conducted with 2494 individuals who were asked to complete (1) the Visualizer–Verbalizer Cognitive Style Questionnaire (VVCSQ; Kozhevnikov, Hegarty, & Mayer, 2002; Lean & Clements, 1981), and (2) the Object–Spatial Imagery and Verbal Questionnaire (OSIVQ; Blazenkova & Kozhevnikov, 2008). The VVCSQ allowed us to classify each person as high in verbalization or visualization, based on the respondent's strategies for solving a series of math problems. The OSIVQ yields scores for the spatial visualization and object visualization cognitive styles, and these scores have been shown to correlate with spatial and object processing abilities (Blazenkova, Kozhevnikov, & Motes, 2006; Chabris, Jerde, Woolley, Hackman, & Kosslyn, 2006; Kozhevnikov et al., 2005). The goal of the screening was to select individuals from the tails of the distributions for object visualization and spatial visualization, and choose individuals who were high only on one of the two visualization cognitive styles, and not both, in order to compose maximally diverse or homogenous teams. Of the 140 individuals who participated in the main study, half were strong spatial visualizers and the other half were strong object visualizers. Participants were not given feedback on how they scored. Among those who participated in the main study, 77% were Caucasian, 65% were female, and participant ages ranged from 18 to 60 with a median age of 24. Preliminary analyses revealed no significant effects of gender and age composition on group performance, so these variables were not incorporated into further analyses.

Task

The task was a navigation and identification task set in a computer-based maze. The maze consisted of a long, winding corridor with many hallways branching off. The hallways were populated by complex, unfamiliar objects called "greebles" (Brainard, 1997; Gauthier & Tarr, 1997). First person maze navigation is a prototypical task for testing spatial visualization. Greebles are objects that are difficult to distinguish from one another and thus are good stimuli for tapping into object visualization. In pretesting the task, strong spatial visualizers did well on the navigation component, but not well on greeble recognition, and the reverse was true for strong object visualizers. Thus, the task provided a context where both skills would be important resources for the dyads. Dyads viewed the virtual maze environment on a single monitor, and had access to just one keyboard and one joystick.

Each maze contained 12 greebles, including three pairs of identical greebles and six lone distractor greebles. The dyads were instructed to navigate through the entire maze and to find and tag

[1] These dyads were taken from the sample for a larger study investigating other research questions, as reported in Woolley et al. (2007).

as many of the identical greeble pairs as possible. Teams incurred penalties for tagging the wrong greebles. Teams earned a bonus for each correctly tagged greeble, lost money for each incorrectly tagged greeble, and earned a bonus for navigating enough of the maze to see all of the greebles. Participants were guaranteed a base pay, to which a bonus based on performance was added. The bonuses received ranged from $0 to $6.80, above the base pay promised.

Measures

Process focus. Team level of process focus was measured using observational coding of the teams' 2-min planning period (between Maze 1 and Maze 2). Two raters coded each team on the amount of discussion about details such as what each person should do, the order in which things should be done and how much to collaborate on work versus work independently. All of these evaluations were made on a 1 (low) to 3 (high) scale. Other topics teams discussed included clarifying the task instructions and scoring structure, coaching each other on how to use the equipment, and general performance. The process focus observational scale exhibited acceptable reliability across raters ($M = 1.84$, $SD = 0.77$, $Max = 3$, $Min = 1$, *Cohen's kappa* = .86).

Errors. Errors in this context consisted of tagging greebles that should not have been tagged. Two factors affected the commission of errors—the degree to which the dyad navigated the maze well, so that each greeble that appeared on the screen was in a unique part of the maze, and the degree to which the dyad recognized whether a greeble had been seen before or not. Thus both object and spatial visualization influenced the number of errors committed. Our analyses focused on the percent of greebles incorrectly tagged.

