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Bos, N; Olson, J.S.; Nan, N.; Cheshin, A.

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Subgroup Biases in Partially-Distributed Collaboration

Nathan Bos, Johns Hopkins University, USA
Judith S. Olson, University of California - Irvine, USA
Ning Nan, University of Oklahoma, USA
Arik Cheshin, Israel Institute of Technology, Israel

ABSTRACT

Modern organizations often bring together groups in which some people are collocated and some remote. These groups often take the form of loosely-organized networks rather than hierarchies. Partially distributed groups may have characteristics that are different from fully collocated or fully distributed groups, such as being particularly vulnerable to subgroup formation. A ten-person simulation game called Shape Factory was used to model partially-distributed collaboration networks. We found that biases in trade patterns did occur among both collocated and remote (isolated) players. Collocated players formed a strong subgroup, with a bias toward ingroup trading, which almost immediately led remote players to form their own subgroup. These groups strengthened over time. Despite being at a technological disadvantage, the remote group performed as collocated workers.

Keywords: 7 keywords or less, please.

INTRODUCTION

Simulations with human subjects are a critical research tool for understand the dynamics of organizations facing modern challenges, such as long-distance work.

Today, much work that used to be done within a single, collocated corporation is often done by flexible, geographically distributed collaboration networks of people. The majority of large organizations in the world today—be they corporations, institutions of higher education, nonprofits or government entities—have the problem of coordinating work across distances. Research suggests that companies are struggling with problems arising from the use of long-distance teams (Olson and Olson, 2000), even though the number of organizations using such teams is growing enormously (McDonough, Kahn, and Barczak, 2001). Large investments in communications technology are being made in order to make it possible to collaborate at a distance via web conferencing suites, distributed supply chain systems, e-learning platforms, etc. However, despite the money and attention being paid this problem of effective distant collaboration is far from being solved.

Our work focuses on one common situation in distributed work called partially distributed work. Partially distributed groups are those that have some individuals who are collocated, and some proportion joining in at a distance. This configuration is probably at least as common as configurations with completely collocated or completely distributed (virtual) groups. Yet, this partially distributed format has received little research attention (O'Leary and Cummings, 2002).

Work Across Distance

To understand the challenges of long-distance work, one must first understand the considerable benefits of collocated work. In a study by Teasley, Covi, Krishnan and Olson (2002), 'radically collocated' software development teams, those where all team members were collocated in one large room for the duration of the project, were in one study found to have doubled their productivity compared to teams working out of separate offices. These teams benefited from easy access to each other, which lowered the communication cost. They also benefited from shared artifacts and shared context, which created common ground for communication (Clark and Wilks-Gibbs, 1986; Veinott, Olson, Olson and Fu, 1999).

Collocated groups also benefit greatly from 'workplace awareness' (Gutwin and Greenberg, 2004). They can "bump into" each other, which serves as a reminder of things promised but not delivered. They can see when others are available. Peripheral observation of each other helped people know when their co-workers were busy and when they were interruptible (Dabbish and Kraut, 2004). Kraut, Egido and Galegher (1988) found that researchers in a private research lab were more likely to co-author papers with each other when their offices were closer together. Researchers whose offices were within 30 meters of each other were significantly more likely to collaborate with each other, and the effect of collocation was *stronger than the effect of mutual interests* as measured by analysis of their published papers. In other words, two researchers who happened to have offices on the same floor were more likely to coauthor in the future than two researchers who share similar interests, but whose offices were further apart.

Most of the research on overcoming distance in collaboration is in the area of virtual teams. Studies of naïve team members put together into virtual teams illustrate how prone these groups are to failure due to lack of trust (Jarvenpaa and Leidner, 1999), lack of coordination, misunderstandings (Cramton, 2001), delays, and other human failures. To reduce these problems researchers and practitioners prescribe disciplined communication and coordination through explicitly-shared norms. Virtual teams are advised to set explicit agreements for how quickly email will be responded to, how quickly phone calls should be returned, how consistently instant messengers, pagers, and cell phones should be used (Duarte and Tennant-Snyder, 2000; Haywood, 1998; Raffoni, 2000). Haywood (1998) goes so far as to claim “If you want to do one thing that will dramatically improve your team’s communication, you should develop availability standards” (Haywood 1998, p. 19). But the question arises: Is the more-disciplined approach that is necessary for distant collaboration incompatible with the fast-paced informality of high functioning collocated teams? What would happen in a group that had elements of both collocated and distributed groups?

Partially Distributed Groups

What practices may we expect to find in *partially* distributed groups, or groups with both collocated and remote members? A survey of corporate work teams by Kinney and Panko (1996) found that 56% of project teams had members from multiples sites, but of these only 9% were pure virtual teams. It is now common for corporate meetings to include part of a team seated around a conference table with either groups or isolates joining by phone or video. In distance education, it is increasingly common for a professor to be leading a group that is partially present and partially joining from a distance. Many work teams accommodate part-time remote employees, so that they are partially distributed only some of the time.

