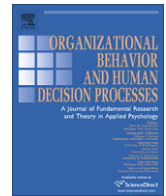




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## Diversity's harvest: Interactions of diversity sources and communication technology on creative group performance

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## ABSTRACT

Our research is based on arguments that three different diversity sources in groups – agreeableness, openness, and ethnicity – might simultaneously possess separation properties that result in social categorization and variety properties that provide non-redundant and value-adding information resources. To help understand how these diversity sources interact with the additive and reductive features of communication technology to impact group creativity, we designed two studies involving computer mediation, nominal group technique, and face-to-face (control) communication. Our findings suggest that agreeableness, openness, and ethnic diversity possess both negative separation and positive variety properties. Whereas the separation properties of all three diversity sources, as well as the variety properties of openness diversity, are evident in newly-formed groups, the variety properties of agreeableness and ethnic diversity are only manifest in mature groups. Finally, the additive and reductive features of communication technology interact with all three diversity sources to impact creative group performance in different ways.

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## Introduction

In recent years, several interesting developments in the field of group diversity research have enriched the literature. Among these are investigations of the complex nature of diversity and its relationship to group processes and outcomes over time (e.g., Harrison, Price, Gavin, & Florey, 2002; Watson, Kumar, & Michaelsen, 1993; Zellmer-Bruhn, Maloney, Bhappu, & Salvador, 2008), research that describes communication technology interventions to facilitate diverse group performance (e.g., Carte & Chidambaram, 2004; Staples & Zhao, 2006), and studies that examine how different sources of diversity impact group outcomes, theory, and research design (e.g., Harrison & Klein, 2007; Harrison, Price, & Bell, 1998; McGrath, Berdahl, & Arrow, 1995; Van Knippenberg, De Dreu, & Homan, 2004).

Much of this progress has been motivated by the confusing results found in the group diversity literature; Milliken and Martins (1996) appropriately described diversity in groups as a “double-edged sword” when referring to these paradoxical findings. The paradox refers to the potential for diverse groups to solve complex problems requiring increased creativity, multiple perspectives, and variegated expertise (Westphal & Milton, 2000), which is offset by

the fact that diverse groups often experience frustration and tension (Milliken & Martins, 1996), conflict while working on complex tasks (Jehn, Northcraft, & Neale, 1999), and low levels of satisfaction with their group experience (De Dreu & Weingart, 2003). Further inhibiting diversity's potential are ineffective communication norms, such as failure of members to actively share their own ideas, to attend to others' different perspectives, and to encourage others' participation during group discussions (Bhappu, Griffith, & Northcraft, 1997; Maznevski, 1994).

In considering different diversity sources, those easily accessible upon initial group contact (e.g., ethnicity, age, and gender) are particularly salient markers of social identity. As a result, such surface-level diversity sources (Harrison et al., 2002) often give rise to “pernicious” social categorizations (Brickson, 2000) that subvert the creative potential of diverse groups. However, the effect of surface-level diversity sources on group effectiveness decreases over time as deep-level diversity sources (e.g., functional expertise, life experience, and personality) become more influential (Harrison et al., 2002; Zellmer-Bruhn et al., 2008). Furthermore, if variety among group members (Harrison & Klein, 2007) on a given diversity source has task relevance (Van Knippenberg et al., 2004), then that diversity source may provide a basis for improved group effectiveness and performance.

Just as task and time considerations are relevant to furthering our understanding of diversity, so too is communication technology. Different communication technologies vary to the extent that

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they possess reductive or additive capabilities (Carte & Chidambaram, 2004). Reductive features essentially strip out elements of the communication environment (e.g., visual and vocal cues about ethnicity, age, and gender) that often give rise to social categorizations whereas additive features (e.g., the ability for individuals to share ideas in parallel) enhance group performance. Given that diversity in groups is a double-edged sword, the potential of communication technologies to reduce social categorization while enhancing group decision-making is of particular interest to some diversity scholars (DeSanctis & Monge, 1999).

This study was motivated by consideration of these and related findings in the literature on diversity in groups. We were particularly intrigued by the possibility that the additive and reductive features of communication technology might positively impact the effect of different diversity sources on group outcomes depending on the propensity of a given diversity source to elicit social categorizations and its relevance to the task at hand. Therefore, we conducted two studies to further explore this possibility. In Study 1, we ran a field experiment among student groups who had been working together for a semester. They performed a creative decision-making task using their choice of either computer-mediated (CMC) or face-to-face (FTF) communication. In Study 2, we further explored these findings using a larger sample, random assignment of individuals to newly-formed groups based on personality diversity, random assignment to communication-technology conditions, a third experimental condition of the nominal group technique (NGT) (Van de Ven & Delbecq, 1971), and a more complex creative, decision-making task.

## Diversity sources

Harrison and Klein (2007) suggest that one way to conceptualize a diversity source is by assessing whether it possesses variety, separation, and disparity properties. Variety refers to the potential of a diversity source to reflect unique and task-relevant perspectives among group members, consistent with the law of requisite variety (Ashby, 1956) and traditional arguments for value in diversity (Hoffman, 1959; Milliken & Martins, 1996). Separation refers to the tendency of a diversity source to generate social categorizations among group members, consistent with social identity theory (Tajfel & Turner, 1986). Disparity refers to situations when a diversity source creates a minority subgroup within the larger group, consistent with theories of inequality (Blau, 1977) and minority influence (Moscovici, Lage, & Naffrenchoux, 1969).

Conceptualizing diversity sources at different levels is analogous to concepts in physics, where considering diversity as an undifferentiated mass might be similar to a molecular view, examining specific sources differently (McGrath et al., 1995; Nkomo, 1995) as an atomistic view, and looking at properties within a source (Harrison & Klein, 2007) as a sub-atomic view. The latter microscopic perspective may be particularly helpful in unlocking the double-edged sword of diversity, for if a given diversity source contains two or more of these properties, its overall effect on group outcomes may be offset, resulting in frequent Type II errors. Furthermore, group outcomes related to diversity source properties of variety, separation, and disparity may vary with group development and/or time (Harrison et al., 2002; Watson et al., 1993), across tasks (Mohammed & Angell, 2003), and communication technology (Carte & Chidambaram, 2004). Therefore, studying groups in various environments may prove essential to identifying variety, separation, or disparity effects of diversity sources on group outcomes.

Harrison et al. (1998, 2002) continue a long tradition (e.g., Bouchard, 1969; Hoffman, 1959; Hoffman & Maier, 1961) of con-

sidering positive (i.e., variety) effects of personality diversity sources on group outcomes. Since the emergence of the Big Five paradigm, however, little support for such a perspective has been found (Barrick, Stewart, Neubert, & Mount, 1998; Mohammed & Angell, 2003; Neuman, Wagner, & Christiansen, 1999). A recent meta-analysis by Bell (2007) found little evidence to suggest that there is any value in personality diversity sources for group outcomes; in fact, conscientiousness diversity has been negatively associated with team performance (Barrick et al., 1998). However, Bell's (2007) meta-analysis did not differentiate among task types; therefore, task-contingent effects of personality diversity sources on group outcomes may have been overlooked. Furthermore, Bell (2007) did not distinguish between the variety, separation, and disparity effects of personality diversity sources.

