Cross-Cutting Faultlines of Location and Shared Identity in the Intergroup Cooperation of Partially Distributed Groups

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ABSTRACT
This paper reports the results of a study comparing the relative influence of location and shared identity in partially distributed work. Using an experimental task called Shape Factory, groups of eight participants were configured such that in the baseline "strangers" condition only the location-based faultline was present while in the experimental "intergroup" condition, participants from two different shared identity groups engaged in distributed collaboration, creating an additional, cross-cutting faultline. The results showed that participants in the intergroup condition, with both location-based and shared identity faultlines, performed at a higher level than participants in the strangers condition, with only the location-based faultline. In the intergroup condition, the performance effects of location and shared identity were roughly equal and did not affect each other differentially in combination.

Author Keywords
Intergroup cooperation; faultline; partially distributed work; shared identity

ACM Classification Keywords
H.5.3. [Information Interfaces and Presentation]: Group and Organization Interfaces—Computer-Supported Cooperative Work

INTRODUCTION
Empirical studies of collaboration often find that subgroups form within workgroups, dividing workgroups into "us" and "them" [1, 5, 11, 15, 19]. Subgroups emerge along faultlines that have been attributed to a number of different factors including location, nationality, professional or organizational affiliation, shared group identity, power, information flow and diversity, subgroup size, resource distribution, values, race, gender, and age [1, 5, 6, 11, 15, 19, 21, 23, 25, 26, 32, 35].

CHI'12, May 5–10, 2012, Austin, Texas, USA.

Given the increasing prevalence of distributed teams, it is not surprising that location has been the most commonly cited subgroup faultline in the research literature on distributed teams. Distance and proximity have great influence over collaborative practices [22, 29].

Cramton offers one explanation for this tendency:

> *Shared location provides a natural basis for the development of strong subgroup identities because such clusters of people typically enjoy more interaction and more common information with each other than they do with remote partners* [11].

Armstrong and Cole call this location-based basis for subgroup identification the "metacontext of the locale" [1].

The presence of geographical faultlines within workgroups does not preclude the presence of additional faultlines, however. If other faultlines align with that of location (e.g., organizational faultlines in a team composed of members from two merging companies still working out of separate offices), subgroup tendencies could be even stronger [11]. But it is not clear what happens if other faultlines do not align with location (e.g., professional faultlines in a team composed of designers and developers who are both distributed across locations). Will these cross-cutting faultlines provide a "source of social integration for the dispersed team" [11] or will they serve to further fragment the composition of the workgroup?

The effects of two different factors—location and shared identity—have been examined separately in a series of laboratory studies of partially distributed teams. A study of the effect of *location* found that collocated participants interacted more with other collocated participants and formed a site-based in-group [5]. Similarly, participants working remotely from isolated settings interacted more with other isolated participants and formed their own in-group. Over the course of a series of studies related to subgroup faultlines, the isolated in-group, in some instances, was strong enough to perform as well as the collocated in-group, but more often the group of isolates performed less well [3, 4, 5].

In a follow-on study, the presence of *shared identity* in distributed teams was introduced to try to mitigate the

subgroup faultline effects of location [2]. This study found that shared identity groups outperformed groups of strangers but that location still served as a significant faultline. Even within shared identity groups, collocated participants outperformed their isolated, remote counterparts; collocated participants took on more leadership roles within the group; and remote participants reported experiencing less affective group identity and less group efficacy.

While both location and shared identity have been found to significantly influence the work of partially distributed groups, we do not understand how these two factors interact. Nor do we understand the relative weight of their influence. What would happen if shared identity subgroups were split between collocated and remote locations? Would one faultline emerge as a more dominant influence? Would one factor help to mitigate the subgrouping influence of the other or further fragment the group?

In this paper, we present the results of an empirical study of partially distributed teams examining the mutual influence between and relative effects of two faultlines—location and shared identity.

RELATED WORK

The Influence of Location on Distributed Work

Location has a multidimensional influence on distributed work; differences in location result not just in geographic differences but time zone differences, organizational differences (e.g., different departments), and cultural differences (e.g., both national and office site cultures) [1, 29]. Each of these differences serves to influence distributed work, both for better and worse. Distributed teams, for example, are often formed in order to take advantage of diversity that is not present at a single site; as a result, the diversity within distributed teams is often greater than would be found in a collocated team, leading to an increased potential for the presence of additional or stronger faultlines [22].