Partially distributed teams may experience unique problems overcoming distance. Herbsleb, Mockus, Finholt and Grinter (2000) studied software engineers located in the U.K., Germany, and India, as they collaborated on integrated and time-sensitive software development projects. Within these partially-distributed teams, it was found that requests for modifications in software took longer whenever they involved engineers in multiple locations. These engineers also reported sharing less personal information, and having less of what is called ‘affective trust’ (McAllister, 1995) with their distant colleagues (Rocco, Finholt, Hofer and Herbsleb, 2001).

Prior research suggests three dynamics that may be relevant to partially distributed teams: unequal communications, unequal distribution of attention and subgroup/ out-group dynamics, detailed below.

Unequal effort in communicating. Different media require different amounts of effort and time to convey the same message. Typing is more effortful and takes longer than speaking. Phone communication is more effortful and less natural than face-to-face communication. In a partially distributed team there may be large inequities in how much the 'cost' of communication with one team member versus another. This cost may be in time, but also in the cognitive effort needed to produce and interpret communication.

Unequal distribution of attention. In the press of daily events, one would expect that distant coworkers in a partially distributed team would also be at a disadvantage in competing for attention from colleagues who are collocated with each other (Armstrong and Cole, 2002). Collocated workers may intend to treat all of their coworkers equally, but when forced to make difficult allocation choices, the social pressure and multiple awareness cues of co-presence may overwhelm the relatively sparse communication channels of distant collaborators. In an experimental study, Fussell, Kiesler, Setlock Scupelli and Weisband (2004) found that collaborators had difficulty managing time and attention equitably across projects with different geographic configurations. When involved in both collocated and distributed collaborations, participants favored tasks with collocated partners despite equal importance of tasks. The unequal distribution of attention may partially explain Herbsleb et al's (2000) field findings that software modification requests that originate locally are completed more quickly than distant ones.

Subgroups may inhibit whole-group performance. Within a partially-distributed collaboration network there is a strong likelihood that subgroups will form. We define subgroups as a set of individuals within a larger group. This definition is compatible with other uses of the term in social network analysis (Hawe, Webster, and Shiell, 2004), and inclusive of subgroup types such as cliques and clans (Wasserman and Faust, 1994).

Subgroups can be problematic when they inhibit the effectiveness of the whole group. Demange's (2004) exploration of the economics of large collaboration networks shows how the 'selfish' wishes of a cohesive teams within a larger group can inhibit network effectiveness. Networks with strong subgroups run the risk of negative subgroup/ out-group dynamics forming within the group. Researchers have, for some time, recognized the danger that distant communication poses in creating and reinforcing in- group and out-group dynamics (Fiol and O'Connor, 2005; Brown, 2000; Lea and Spears, 1992). Social psychologists have long recognized the tendency for *any* small difference between subgroups to evoke subgroup behaviors. Even meaningless and arbitrary methods of dividing people into groups tend to encourage formation of a subgroup identity that excludes others (Taijfel, 1978). Distributed organizations are vulnerable to small groups of collocated individuals forming subgroups and excluding others. Pool (1976) found that manipulating the availability of computer-mediated communication (CMC) channels significantly affected how individuals within larger groups formed coalitions with each other. Any sort of inequality in communication channel may possibly bring about factionalism and subgroup biases. Subgroups are desirable when they include the entire company or function team, promoting 'team spirit' and individual self-esteem (Brown, 2000). But when subgroups form within a team, they can be a drag on efficiency and morale. In allocating scarce resources, members tend to distribute resources in ways that favor the subgroup, and neglect the out-group (Dobbs and Crano, 2001). Individuals tend to see members of their subgroup as more similar to themselves than out-groups, affecting their willingness to trust outsiders. Out-group members are likely to be seen as similar to each other, or stereotyped, and once these stereotypes are formed they may be difficult to undo (Tajfel, 1978). Once subgroups have formed for whatever reason, they tend to reinforce each other and resist interventions to change them.

METHOD

We used a group simulation called Shape Factory (Bos et al, 2004), to investigate how groups of 10 people would collaborate when five of them were collocated in a room, and five were located in rooms by themselves, able to communicate with email. We ran 13 groups of 10 in this simulation to measure patterns of collaboration and differences in performance.