Similarly, Horwitz and Horwitz (2007) conducted a meta-analysis on diversity and performance, finding some support for the value of task-relevant diversity, such as functional expertise, education, and organizational tenure, on performance quality and quantity. They, however, did not find any general support for diversity's relationship to group performance. While Horwitz and Horwitz (2007) did consider task, their moderated analysis focused on task complexity generally rather than the qualitatively different nature of various task types.

Furthermore, we believe that by distinguishing between the separation and variety properties of personality diversity sources, we may be able to better isolate their effects on group outcomes, particularly in a creative task context. Therefore, we include personality diversity sources in our investigation.

## Separation properties of diversity sources

Ethnic diversity's separation properties are believed to be so pervasive that they are generally assumed rather than tested empirically, as we did in Study 1 by studying whether perceptions of diversity were correlated with actual diversity. Less obvious is our contention that personality diversity, too, can be perceived and contain separation properties.

Fundamental to our argument that personality diversity sources contain separation properties is the assumption that group members can perceive differences in their personalities when interacting with one another. Personality scholars have found that Big Five personality can be detected in others with some validity from the earliest stages of acquaintanceship (Borkenau, Mauer, Riemann, Spinath, & Angleitner, 2004; Funder & Sneed, 1993; Paulhus & Bruce, 1992), with statistically significant detection beginning and persisting within a few minutes of observing behavior. Given the bewildering array of social and other stimuli bombarding individuals during group interactions, it follows implicitly from the above findings that group members will actively assess, with some validity, others' personalities as soon as they become acquainted. Group members are motivated to bond with each other in the normal process of group development, and we know that interpersonal attraction extends well beyond surface-level diversity to include attitudes and personality (Byrne, 1971; Schneider, 1987). We are not arguing, however, that personality diversity sources will be as influential as demographic diversity sources during self and social categorization in groups. Rather, we assert that ethnic diversity, as well as agreeableness and openness diversity, are diversity sources possessing separation properties that can be detected by group members upon interaction. In other words, we are arguing that group members should perceive actual differences on these diversity sources. Therefore, we propose that: "H1: Actual agreeableness, openness, and ethnic diversity will be positively associated with perceived agreeableness, openness, and ethnic diversity, respectively, in groups."

### Agreeableness diversity

Descriptors used by Goldberg (1992) for agreeableness diversity include words like kind, cooperative, trustful, pleasant, and helpful. It seems plausible that group members would seek to detect such individual attributes upon acquaintanceship, and the findings of Borkenau et al. (2004), Funder and Sneed (1993), and Paulhus and Bruce (1992) support this assertion. Also consistent with our argument that personality diversity sources contain separation properties, Barrick et al. (1998) found agreeableness diversity to correlate significantly and negatively with various group process-related variables such as cohesion, conflict, communication, and workload sharing. It is not difficult to imagine group members who are high on agreeableness labeling those low on agreeableness as being “cold” or “rude” (Goldberg, 1992), or those low on agreeableness labeling their counterparts as insufferable do-gooders, which could form the basis of social categorizations and subgroups.

### Openness diversity

Descriptors such as “imaginativeness”, “perceptive”, “curious”, “creative”, and “intelligent” (Goldberg, 1992) are commonly used to characterize openness, and such individual attributes can be detected among mere acquaintances (Borkenau et al., 2004; Funder & Sneed, 1993; Paulhus & Bruce, 1992). In particular, Borkenau et al. (2004) found that openness was more readily detected when a task had a creative element. And although Funder and Sneed (1993) found that openness was the most difficult dimension of the Big Five to detect, strangers were able to validly assess the following individual attributes that appear relevant to creative tasks: “discusses philosophical issues”, “discusses large number of topics”, “shows genuine interest in intellectual matters”, and “expresses interest in fantasy/daydreams” (Funder & Sneed, 1993, p. 486). Based on thin slices of behavior, group members who are low on openness might label their counterparts as pie-in-the-sky idealists, whereas group members who are high on openness might see those who are low on openness as having no vision, depth, imagination, or intellect. Furthermore, the relevance of openness diversity to creative tasks may make any individual attributes associated with it more salient to group members (Borkenau et al., 2004; Van Knippenberg et al., 2004), giving rise once again to social categorizations and subgroups.

### Ethnic diversity

The diversity literature (e.g., Elsass & Graves, 1997; Milliken & Martins, 1996) is much more conclusive about the separation effects of ethnic diversity and the ability of group members to readily detect ethnic differences upon acquaintanceship. And though the salience of ethnic differences among group members decreases with group development time (Harrison et al., 2002; Zellmer-Bruhn et al., 2008), ethnic diversity has been unequivocally associated with social categorization and subgroup formation (Brickson, 2000).

Van Knippenberg et al. (2004) suggest that when a diversity source is cognitively accessible, the negative consequences associated with its separation properties hinge on threats to group identity. Furthermore, we know that social categorization and subgrouping are associated with “reduced cohesiveness, more interpersonal conflict, distrust, [and] decreased task performance” (Harrison & Klein, 2007, p. 1203) in groups. Therefore, if a diversity source has separation properties, we can expect it to have a negative effect on group effectiveness (e.g., Barrick et al., 1998; Harrison et al., 2002; Zellmer-Bruhn et al., 2008). While these findings may be task-bound (McGrath et al., 1995) and time-bound (Harrison et al., 2002), the group process implications of separation are severe enough to justify hypothesizing a robust negative association between diversity source and group effectiveness, regardless of diversity source. Importantly, this literature is limited to groups

using FTF communication. Therefore, we propose that: “H2: Actual agreeableness, openness, and ethnic diversity will each be negatively associated with creativity in groups using FTF.”

### Variety properties of diversity sources

Harrison and Klein (2007) discuss variety as occurring when individuals offer different and relevant *categories* of knowledge or experience and advocated its measurement as a categorical variable, predicting greater creativity, innovation, and decision quality stemming from its presence. While we concur generally with their conceptualization, we assert that some diversity sources may possess variety in certain contexts without necessarily being categorical in nature. Personality scholars who have operationalized personality differences categorically have been roundly criticized (Barbuto, 1997). Personality describes individuals' unique and relatively stable patterns of behavior, thoughts, and emotions (Greenberg & Baron, 1997), and in the case of the Big Five personality dimensions, are assessed on continua rather than categorically.