Members of distributed teams lack the same kind of situational awareness about their colleagues' behavior that is available to collocated teams [11]. Team members have fewer cues with which to help them interpret their distributed colleagues' behavior; as a result, members of these teams tend to make harsher or more "uncharitable" attributions about their distributed colleagues [11, 15, 34].

Distributed teams also face a number of information-related challenges including communicating and maintaining contextual information across sites, managing the uneven distribution of information, cueing distributed colleagues about the importance of different kinds of information, overcoming differences in access to information and communication technology, interpreting silence during exchanges with colleagues at remote sites, and identifying sources of expertise and help from distributed colleagues [11, 16]. As a result of these challenges, some distributed teams have been found to fail to exchange necessary information with all relevant parties, misinterpret information (or focus on the wrong aspect of the information they have been given), and have less effective transactive memory [1, 11, 20, 28]. Indeed, researchers have identified instances in which members of distributed teams have expressed a reluctance to share information across sites [15]. Remote colleagues in distributed teams have reported feeling "cut off from key conversations" and even being ignored during tele- and video- conferences [1].

Location also influences the development of group identity within distributed teams. Individuals come to identify with a group by conforming to the norms of that group [37]. For remote collaborators, the process of observing and interacting with the group in order to discover those norms takes longer, and group identification is "diluted" through whatever medium is used to replace face-to-face collaboration [8]. Empirical studies of distributed work have, indeed, found that remote group members self-report significantly lower levels of affective group identity than their collocated colleagues [2] as well as problems forming groups and maintaining ties [1].

Finally, location has been found to cause the emergence of subgroups within distributed teams, with collocated colleagues forming one in-group and remote colleagues forming another [1, 5, 32]. The presence of location-based in-groups has been found to cause additional problems, as well, with location-based subgroups attending disproportionately to people and information within their in-group, leading to information bias and, ultimately, diminished performance [1, 4, 24]. More generally, biased dynamics between subgroups threatens group cohesion and can have significant negative consequences on the performance of the superordinate group [1, 18, 31].

The Influence of Shared Identity on Distributed Work

Shared (or group) identity is one aspect of an individual's social identity, "that *part* of the individuals' self-concept which derives from their knowledge of their membership of a social group (or groups) together with the value and emotional significance of that membership" [35]. Shared identity has three components: the cognitive component, characterized by social categorization; the affective component, characterized by interpersonal attraction; and the behavioral component, characterized by interdependence [14].

Shared identity has been posited to create a "psychological tie" among distributed team members, leading team members to have more faith in each other and be more likely to communicate about issues as they arise [17, 18]. Shared identity increases group cohesion, reduces conflict (particularly interpersonal and affective conflict), and increases motivation [13, 18, 21, 23, 27]. Additionally, shared identity has been found to correlate with increased employee compliance, increased job satisfaction, and decreased attrition [23].

Shared identity improves the performance of distributed workgroups, although empirical studies suggest that even within groups with strong shared identity, other faultlines can still influence work practices and perceptions of the work experience [2]. When location-based faultlines occurred within shared identity groups, for example, remote colleagues performed less well and reported less shared identity and trust than their collocated counterparts.

Research Questions

While there is ample literature exploring the influence of location and shared identity independently on distributed work, there is little research that explores the mutual influence between these two factors. This study, then, is exploratory in nature and motivated by two research questions: when shared identity and location are present as faultlines in distributed teams, (a) to what extent does each factor influence the productivity of teams and (b) in what ways do the two factors influence each other?

METHOD

Eighteen partially distributed groups of eight participants each played a serious game called Shape Factory, described in the next section, that has been designed to simulate distributed work. Each group was composed of four collocated players and four remote, isolated players (simulating telecommuters). Nine groups were composed entirely of strangers; half were collocated and half were remote. Nine groups were composed of members with shared identity from two different campus organizations; half of the individuals from each organization were collocated and half were remote. During each game, we logged messages exchanged in the game and recorded face-to-face interactions among collocated group members. Participants individually completed a post-game questionnaire. Researchers also took qualitative "field"notes about the collaboration strategies that they observed during each game.

Shape Factory

The experimental context for this research was a serious game, Shape Factory, designed to simulate the collaborative work of distributed teams [5]. We provide an overview of the game and then discuss the ways that it has been designed to simulate the dynamics of collaborative work.