The Shape Factory Simulation

The Shape Factory Simulation is a ten-person group simulation that recreates realistic dynamics of interdependent workgroups with a cooperative/competitive incentive structure. In Shape Factory, each player is both a producer of 'shapes' and someone who fulfills orders for strings of shapes. Each player is designated as a colored shape, such as Blue Square. Each player can make all the shapes, but have only one they can make cheaply, which is their specialty shape. There are two specialty producers of each shape, each with a different color (e.g. Blue Square and Orange Square), setting up some choice for others when they need a particular shape. Each player has a set of three orders in each round of the five-round game. Two orders are short (two shapes) and one is long (four shapes) and none of their orders requires their own specialty shapes. Each player would ideally like to obtain eight shapes from other players each round. To create some scarcity and resource pressure, we set a production limit of six shapes for each player every round. If a player cannot obtain all eight needed shapes, they can still make the other shapes but at a higher cost.

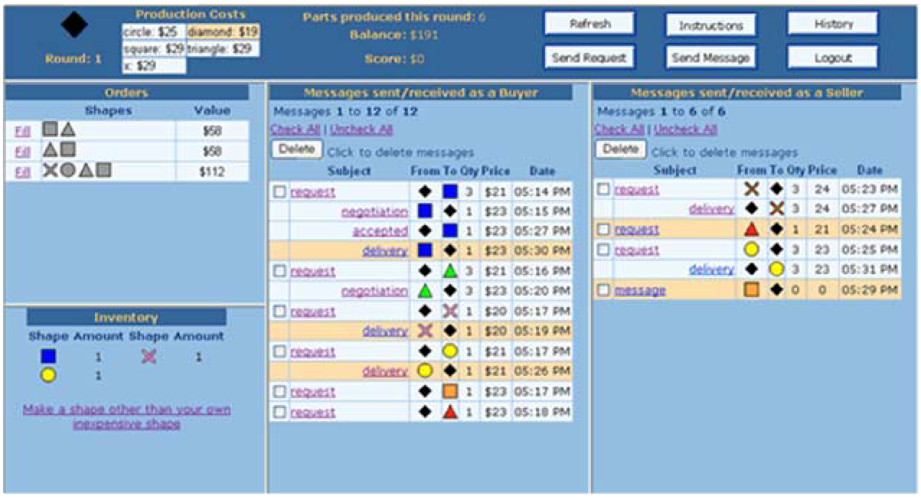
Thus there are five shapes in the game, each made by two players. Because each shape is made by two players, other players have a choice of whom to ask for a shape when they need to fulfill an order. Since the game is played over a number of rounds, it is in the players' interests to establish good working relationships with others so that they both pay attention to their colleagues and deliver shapes in a timely manner.

The game is played through a web interface (Figure 1). The view in Figure 1 is for one of the players who can make diamonds cheaply, Black Diamond, identified in the upper left-hand corner. Immediately to the right are the costs for producing Black Diamond's shapes; note that the diamond costs only $19 to make, whereas the others cost from $25-29. Below the diamond are three orders, two of length two and one of length four.

Note that the orders are gray because it does not matter which colored shapes fulfill the orders as long as the shapes are correct. The pay for filling an order is listed on the right of each order; it is set to be the sum of the *costs* of producing the shapes by oneself. If a player fills an order by making all of the shapes herself, she makes zero profit. The only way to make a profit is to buy at least one of the shapes from someone who can make them more cheaply.

Beneath the orders is an area depicting the player's current inventory. This player has purchased a square (blue), an X (pink), and a circle (yellow). This person would two more squares and

Figure 1. A screen shot of the interface for playing Shape Factory



three triangles in order to fulfill all of his/her orders. Players are not obligated to fill all available orders.

On the right are two panels of text message conversations with other players, the middle panel showing conversations about this player wanting to *buy* shapes, and the ones on the right showing conversations in which the person is being asked to *sell* shapes.

The game is played in five rounds. Inventory is cleared after each round and people are not allowed to sell shapes in their inventories to others. In the first round, people are allowed 20 minutes to play (with a known ending time); all subsequent rounds are 15 min. each.

The players are instructed to maximize their earnings. They do this by selling their specialty shape at a profit and buying others shapes for less than they could produce them on their own. There is some time pressure, although most players finish their transactions in the time allotted. There is also a shortage of cheap parts since each player needs eight parts but can make and sell only 6. The combination of time pressure and shape scarcity creates a situation in which players cannot afford to be completely generous with their time and resources with all eight potential collaborators; they must prioritize, and are served best when they establish consistent relationships with some others.

Shape Factory is designed to simulate these characteristics of a modern, distributed workplace:

1. Work is accomplished in collaborative networks
2. Unequal communication opportunities between players—some are more accessible than others
3. Limited resources and time
4. Players have both cooperative and competitive rewards, (also known as mixed-motive games)

Setting and Procedure

Ten paid subjects participated in each session, for five rounds of play. There were 13 sessions, for a total of 130 participants. Subjects were recruited from a recruiting email list, an ad in a university newspaper, and signs posted throughout a large university campus. Participants were paid $15 for completing the session plus a chance to win up to $10 based on performance. The average amount paid was $17. Fifty two percent of the participants were female, 97% were students, and the average age was 22. They had an average of 14 years of education. Almost all of the participants (99%) stated that they had used computers, the Internet and email regularly for over three years.