Procedure

Participants were told that they would be participating in a group collaboration study. We manipulated dyad composition to create three conditions. In the diverse condition, the individual high in spatial visualization was given the role of the navigator, and the individual high in object visualization was assigned the role of a tagger. In the homogeneous conditions, these roles were randomly assigned. Once the participants were introduced and seated in their assigned positions, they viewed task instructions on the computer monitor and navigated two small practice mazes. During this practice period, dyads received feedback when they correctly tagged the greeble pair in each maze. Such feedback was not given later on in the study. Following the practice period, dyads navigated two mazes. We counterbalanced the order of presentation of the mazes such that within each condition, half of the teams saw Mazes 1 and 2 in each of the two possible orders. We later tested for order effects, but none were observed.

Participants were not allowed to communicate while working on Maze 1, but they were allowed to discuss the task freely for 2 min between Maze 1 and Maze 2. They could continue to communicate while working on Maze 2. The planning break was created to allow us to evaluate process focus. All dyads were videotaped, with the knowledge and consent of the participants. All participants were debriefed (in writing) at the conclusion of each session.

Results

Descriptive statistics for the various measures are displayed in Table 1.

Hypothesis 1 predicted that spatial visualization will be a more positive predictor than object visualization of process focus in teams. We ran a one-way ANOVA examining the effect of the three conditions on the team's level of process focus. This analysis yielded significant results, $F_{(2,67)} = 8.40$, $p = .01$, $\eta^2 = .20$. Pairwise contrast testing demonstrated that homogeneous teams predominant in spatial visualization had significantly higher levels of process focus ($M = 2.25$, $SD = .85$) than did homogeneous teams predominant in object visualization ($M = 1.35$, $SD = .59$), $t = 3.89$, $p = .0001$ (Table 1), providing support for our hypothesis. Additional analyses showed that homogeneous teams predominant in object visualization had significantly lower levels of process focus ($M = 1.35$, $SD = .59$) than did diverse teams ($M = 1.90$, $SD = .66$), $t = 3.08$, $p = .004$. Homogeneous teams predominant in spatial visualization did not have significantly different levels of process focus from diverse teams, $t = 1.55$, $p = .13$.

Table 1
Mean (and standard deviations) for process focus and errors (Study 1).

Condition	N	Process focus	Maze 1 errors	Maze 2 errors
Spatial–object	30	1.90 (0.66)	50.85 (34.51)	44.68 (37.44)
Spatial–spatial	20	2.25 (0.85)	51.48 (28.89)	35.98 (31.90)
Object–object	20	1.35 (0.59)	56.69 (28.17)	46.87 (30.28)
Minimum		1	0	0
Maximum		3	100	100
Mean		1.84	52.70	42.82
SD		0.77	30.91	33.79

Note. Homogeneous teams predominant in object visualization (object–object) are significantly different from homogeneous teams predominant in spatial visualization (spatial–spatial) in process focus; homogeneous teams predominant in object visualization (object–object) are significantly different from diverse teams (spatial–object) in process focus.

Hypothesis 2 predicted that process focus would be negatively associated with errors. We ran a regression with process focus as the independent variable, errors in Maze 1 as the control variable, and errors in Maze 2 as the dependent variable. The analysis supported our hypothesis ($F_{(2,67)} = 11.39$, $p < .001$, $R^2 = .25$); we found that process focus was negatively associated with errors in Maze 2, $\beta = -.30$, $t(69) = -2.87$, $p = .006$, controlling for the errors made in Maze 1. We found a similar pattern when controlling for the experimental condition as well, $F_{(4,65)} = 5.81$, $p < .001$, $R^2 = .26$.

Conclusions

The research question we addressed in Study 1 was how cognitive styles affect team strategic focus and error commission during an execution task. The results demonstrated that the cognitive style composition of a team influenced the team's level of process focus. Teams that were high in spatial visualization were more process-focused than teams that were high in object visualization. Homogeneous teams high in spatial visualization did not have significantly different levels of process focus from diverse teams, suggesting that the presence of even one strong spatial visualizer helped a team to be process focused. In addition, the study demonstrated that process focus strongly affected the commission of errors in a team, which was an important aspect of performance. Keeping the errors committed by teams in the first maze constant, higher process focus was associated with more errors in the second maze. This study helped us understand the processes and task subcomponents most affected by a team's cognitive style composition. Given the number of situations in which teams are left to their own devices to determine a work strategy, the cognitive style composition of a team can have a significant influence on the team's strategic priorities and performance.

