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ABSTRACT

This study investigates the effects of social comparison and social loafing on virtual team performance when teams engage in asynchronous ideation process. The results of the study suggest that the effects of social comparison and social loafing co-exist in virtual teams. Team members may choose to engage in different behaviors (social loafing vs. social comparison) in different team interactions. Furthermore, team members tend to elaborate on the ideas generated by co-workers. As a result, teams with less social loafing will produce richer elaboration on ideas generated.

INTRODUCTION

Virtual teams and virtual teamwork are pervasive organization phenomenon nowadays (Cohen & Gibson, 2003; Powell, Piccoli, & Ives, 2004). Virtual teams have been used to perform different tasks such as software development, project management, and etc. (Chen, Romano, & Nunamaker, 2006). A team can be viewed as "a group of people who work towards a common goal", teamwork "is the process that a team employs (including both individual and group activities that team members engage in) to achieve that goal." (Chen & Sager, 2007) Some researchers regard a virtual team the same as a distributed team. Others define a virtual team as a team that relies heavily on computer-mediated communication (CMC) regardless of the geographical locations of the members. Moreover, some researchers define virtuality as a continuum rather than a point, and the level of virtuality can be determined by three dimensions: the degree of synchronization, the presence of nonverbal and para-verbal cues, and the extent of using CMC (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Kirkman & Mathieu, 2005; Jong, Schalk, & Curseu, 2008). In this paper, we use the term "virtual teamwork" to refer to teamwork that is conducted via CMC regardless of team members' geographical locations. As a result, virtual teamwork is an integral part of any teams, even for teams that are co-located.

Previous studies show that virtual teamwork conducted through electronic meetings can become more efficient and effective than traditional oral discussions (Aiken & Park, 2009). However, understanding how virtuality affects team performance is far from well-established.

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Organizations often use trial-and-error to determine what managerial practices work best in virtual team environment (Oakley, 1999). In this study, we investigate how virtuality affects team productivity when teams are engaged in an ideation process. *Ideation*, also known as *idea generation* or *brainstorming*, is one of the fundamental mechanisms of decision making or problem-solving process (Briggs, Vreede, & Reinig, 2003) that involves coming to understand the problem, generating possible solutions, generating objective assessment criteria, and evaluating and selecting the best solution (Robbins & Judge, 2007).

Existing literature on teamwork and ideation indicates that anonymous input increases team performance. However, these studies were frequently conducted in a face-to-face (FtF) setting, and they only focused on two effects: evaluation apprehension and social loafing. When teams engage in ideation in an asynchronous virtual environment, there could be factors that impact the effect of anonymity, making it more or less effective than in FtF interactions. In this study, we investigate how the effects of social loafing and social comparison affect team performance when teams engage in anonymous and asynchronous electronic ideation. In the next section, we summarize previous studies of ideation in virtual team research, and explain the theoretical foundations, research hypotheses, and research questions. Then we describe the study design followed by the study results. Finally, we discuss the managerial implications, limitations, and future research.

RESEARCH BACKGROUND AND HYPOTHESES

Organizations are increasingly employing virtual teams as a new form of teamwork due to the need to "collaborate quickly and efficiently within and across organizational boundaries" (Oakley, 1999). Virtual teams potentially offer a major advantage over traditional teams for problem-solving. The organization can draw in people from a wider pool to build a team with diverse expertise, experiences, and backgrounds, and therefore a wider variety of perspectives. Such teams may be able to work in broader problem and solution space as they seek and implement solutions. In other words, virtual teams may have a higher possibility for better problem solving. In addition, collaboration systems, a common type of tools used by virtual teams, may contribute to the effectiveness of teamwork as these systems introduce soft management functions such as Emotional Intelligence that facilitate intelligent interactions among team members (Burkhard, Horan, Hilton, & Leih, 2009).