Overview of Gameplay

In the Shape Factory game, groups of eight participants try to fill orders of strings of shapes, such as circle-circle-triangle. Players are assigned a specialty shape that they can build for $10. They can fill orders with their own specialty shape, they can opt to build any other shape in the game (their non-specialty shape) for $25, or they can buy shapes from other players who can make them more cheaply than they can.

Each participant manufactures shapes and sells them to other players, negotiating a price per shape anywhere between $10 and $30. Players who are able to fill orders earn game dollars commensurate with the length of the orders, from $35 for orders requiring two shapes to $220 for orders requiring eight shapes. Longer orders are more difficult to fill, requiring a greater amount of collaboration to acquire the necessary shapes.

Each group of participants played Shape Factory for ten rounds; each game lasted two and a half hours. During each round, players were given two new orders to fill and were allowed to build up to four shapes. Orders and shapes persisted for two game rounds before expiring.

All participants had access to a lightweight messaging system within the game. In the messaging system, participants could send requests for shapes, negotiate for the price of shapes, or send any other freeform messages that they desired. Collocated participants were also able to talk freely among themselves.

Simulated Real World Dynamics

Shape Factory is an established platform for conducting research on distributed work and provides a degree of ecological validity appropriate to an experimental context [2, 3, 4, 5, 10]. The game has been designed to simulate a number of key characteristics of workplace collaborations:

- As is typical in workplace collaborations, all group members had *individual expertise* that made them a valuable part of the collaboration. In Shape Factory, each participant's expertise is mirrored in their ability to make a shape inexpensively, either for their own orders or to sell to other players who need that shape.
- As is also typical in workplace collaborations, group members *work interdependently*, relying on the expertise of other group members in order to get their own work done. In Shape Factory, each group member was tasked with filling orders that included strings of shapes (e.g., square-circle-triangle), necessitating collaboration with other group members who could supply the needed shapes. Group members bought and sold shapes from each other in order to complete their own orders.
- Similar to the dynamic in workplace collaborations in which individuals have some degree of choice about with whom they collaborate, players of Shape Factory also have a degree of *choice among collaborators*. In each group, two participants have similar expertise, i.e., can build the same shape; players can choose the person from whom to buy that particular shape.
- As is typical in workplace collaborations, Shape Factory imposes *resource scarcity*. During each round of the game, each player is only able to build four shapes, enough to fill many, but not all, orders.
- Finally, participants were *incentivized in two ways* to most closely correspond with the incentive structure in typical work teams. Half of group members' compensation was based on a percentage of their individual performance in the game, while the other half was based on a percentage of their entire group's performance in the game.

Participants

We recruited participants from the undergraduate population at a large, public university. Each group of eight was composed of either all male or all female participants in order to avoid introducing gender as an additional faultline. Five groups in each condition were composed of male participants; four groups in each condition were composed of female participants. For the nine groups in the "strangers" condition, we recruited participants at new student job fairs and in large, introductory courses across campus. Participants in the strangers condition did not know any other participant in their session. For the nine groups in the "intergroup" condition (in which there were two different shared identity subgroups), we recruited participants who knew each other through participation in campus organizations that fostered shared identity among its members, either through shared housing and frequent group activities (e.g., fraternities and sororities) or through frequent collaborative activities that pitted members of their organization against others (e.g., club sports teams)[1].

Configuration of Participants

Half of the participants were collocated during the game, sitting around a conference room table. The other half of the participants played the game remotely, each in a separate room. In order to understand the relative influence of location on collaborative work, we ensured that one participant with the expertise to build each shape was present among collocated players and was also present among remote players, as shown in Figure 1.

Additionally, in the intergroup condition, half of the participants were members of one campus organization (A) and half of the participants were members of a second campus organization (B). In order to understand the relative influence of shared identity on collaborative work, we ensured that one member of each organization had expertise in building each shape (Figure 1). Members of each organization were divided equally between the collocated and remote conditions. Coarsely, then, a participant needing any particular shape had two options: to buy it from another player who shared his or her geographical characteristics (collocated or remote) or to buy it from another player with a common shared identity (from the same organization).

In the strangers condition, participants did not know each other beforehand and were randomly assigned to any one of the eight shape-location roles in the game.