During the game, five of the players were collocated in a large room and sat around a table together while the other five played in separate rooms each by themselves. All players used the web interface to make requests for shapes from each other and to deliver them. Those collocated in the large room could also talk to each other to get others' attention, find out if they had any parts left, negotiate a price, and commit to a delivery. The interface allows negotiation between buyer and seller, but does not support multi-player auctions. Roles (e.g., who plays Black Diamond) were randomly assigned to players with the constraint that one of each of the different shapes was in the room, and one of each in the remote rooms.

At the end of each session, all players completed a 37-item survey with questions on player demographics, self-reported strategies, attitudes toward the game and towards other players.

HYPOTHESES

At the beginning of this research, we had three hypotheses:

H1: *Collocated players outperform Remote players.*

Collocated players may have advantages in how quickly they can communicate with each other, how easily they can coordinate, how quickly they can learn strategies and how easily they can build trust among other collocators. These advantages could allow them to outperform remote players.

H2: *Subgroup forms*

The partially distributed configuration may lead to formation of subgroup collaborations.

H2a: *Collocated players may form a subgroup.*

Collocators may preferentially buy and sell shapes from each other rather than from the remote players. Several factors may contribute to this bias: ease of communication, convenience of access, and interpersonal trust.

H2b: *Remote players may form a subgroup.*

Remote players may preferentially buy and sell shapes from each other, to the exclusion of collocated players.

RESULTS AND DISCUSSION

Performance Differences

Collocated players would seem to have many advantages in this game. Yet the results showed no significant difference in the overall scores between collocated and remote players. Remote players scored an average of 203 and collocated players scored 191. A multilevel model regression on player scores, controlling for effects at the session level, showed this difference to be non-significant ($p<0.55$). There was also no significant differences in the number of shapes sold, number of shapes purchased, or purchase or sales prices. Thus, hypothesis H1 was not supported. Overall, the groups sold on average of 276.1 shapes out of a possible 300 (92% efficiency). Further analysis will explain how remote players managed to overcome their hypothesized disadvantages.

Subgroup Formation

Collocator subgroup. Collocated players had strong trading biases toward other collocated players, supporting Hypothesis 2a. This tendency is shown in Table 1, by comparing the top left cell (collocator to collocator sales) with the top right and middle left cells. To test the statistical significance, we calculated the total number of parts sold by each collocated player to other collocated and to remote players. We again used multilevel regression to control for effects at the session level. Condition was a significant predictor of the number of shapes sold between players, $F = 6.18$, $p < .001$, showing that collocated players had strong statistical tendencies to sell to other players in their own room.

Remote player subgroup. Hypothesis 2b was also supported: remote players developed a subgroup trading bias nearly identical to that of the collocated players, $F = 9.1$, $p < .0001$, as shown by the large number in the middle right cell of Table 1.

How did the remote players respond to the trading subgroup of the collocators? In these experiments, they responded by very quickly and very effectively forming a trading subgroup of their own. The surprising aspect of this is that the remote players were only vaguely aware of their status, and had no effective way of knowing who the other remote players were at the beginning of the experiment. The remote player subgroup formed when remotes were ignored by the members collocated group. At the beginning of the game, remote players sent roughly equal numbers of purchase requests to both collocators and remote players. However, they did not receive requests in equal numbers, and did not receive responses to their requests in equal numbers. We examined a dataset comprised of all requests sent in the first rounds. There were a total of 985 requests sent in the first rounds of the 13 sessions. For each request we could see how long it had taken that player to receive a message in response

Table 1. Number of shapes delivered between collocators and remote players per session

		SHAPES BOUGHT	
		To Collocators	To Remote Players
SHAPES SOLD	From Collocators	**89.5** (65%)	**48.2** (35%)
	From Remote Players	**48.9** (35%)	**89.6** (65%)
	Total	**138.5**	**137.8**

(not necessarily an acceptance, but any response) and whether this request was eventually filled (not necessarily for the asked amount or price.) Table 2 shows the pattern of requests, the average response time, and the average acceptance rate. (Note that since response time and acceptance rate refer to responses to requests, these figures are interpreted 'backwards' from request counts. For example the 201 second response time in the lower left is the response from collocators to remote players, not the other way around.)