On the other hand, the opportunity for FtF interactions in virtual teams is greatly reduced or even eliminated, forcing teams to rely on CMC heavily if not entirely. However, CMC may not be less effective than FtF communication for certain tasks. Studies that investigated different communication modes (FtF, synchronous, asynchronous, or combined) (Chidambaram & Jones, 1993; Ocker & Fjermestad, 1998; Ocker, Fjermestad, Hiltz, & Johnson, 1998; Ocker, Hiltz, Turoff, & Fjermestad, 1995) indicate that asynchronous teams achieved similar performance as FtF teams or synchronous-distributed teams in terms of quality and creativity when the teams engaged in problem solving or decision making that consisted of ideation as a subtask. Two of these studies indicate that asynchronous teams produced more creative solutions than FtF teams (Ocker & Fjermestad, 1998; Ocker, Hiltz, Turoff, & Fjermestad, 1995). Furthermore, a recent study shows that team organization and the type of tasks could affect the performance of large asynchronous virtual teams (Vreede, Briggs & Reiter-Palmon, 2010).

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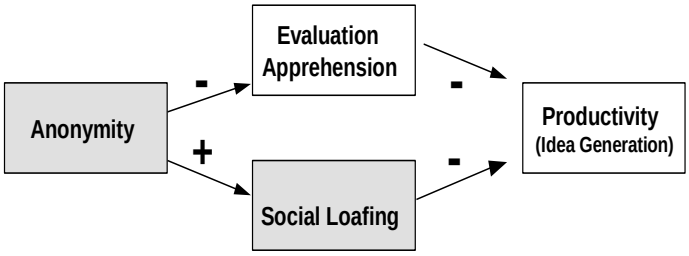
When virtual teams engage in CMC, it will be either synchronous communication (e.g., phone calls, video conferencing, Web conferencing), or asynchronous communication (e.g., email, online bulletin board, online forum). Utilizing asynchronous communication for ideation is convenient for virtual teams when team members have tight schedules or reside in different time zones. It is unclear whether techniques proven to be effective in FtF interactions are still effective in asynchronous interactions. For example, previous research suggests that anonymity can be used to increase team ideation performance in FtF interactions. Does anonymity have the same positive effect on the performance of asynchronous virtual teams? In this paper, we attempt to address this question by investigating how the co-effect of social comparison and social loafing affect the performance of virtual teams when team members interact anonymously in an asynchronous setting.

Anonymity and Productivity in Ideation

As specified by Vreede and Briggs (Vreede, Duin, Enserink, & Briggs, 2000) as illustrated in Figure 1, anonymity afforded by collaboration technology may have two opposing effects: increased social loafing and reduced evaluation apprehension. *Social loafing* (also called *social ride* or *free ride*) refers to a phenomenon that individuals tend to expend less effort in team tasks than they do in individual tasks, unless their contribution can be specifically identified and evaluated, or unless they believe that their contribution is critical to the success of the task, see, for example, (Diehl & Stroebe, 1987; Harkins & Jackson, 1985; Karau & Williams, 1993; Kerr & Bruun, 1983; Paulus & Dzindolet, 1993; Sanna, 1992; Shaw, 1998).

Figure 1: Impacts on ideation productivity (Adapted from (Vreede, Duin, Enserink, & Briggs, 2000))



On the other hand, when participants contribute to ideation anonymously, they may not experience *evaluation apprehension*, which is the anxiety "induced in a person performing some task while being observed by others and feeling anxious about being judged or appraised by them." (Hall, 2001) Thus, according to Vreede and Briggs (Vreede, Duin, Enserink, & Briggs, 2000), the outcome with anonymous brainstorming "may be the net of two opposing effects of anonymity". However, we propose that a third effect - social comparison - needs to be included in the model, in addition to the effects of evaluation apprehension and social loafing.

Social comparison is a theory of motivation used to predict levels of effort. It is "a phenomenon wherein people match their rate of performance to the rate of the people working around them.

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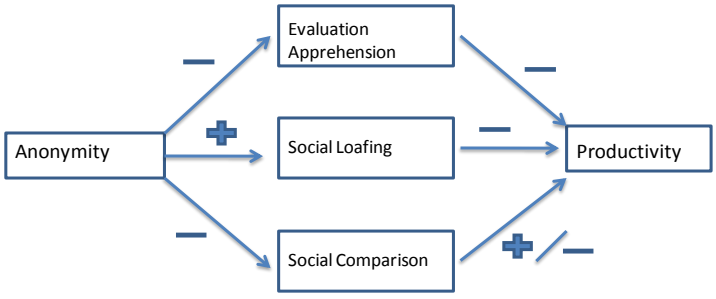
Participants working in an environment where others are performing at a high level also tend to perform highly. Participants working in an environment where others are performing at a low level match the inferior performance rate (Goethals & Darley, 1987)." (Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1996)