We believe a key to variety lies in *non-redundancy*, for which categorical variability (Miner, Haunschild, & Schwab, 2003) is sufficient but not necessary. We believe that variety may evidence itself in at least two ways in the current studies. First, our diversity sources may present non-redundant resources arising through different perspectives that provide a greater pool of unique ideas, consistent with Bouchard (1969) and Hoffman (1959) and Hoffman and Maier (1961). Second, group diversity on personality or ethnicity implies different life experiences and perspectives that should relate to different perceptions, ideas, and judgments not only regarding alternatives, but also regarding group process and communication generally.

### Agreeableness diversity

Diversity in agreeableness may align individual differences to increase the likelihood of a productive conformity/deviance balance. Indeed, Digman (1990) and Digman and Takemoto-Chock (1981) have argued that friendly compliance versus hostile non-compliance is “a more adequate interpretation” (Digman, 1990, p. 424) of agreeableness. Given conformity's close relationship to cohesion (Hackman, 1990) and cohesion's curvilinear and positive-sloping complex relationship to creativity (Woodman, Sawyer, & Griffin, 1993), combined with the deleterious effects of excessive conformity (Janis, 1972, in hypothesizing groupthink) moderate compliance, cohesion, or conformity is preferable for group functioning. Indeed, a key groupthink mechanism is concurrence seeking, which literally means members actively seek to behave agreeably.

Barrick et al. (1998) found that despite many significant negative process outcomes associated with agreeableness diversity, it was not significantly correlated with performance. Others have even argued that conflict and dissent are potentially positive attributes of diverse groups (Jehn et al., 1999; Pelled, Eisenhardt, & Xin, 1999). Agreeableness diversity as variety may be especially important for problem-solving tasks that require both divergent (idea generation) and convergent (judgment & choice) processes. Indeed, a group composed predominantly of agreeable individuals may struggle with confirmation biases (Wason, 1960) and groupthink (Janis, 1972) in emphasizing cooperation and consideration of group norms and others' preferred ideas whereas a group composed predominantly of disagreeable individuals may struggle to create a climate conducive to creativity, as ideas might be dealt with skeptically and cynically. A mix of agreeable and disagreeable individuals may hedge against groupthink while also preventing the group from being so critical as to quash idea generation.



### *Openness diversity*

Despite a general lack of support linking openness diversity in groups to performance outcomes (Barrick et al., 1998; Bell, 2007; Neuman et al., 1999), the descriptors from Goldberg's (1992) lexical approach such as imaginativeness, perceptive, curious, creative, and intelligent are relevant, on the face of it, to complex or creative problem solving. Therefore, greater levels of openness among individuals and groups should, other things being equal, be associated with greater performance on creative tasks. We go further, however, in contending that diversity on openness may also constitute a potential task-relevant group asset for creative problem solving.

A creative task (the context of both our studies) requires problem identification, alternative generation and, frequently, choice. One of our studies also featured implementation of that choice. Thus, both divergent thinking associated with creativity as well as convergent thinking associated with decision-making are important aspects of creative problem solving. Further, creative ideas have been defined as being both novel and useful (Thompson, 2003). While novelty clearly relates to openness descriptors, idea characteristics such as usefulness, feasibility, and practicality are less clearly so.

Nonetheless, we envision at least three ways in which diversity on openness may facilitate creative problem solving in groups. First, the various subtasks involved in problem solving (McGrath, 1984) require, at different points, both divergent and convergent thinking. The propensity to engage in divergent thinking should be characteristic of highly open individuals, while convergent thinking should be characteristic of individuals low on openness. Thus, group diversity on openness should promote an effective balance between divergent and convergent thinking, while a group lacking diversity on openness should suffer from a relative imbalance. Second, the novel and useful aspects of creative ideas introduces a tension; highly open individuals would probably be inclined towards novel, "way out" ideas whereas less open individuals would probably be inclined towards practical and feasible ideas. Either extreme might fail one of the joint creativity criteria of novelty and usefulness, but a group diverse on openness would be likely, through discussion among such diverse individuals, to consider both criteria in generating and assessing ideas. Third, while common group process problems, such as rushing to judgment, premature closure, and confirmation biases, would seem to be characteristic of a group of individuals low on openness, a group of individuals high on openness may struggle to move forward in task progress, as they would enjoy long philosophical discussions and be likely to stay in divergent-thinking mode. A group of individuals diverse on openness, however, would seem well composed to ensure a balance of motivation to continue generating ideas and motivation to reach closure. Thus, the compositional mix offered by openness diversity offers a healthy balance between divergent and convergent thinking that is essential to creative performance.

### *Ethnic diversity*

While ethnic diversity per se may have little task relevance generally, it is a "messy" diversity source in that it encompasses other diversity sources. Consistent with this view, McGrath et al. (1995, p. 25) theorized that an individual's demography shapes an individual's skills, knowledge, and abilities (SKAs), values, beliefs, and attitudes (VBAs), and personality and cognitive/behavioral styles (PCBs). Furthermore, an individual's demography influences expectations by others about these three dimensions. Following McGrath et al. (1995), we view ethnic diversity as the visible tip of a larger, otherwise hidden, diversity iceberg with latent diversity sources that are likely to possess varied relevance to many tasks. While future research may eventually untangle the dauntingly complex nexus of direct, moderated, and mediated relationships that such a perspective implies, the current state of theory and certainly of practice focuses primarily on studying ethnic diversity as one entity.

A McGrathian perspective would attribute ethnicity's task relevance and possible diversity performance gains to complementary skill sets and schemata, or to varied VBAs that could inform the framing and process of problem solving. And Watson et al.'s (1993) finding that ethnically diverse groups eventually outperform homogeneous groups on creativity is consistent with the embedded nature of ethnic diversity's task relevance.

Therefore, we now present a variety-based hypothesis for the three diversity sources in our current studies. And again, this hypothesis is limited to groups using FTF because that is the context studied in the literature discussed above. It centers on task relevance (Van Knippenberg et al., 2004), and we have argued that, to differing degrees, openness, agreeableness, and ethnic diversity sources are relevant to creative problem-solving tasks. In summary, ethnic diversity's relationship to increased creativity in groups is somewhat complex and based on the assumption that surface diversity is a proxy for important psychological differences (Hambrick, Cho, & Chen, 1996) that offer non-redundant cognitive resources to groups. Personality diversity may also offer both non-redundancies and process advantages to groups. "H3: Actual agreeableness, openness, and ethnic diversity will each be positively associated with creativity in groups using FTF."

Our competing hypotheses (H2 and H3) boil down to whether the separation liability outweighs the variety asset for a given diversity source in the current studies. We expect ethnic diversity's high salience and potential for social categorizations (e.g., Brickson, 2000; Jackson et al., 1991), and relatively low, latent, and mostly indirect relationships to variety, favors separation effects (H2). For openness diversity, the opposite is true (H3); while openness is detectable, its detectability is neither strong (Funder & Sneed, 1993) nor robust (Borkenau et al., 2004) whereas its potential for non-redundant cognitive resources in creative problem solving seems relatively strong. Agreeableness diversity is somewhere between these extremes, and thus most difficult to predict. We, therefore, rely on Barrick et al. (1998) and expect that for agreeableness diversity separation effects (H2) are more likely to be supported in the current studies.