How did these strong biases come about? To understand the process of subgroup formation, we ran similar analyses on the first round of trading data. Analysis of all first round requests show that for remote players, sending a request to a collocated player meant they were less likely to get a positive response and it would take significantly longer to receive a reply. We again ran regression tests of the effect of receiver condition on likelihood of a positive response and response time, controlling for session-level effects. When the sender was a Remote player, there was a significant difference in response times ($F=5.9$, $p < .05$). We used ordinal logistic regression to examine likelihood of response and again found a positive relationship, ($p<.05$).

For collocators in the first round, there was no significant difference in response time based on the recipient of their requests ($F=.43$, $p<.51$) or rate of filling requests ($p<.22$) when session-level effects are controlled, although there were already trends in that direction.

Why were the remote players ignored by collocators in the first round? Mostly, because the collocators were negotiating verbally, responding to each other preferentially, and being less responsive to those outside the room. So, remote players began preferentially responding to those players who responded to them, and preferentially delivering shapes to those who had sold shapes to them. The remote players did this very quickly and efficiently, and by the end of the first round the trading biases were established.

Subgroups strengthen over time. The tendency of these subgroups to trade with each other exclusively increased over time. Figures 2 and 3 show trading

Table 2. Average outcome of requests sent in round 1

REQUESTS	To Collocators	To Remote Players
From Collocators	Requests sent: 263 Response time: 175 sec Acceptance rate: 38%	Requests sent: 222 Response time: 172 sec Acceptance rate: 35%
From Remote Players	Requests sent: 235 Response time: 201 sec Acceptance rate: 33%	Requests sent: 265 Response time: 164 sec Acceptance rate: 44%

patterns over the five round experiment. For both collocators (Figure 2) and remote players (Figure 3), the discrepancy in trading was present from the first round, increased markedly in the second round, and continued to increase throughout the experiment.

To test the significance of this increase we used a dataset where each case was data from one round of one experiment, from one specific player to one condition of player. The outcome variable was the number of parts sold. For both conditions we ran regression tests predicting sales from four variables – round number, buyer condition, experiment session (for control) and an interaction term, round x condition. The interaction term was to test for different effects by condition. We again used multilevel regression to separate effects of particular experimental sessions from effects related to the conditions of interest.

There was a significant interaction between round and player condition related to total sales for both remote players (F=10.4, p< .01) and collocated

Figure 2. Shapes sold by collocators to both other collocators and remote players, by round

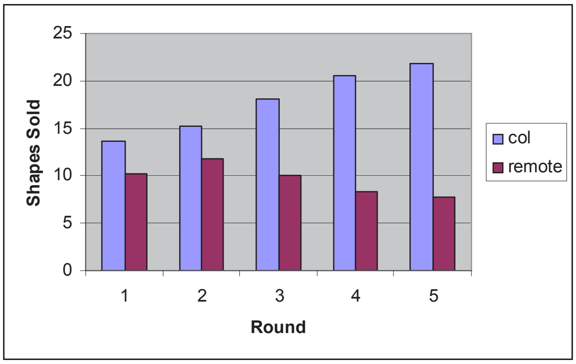
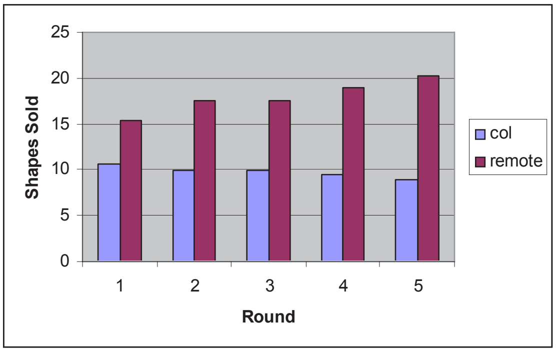


Figure 3. Shapes sold by remote players by round



players (F=37.2, p<.01). We interpret these results to mean that both types of players increased their subgroup sales bias over time. This is consistent with prior research on ingroup and out-group formation (Tafjel, 1978), which says that once subgroup dynamics are established, they tend to reinforce and strengthen over time.

Players' Self-Reported Strategies

How did the players perceive the patterns of collaborations that resulted from this experiment, and their roles in forming them? In the post-task survey, we asked every player this question: "Each shape was represented by two players. What influenced your choice of which player to request shapes from? (Select all that apply)." They were presented with the items in Table 3 with checkboxes. Table 3 shows post-survey results separated by group.

Remote players endorsed all of the three history-related statements (1, 2, and 3) a higher percentage of the time. We used multi-level regression to control for effects of experimental sessions and test differences between Remote and Collocated players on these post-survey items. Table 3 shows that differences were significant on one item and marginal on another.