The effect of social comparison could be positive or negative on team performance. One social comparison study in ideation (Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1996) tested the positive effect of social comparison and illustrated how social comparison can be invoked to improve anonymous idea generation in a FtF setting. By constantly presenting teams a feedback image with an imaginary "average" or "baseline" team performance, they invoked social comparison among teams, and therefore increased the number of solutions by 63%. Another study in ideation (Valacich, Jung, & Looney, 2006) tested both the positive and negative effects of social comparison. The study found that the performance of team members with high cognitive ability could be enhanced when given high-quality stimuli or be inhibited when exposed to low quality stimuli. In other words, when a team member perceives that other members' performance is high, she may increase her effort to match; when she perceives that other members' performance is low, she may lower her performance to match as well. Since both studies utilize anonymous input, therefore, social comparison could be a team effect that is introduced by anonymity just as the effect of social loafing. As a result, the relationship between anonymity and team performance or productivity is illustrated by Figure 2, which is a revised model from (Vreede, Duin, Enserink, & Briggs, 2000).

Figure 2: Impacts of anonymity on ideation productivity.



Previous studies indicate that "the benefits of reduced evaluation apprehension may outweigh the losses from social loafing" (Vreede, Duin, Enserink, & Briggs, 2000). Therefore, anonymity has positive effect on team performance. However, anonymity may not have the same effect on asynchronous interactions if team members have different perceptions about evaluation apprehension, social loafing, and /or social comparison.

First, people may experience less evaluation apprehension in asynchronous interactions than in FtF interactions. In FtF interactions, people have a stronger sense that their performance is being observed by others, and inappropriate behaviors are more likely to get negative attention or criticism. When team members interact asynchronously, they have a much weaker sense that their performance is being observed, and inappropriate behaviors are less likely to get negative attention or criticism. Even if there is criticism about their behaviors, the criticism may not

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appear as embarrassing as it is in FtF interactions. As a result, anonymity may reduce evaluation apprehension to a much greater extend in FtF interactions than in asynchronous interactions.

Second, team members may perceive social loafing differently in FtF and asynchronous interactions. Social loafing may not be as big a problem in FtF interactions as it could be in asynchronous interactions. In FtF interactions, team members are usually able to see each other during the ideation process, and tell whether a particular member is contributing by watching over his/her shoulder accidentally or deliberately. If an unwilling participant does not type at all or pretends to be contributing by typing on a different user interface (such as an email program), people sitting nearby would know he/she is not contributing. The awareness of being watched or observed may create some normative pressure for people to contribute in FtF interactions. However, when teams engage in anonymous interactions asynchronously, there are fewer indications about the level of participation of individual team member. In this case, anonymity may create a much higher possibility for social loafing in asynchronous settings than in FtF settings. Moreover, in FtF interactions, each member is committed to a task in a fixed period of time, while in an asynchronous setting, a member can freely choose how much time to be spent on a task and when. This flexibility may encourage cyberloafing (i.e., conducting non-work related activities on the Internet during work time (Kidwell, 2010)) or other activities that involve the use of organizational computer resources for personal purposes (Strader, Simpson& Clayton, 2009), thus reduce work productivity.

Third, team members may perceive social comparison differently in FtF interactions than in asynchronous interactions. The ability to watch each other in FtF interactions makes the identity of each member more salient and the effort they are making more visible than in asynchronous interactions. Therefore, FtF interactions should have stronger social comparison effect than asynchronous interactions.

In summary, how anonymity works in asynchronous virtual teamwork may be very different from that in FtF teamwork. The result that anonymity has increased the team performance of ideation in FtF interactions cannot simply be generalized to asynchronous interactions without further investigation.

In this study, we limit our investigation to how the effects of social loafing and social comparison manifest and affect team performance in asynchronous virtual team collaboration. In a follow up study, we will investigate all three effects: social loafing, social comparison, and evaluation apprehension. This paper only reports on the current study.