In Study 2, we relaxed some of the constraints employed in Study 1 to further explore these effects. First, the task used in Study

1 was specifically designed to incorporate components that tapped directly into the two cognitive styles that interested us. In the second study, we adapted a task that was not designed to tap into these cognitive styles, but should generally benefit from the skills associated with them (Woolley, 2009a). Second, rather than pre-screening and selecting individuals from the tails of the distributions in cognitive style, we randomly assigned individuals to teams to allow for a broader distribution of cognitive style heterogeneity. Third, although dyads were necessary in Study 1 to insure equal representation of the different skills in the diverse condition, in Study 2 we employed larger teams, and controlled for team size. Finally, we added an examination of strategic consensus (in addition to strategic focus), to determine the effects of agreement among team members about strategic priorities on the team's commission of errors.

Study 2

Method

Participants

The study was conducted with 231 participants, who were randomly assigned into 64 teams of size two to five. Participants were paid for their participation. The mean age of the participants was 23.6 years and 53% of them were male. Preliminary analyses revealed no significant effects of gender or age composition on group performance. Thus, these variables were not incorporated into further analyses.

Task

Teams were asked to use a set of building blocks to build a housing complex that included a house, garage, and swimming pool (Woolley, 2009a). The structures were evaluated 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 parking spaces included in the garage). Several building codes were also specified. For example, the foundation of the house had to be built with cement/white bricks, and the swimming pool had to have a diving board. Teams could lose more points than they earned if they neglected these details or committed errors in execution. All requirements and associated payoffs were described in detail in an instructional video played before the teams began to work. This information was also available in reference materials that the teams could access during their work.[2]

Measures

Levels of cognitive style. The Object–Spatial Imagery and Verbal Questionnaire (OSIVQ) (Blazenkova & Kozhevnikov, 2008) was again used to measure object and spatial visualization among participants. For each participant, scores were calculated for both the object and spatial visualization scales ($M = 3.46$, $SD = 0.51$, $Max = 4.73$, $Min = 1.40$ for the object scale, $M = 3.07$, $SD = 0.60$, $Max = 4.6$, $Min = 1.2$ for the spatial scale). Cronbach's α was 0.81 for the object scale and 0.85 for the spatial scale . *Levels* of team object and spatial visualization were calculated as the mean level of each cognitive style across members.

Cognitive style heterogeneity. This was calculated as the within-group variance in team members' scores on object and spatial visualization.

[2] This task was used in a larger study investigating other research questions, reported in Woolley, Chabris, Pentland, Hashmi, and Malone (2010).

Process focus. This was measured using a survey developed by Woolley (2009b). Participants were asked to indicate how important different issues were for their planning. These issues included how the team should divide its time among the various structures/parts of the task, and what each person would work on. Participants' judgments were made on 1–7 scales, where 1 was very uncertain, and 7 was very certain. The nine items on the scale exhibited acceptable reliability (Cronbach's $\alpha = .89$; $M = 4.44$, $SD = 1.36$, $Max = 7$, $Min = 1$), and were averaged to form a measure of process focus.

Strategic consensus. This was calculated using the within-group variance of the process focus measure. That index was reverse-scored to facilitate its interpretation as a consensus measure (Knight et al., 1999). Lower strategic consensus would indicate less agreement about the level of process focus in the team.

Errors. These were calculated by adding the penalties associated with deviations from the building codes for each structure (garage, house, and swimming pool), as specified in the task instructions.

Procedure

After participants arrived at the laboratory, they completed a consent form, followed by measures of cognitive style and other measures, such as individual intelligence (based on the Wonderlic Personnel Test). They were told that they would be participating in a group collaboration study. Cognitive styles and their relevance to the study were not mentioned. All teams were videotaped with the knowledge and consent of their members.