Collocators, meanwhile, were less conscious of individual relationships. Instead, they seemed to be more influenced by who was in the room with them. 69% of collocators endorsed a statement that they traded preferentially with "whoever was in the room with me". In a separate part of the post-questionnaire, we also asked collocators to rate the following items related to in-room bias items. Table 4 lists these

Table 3. Rate of endorsements from post- task survey question

Answers	Collocators	Remote Players	Difference
Whomever I had sold parts to most recently	28%	38%	P<.06
Whoever had sold me parts most recently	32%	50%*	P< .02*
Whoever was more reliable	35%	52%	P<.15

Table 4. Collocators' responses to questions about in-room bias

Item	Average Rating
When trying to buy parts, I did not care whether a player was in the same room with me or alone.	2.5 (disagree)
I usually tried to get parts from players in the room before requesting parts from players out of the room.	3.4
We tried to trade with players only in our room.	2.5 (disagree)

items along with average results, a scale going from 1 = strongly disagree to 5 = strongly agree. The first two items show that collocators were intentional about their predisposition to collaborate in-room. This bias to buy and sell within the collocated room drove the pattern of subgroup trading among the collocators.

The post-questionnaire responses from both groups suggest possible mechanisms for how subgroups formed and strengthened over time. The subgroups initially formed due to the collocators' bias to sell to each other. This bias was driven by convenience and probably other psychological factors such as social pressure. The collocators were not very deliberate about forming this subgroup, and likely did not set out to exclude remote players. Yet, they did exclude them, or at least delayed including them long enough that the remote players formed relationships preferentially with each other. Once these trading groups formed, players' tendencies to keep the same trading partners made the subgroups grow stronger over time. Interestingly, since the remotes had a stronger self-reported bias toward keeping the same partners, it would have been the actions of the remote players more than those of the collocators that made the subgroup bias increase over time.

SUMMARY AND DISCUSSION

Collocator Subgroup

As in previous research, collocation is shown to be a powerful determiner of collaboration. Five randomly assigned collocators began to favor each other, very strongly and very quickly. A subgroup trading bias among the collocators was evident within the first few minutes of the experiment and continued to gain strength through the experiment. By the end of the experiments, collocators had done nearly twice as much trading with each other as with remote players.

Why did this trading bias occur? For collocators, working with other players in the collocated room was easier and more convenient than it was with people out of the room because they could use verbal communication before having to finalize the deal through the messaging system. Physical presence also aids trust and creates subtle social preferences. In Shape Factory, simply sitting across a table with another player may make these players' presence more salient to each other, so that they went to each other first for parts. Players probably felt more social pressure to respond to collocators; it is relatively easy to ignore or say 'no' to an email message from an unseen player, but harder to say no to someone sitting across the table. Players might also feel that those located in a room with them would be more responsive to their requests than those not visible.

In post-experiment surveys collocators report that they were aware of their bias toward collaborating with each other. There did not seem to be a strong motivation to intentionally excluded remote players. Thus, some previous findings about ingroups were reproduced here: the ingroups tend to prefer each other and distribute favors unequally. But negative out-group dynamics, whereby subgroups sometimes develop exclusionary tendencies and negative attributions about out-groups, were not prevalent in these experiments.

Remote Player Subgroup

How did remote players respond to this exclusion? They quickly and effectively formed their own trading subgroup within the first five to ten minutes of the first round. Remote players formed trading relationships with each other that grew stronger over the course of the experiment. The same subgroup bias also appears in other settings in which the distribution of players is not so symmetric (Shami et al. 2004; Bos, et al., 2005; Bos et al, 2006).

What does this mean for real-world partially distributed groups? We argue that subgroup collaborations are very likely to form when the conditions of this experiment apply: When individuals have interdependent skills, choice among collaborators, a level of self-management, unequal communication channels, and time and resource pressure. These are increasingly common conditions in modern, knowledge-oriented workplaces; so the phenomena of subgroup collaboration is worth paying attention to. Managers and workers alike should understand the ways in which location, technology, and social practices can interact to change collaboration patterns.

Subgroups are not necessarily a bad thing. It is not necessary for every worker to have exactly equal levels of contact with every one of their coworkers. There are many cases, however, when a large division of the social network could hurt organizational effectiveness. In the Herbsleb research (2000), the inability to obtain the time and attention of distant coworkers slowed distributed software development. Coworker relationships have been shown to affect things such as the flow of information (Granovetter, 1973) and adoption of new innovations (Rogers, 1995). 'Fault lines' (Lau and Murnighan, 1998) in the social network of an organization may lead to unnecessary conflicts, difficulties in building consensus, as well as less-efficient work processes. It is worthwhile to continue to try to understanding better how work relationships form, and how they interact with distance, technology, and other factors.