The effects of social loafing and social comparison have been subjected to extensive testing (see, for example, (Michinov & Primois, 2005). However, these studies usually investigated the two effects separately in different studies. This is a limitation due to the fact that these two effects could co-exist, and potentially work against each other. For example, if a group of people engage in a team activity anonymously, a team member could engage in social comparison or social loafing. If she chooses to engage in social comparison, then she would match her level of effort with other team members. If others have done little, she would contribute little. If others have done a lot, she would contribute more. On the other hand, if she chooses to engage in social loafing, then she would contribute little when others contribute more. This example illustrates

that the effects of social comparison and social loafing could work against each other, and individual team members may choose to engage in one of these behaviors. The question of which effect is stronger than the other in different team interactions remains unanswered in the current literature. Understanding how the two effects work simultaneously in team collaboration is important because team leaders could potentially manipulate the collaboration process to minimize or maximize one of the effects for improved productivity. The investigation is especially useful for virtual team management since an individual's contribution toward teamwork may not be as salient as that in FtF interactions, and there may be different perception towards social loafing and social comparison.

Research hypotheses

In this study, we investigate how the two effects of social comparison and social loafing manifest when team members engage in anonymous and asynchronous virtual collaboration. The following three conditions are considered: (1) when there is no opportunity for social loafing, in other words, when a team member perceives that her co-worker does not contribute ideas; (2) when there is opportunity for social loafing, and the co-worker contributes a little; and (3) when there is opportunity for social loafing, but the co-worker contributes a lot.

We speculate that in the context of team ideation, team members will behave differently in the above three conditions. In condition 1, when a team member sees that her co-worker does not contribute any ideas, she could engage in social comparison by matching her level of effort to that of the co-worker, in other words, she would not contribute any ideas either. However, if she still wants to earn credits for the team work, she would perceive that there is no opportunity to engage in social loafing. As a result, she may work hard to contribute ideas. In this case, the effect of social comparison will not manifest, and the effect of social loafing (not taking free ride) will manifest. In condition 2, when a team member sees that her co-worker has made some, but not much, contribution, then she may perceive that there is opportunity for social loafing. Moreover, she may choose to match her level of effort with her co-worker by contributing a few ideas. In this case, both the effect of social loafing and the effect of social comparison may have negative impact on team performance. In condition 3, her co-worker contributes a large number of ideas, which creates opportunity for social loafing but also certain social norm pressure. It is more likely that the team member will match the level of effort with that of her co-worker by generating a large number of ideas. In this case, social loafing effect may not be evident, and social comparison effect may be strong. As a result, the team members in both condition 1 and condition 3 may perform better than those in condition 2. Therefore, we have the following hypotheses:

> **H1: Team members who perceive that their co-workers do not contribute will perform better than those who perceive that their co-workers contribute a little.**
>
> **H2: Team members who perceive that their co-workers contribute a lot will perform better than those who perceive that their co-workers contribute a little.**

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As to which team members will perform better: condition 1 or condition 3, we speculate that when a team member sees her co-workers' ideas, these ideas could inspire her to generate new ideas. As a result, we have the hypothesis:

H3: Team members who perceive that their co-workers contribute a lot will perform at least as well as those who perceive that their co-workers do not contribute.

RESEARCH METHODOLOGY

For this study we conducted an experiment of three different asynchronous ideation approaches, which are referred as conditions later in the paper.

Subjects

100 students from four introductory MIS classes in a U.S. University participated in the study voluntarily. Students were told that they were randomly assigned to a team of several members to finish a team task. In fact, we only assign one participant to each team. Then we randomly assign "teams" into different conditions. There were 34, 33, and 33 "teams" in condition 1, 2, and 3 respectively. There is no difference in terms of age ($F= 0.91$, $p = 0.41$) and number of years of working ($F= 1.16$, $p = 0.32$). The mean of age is 21.67 and the mean of number of years of working is 2.34 across all three conditions.

In this study, we have adopted a research design that uses simulated team interaction instead of real team interaction in order to strengthen the effect of different approaches. This kind of design – simulated team ideation with one person in a "team"- has been used in prior research, such as (Valacich, Jung, & Looney, 2006). In their study, Valacich and other researchers investigated how the quality of seeded ideas affected the quality of ideas generated by persons with high cognitive ability vs. low cognitive ability. A simulator was used to post ideas automatically so that participants felt that they were generating ideas with other team members synchronously. In our study, we manually seeded ideas asynchronously. Using simulated team ideation with only one person in a team could eliminate the confounding effects introduced to the experiment from real team interactions. As a result, our design isolates and strengthens the experiment effects.