[1] The groups we recruited for the shared identity condition had a number of co-occurring characteristics. In addition to shared identity, they also had individual relationships with each other (familiarity). Since they were both single-gender groups and belonged to organizations that usually self-select into houses based on personality and other interests, groups also had perceived similarity (homophily). In social psychology, these three constructs are distinct, albeit often co-occurring in the real world. Our research design mirrors real-world co-occurrence. The work of teasing apart the effects of these constructs would be an interesting challenge for future research.

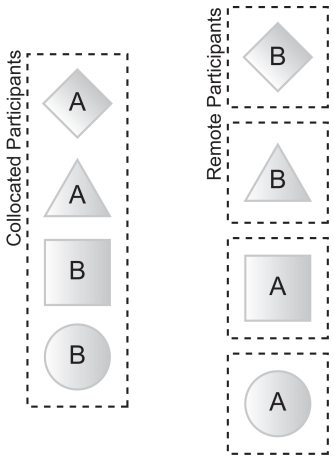

Figure 1. Configuration of participants in the intergroup condition. Dotted lines delineate rooms in which participants played the game, letters indicate shared identity subgroup membership, and shapes correspond to in-game expertise.

Procedure

Participants received instruction on how to play Shape Factory while in the same room. During instruction, two types of activities were interleaved[2]:

- Participants watched a series of videos explaining a particular aspect of the game (e.g., how to build shapes, how to buy shapes, or how to fill orders), and
- Participants logged into a "sandbox" version of the game and practiced that particular aspect of the game.

Afterwards, participants completed a quiz to ensure that they understood the rules of the game. The instructional phase of the study typically lasted about an hour. At this time, participants were also randomly assigned a shape expertise and location for gameplay within the constraints of shared identity and location as described above and shown in Figure 1. In the strangers condition, players were randomly assigned from among all eight possible shape-location permutations. In the intergroup condition, players from each campus organization were randomly assigned from among only the shape-location permutations allocated to their shared identity subgroup (e.g., For group A: collocated diamond, collocated triangle, remote square, and remote circle [Figure 1]).

Remote participants then moved to their individual rooms; collocated participants stayed together in the group room. Once situated, participants played ten rounds of Shape Factory, each lasting 15 minutes, for a total of 2 hours and 30 minutes of gameplay. Players took a short break between rounds five and six.

[2] The instructional phase of this study was different than the instructional phase of previous Shape Factory studies. The new instructional phase was designed to help participants understand the pragmatics of the game and its interface so that once the game had begun, they would be able to focus more on crafting and carrying out collaboration strategies.

Participants completed a post-game questionnaire, comprised of questions measuring the following constructs:

- *Shared Identity.* Participants rated four statements measuring affective group identity (e.g., "I enjoyed interacting with members of this group"). The group identity scale was developed by Henry et al. [14].
- *Group Efficacy.* Participants rated three statements measuring group efficacy, individuals' confidence in the group (e.g., "Our group worked well together"). The group efficacy scale was developed for a previous Shape Factory study [2] based on the concept described by Carroll et al. [9].
- *Reciprocity.* Participants rated seven statements measuring reciprocity, the extent to which individuals were motivated by a desire to dole out or receive "payback" (e.g., "I went out of my way to help players who had helped me"). The reciprocity scale was adapted for a previous Shape Factory study [2] based on a scale from Perugini et al. [30].
- *Individual versus Group Motivation.* Participants rated two statements about the extent to which they were motivated by individual incentives in the game (e.g., "My primary goal in the game was to maximize my own profit") and five questions about the extent to which they were motivated by group incentives in the game (e.g., "I sacrificed personal profits to help increase the overall group profit by helping other players fill longer orders"). The motivation scales were developed for a previous Shape Factory study by Bos et al. [2].
- *Trust.* For each other player in the game, participants rated their degree of trust in that individual along a five-point Likert scale (e.g., "Blue Square—I trust this player").
- *Leadership.* For each other player in the game, participants rated the leadership presence of that individual along a five-point Likert scale (e.g., Green Circle—"This player was one of the leaders of the group").

RESULTS

Comparison of Superordinate Group Performance Between Intergroup and Strangers Conditions

The superordinate groups[3] in the intergroup condition performed significantly higher, on average, than superordinate groups of strangers. In the intergroup condition, superordinate groups scored an average of 3520.00 points per game while in the strangers condition, superordinate groups scored an average of 3138.89 points per game ($t[16]=3.21$, $p=0.005$).