### *Communication technology, cue reduction, & process structuring*

Carte and Chidambaram (2004) argue that various group communication technologies offer a mix of additive and reductive features relative to FTF. Additive features enhance group performance by structuring group process whereas reductive features strip the communication environment of information that often limits group productivity. A common additive feature of CMC – parallel processing – eliminates production blocking because the technology enables multiple individuals to "talk" at the same time. On the other hand, social cues (visual and vocal) are reduced in CMC because individuals typically exchange text-based messages in virtually distributed environments.

The reductive features of CMC are believed to lower social categorization and related process losses in diverse groups (e.g., Bhappu et al., 1997; Staples & Zhao, 2006). Thus, CMC may enhance group performance if the diversity source in question is task relevant (Van Knippenberg et al., 2004). Even absent task relevance, however, diverse groups may benefit more than homogenous groups from CMC simply through reducing the marginal performance liability of social categorizations to which they are more prone. Our use of CMC in both Study 1 and Study 2 involved reduced social cues – a reductive feature, as well as the ability for participants to share ideas in parallel, which is an additive feature of communication technology.

In terms of process structuring, Van de Ven and Delbecq (1971) speculated that the NGT might be of particular value to diverse groups. The NGT consists of, in strict order, nominal idea generation,

round robin listing of ideas, discussion of ideas, and nominal voting (Van de Ven & Delbecq, 1971, p. 208). It is specifically designed to facilitate social interaction when needed (discussion of ideas) and to minimize it when unneeded or potentially harmful (other phases). Diverse groups have been found to suffer from various process-related problems such as understanding each other (Maznevski, 1994), less communication (Zenger & Lawrence, 1989), low attachment or commitment (Tsui, Egan, & O'Reilly, 1992), and lower social integration generally (Smith et al., 1994); therefore, enforcing a normative group process may offer extra benefit to diverse versus homogenous groups as they are further removed from their potential than homogenous groups. Similarly, an optimal group process enhances the likelihood that a given diversity source's variety may be distilled out instead of left untapped. Indeed, Van de Ven and Delbecq (1971) argued that groups using NGT should experience psychological momentum by seeing their creative power unleashed. Given the lack of social integration common in diverse groups (Smith et al., 1994), diverse groups may have greater need for such psychological momentum. Our use of the NGT in Study 2 can be categorized as an additive feature of communication technology because of its designed attempt to optimize group interaction by imposing a normative problem solving process.

Finally, both the additive and reductive features of communication technology might also dampen the extent of potentially harmful initial categorizations and stereotyping in diverse groups with little history, simply by diverting members' attention away from the separation properties of diversity sources and towards task-relevant, variety properties. This argument is similar to Chatman and Flynn's (2001) functional antagonism – one type of categorization salience reduces salience of other categorizations. Reduced social cues in CMC may, therefore, lower the salience of separation properties of a given diversity source whereas process structuring in the NGT and parallel processing in CMC may increase the salience of task-relevant, variety properties of the same diversity source. In all cases, pressure may then be exerted on individuals to comply with a group's emerging task-oriented identity, with positive expectations for group performance (Van de Ven & Delbecq's, 1971).

We believe that through reducing categorizations and inducing salience of task-relevant variety properties, diverse groups may experience greater improvement on their cohesion and information sharing than homogenous groups when exposed to communication technologies' reductive and additive features, respectively. Any invocation of categorizations seems likely to reduce cohesion and communication. Thus, technologies that reduce the salience of social cues and/or add task-focused cues have the potential to draw attentional focus away from the sources of categorization that depress cohesion and communication, with information sharing representing a type of communication.

To the extent that we have already argued that agreeableness, openness, and ethnicity have separation and variety properties, we believe that reduced social cues in CMC, by mitigating social categorizations accruing from separation, will reduce the salience of social identity and thereby enhance the performance of groups that are diverse on these diversity sources. Furthermore, to the extent that each diversity source possesses variety, we believe that process structuring in the NGT and parallel processing in CMC will help distill that variety. "H4: Communication technologies with reductive (CMC) and additive features (CMC and NGT) will interact with actual agreeableness, openness, and ethnic diversity to increase creativity."

## Study 1 method

In Study 1, we developed two samples to test all four hypotheses. Sample A was from a medium-sized private university in the

northeastern United States, while Sample B was from a large public university in the southwestern United States. In both cases, participants engaged in a creative decision-making task in their existing work groups for extra credit. In both samples, participants had been working together for approximately three months, although their interaction as work groups was not intensive. They mainly interacted to complete assigned group tasks and projects. In total, we had 50 groups comprising 221 participants, with 24 groups from Sample A and 26 groups from Sample B.

Participants completed a questionnaire prior to the study, which measured their personality along the Big Five dimensions (Saucier, 1994) of openness and agreeableness as well as their ethnicity. Participants were also asked about perceived similarity on the above diversity sources. After the experiment was conducted, participants filled out a post-questionnaire about their group's creative task performance.

Groups were asked to decide what communication technology they preferred to use in order to complete the task. Twenty-eight groups chose FTF while 22 groups chose CMC. CMC groups met using online chat rooms. Group members were instructed to be physically separate from each other, therefore the online chat room provided reduced social cues and parallel processing consistent with many forms of CMC but did not provide process structuring commonly associated with the NGT. Thus, because groups were not randomly assigned to these communication-technology conditions, Study 1 is most accurately described as a field study and was exploratory in nature.

The creative decision-making task, Insite!, was modified with permission from Northwestern University's Dispute Resolution Research Center (DRRC). In this task, groups are asked to develop creative new product designs for a common but unpleasant everyday household function, specifically devices that remove dog excrement.

## Measures

Independent variables of *perceived openness* and *agreeableness diversity* were assessed by calculating the mean on a 3-item scale directly borrowing terms from the Goldberg's (1992) lexical approach to personality and reflected on the condensed Saucier (1994) instrument. For openness, participants were asked the extent to which they perceived their group to be similar regarding how open, imaginative, and creative group members were. For agreeableness, similar items identified how kind, cooperative, and sympathetic they perceived their group members to be. Finally, for *perceived ethnic diversity*, participants were asked the extent to which they perceived their group to be similar in culture, national origin, and ethnicity. As these items were adapted from Zellmer-Bruhn et al.'s (2008) perceived similarity scale, we reverse-coded them prior to analysis to capture diversity.

For all above perceptual measures, we justified aggregation to the group level based on median  $r_{wg}$  and ICC values, which are reported in Table 1. Further, we ensured that each multi-item scale derived from one factor using confirmatory factor analysis.