Task

We created a task for the study. The task required the participants to generate solutions to ease or solve a number of problems faced by public schools in the United States when compared with other industrialized countries such as low academic performance, high dropout rate for high school students, teen pregnancy, and campus violence. We chose this task because it has a large number of possible solutions, and the use of seeded ideas will not limit the number of ideas that could be generated by participants.

Procedure

The participants used a Web-based group support system (GSS)[1] to post ideas that they generated for the task over a four-day period. The system provided each team its own electronic

[1] We used GroupSystems' Thinktank product.

page and allowed team members to contribute ideas and comments to the page simultaneously. All the inputs appeared on the page in the order they were contributed and were immediately readable by all team members. Contributions were anonymous. Students could log in the system and input ideas anytime and anywhere they had Internet access.

Before participants started the task, one class period for each participating class was used for training. The instructor introduced team decision making process and computer supported ideation, demonstrated how to use GSS to post ideas. Then students engaged in hands-on experience by generating ideas for a practice task. At the end of the class, the instructor distributed hard copies of the experiment task, and announced the date and time to start the task. A soft copy of the task description was also available online. The instructor told the participants that the assignment was a team assignment, each one of them would work with several other students to complete the task, and the grade would be assigned at a team level, and the assignment grade is worth 5% of their final grade. The instructor obtained students' consent of participation. Participants who missed the training had an opportunity to make an appointment with the instructor to attend one of the additional training sessions. After the training class, each participant received an email including his/her login information (URL, login name, and password), and the starting and ending date and time for the task.

Experiment conditions

The experiment has three conditions. In condition 1, when a participant logged in the system, he/she would see the following sentence as the instruction to do the task "Brainstorm ideas that could improve public school education (from kindergarten to grade 12) in the United States of America" and an additional instruction on what kind of solutions they should generate "When you generate ideas, please generate ideas that can alleviate or solve the problem(s), and that could be implemented inexpensively, or easily, or quickly." Later on, we will refer to this condition as the Control condition.

In condition 2, in addition to the above instructions, participants would also see two ideas entered by an imaginary team member when they first logged in to the system. Later on, we will refer to this condition as the Two Ideas condition. In condition 3, the setup was the same as that in condition 2, except that a participant would see ten instead of two ideas entered by an imaginary team member. We refer to this as the Ten Ideas condition. One of the authors of this paper acted as the "imaginary team member" to provide ideas in the Two Ideas and the Ten Ideas conditions in the evenings of three consecutive days. As a result, there were total six seeded ideas in the Two Ideas condition and total thirty seeded ideas in the Ten Ideas condition during the experiment period. The six seeded ideas were the same for all the teams in the Two Ideas condition, and the thirty seeded ideas were the same for all the teams in the Ten Ideas conditions.

It is worth noting that in the Control condition, since there was no imaginary team member to enter any ideas, the participant virtually worked by himself/herself for the task. Since the participants were told that they had several team members, they might perceive that the other team members were not active. The experiment conditions are listed in Table 1.

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Table 1: Experiment conditions.

	Condition	Set up
1	Control (No seeded ideas)	Brainstorm ideas that could improve public school education (from kindergarten to grade 12) in the United States of America. ADDITIONAL INSTRUCTIONS - When you generate ideas, please generate ideas that can alleviate or solve the problem(s), and that could be implemented inexpensively, or easily, or quickly.
2	Two ideas (Two seeded ideas each day)	The same instruction as in the Control condition and two concrete ideas of how to solve the problem when first log in. Two more ideas were seeded in each of the two consecutive nights. There were 6 seeded ideas altogether.
3	Ten ideas (Ten seeded ideas each day)	The same instruction as in the Control condition and ten concrete ideas of how to solve the problem when first log in. Ten more ideas were seeded in each of the two consecutive nights. There were 30 seeded ideas altogether.

Performance measures

Number of solutions. The major performance measure is the number of solutions. Every message posted by a participant is regarded as a posting. However, not every posting contains solutions. In this experiment, a solution is a verb + objective combination that consists of an idea that could ease or solve the problems faced by the public school K-12 in the United States. A posting could contain zero to many solutions. When a posting contains many solutions, we adopted a disaggregation approach to count solutions. This approach has been shown to yield high inter-rater reliability (Briggs, Vreede & Reinig, 2003). For example, the sentence "advertise in newspaper, TV, and magazine" contains four solutions, and it would be disaggregated to: "advertise", "advertise in newspaper", "advertise in TV", and "advertise in magazine". Sometimes, a noun or noun phrase could also be counted as a solution. For example, the phrase "smaller class" is considered a solution and could be rephrased as a verb + objective combination, such as "reduce class size".