Every team watched an instructional video about the task. After the video, teams were given 5 min to plan their work. Following this planning period, team members completed the measures of process focus. Afterward, they began their 20-min building period. A timer was displayed on a computer screen in the room throughout the task to indicate the amount of time remaining. All participants were debriefed (in writing) at the conclusion of the session.

Results

Descriptive statistics and the correlations among study measures are displayed in Table 2. Team size and mean level of intelligence were used as control variables in the analyses, because both variables have been shown to affect the performance of tasks like the one we used (Woolley et al., 2010).

The data supported Hypothesis 1: spatial visualization was a more positive predictor than object visualization of process focus in teams. Higher process focus was associated with a higher level of spatial visualization, $r = .22$, $p = .03$, and a lower level of object visualization, $r = -.26$, $p = .02$ (Table 2). These correlations with process focus were also significantly different from one another, $Z = 2.56$, $p < .01$ (Steiger, 1980). Spatial visualization and object visualization scores were not significantly correlated with each other at the individual level ($r = -.07$, $p > .05$), or at the team level ($r = -.12$, $p > .05$).

Hypothesis 3 predicted that team heterogeneity in cognitive style would be negatively related to a team's strategic consensus. As evident in Table 3 (Column 4), heterogeneity in object visualization was negatively associated with strategic consensus, ($F_{(6,57)} = 1.90$, $p = .09$, $R^2 = .17$), controlling for heterogeneity in spatial visualization and levels of object and spatial visualization. Heterogeneity in spatial visualization was unrelated to strategic consensus ($t(63) = .34$, $p > .05$) for reasons we will speculate about later on.

Hypothesis 4 predicted that strategic consensus would be negatively associated with errors. We ran a regression with strategic consensus as the independent variable, and errors as the depen-

Table 2
Team means, intercorrelations and internal reliabilities for cognitive styles, process measures, and errors (Study 2).

		1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	Team size	–								
2.	Average member intelligence	.12	–							
3.	Object visualization heterogeneity	.32**	.40**	–						
4.	Object visualization level	.17^	−.003	−.19^	(0.81)					
5.	Spatial visualization heterogeneity	.01	−.34**	.14	.32**	–				
6.	Spatial visualization level	−.03	−.27*	−.12	−.12	.09	(0.85)			
7.	Strategic consensus	−.10	−.09	−.37**	.01	−.07	.22*	–		
8.	Process focus	−.13	−.01	−.10	−.26*	−.10	.22*	.14	(0.89)	
9.	Errors	−.09	−.25*	.36**	−.22*	−.05	−.03	−.55**	−.02	–
	Minimum	2	15.75	5.30	41.50	2.00	30.00	−3.26	1.00	.00
	Maximum	5	32.50	160.33	62.00	312.50	55.50	.00	6.41	47,200
	Mean	3.60	24.15	52.19	52.16	79.60	45.56	−.72	4.60	6257.86
	SD	1.15	3.67	35.79	4.37	74.73	4.66	.72	1.08	8588.46

Note. Zero-order correlations are shown for team size and average member intelligence. All other correlations are controlled for team size and average member intelligence. The values on the diagonals are the reliability coefficients for the corresponding measures.
^ $p < .10$ (one-tailed).
* $p < .05$ (one-tailed).
** $p < .01$ (one-tailed).

Table 3
Results of Hypotheses 3–5 using OLS regression (Study 2).

	Process focus		Strategic consensus		Errors			
	1	2	3	4	5	6	7	8
Team size	−.15	−.15	−.10	−.09	−.11	−.12	−.12	−.16
Average member intelligence	−.25*	−.29*	−.08	−.19	−.30*	−.20	−.21	−.30*
Spatial visualization level	.24*	.22	.25	.18	−.05	−.02	.03	.11
Spatial visualization heterogeneity	−.05	−.02	−.14	−.05	.04	−.04	−.04	−.06
Object visualization level	−.24*	−.28*	.07	−.05	−.25*	−.14	−.16	−.17
Object visualization heterogeneity		−.13		−.36**		.35**	.34**	.17
Process focus							−.04	−.01
Strategic consensus								−.49**
R^2	.13	.14	.06	.17	.12	.22	.22	. 43
F	1.73	1.59	.69	1.90*	1.60	2.67*	2.27*	5.02**
ΔR^2		.01		.11**		10**	.00	.20**

Note. Standardized regression coefficients.
* $p < .05$ (one-tailed).
** $p < .01$ (one-tailed).

dent variable, controlling for heterogeneity and levels of object and spatial visualization. The analysis supported our hypothesis $F_{(8,54)} = 5.02$, $p = .001$, $R^2 = .43$, (Table 3, Column 8).