*Actual openness and agreeableness diversity* measures were developed in both studies by calculating the standard deviation on a given self-reported Big Five personality dimension across group members. *Actual ethnic diversity* was derived from the pre-questionnaires using the familiar Blau (1977) index. We also developed an interaction term for each diversity construct multiplied by the experimental technology condition binary variable.

*Creativity* was assessed through the number of ideas generated during brainstorming, which were recorded on a log sheet by groups at the end of the experiment. Two raters independently coded the number of ideas although some judgment was required to avoid counting ideas that were redundant. The two independent raters correlated at  $r = .91$  on the number of ideas generated by groups.

**Table 1**

Rwg and ICC coefficients for individual variables aggregated to group level (Study 1).

	Median Rwg	ICC
Perceived agreeableness diversity	.89	.29***
Perceived openness diversity	.89	.24***
Perceived ethnic diversity	.84	.52***

Note: N = 50.

\*\*\*  $p < .001$ .

Control variables included the university sample, the size of the group, and the communication-technology condition. Ethnic composition was not included because the group's percentage of whites was highly correlated with ethnic diversity ( $r = .90$ ). However, we were concerned that ethnic composition might be correlated to creativity, so we created a *group grade* variable by calculating the mean of individuals' course grades for each group in the classes. In this manner, we developed a proxy control for any source of task-relevant capabilities, including ethnic composition.

### Study 1 results

Our descriptive statistics and correlations are reported in Table 2. These data reflect that groups in Sample A had 4–5 individuals while those in Sample B had 3–4 individuals ( $r = -.76$ ,  $p < .001$ ). Also, Sample B groups were more likely to opt for CMC ( $r = .29$ ,  $p < .05$ ), had higher mean agreeableness ( $r = .45$ ,  $p < .01$ ), and perceived themselves as less diverse on agreeableness ( $r = -.41$ ,  $p < .01$ ) and openness ( $r = -.31$ ,  $p < .05$ ).

We used hierarchical moderated OLS regression with standardized coefficients to test our hypotheses and centered the diversity variables to facilitate interpretation. The diversity coefficients in the full model in Table 4 represent the slope of the given diversity source-creativity relationship (Aiken & West, 1991) for the control FTF condition. We used this as the basis for testing diversity main-effects hypotheses because most research assumes normal interacting groups. The middle column labeled “diversity” may be of interest to readers, but readers are cautioned to remember that these main effects terms include groups in different experimental conditions, and we did theorize quite different diversity-creativity effects as a function of condition. For this reason, we do not believe those coefficients are particularly interpretable. The interaction coefficients represent the difference between the slope in the interaction condition and the control FTF condition, thus testing whether diverse groups improve their creative performance more

than homogenous groups do when introduced to different communication technology.

Hypothesis 1 proposed that actual agreeableness, openness, and ethnic diversity would be positively associated with perceived agreeableness, openness, and ethnic diversity, respectively. Perceived diversity was positively associated with actual diversity (see Table 3) for agreeableness ( $\beta = .23$ ,  $p = .052$ ), openness ( $\beta = .48$ ,  $p < .001$ ), and ethnicity ( $\beta = .62$ ,  $p < .001$ ). Therefore, H1 was supported.

Hypothesis 2 predicted that actual agreeableness, openness, and ethnic diversity would each be negatively associated with creativity in groups using FTF whereas Hypothesis 3 predicted that they would be positively associated. Looking at the regression data for creativity in Table 4, we found no significant effects for the three diversity sources. Therefore, neither H2 nor H3 were supported.

Hypothesis 4 predicted that communication technologies with reductive (CMC) and additive features (CMC & NGT) would interact with actual agreeableness, openness, and ethnic diversity to increase creativity. Since we did not have a NGT condition in Study 1, we only tested the difference in the diversity-creativity slopes (see Fig. 1) between CMC and FTF groups. In general support of H4, Cohen's F indicated that the three diversity-communication technology interaction terms explained a significant amount of incremental variance ( $\Delta R^2 = .15$ ,  $p < .10$ ). We found, however, that CMC interacted with ethnic diversity ( $\beta = .33$ ,  $p < .10$ ) to increase creativity in groups but with agreeableness diversity ( $\beta = -.64$ ,  $p < .05$ ) to decrease it. Therefore, we found mixed support for H4.

### Study 2 method

Having established in Study 1 that participants are able to accurately perceive personality and ethnic diversity (H1), we focused on testing the remaining three hypotheses in Study 2. In particular, Study 2 built on Study 1 by testing the hypotheses related to creative group performance using a more rigorous, experimental design. In Study 2, we created 79 newly-formed groups comprised of 349 students from a large public Midwestern university, recruited from two undergraduate classes and one graduate class. Participants completed a questionnaire prior to the experiment, which measured their personality along the Big Five dimensions (Saucier, 1994) as well as capturing demographic information. To maximize personality diversity, participants were assigned to groups by calculating whether they had low or high inter-correlations across all Big Five personality items, eight per dimension,

**Table 2**

Descriptive statistics and correlations (Study 1).

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1 Group size	4.12	.96												
2 CMC	.44	.50	-.20											
3 Sample	.52	.50	-.76***	.29*										
4 Mean agreeableness	56.75	5.28	-.39**	.07	.45**									
5 Mean openness	52.56	4.18	-.26*	.16	.22	.56***								
6 Group grade	86.89	4.56	.03	-.11	.00	.13	-.14							
7 Perceived agreeableness diversity	16.43	2.33	.31*	.07	-.41**	-.54***	-.20	-.04						
8 Perceived openness diversity	14.60	2.29	.24*	.08	-.31*	-.37**	-.19	-.13	.81***					
9 Perceived ethnic diversity	15.23	3.88	.10	-.02	-.10	-.16	-.09	-.11	.48***	.50***				
10 Actual agreeableness diversity	6.24	3.72	.21	.12	-.05	-.44**	-.49***	-.19	.38**	.27*	.24*			
11 Actual openness diversity	6.38	2.89	.29*	.13	-.19	.37**	-.27*	-.19	.55***	.52***	.31*	.52***		
12 Actual ethnic diversity	.23	.22	-.21	.22	.19	.04	.01	-.15	.10	.01	.55***	.20	.09	
13 Creativity	13.46	5.64	-.04	-.15	.16	.06	-.05	.15	-.17	-.22	.16	-.01	.02	.04

Note: N = 50.

\*  $p < 0.10$ .\*  $p < 0.05$ .\*\*  $p < 0.01$ .\*\*\*  $p < .001$ .

**Table 3**

Regression analyses for perceived diversity predicting actual diversity (Study 1).