Elaboration coefficients. Another measure that we adopted to evaluate the solutions is the elaboration coefficients. According to Vreede and Briggs (2005), an elaboration is an input related to a previously submitted idea such as an opinion or extension of the idea, clarification or proposed implementation of the idea, or as simple as a comment "This is a great idea." Elaborations help build the richness of an idea, and may encourage thoughts and potential new idea generation. The formula for calculating elaboration coefficients will be explained in the next section.

RESULTS

Not all participants posted ideas on the system. There were 23, 27, and 28 participants posted ideas in the Control, Two Ideas, and Ten Ideas conditions respectively. Some of these participants did not fill out the surveys. There were 22, 27, and 26 filled-out surveys in the

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corresponding conditions listed above. All survey items have 7-likert scale, with 1 indicating strongly disagree and 7 indicating strongly agree.

Manipulation Check

There were two questions for manipulation check. The first question was "The interactions with other team members for the task made me feel we work as a team." The second question was "In general, my team members are working hard for the team task." Table 2 shows the descriptive analysis the two questions for the three experimental conditions.

Table 2: Means of manipulation check.

	Question 1		Question 2	
Condition	Mean	SD	Mean	SD
Control	2.05	1.70	1.86	1.49
Two Ideas	3.07	1.71	2.93	1.41
Ten Ideas	3.92	1.74	3.92	1.47
Total	2.87	1.87	2.79	1.71

An ANOVA test indicated that there was significant difference among the three conditions for both manipulation check questions. For manipulation check question 1 ($F=7.11$, $p=0.001$), the post hoc Bonferroni indicated that the difference between the Control and the Ten Ideas conditions was significant ($p = 0.001$), and the difference between the Control and the Two Ideas conditions was approaching significant ($p = 0.10$). The comparison between the Two Ideas and the Ten Ideas conditions was not significant ($p = 0.17$). For manipulation check question 2 ($F = 11.96$, $p<0.001$), the post hoc Bonferroni indicated that all three comparisons were significant: Control and Two Ideas ($p = 0.035$), Two Ideas and Ten Ideas ($p = 0.039$), and Control and Ten Ideas ($p < 0.001$).

The participants' responses to both manipulation questions indicated that the manipulation was a success to a large degree. Since there were seeded ideas in Two Ideas and Ten Ideas conditions, participants in these conditions should have felt they worked as a team.

Evaluation of solutions

Two research assistants (RAs), who were blind to experiment conditions, extracted solutions from postings in all three conditions. The seeded ideas in the Two Ideas and the Ten Ideas conditions were excluded from the data analysis. The solution extraction consisted of three steps. In the first step, one of the authors trained the RAs to do the extraction by showing examples, and asked them to extract solutions from several postings independently. Then the author demonstrated the correct extraction and reemphasized the extraction method. In the second step, each RA used an Excel file to store the extracted solutions from each posting independently. In the last step, the author compared all the extractions from the two RAs to identify those that did not match with each other, and asked the RAs to discuss FtF and come up an agreed extraction for each disagreement. After the RAs have resolved their disagreements, the author counted the

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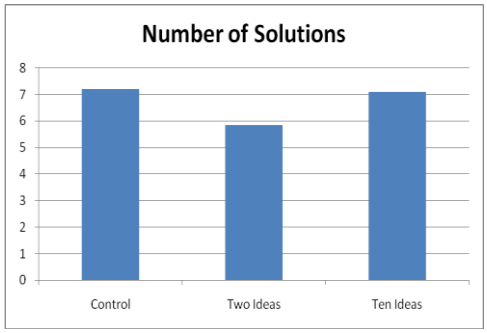
number of solutions for each posting and calculated the number of solutions for each team in every condition. Table 3 and Figure 3 show the average number of solutions for each condition.

Table 3: Means of number of solutions.

Condition	Mean	SD
Control	7.21	4.44
Two Ideas	5.85	2.86
Ten Ideas	7.11	4.18
Total	6.71	4.18

Figure 3: Means of number of solutions.