We performed a set of t-test comparisons on other measures to understand what led to higher superordinate group scores. Groups did not differ significantly on any of the following measures:

- The number of orders filled (for which participants would have been paid),
- The number of shapes sold in the process of trying to fill those orders,
- The price accrued for shapes sold, and
- The extent to which participants built their own specialty shapes at reduced cost (at $10 per shape) versus building non-specialty shapes (at $25 per shape).

What did vary was that superordinate groups in the intergroup condition filled significantly *longer* and therefore more lucrative orders. Filling longer orders required more coordination between multiple suppliers. Filling longer orders also required some trust and confidence in collaborators, because of the higher need for coordination and because the player stood to lose more money in unusable parts if the order couldn't be filled. Superordinate groups in the intergroup condition filled orders with an average length of 4.53 shapes while superordinate groups in the strangers condition filled orders with an average length of 4.09 shapes ($t[16]=2.37$, $p=0.031$). The average value of an order filled by a superordinate group in the intergroup condition was 106.46 while the average value of an order filled by a superordinate group in the strangers condition was 92.46 ($t[16]=2.49$, $p=0.024$). Participants in the intergroup condition engaged in more successful collaboration, then, because longer orders required more collaboration in order to be filled.

Comparison of Group Self-Report Measures Between Intergroup and Strangers Conditions

In order to examine whether participants in the strangers and intergroup conditions varied in their perceptions related to the collaboration, we compared self-report measures from post-game questionnaires. We used individual responses instead of group averages, which required consideration of possible effects at multiple levels. To test for effects at the superordinate group level we used the mixed model procedure in SPSS, constructing an 'empty' model for each scale with superordinate group first as a random effect, and then as both a fixed and random effect. In all cases, the superordinate group did not account for a significant amount of variance, indicating that it was not necessary to use a multilevel model including each variable as both fixed and random effects.

Instead, we used an ANOVA to compare responses to survey scales between participants in the strangers and intergroup conditions. Table 1 shows comparisons between conditions on questionnaire scales that had significant differences. Compared to participants in the strangers condition, participants in the intergroup condition reported

[3] In order to differentiate between the various groups and subgroups in our study, we refer to the full complement of eight participants in each study session as the superordinate group. Four-person subgroups based on location in both the strangers and intergroup conditions are referred to as the collocated and remote subgroups. Four-person subgroups in the intergroup condition based on organizational affiliation/shared identity are referred to as shared identity subgroups.

significantly higher affective group identity, group efficacy, and motivation to work for the group, with significantly lower demands for reciprocity and motivation for individual incentives. For each of these comparisons, df=(1,141). This pattern of results is similar to those found in Bos et al [2], where all members of the superordinate group were members of the same shared identity group.

Scale (Cronbach's alpha)	Intergroup Participants' Mean	Stranger Participants' Mean	F	p
Affective Group Identity (.64)	4.03	3.74	4.44	=.037
Group Efficacy (.70)	3.74	3.27	13.74	<.001
Reciprocity (.70)	2.96	3.19	5.20	0.024
Individual Motivation (.60)	3.22	3.79	14.07	<.001
Group Motivation (.80)	3.76	3.20	19.00	<.001

Table 1. Post-game questionnaire results

Comparison of Collocated and Remote Subgroup Performance within the Strangers and Intergroup Conditions

We next began to look for differences between collocated and remote team members. For these analyses, we examined the stranger and intergroup conditions separately. We first tested for superordinate group level effects using SPSS's mixed model procedure, as before, and found no significant effects of superordinate groups that would necessitate a multilevel model. We then compared scores using ANOVA. We found that within the strangers condition, collocated participants earned significantly higher scores than remote participants. Collocated participants averaged 424.17 points per game while remote participants averaged 360.56 points per game ($F[1,62]=4.85$, $p=0.031$). This finding replicates performance differences between collocated and remote participants found in some previous Shape Factory studies [2, 4].

In contrast, this performance difference did *not* manifest in the intergroup condition. The average difference in scores between collocated participants (440.83 points per game) and remote participants (439.17 points per game) was not significant. This result suggests that shared identity has an effect, reducing the impact of the location-based faultline on performance.