Predictor variables	Perceived agreeableness diversity		Perceived openness diversity		Perceived ethnic diversity	
	Control	Full model	Control	Full model	Control	Full model
Group size	.07	.15	.03	.17	-.05	-.15
CMC	-.18*	-.15	-.20*	-.10	-.01	.11
Sample	.32*	.41*	.36*	.37*	.07	.07
Mean actual agreeableness	.43**	.32*				
Mean actual openness			.15	.04		
Actual agreeableness diversity		.23+				
Actual openness diversity				.48***		
Actual ethnic diversity						.62***
R <sup>2</sup>	.35	.39	.15	.36	.01	.36
$\Delta R^2$		.04*		.21***		
Model F	6.17**	5.68**	1.95	4.47**	.17	6.44***

Note: N = 50, All tests are 1-tailed.

\* p &lt; .10.

\* p &lt; .05.

\*\* p &lt; .01.

\*\*\* p &lt; .001.

**Table 4**

Regression analyses for creative group performance (Study 1).

	Control	Diversity	Full model
Group size	.17	.17	.18
CMC	-.22*	-.25*	-.29*
Sample	.38+	.39*	.43*
Mean agreeableness	-.01	-.00	-.06
Mean openness	-.05	-.06	-.05
Group grade	.12	.13	.17
Actual agreeableness diversity (AD)		-.08	.33
Actual openness diversity (OD)		.13	-.03
Actual ethnic diversity (ED)		.10	-.10
CMC*AD			-.64*
CMC*OD			.29
CMC*ED			.38*
R <sup>2</sup>	.11	.12	.27
$\Delta R^2$		.02	.15*
Model F	.82	.61	1.14

Note: N = 50, Coefficients are standardized. Diversity coefficients in diversity model test overall relationships across experimental conditions, while those in the full model test diversity relationships with dependent variables within FTF (omitted) condition. All tests are 1-tailed.

\* p &lt; .10.

\* p &lt; .05.

with other individuals who had indicated availability to perform the task on a given day and time.

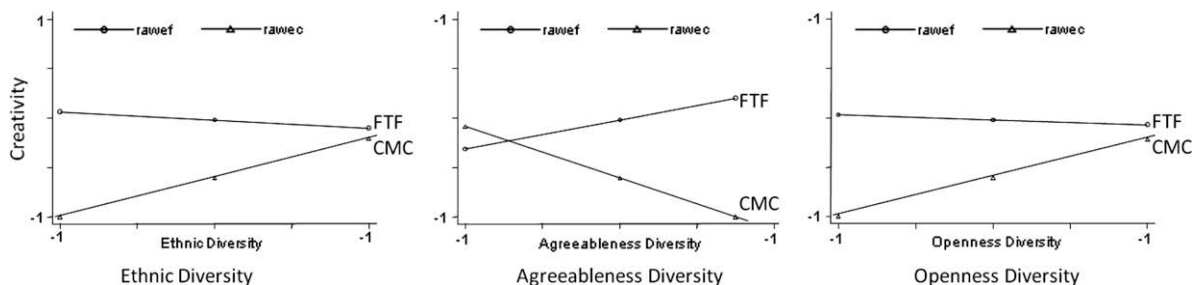
The task asked groups to develop a 30-s radio commercial for a major airline company, following Gersick (1989) and Waller, Zellmer-Bruhn, and Giambatista (2002). This task was chosen because of its relative realism and subtask variety versus some other experimental tasks. In fact, the task required at least 5 of the 8 task dimensions identified by McGrath (1984), including planning, idea

generation, conformance to requirements, judgment, and resolving different points of view. All groups had two hours to brainstorm, develop the theme and content of the advertisement, and implement the ad via audio tape recording. All participants received instructions, background materials referencing the firm in question, and requirement guidelines for the commercial, and all groups were videotaped. Instructions indicated that the ad required several elements, including creativity, humor, at least one music track, communicating the friendly atmosphere, company spirit, customer-service atmosphere and low-cost atmosphere of the company. Several music CDs were left in the room along with a CD player to help groups incorporate music in the ad's soundtrack. A budget was given to the groups, with costs delineated for the recording of the commercial, costs per music track, and cost per actor (each individual person whose voice was in the final radio ad).

Students received course credit for their participation. Monetary awards were given to the group with the best advertisement in each experimental condition, and an additional bonus award was given to the group with best overall commercial.

We created three distinct communication-technology conditions: traditional FTF, the NGT conducted face-to-face, and CMC conducted via a threaded online discussion and featuring anonymity to further reduce social cues. Groups were randomly assigned to the conditions.

In all conditions, a research associate introduced the task instructions and available resources. In the FTF (control) condition, the associate simply left the room after introducing the task. In the NGT condition, the associate facilitated a modified NGT process for 90 min through to the selection of an advertisement theme, after which the group was left alone to interact face-to-face and develop their theme into a complete commercial. In the CMC condition, multiple groups met simultaneously in a computer lab. These par-

**Fig. 1.** Observed relationships between diversity source, communication technology, and creativity (Study 1).



ticipants were seated randomly and did not know which other individuals in the computer lab were their teammates. Two associates facilitated the CMC condition by introducing the users to the software and answering basic questions regarding software use. The groups used CMC through to the selection of an advertisement theme, after which they were escorted to private breakout rooms and left alone for the remainder of their time to develop their theme into a complete commercial face-to-face. Groups were allowed 90 min from the beginning of the session until online theme choice, just like in the NGT condition.

Experience in observing videotapes of groups performing the task from previous research (e.g., Waller et al., 2002) made it clearly apparent that as the deadline approached, intensive FTF interaction was essential to satisfactorily complete the task. For example, developing a specific script from thematic points requires considerable back-and-forth dialog, and groups also needed to orally rehearse script drafts, make revisions, and synchronize music tracks to the script as the deadline approached. This is why the NGT and CMC conditions were followed by a short FTF session.

In this way, all groups experienced some FTF interaction, making for a conservative test of our hypotheses. Additionally, we do believe that the norms and social interactions established in the NGT and CMC were formative in nature because they preceded FTF interaction and were occurring in newly-formed groups. This design also reflects the reality of work groups and their common use of multiple communication technologies to conduct their work.

### Measures

Our dependent variable, *creativity*, was assessed by six raters who had taken Ph.D. courses in organizational behavior assessed each group commercial. Using a 5-point Likert scale, we measured creativity with the item, “The commercial was creative.” Inter-rater reliability was assessed by Cronbach’s alpha ( $\alpha = 0.68$ ).

As we did in Study 1, *ethnic diversity* was assessed using the Blau (1977) index. Of the 79 groups, 42 groups (53% of our sample) had no ethnic diversity, while 37 groups (47% of our sample) had one (28 groups, or 35%) or more (9%, or 11%) ethnic minority participants. Thus, our range of variability on ethnic diversity was restricted. We believe this represents a conservative and admittedly limited test of ethnic diversity.