As Figure 3 illustrates, team members, who perceived that their co-workers did not contribute and that there was no opportunity for social loafing (Condition 1, Control) generated a greater number of ideas than those who perceived that there was opportunity for social loafing but their co-workers contributed a little (Condition 2, Two Ideas) (Mean = 7.21 vs. Mean = 5.85). However, the difference was not significant (F= 1.72. p = 0.20). H1 did not receive support in terms of the number of solutions. A possible explanation for this result is that team members in both Control and Two Ideas conditions worked hard when they perceived that there was no or not much room for free ride, while some team members in the Two Ideas condition tended to engage in social loafing and/or downward social comparison as their co-workers did not contribute much. Therefore, teams in the Two Ideas condition produced fewer solutions than their peers in the Control Condition, but the difference was not great.

When there was opportunity for social loafing, team members who perceived that other team members contributed a large number of ideas (Condition 3, Ten Ideas) generated a greater number of ideas than those who perceived that other team members contributed a small number of ideas (Condition 2, Two Ideas) (Mean = 7.11 vs. Mean = 5.85). However, the difference was not significant (F = 1.36, p = 0.26). Therefore, H2 did not receive support in terms of the number of solutions. A possible explanation for this result is that although there was room for social loafing in the Two Ideas condition, the perceived opportunity for social loafing was very limited. Thus, team members in this condition worked hard while at the same time they were inclined to engage in downward social comparison. Team members in the Ten Ideas condition, on the other hand, had the tendency to engage in upward social comparison. However, some of them engaged

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in social loafing as they perceived there was room for free ride. Therefore, the teams in the Ten Ideas condition produced more solutions than those in the Two Ideas condition, but not much.

H3 predicts that team members who perceive that their co-workers contribute a lot (Condition 3: Ten Ideas) will perform at least as well as those who perceive that their co-workers do not contribute (Condition 1, Control). The statistical analysis showed that there was no difference between the number of solutions generated in these two conditions (Mean = 7.21 vs Mean = 7.11; F = 0.006, p = 0.94). H3 was supported in terms of the number of solutions. The result implies that more team members in the Ten Ideas condition engaged in upward social comparison than social loafing. Therefore, their productivity was comparable to the productivity of teams in the Control condition.

In addition to the statistical analyses of the number of solutions, another measure, elaboration coefficients, was used to analyze the three conditions in terms of the amount of elaborations produced. We calculated the measure by using the formula proposed by Vreede and Briggs (2005):

$$\text{Elaboration Coefficient } \varepsilon = \delta / ((N-1) - \tau - \rho) \quad (1)$$

- δ *means the total number of contributions that refer to previously proposed ideas.*
- *N means total number of contributions, consisting of task-relevant ideas, task-relevant elaborations, redundancies, and noise.*
- τ *means non-task relevant contributions, i.e. noise.*
- ρ *means task relevant redundancy, e.g. the same original idea being contributed again.*

The elaboration coefficients were 0.13, 0.50, and 0.57 for the Control, Two Ideas, and Ten Ideas conditions respectively. Conforming to our expectation, the teams in the Control condition did not produce many elaborations as a person normally does not comment on her own ideas. On the other hand, teams in the other two conditions produced significantly more elaborations. The results demonstrated that although there was no significant difference among the number of solutions generated in different conditions, the richness of the ideas varied greatly. Both Two Ideas and Ten Ideas teams produced a lot more elaborations, some of which were solutions, and some of which were not. However, all elaborations enriched the meanings of the ideas generated as an elaboration could imply one or more of the following: (1) the team member agreed or disagreed with an idea, (2) the team member asked for clarification of an idea, (3) the team member thought an idea was practical or impractical, and (4) how an idea should be implemented.

In summary, according to the elaboration coefficients, team members in the Two Ideas and Ten Ideas conditions performed better than team members in the Control conditions, and there was no big difference between the Two Ideas and the Ten Ideas conditions. This conclusion again supports H3, but fails to support H1 or H2.