Performance Differences Between Collocators and Remote Players

One unexpected result of this set of experiments was the failure of the collocated players to outperform the remote players. Collocated players had the advantages of being able to verbally negotiate and the favoritism of being collocated, but remote players may also have had some advantages. Players who are not easily accessible to others may be able to concentrate better. Freedom from distraction is a common reason given by real telecommuters for why they work from home (Belanger, 1999). Remote players may have been able to organize themselves better and stay more focused on the incoming and outgoing transactions without any verbal distraction. Remote players may also be more resistant to social pressure from coworkers, and able to make more pragmatic decisions about how to allocate their resources and attention. In the Shape Factory game, remote players were more likely to take prior history into account in deciding who to sell their scarce parts to, while collocated players may have felt more obligated to sell to other players in the room, regardless of need or past history. If it is true that remote workers in the real world also can be more pragmatic (or even selfish) in allocating their attention and resources, this would be an interesting finding, worthy of further research.

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REFERENCES

Armstrong, D., and P. Cole. 2002. Managing distances and differences in geographically distributed work groups. In P. Hinds and S. Kiesler, eds. Distributed Work. Cambridge, MA: MIT Press. 167-189.

Belanger, F. (1999). Workers' propensity to telecommute: an empirical study. *Information & Management* 35, 139-153.

Bos, N.D., Olson, J.S., Cheshin, A., Kim, Y.S., Nan, N. (2005). Traveling Blues: The effect of relocation on partially distributed teams. Short paper in *Proceedings of CHI 2005.* New York: ACM Press.

Bos, N.D., Olson, J.S., Nan, N., Shami, N.S., Hoch, S., Johnston, E. (2006). Collocation blindness in partially distributed groups: is there a downside to being collocated? *Proceedings of CHI 2006.* New York: ACM Press.

Bos, N.D, Shami, N.S., Olson, J.S., Cheshin, A. & Nan, N. (2004) Ingroup/ out-group effects in distributed teams: an experimental simulation. In *Proceedings of CSCW 2004*. New York: ACM Press. 429-436.

Brown, R. (2000). Social Identity Theory: past achievements, current problems, and future challenges. *European Journal of Social Psychology* 30,745-77

Clark, H. H. & Wilks-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, 22, l-39.

Cramton, C. (2001). The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science, 12,* 346 – 371.

Dabbish, L. & R. E. Kraut. (2004). Controlling Interruptions: Awareness Displays and Social Motivation for Coordination. *Proceedings of CSCW 2004.* New York: ACM Press. 182-191.

Demange, G. (2004). On Group stability in hierarchies and networks. *The Journal of Political Economy 112* (4), 754-778.

Dobbs, M., & W. D. Crano. (2001). Outgroup accountability in the minimal group paradigm: Implications for aversive discrimination and social identity theory. *Personality and Social Psychology Bulletin.* 27(3) 355-364.

Duarte, D. & N. Tennant-Snyder. (2000). *Mastering Virtual Teams.* Jossey-Bass.

Fiol, C. M. & E. J. O'Connor. (2005). Identification in face-to-face, hybrid, and pure virtual teams: Untangling the contradictions. *Organization Science.* 16(1), 19-32.

Fussell, S.R., S. Kiesler, L. D. Setlock, Scupelli & Weisband. (2004). Effects of instant messaging on the management of multiple project trajectories. In *Proceedings of CHI 2004*. ACM Press. 191-198.

Granovetter, M. S. (1973). The Strength of Weak Ties. *American Journal of Sociology* 78 (6), 1360-1380.

Gutwin, C., & S. Greenberg. (2004). The importance of Awareness for team cognition in distributed collaboration. In E. Salas and S. M. Fiore, eds. *Team Cognition: Understanding the Factors that Drive Process and Performance,* 177-201, Washington: APA Press. Downloaded May 4, 2005 from http://grouplab.cpsc.ucalgary.ca/papers/

Hawe, P., Webster, C., & Shiell, A. (2004). A Glossary of terms for navigating the field of social network analysis. *Journal of Epidemiological Community Health* 971-975. Downloaded February 6, 2006 from http://jech.bmjjournals.com/cgi/reprint/58/12/971

Haywood, M. (1998). *Managing Virtual Teams.* Boston, MA: Artech House.

Herbsleb, J.D., A. Mockus, T. A. Finholt, & R. E. Grinter. (2000). Distance dependencies, and delay in global collaboration. In *Proceedings of CSCW 2000* (pp. 319-328). New York: ACM Press. 319-328.

Jarvenpaa, S., & D. Leidner. (1999). Communication and trust in global virtual teams. *Organization Science,* 10, 791-815.

Kinney, S.T. & Panko, R.R. (1996). Project teams: profiles and member perceptions—implications for group support system research and products. In Proceedings of the 29th Annual Hawaii International Conference on System Science.