We measured personality diversity, similar to Study 1, by calculating the standard deviation among group members across the eight items for *agreeableness diversity* ( $\alpha = .85$ ) and for *openness diversity* ( $\alpha = .75$ ) from Saucier’s (1994) 40-item Big Five scale.

We also included control variables in our analyses. For each group, we calculated their mean levels of agreeableness and openness. Given that group grades, which could potentially be influenced by ethnic composition, had no relationship to creative performance in Study 1 and moreover were unavailable to us, we excluded this variable from our analyses in Study 2. We did, however, include group size and the two communication-technology conditions (NGT and CMC) in our analyses, which were inputted as dichotomous dummy variables.

### Study 2 results

Descriptive statistics and Pearson correlations for all study variables are presented in Table 5. Similar to Study 1, we used hierarchical moderated OLS regression with standardized coefficients to test our hypotheses and centered the diversity variables to facilitate interpretation. Regression results are presented in Table 6, and depicted graphically in Fig. 2.

Hypothesis 2 predicted that actual agreeableness, openness, and ethnic diversity would each be negatively associated with creativity in groups using FTF whereas Hypothesis 3 predicted that they would be positively associated. We found that ethnic diversity was negatively associated with creativity ( $\beta = -.52, p < .01$ ), as was agreeableness diversity ( $\beta = -.32, p < .05$ ). Therefore, we found some support for H2 and not H3.

The full model did explain a significant amount of incremental variance in creativity ( $\Delta R^2 = .27$ , Cohen’s  $F = 3.71, p < .01$ ), providing general support for Hypothesis 4. Specifically, H4 predicted that communication technologies with reductive features (CMC) and additive features (CMC and NGT) would interact with actual agreeableness, openness, and ethnic diversity to increase creativity. Therefore, the diversity-creativity slopes (see Fig. 2) should be significantly higher for CMC and NGT groups than for FTF groups. We found that the reductive and additive features of CMC interacted with ethnic diversity ( $\beta = .37, p < .05$ ) and openness diversity ( $\beta = .26, p < .05$ ) to increase creativity in groups. We also found that the additive features of NGT interacted with ethnic diversity ( $\beta = .32, p < .05$ ) and agreeableness diversity ( $\beta = .20, p < .10$ ) to increase creativity in groups. However, the additive features of NGT interacted with openness diversity ( $\beta = -.22, p < .10$ ) to decrease creativity in groups. Therefore, we found mixed support for H4.

### Discussion

In this section, we now integrate the reported results of both Study 1 and Study 2 while highlighting how our findings contribute to the literature that we have previously cited, followed by the limitations of the two studies, as well as directions for future research. As we will discuss at length, our study contributes to the literature by: (a) establishing perceptual awareness of personality diversity in groups, thus presenting the possibility of separation properties of personality diversity, (b) testing perceptual awareness of ethnicity diversity directly, and (c) finding interactions of diversity and communication technology, which supports both separation and variety properties of the diversity sources in our study, as well as establishing the particular value that communication technology holds for diverse groups. Our two different studies also allow us to conjecture, however tentatively, about dynamic relationships of diversity, communication technology, and creative performance in both newly-formed and mature groups.

When it comes to personality diversity sources, we found that group members can detect both agreeableness and openness diversity. Perceived agreeableness and openness diversity were significantly and positively related to actual agreeableness and openness diversity, respectively, in Study 1. The actual detection of personality occurred prior to Study 1 because the groups in question had worked together for almost 3 months before Study 1 commenced and participants were asked about the perceived personality of their group members. Furthermore, the results of both Study 1 and Study 2 indicate that personality diversity sources have a meaningful influence on creative group performance.

Agreeableness diversity appears to have separation properties because it had a significant and negative effect on creativity in Study 2’s in newly-formed FTF groups. This finding is consistent with previous research (Barrick et al., 1998) that found agreeableness diversity to correlate significantly and negatively with various group process-related variables. But the lack of a significant effect for agreeableness diversity on creativity in Study 1’s mature FTF groups may indicate that the negative separation properties of agreeableness diversity were actually suppressed by its positive variety properties. Zellmer-Bruhn et al.’s (2008) finding that informational diversity only manifests during later stages of group development provides some support for this plausible explanation.



**Table 5**  
Descriptive statistics and correlations (Study 2).

		Mean	SD	1	2	3	4	5	6	7	8	9
1	FTF	.32	.47									
2	NGT	.34	.48	-.49***								
3	CMC	.34	.48	-.49***	-.52***							
4	Group size	4.43	.67	.09	-.14	.05						
5	Mean agreeableness	7.20	.52	-.12	.11	.01	.01					
6	Mean openness	6.14	.53	-.18	.20*	-.02	.07	.32**				
7	Ethnic diversity	.19	.21	.02	.04	-.07	.26*	-.36**	.05			
8	Agreeableness diversity	.86	.35	.05	-.08	.03	.19*	-.49***	-.06	.30**		
9	Openness diversity	.94	.33	.13	-.08	-.05	.20*	-.12	-.05	.02	.20*	
10	Creativity	15.95	3.36	.09	-.09	.00	-.01	.22+	.27*	-.13	-.11	.20*

Note:  $N = 79$ .

\*  $p < .10$ .

+  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

**Table 6**  
Regression analyses on creative group performance (Study 2).

	Control	Diversity	Full model
Size	-.04	-.08	-.03
NGT	-.23*	-.20*	-.23*
CMC	-.11	-.09	-.08
Mean agreeableness	.16*	.13	.09
Mean openness	.28*	.29**	.30**
Agreeableness diversity (AD)		-.06	-.32*
Openness diversity (OD)		.24*	.21
Ethnic diversity (ED)		-.07	-.52**
NGT*AD			.20+
NGT*OD			-.22+
NGT*ED			.32*
CMC*AD			.21
CMC*OD			.26*
CMC*ED			.37*
$R^2$	.13	.19	.40
$\Delta R^2$			.27**
F	2.19*	1.81*	3.08**

Note:  $N = 79$ . All tests are 1-tailed. Coefficients are standardized. Diversity coefficients in diversity model test overall relationships across experimental conditions, while those in the full model test diversity relationships with dependent variables within FTF (omitted) condition.

\*  $p < .10$ .

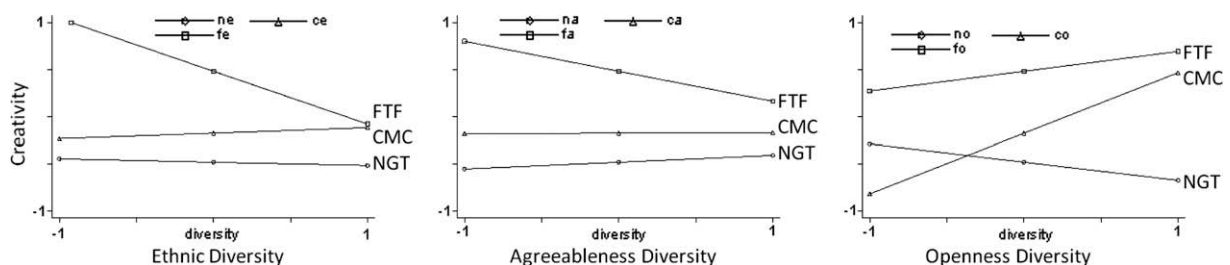
+  $p < .05$ .