Although only H3 received support, the data on the number of solutions revealed an interesting pattern of the effects of social loafing and social comparison. If only social loafing effect existed, then the order of the three conditions based on the average number of solutions, from the largest

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to the smallest, would be Control, Two Ideas, and Ten Ideas because the possibilities for social loafing was ranked from no possibility, low possibility, to high possibility for these three conditions respectively. On the other hand, if only social comparison effect existed, then the order of the three conditions based on the average number of solutions, from the largest to the smallest, would be Ten Ideas, Two Ideas, and Control, since the perceived effort made by co-workers should be ranked high effort, low effort, and no effort respectively.

The pattern of the data indicates that the effects of social loafing and social comparison co-existed. However, the insignificance of the statistical analyses for H1 and H2 does not allow us to claim that one effect is stronger than the other in a given situation.

DISCUSSION

This study provides evidence that the effects of social loafing and social comparison co-exist, and may produce mixed outcome in virtual teamwork. Although this study did not demonstrate conventional levels of significance in regard to the number of solutions, the number of solutions generated by team members who perceived that their co-workers contributed a few ideas was on average lower than those generated by team members who perceived that their co-workers either did not contribute or contributed a lot. We speculate that in different virtual team interactions, the participants might have chosen different behaviors (social comparison vs. social loafing) to engage in. When they perceived that their co-workers' contribution level was low, the participants might be presented with a false perception of norm and engaged in downward social comparison or social loafing. The team performance suffered as a consequence.

In addition, this study suggests that when team members participate in team tasks, they can build upon others' ideas, clarify ideas, and engage in more in-depth discussion of a particular idea, as indicated by the elevated elaboration coefficient scores of the Two Ideas and Ten Ideas conditions in our experiment. When team members take free ride and do not contribute, there will be much less elaboration and discussion of ideas. From this perspective, social loafing exerts a significant negative impact on the performance of virtual teams.

MANAGERIAL IMPLICATIONS

There are several important implications for organizations associated with this study. First, managers need to be mindful that in virtual teams, team members may at free to engage in social loafing or social comparison. Some team members' high level of performance may create opportunities to take free ride for some and motivations to work hard for others. Carefully designing collaboration processes to minimize social loafing is crucial for successful team management. Second, when a virtual team is staffed with low performers, the team performance will suffer due to the effect of downward social comparison and social loafing. To increase team productivity, managers could form mixed teams and assign leadership roles to self-motivated high performers so that upward social comparison can be exerted and the overall team performance can be improved. Finally, managers should encourage all team members to contribute and build on each other's work in ideation sessions. As in virtual teams, members typically do not meet face-to-face and may have different working schedules, it is particularly

important to set up milestones and checkpoints, and design performance measures that cover different evaluation aspects.

LIMITATIONS

The study reported in this paper has several limitations. First is the use of students in the experiment. The controlled environment in the experiment makes it possible to isolate the variables being studied and maximize the effects of those variables, but the artificial setting may suffer limited generalizability across different participants and settings (Solansky, 2008). Although the findings may not be directly translated to real-world virtual teams, the manifestation of social loafing and social comparison effects is likely to occur in similar situations where people with diverse background and skills work together across time and space boundaries.

The task used in this study is also a limitation. The posttest survey demonstrates that the experiment task was not very relevant to the subjects. Therefore, the subjects might lack genuine interest in completing the task. As a result, the experiment effect was not as strong as it was expected.

CONCLUSION

Previous studies of anonymous ideation usually focused on the effects of evaluation apprehension and social loafing caused by anonymity in FtF interactions. These studies indicate that anonymity usually provides more team process gains (by reducing evaluation apprehension) than team process loss (by providing an opportunity for social loafing) in FtF interactions. Therefore, anonymity has positive effect on team performance in FtF interactions. However, this result should not be generalized to asynchronous virtual team interactions without further investigation.

We proposed that a third effect - social comparison – should be considered when managers create and staff virtual teams. This paper reports an empirical study that investigated virtual team performance in anonymous asynchronous ideation when there were different possibilities for social loafing and different levels for social comparison.

This research provides some preliminary insight into how the effects of social loafing and social comparison work together to affect virtual team productivity. However, more extensive research is needed to complement these findings. For example, a field study of real-world virtual teams would further validate these laboratory findings. In addition, future studies with more appropriate tasks, and more fine-grained design should be conducted to see (1) which effect, social loafing or social comparison, is stronger and under what conditions, and (2) how the effects of social loafing and social comparison could be minimized or maximized to increase team performance.

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