Relative Influence of and Interaction Between Location and Shared Identity on Collaboration Patterns

Next we examined trading patterns between participants in the intergroup condition to understand whether location or shared identity affected with whom players chose to collaborate. We constructed a matrix in which each vector represented a unique relationship between two players (e.g. Blue Square & Green Circle), excluding relationships between players with the same specialty shape (who rarely traded with each other). For each relationship, we aggregated the total number of shapes bought and sold (transactions occurring in both directions) as a measure of the amount of collaboration.

To examine what relationship characteristics predicted higher levels of trade, we created two Boolean variables, 'SameLocation' indicating whether the players were in the same location-based subgroup and 'SameIdentity' indicating whether they were both members of the same shared identity subgroup. As in the previous analysis, we first checked for superordinate group level effects using the mixed model procedure in SPSS; as before, there were no significant effects at this level that would necessitate a multilevel model. We analyzed the effects of these two variables with a two-way ANOVA in SPSS. We found that both being in the same location-based and shared identity subgroups were significant and fairly strong predictors of higher trade totals ($F[1,428]=90.45$, $p=<.001$ and $F[1,428]=122.105$, $p<.001$, respectively). The interaction between them was not significant. The adjusted R Squared for this model was a decent 0.268.

Having established these statistical relationships, we then inspected the trading patterns between players of different types. Turning to participants in the strangers condition, we found that, in line with previous Shape Factory studies, being in the same location-based subgroup led to a greater amount of trading between player pairs ($F[1, 430]= 450.7$, $p<.001$). The larger numbers of shapes in the upper left and lower right cells of Table 2 show the strong tendency for strangers to trade with other players in the same location-based subgroup.

		To Buyer	
		Collocated	Remote
From Seller	Collocated	973	267
	Remote	357	704

Table 2. Sum of shapes sold among collocated and remote players in the strangers condition

We then examined trading in the intergroup condition. In this condition, being in the same location-based subgroup was crossed with being part of a shared identity subgroup. Table 3 shows a much more equitable trading pattern between collocated and remote players in the intergroup condition. However, while the effects of location appeared to have been mitigated, they did not disappear. The effect of being in the same location-based subgroup was still a highly significant predictor of trading levels as reported above ($F[1,428]=90.45$, $p=<.001$). But being in the same shared identity subgroup was also highly significant ($F[1,428]=122.105$, $p<.001$). There was no significant interaction between these two factors.

		To Buyer	
		Collocated	Remote
From Seller	Collocated	692	497
	Remote	496	617

Table 3. Sum of shapes sold among collocated and remote players in the intergroup condition

Table 4 shows the average number of shapes exchanged by pairs with different permutations of subgroup affiliations. As expected, participants that shared both a location-based and shared identity subgroup traded the most (an average of 16.2 shapes exchanged) and those that shared neither subgroup affiliation traded the least (an average of 5.3 shapes exchanged).

	Same Shared Identity Subgroup	Different Shared Identity Subgroup
Same Location-Based Subgroup	16.2	10.0
Different Location-Based Subgroup	10.9	5.3

Table 4. Average number of shapes exchanged by pairs with varying subgroup affiliations

But comparing the effects of the two factors against each other, the effects were very similar. An average of 10.0 shapes were traded between pairs that shared location-based but not shared identity subgroup affiliations, and an average of 10.9 shapes were traded between pairs with the same shared identity but not location-based subgroup affiliation. That the two factors of interest, location and shared identity, were very similar in effect can be seen in their similar effects reported earlier and similar trading frequencies (10.0 vs 10.9) seen in Table 4. We explored the data using other methods (linear regression and multilevel regression) and found comparable effects; we also found no evidence of a significant interaction between the variables. Thus, within the intergroup condition, shared identity and location had roughly equal effects.

Superordinate Group Strategies

The Shape Factory game is designed such that if participants want to maximize their payoff, they must work together as a superordinate group. The most common superordinate group strategy involved players agreeing to buy and sell shapes for a standard amount (e.g., "sell everything for 10 next round so the group total goes up"). The second most common strategy (and the one most critical for optimizing superordinate group scores) involved players agreeing to sell shapes to others to fill the largest orders every round. For example, one participant sent the following message to other players:

> *why dont we just tell each other how big our orders are and take the highest four and fill those...i mean there are 8 of us so i figure half the orders per round or something u know, that way we"l be maximizing profits for each round...tell the girls your with :)*

Common variants of the largest-order strategy involved either asking everyone to fill only those orders worth more than 100 points or asking everyone only to fill only their largest order each round. Both of these variations are notable in that they demonstrate ways that players were attempting to balance the optimal strategy (of filling only the largest orders each round) with the overhead involved in having to continually maintain an awareness of who had what orders each round and which of those orders should be filled.