\*\*  $p < .01$ .

Interestingly, we found that the additive (process structuring) features of NGT in Study 2 were beneficial for groups diverse in agreeableness but that the additive (parallel processing) and reductive (no visual and verbal cues) features of CMC in Study 1 were actually detrimental for them. By formally separating idea generation from idea evaluation, NGT in Study 2's newly-formed groups may have diminished the separation properties of agree-

ableness diversity by helping members low in agreeableness be less judgmental and those high in agreeableness share more controversial ideas, thereby enhancing their group creativity. But in Study 1's mature groups, CMC may have augmented the separation properties of agreeableness diversity by making individuals low on agreeableness that much more critical of their group members' ideas; parallel processing gave them unbridled voice while the lack of visual and verbal cues deindividuated their group members and made the social impact of their comments less evident. This type of CMC interaction may have alienated group members high on agreeableness and caused them to participate less during group discussions, thereby reducing the number of creative ideas generated in these groups. But what's perplexing is why we did *not* find a similar significant and negative effect for agreeableness diversity on creativity in Study 2's newly-formed, CMC groups. It may be that the disinhibiting and deindividuating environment of CMC is only consequential for groups diverse on agreeableness that have matured to where members are familiar with each other and comfortable expressing criticism.

We did not find any significant main effects for openness diversity on creativity in Study 1 or Study 2. This finding is consistent with the general lack of support in the literature when it comes to linking openness diversity in groups to performance outcomes (e.g., Barrick et al., 1998; Bell, 2007; Neuman et al., 1999). That being said, this finding may actually indicate that, in both newly-formed and mature groups, the negative separation properties of openness diversity were suppressed by its positive variety properties. This explanation is even more plausible when considering that the additive (parallel processing) and reductive (anonymity) features of CMC were beneficial for Study 2's newly-formed groups that were diverse in openness. In CMC, anonymity may have reduced the separation properties of openness diversity by preventing individuals from categorizing their group members whereas parallel processing may have increased the variety properties of



**Fig. 2.** Observed relationships between diversity source, communication technology, and creativity (Study 2).

openness diversity by facilitating a healthy balance of both divergent and convergent thinking. But again, what's puzzling is why we did *not* find a similar significant and positive effect for openness diversity on creativity in Study 1's mature, CMC groups. It may be that, because openness diversity has such strong separation and variety properties, the additive and reductive features of CMC are not able to reduce social categorization or enhance information processing in mature groups that have already developed sub-groups and/or ineffective communication norms as a result of their openness diversity.

We also found that the additive (process structuring) features of NGT were detrimental for Study 2's newly-formed groups that were diverse in openness. One way to interpret this finding is that the process structuring of NGT may have minimized premature closure in groups low (but not diverse) on openness while enabling groups high on openness to reach closure during group brainstorming.

Similar to agreeableness diversity, we found that ethnic diversity had a significant and negative effect on creativity in Study 2's newly-formed FTF groups but not in Study 1's mature FTF groups. This finding suggests that the negative separation properties of ethnic diversity are stronger when FTF groups first form but that they are suppressed by the positive variety properties of ethnic diversity at later stages of group development, which is consistent with findings from previous research (e.g., Harrison et al., 2002; Zellmer-Bruhn et al., 2008).

We also found that groups diverse in ethnicity benefited from the additive (process structuring) features of NGT, as well as the additive (parallel processing) and reductive (no visual and verbal cues in Study 1 and anonymity in Study 2) features of CMC; ethnic diversity had a positive and significant effect on creative group performance in both these technology conditions. Process structuring in NGT appears to have distilled the task-relevant, variety properties of ethnic diversity by formally separating idea generation from idea evaluation. But the lack of visual and verbal cues plus anonymity in CMC may have suppressed ethnic diversity's separation properties by diminishing social categorization and ingroup bias whereas parallel processing may have highlighted its variety properties by eliminating conversational dominance and giving voice to otherwise silent group members. Bhappu et al. (1997) made similar conclusions about the effects of CMC and gender diversity in groups.

Interestingly, eight of the nine interaction terms across our studies were in the opposite direction of the main effect term. Thus, a parsimonious second, not necessarily competing explanation, for our findings is that communication technology serves not just as a performance enhancer for diverse groups as we proposed, but as a performance equalizer that generally mitigates group process losses attributable to either diversity or homogeneity. While we focused on diversity in the current studies, homogeneous groups may at times spend a great deal of their energy on the social aspects of group development to the ultimate detriment of task performance. It may be that appropriate communication technologies generally shift a group's attention towards the task. If so, a shift in attention that either reduces social cues or imposes task structure may in some contexts provide benefits when group process losses associated with homogeneity (or diversity) are present.

In summary, the combined findings of our two studies suggest that group members perceive agreeableness and openness diversity, in addition to ethnic diversity. Agreeableness, openness, and ethnic diversity all appear to have negative separation and positive variety properties when it comes to creative group performance. Whereas the separation properties of all three diversity sources, as well as the variety properties of openness diversity, are evident in newly-formed groups, the variety properties of agreeableness and ethnic diversity are only manifest in mature groups. Finally, the additive and reductive features of communication technology

interact with all three diversity sources to impact creative group performance in different ways.

A key contribution of this research is that we were able to empirically distinguish between the separation and variety properties of different diversity sources. We were also able to isolate the reductive and additive features of communication technology. In doing so, we have shown that research designs capable of varying one or more contextual factors can be very useful in teasing out and better understanding otherwise elusive effects of diversity in groups, thereby facilitating theory development. Finally, we believe that because managers today often have little control over group composition, shifting their strategic focus to things they can control, such as the additive and reductive features of communication technology, should help them better harvest the value in diversity.

Key limitations of this research are those typically associated with experimental designs. Field research would allow us to study groups working together using different communication technology in an intensive nature across a range of tasks. This would allow us to understand temporal and special dynamics beyond the polar opposites considered in our current research. Future research, in addition to focusing on the field, needs to strategically consider and assess other diversity sources that vary in properties such as those identified by Harrison and Klein (2007). We believe that what we earlier described as a "sub-atomic" view of diversity is essential to unlocking diversity's "double-edged sword" (Milliken & Martins, 1996) and helping to untangle the confusing and paradoxical findings in the diversity literature. Specifically, we believe that previous scholars have underestimated the separation properties of personality diversity. Ideally, research should systematically vary diversity sources and properties with contingencies that help to move the field forward more efficiently and effectively.

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