Hypothesis 5 predicted that strategic consensus would mediate the relationship between cognitive style heterogeneity and committed errors. Mediation analyses supported this hypothesis (Sobel test for mediation: $t = 2.05$, $p = .001$). After adding strategic consensus to the model, the significance of the effect for heterogeneity in object visualization on errors ($\beta = .35$, $p < .01$) became non-significant ($\beta = .17$, $p > .05$), indicating full mediation (Table 3, Columns 6–8).

Conclusions

The purpose of this study was to further investigate the effects of cognitive style composition and heterogeneity on error commission in teams, and to explore the role of team strategic consensus in performance. Consistent with Hypothesis 1, and the patterns observed in Study 1, we found that spatial visualization was a more positive predictor than object visualization of process focus in teams. Specifically, we found that a team's level of spatial visualization had a positive effect on its process focus, whereas a team's level of object visualization had a negative effect. Also, consistent with Hypothesis 3, we found that heterogeneity in object visualization had a negative effect on a team's strategic consensus. Integrating the two results, we saw that the level of object visualization in a team reduced process focus, and heterogeneity in object visualization reduced team's strategic consensus around process focus.

We did not find a similar negative effect of heterogeneity in spatial visualization on strategic consensus. However, heterogeneity in object visualization had a stronger negative effect than heterogeneity in spatial visualization on a team's strategic consensus ($Z = -1.85$, $p < .05$, Steiger, 1980). We speculate that this is due to the asymmetric effects of negative versus positive influences in groups; factors that contribute to disagreement and reduced cooperation tend to be more influential than factors that contribute to agreement or increased cooperation (Johnson et al., 2006; Myatt & Wallace, 2008). Because heterogeneity in object visualization was *negatively* associated with strategic consensus, it was a factor that detracted from team agreement. Hence, it is not surprising that heterogeneity in object visualization had a stronger negative effect on the team's strategic consensus than did heterogeneity in spatial visualization.

We also found that strategic consensus was negatively related to the errors committed by teams. At a given level of process focus, teams with more strategic consensus incurred fewer errors than did teams with less strategic consensus. Also, strategic consensus fully mediated the relationship between team heterogeneity in object visualization and errors, and thus was the main mechanism through which heterogeneity in object visualization affected errors.

Discussion

Our research provides an initial answer to the recent call in the diversity literature for research on the psychological mechanisms underlying the effects of diversity on team processes and performance (see Mannix & Neale, 2005; van Knippenberg & Schippers, 2007). We examined the effects of deep-rooted differences in how individuals process and represent information in a team setting. The cognitive styles we investigated have been shown to distinguish individuals working in different professional disciplines (such as science and the visual arts) that frequently experience difficulty in collaboration (Cronin & Weingart, 2007). This research is relevant to organizations because organizational teams are often the locus of cognitive diversity, but team members are generally unaware of such diversity, let alone its effects on team performance.

We were interested in exploring *how* cognitive style matters in teams. Our research indicated that team members' cognitive styles influence both the strategic focus that a team develops, as well as the team's strategic consensus. The positive relationship between spatial visualization in teams and process focus that was established in Study 1 was replicated in our second study. Study 2 established the importance of strategic consensus. Both strategic focus and strategic consensus, in turn, affected the errors committed by the teams.

Study 1 showed that one way of achieving process focus (and thus limiting errors) in teams is to have at least one member who is high in spatial visualization. The other desirable factor in relation to errors is strategic consensus, which can be attained by having cognitive style homogeneity in the team. If a task greatly benefits from both process focus and strategic consensus, then it will be beneficial to have team members who are high in spatial visualization. Future research can also investigate the role that individuals strong in more than one cognitive style may play in team performance.