Of the nine superordinate groups in the intergroup condition, two did not discuss any superordinate group-level strategy with each other, two developed a superordinate group strategy among the four collocated subgroup members and shared it with their remote collaborators, and five had one or two people from the same shared identity subgroup work via the messaging system to advocate for a superordinate group strategy. In the latter case, if there were only one strategist, that strategist was always isolated and working remotely; if there were two strategists, at least one of the two worked remotely. Oddly, in all five of these latter cases, the shared identity subgroup to which the strategist(s) belonged performed less well than the shared identity subgroup without the strategist(s). Our data does not fully explain this phenomenon.

We know that groups generally did not run out of time during each round so we do not believe that the lower performance was due to coordination costs impinging on time constraints. We also know that, in most cases, the proposed superordinate group strategy was one of the variants of the optimal strategy that required less continual coordination so we do not believe that the lower scores were due to increased coordination overhead. We know, too, that the strategist was not always the lowest performing member of his or her shared identity subgroup, so we believe that the phenomenon is a subgroup-level effect and not the effect of the strategist(s) individually lowering the collective subgroup performance.

From the post-game questionnaire, we know that in four of the five groups, the strategists were rated more highly than non-strategists on the scale measuring leadership.

This phenomenon, if replicated, will require additional analysis in order to understand its underlying cause.

DISCUSSION

In this research, we studied the cross-cutting effects of location-based and shared identity faultlines on partially distributed work. We found that shared identity ameliorated some of the effects of the location-based faultline but both faultlines *still* had an effect on performance. Indeed, under

the circumstances of this study, shared identity and location had roughly equal effects in shaping a team's performance. We did not identify any significant interactions between the two factors.

Shared identity affected performance by enabling greater collaboration as team members filled longer orders which had a higher payoff but required increased coordination. Increased coordination comes with costs [33], and adding multiple faultlines into the mix only accentuates this. Finally, we observed some puzzling trends in performance related to the coordination of superordinate group strategy in the intergroup condition, which suggest directions for future work.

Leadership and Subgroup Affiliations

The phenomenon we observed related to the lower performance of the superordinate group strategists' shared identity subgroup, although unexplained, does suggest the need to better understand leadership in teams that have been divided by subgroup faultlines. In a previous Shape Factory study in which all participants belonged to the same shared identity group, collocated participants typically collaborated to develop a superordinate group strategy and communicated that strategy to their remote counterparts [2]. In that study, the collocated subgroup formed a leadership team, making all strategic decisions and delegating many responsibilities to remote group members. The extent to which the collocated subgroup dominated superordinate group leadership raised concerns about the inequitability of leadership opportunities for remote colleagues in workgroups divided by a strong location-based faultline.

In the current study, the superordinate group strategists were more equitably distributed across location-based subgroup faultlines. Although the number of groups in this study is too small to generalize, half of the groups had strategists, rated by others as leaders, who were members of the remote subgroup. It may be the case, then, that the interaction between location and shared identity faultlines creates a working context in which remote colleagues are more likely to gain leadership experience than when a location-based faultline exists on its own.

However, it is troubling that the strategists' shared identity subgroups consistently underperformed relative to subgroups without strategists. Indeed, research has found that leadership can be challenging in the presence of shared identity faultlines, that "identical leadership behavior is interpreted differently depending on whether it is enacted by an ingroup or outgroup member" [12]. Further, it seems that the effectiveness of leaders depends on their ability to create shared identity among a workgroup:

> *The potential of leaders or managers to communicate and create a sense of shared identity is an important determinant of the likelihood that their attempts to energize, direct, and sustain particular work-related behaviors in their followers will be successful* [12].

If the prevailing shared identity within workgroups exists at the superordinate group level, then the leader may be more successful in his or her attempts to advocate for collaboration at the superordinate group level. If the prevailing shared identity within workgroups exists at the subgroup level, however, then the leader may have a more difficult time convincing colleagues to follow his or her lead.