Kraut, R. E., C. Egido, J. Galegher. (1990). Patterns of contact and communication in scientific research collaborations. In Kraut, R. E., Egido, C., Galegher, J. (Ed.) *Intellectual Teamwork: Social and Technological Foundations of Cooperative*. Hillsdale, NJ: Lawrence Erlbaum. 149-172

Lea, M., and R. Spears, R. (1992). Paralanguage and social perception in computer-mediated communication. *Journal of Organizational Computing,* 2, 321-341.

Lau, D.C. & Murnighan, J.K. (1998). Demographic diversity and faultlines: the compositional dynamics of organizational groups. Academy of Management Review, 23 (2), 325-340.

McAllister, D. J. (1995). Affect- and Cognition-Based Trust as Foundations for

Interpersonal Cooperation in Organizations. *Academy of Management Journal 38*, 24-59.

McDonough, E. F., K. B. Kahn, & G. Barczak. (2001). An investigation of the use of global, virtual, and collocated new product development teams. *The Journal of Product Innovation Management.* 18, 110-120.

O'Leary, M.B. & J. N. Cummings. (2002). The Spatial, Temporal, and Configurational Characteristics of Geographic Dispersion in Teams, *Academy of Management Conference*.

Olson, G. M., & J. S. Olson. 2000. Distance matters. *Human Computer Interaction*, 15, 139-179.

Pool, J. (1976). Coalition formation in small groups with incomplete communication networks. *Journal of Personality and Social Psychology.* 34(1) 82-91.

Raffoni, M. (2000). Managing Your Virtual Company: Create a Communication Plan. *Harvard Management Communication Letter*, April 2000,. 7-8.

Rocco, E., Finholt, T.A., Hofer, E.C., & Herbsleb, J.D. (2001, April). Out of sight, short of trust. Presentation at the Founding Conference of the European Academy of Management. Barcelona, Spain.

Rogers, E. 1995. *Diffusion of Innovation* 5th Edition. New York: Free Press.

Shami, N.S., N. D. Bos, Z. Wright, S. Hoch, K. Y. Kuan, J .S. Olson, G. M. Olson. (2004). An experimental simulation of multi-site software development. In *Proceedings of IBM Center for Advanced Studies Conference (CASCON)*, October 2004.

Tajfel, H. (1978). *Differentiation in social groups: Studies in social psychology of intergroup relations.* London: Academic Press.

Teasley, S. D., L. A. Covi, M. S. Krishnan, & J. S. Olson. (2002). Rapid software development through team collocation. *IEEE Transactions on Software Engineering*, 28(7), 671-683.

Veinott, E.S., J. S. Olson, G. M. Olson, X. Fu. (1999). Video helps remote work: speakers who need to negotiate common ground benefit from seeing each other. *Proceedings of CHI 1999.* New York: ACM Press. 302-309.

Wasserman, S., & Faust, K.(1994). Social Network Analysis: Methods and Applications. Cambridge University Press.

Nathan Bos is a senior researcher in cognitive engineering at the Johns Hopkins Applied Physics Laboratory. His research is in the areas of computer-supported collaborative work, and design of multiplayer simulations that integrate software agents and human subjects. Prior to joining APL Bos was a faculty research scientist at the University of Michigan's School of Information and developed educational technology for the Ross School of Business' MBA program. He received a PhD in psychology and education from the University of Michigan.

Judith Olson is the Donald Bren chair of information and computer science, and professor of business and social ecology at the University of California at Irvine. Prior to this, she was the Richard W. Pew chair of human computer interaction, and professor in the business school and the psychology department at the University of Michigan. She has a PhD in psychology from the University of Michigan and was a postdoctoral fellow at Stanford. Her research spans the areas of human computer interaction and computer supported cooperative work, looking most recently at teams of people who have to work long distance.

Ning Nan is an assistant professor of management information systems at Price College of Business, University of Oklahoma. She received her PhD from the Ross School of Business at University of Michigan. Her research interests focus on behavioral and economic factors in management information systems. She has employed empirical analysis, experiments and multi-agent models to study in-group behaviors in distributed teamwork, impacts of time zone difference on global teams and schedule and budget pressure in software engineering. She earned a master of art in journalism and mass communication from University of Minnesota and a bachelors of art in advertising from Peking University, China.

Arik Cheshin is a graduate student at the Technion – Israel Institute of Technology, pursuing a PhD in organizational behavior from the faculty of industrial engineering and management. He completed an MA in organizational behavior from the Technion in 2008, master's thesis titled: Affect in Virtual Teams: Contagion and Performance. *Cheshin completed his undergraduate studies in psychology from the University of Michigan (2003), after which he worked at the Collaboratory for Research on Electronic Work (CREW). His work has been presented in the following conferences: CSCW, Academy of Management, and CHI. Arik's research interests include: virtual teams, and emotions in organization.*