Our focus in these studies was on execution tasks that required attention to detail and for which errors were costly. These conditions are similar to those faced by many real-world teams, especially inhigh-reliability organizations where minimizing errors is crucial. Although our laboratory tasks were chosen because they allowed us to focus on the effects of cognitive styles on error commission, they resemble the tasks done by teams in other settings. For example, the task used in Study 1 involved navigation and object identification, which are often done by sports, police, military, search and rescue, and intelligence teams. In all these contexts, errors can be costly, with implications that range from losing a match to missing terrorist threats. The task used in Study 2 was modeled after complex R&D type problems, where trade-offs among multiple criteria must be managed. It is also similar to tasks that teams perform in architectural, engineering, construction, and design firms. In addition, the team processes necessitated by the tasks we used —such as coordination among members, operating in conditions where there is no clear expert, decision-making under time pressure, strategizing to maximize gains and/or minimize losses, and dividing work among members—are applicable to many organizational tasks and settings.

Admittedly errors may not be costly in all task contexts, and so heterogeneous team composition may not always be problematic. There are, for example, tasks where divergent thinking and creativity are as important as task execution, if not more important. In such contexts, a high level of process focus may lead a team to be less flexible in thinking about alternatives, and thereby hinder creative performance. Future work in this area will facilitate a broader understanding of the conditions under which cognitive style heterogeneity is an asset versus a liability.

We tested our hypotheses by manipulating team composition using individuals at the extremes of the cognitive style distribution (in Study 1), and by allowing cognitive style to vary by random assignment of individuals to teams (Study 2). We tried to address the issue of generalizability by recruiting people from the general population, and not just a student population. In addition, we tested these effects using two different kinds of tasks and teams of various sizes. These steps were taken in order to bolster the external validity of our research.

In spite of our efforts, it is not possible in a laboratory setting to simulate all the complexities faced by organizational teams. For example, our participants were briefed on a clear set of rules and the consequences of breaking those rules, but organizational team members may not be fully aware of what constitutes an error, the implications of errors for organizational outcomes, and the costs and benefits of different courses of action. To overcome such limitations, future research should complement our laboratory studies with field studies in high-reliability organizations. Another limitation of our first study was that we may have created more diverse teams than arise in nature, given the principle of homophily. However, our second study, where participants were recruited from the general population and randomly assigned to teams, supports our confidence in the generalizability of our findings.

Our findings have important implications for how team leaders can manage cognitively diverse teams in organizational settings. Although managers might not always be able to control the composition of a team, an understanding of the processes affected by team composition could help managers to identify interventions to counteract the negative effects of cognitive diversity. Our findings suggest that interventions that encourage the development of process focus (where appropriate), or that increase strategic consensus, should help to mitigate the dangers of cognitively diverse teams. Such interventions could take the form of facilitated discussions to get team members to make explicit agreements about strategic priorities. The inclusion of individuals who are strong in more than one cognitive style may also help to improve coordination and communication among team members with different cognitive styles. Failure to appreciate the importance of strategic consensus, and to facilitate such consensus in cognitively diverse groups, will lead teams to continue to perform well below their potential. We encourage both researchers and managers to be cognizant of these processes so that they can better understand teams and maximize their outcomes.

Acknowledgments

This work was made possible by financial support from the National Science Foundation (Grant IIS-0963451) and from Cisco Systems, Inc. through their sponsorship of the MIT Center for Collective Intelligence. We sincerely thank Richard Hackman, Stephen Kosslyn, Christopher Chabris and Thomas Jerde for their contributions to the design and collection of the data for Study 1. We would like to thank Laurie Weingart, John Levine and Mark Fichman for their insightful and helpful comments. In addition, we would like to thank several research assistants for their invaluable assistance with data collection and analysis for Study 2 including Emily Anderson, Chris Lee, Stuti Pandey, and Helen Ra.

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