In the present study, we do not have systematic evidence of the extent to which shared group identity existed at the superordinate- versus sub- group level. We can point to one instance in which participants became skeptical about the efficacy of a superordinate group strategy and decided, via backchannel messages to each other, that they would just focus on helping out the members of their shared identity subgroup:

> *...noone ever responds so idk what is going on anywhere! im just gunna try to fill orders*
>
> *wanna just help each other out? and still act like were trying to help the group? Lol*
>
> *Should we try to fill our own orders? within our group? the highest within our little area? or try to keep doing the mass group thing?*
>
> *lol im down, thats what kelly and i are doing anyways. our group profit isnt gunna take us anywehre, they used 20,000 as the group profit example...check ours out...FAIL*

Although our understanding of the causality and implications of this phenomenon is incomplete, it does suggest that more research is needed to understand leadership in workgroups with multiple faultlines. In the presence of cross-cutting location and shared identity faultlines, the shared identity faultline may be a double-edged sword. On one hand, it may help allow for more equitable leadership opportunities in distributed teams. On the other hand, if the shared identity faultline is strong enough that the subgroup identification dominates over the superordinate group identification, leaders may be faced with significant challenges in undertaking superordinate group-level collaborative work.

Design Challenges

While the emergence of subgroups can sometimes lead to in-group bias and negative effects on performance, researchers studying intergroup cooperation find that a balanced acknowledgement of the multiple superordinate and subgroup affiliations present in teams may, in fact, be the most productive way to overcome these negatively impactful biases:

> *An integrated perspective would involve the presence of a salient superordinate level of categorization that simultaneously preserves (allows for) subordinate differentiation (distinctive category identities) and individualization of members of both subgroups. Such a representation can be achieved by social structures*

that are not nested hierarchies but are characterized instead by cross-cutting roles and social categories [6].

It may prove useful, then, to explore the design space for systems that more explicitly acknowledge or support superordinate groups, subgroups, and the individual. That individuals maintain identities at multiple levels means that realistically, intergroup cooperation (at the superordinate group level) and in-group bias (at the subgroup level) are not mutually exclusive [36]. The challenge for design, then, may be in walking a very fine line between systems that simultaneously allow for a variety of categories of social identification to co-exist without fostering the negative effects that can sometimes result from in-group bias.

CONCLUSION

Researchers have become increasingly nuanced in their understanding of the ways that different configurations of the location faultline within distributed teams influences distributed work—that the effects on and challenges of distributed work are different in totally virtual teams than in partially distributed teams, for example (e.g., [13, 28]). Similarly, researchers have become increasingly nuanced in their understanding of the ways in which different configurations of the shared group identity faultline influence cooperative work—that individuals maintain layers of multiple shared group identifications as part of a complex social identity (e.g., [6, 7]).

Yet, while the field delves more deeply into understanding the nuances of individual faultlines and factors in distributed work, there is much less research that has focused on examining the interactions between multiple faultlines, particularly empirical laboratory studies that enable us to develop a more precise theoretical understanding of the relative weight and interaction of multiple factors.

Distributed teams are an undeniably complex phenomenon, and in the real world, multiple faultlines co-exist in a dizzying array of permutations and configurations. Corporations merge, for example, and distributed teams composed of new colleagues from different companies have to come together and function in the presence of different national, organizational or site cultures all while working from different locations or time zones and likely also taking into account a diversity of different disciplinary backgrounds and expertise. As merging companies are more fully integrated, each of these faultlines becomes a moving target, sometimes aligned with other faultlines and sometimes intersecting in different ways. Throughout, then, the need to understand the numerous (and evolving) permutations and configurations of faultlines becomes even more pressing.

In this research, we have begun to address this need and to more systematically study one of the many permutations and configurations of faultlines that co-exist in real-world distributed teams—the cross-cutting faultlines of location and shared identity. Much work still remains to be done to understand the effects of the many different permutations and configurations of faultlines present in real-world teams. The Shape Factory simulation has proven to be a productive context for exploring cross-cutting faultlines in collaborative work. However, the additional logistical complexity of recruiting and scheduling large groups of individuals with increasingly specific individual- and group- level characteristics makes this research trajectory a challenging enough enterprise to warrant the combined efforts of additional researchers who can bring a diversity of expertise to bear on this important and challenging problem.

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