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Social Indispensability in Spite of Temporal and Spatial Separation: Motivation Gains in a Sequential Task During Anonymous Cooperation on the Internet

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Abstract*:* Recent research has demonstrated motivation gains during synchronous group work compared to individual work when group members' contribution was indispensable for the group's success (e.g., Hertel, Kerr, & Messé, 2000, Hertel, Deter, & Konradt, 2003). The current study extends this earlier research (a) by examining indispensability effects during sequential cooperation (temporal separation), and (b) by exploring these effects under conditions of high anonymity on the Internet (spatial separation). A 2 (Internet vs. laboratory context) x 3 (high vs. low vs. no impact of personal contribution for a group) x 2 (individual vs. group trial) design was used with the last factor measured within subjects ($N = 231$). Motivation was measured with a vigilance task that simulated an Internet travel agency selling package holidays according to incoming customer requests. During all trials, participants received contemporaneous feedback about their own performance. During the group trials, participants additionally received information about their partner's alleged previous performance at this point of the trial, which suggested that the partner had always performed slightly better than the participant. As expected, both in the laboratory and the Internet setting, the highest motivation gains occurred when participants' contribution to the group's outcome was indispensable for the group. This finding provides evidence that motivation gains among inferior group members are possible even during sequential group work under highly anonymous conditions.

Keywords: Group, performance, motivation gain, social indispensability, online experiment

Introduction

Emerging markets in separate geographic locations, as well as acquisitions and alliances between organizations all over the world are among the potential causes for the increasing prevalence of distributed work in virtual teams (e.g., Hertel, Geister, & Konradt, 2005). A main challenge in the management of distributed teams is to maintain work motivation of group members since anonymity and decreased interpersonal control have

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frequently been shown to decrease motivation in groups, as, for instance, demonstrated in research on social loafing (Karau & Williams, 1993).

The negative effects on work motivation in distributed teams might partly be due to the nature of virtual group tasks requiring little interaction and coordination between group members (i.e., independent or "summative" group tasks; Crown & Rosse, 1995). Moreover, if group members do not work simultaneously (e.g., when individual performance outcomes are added consecutively), interpersonal interaction and coordination, if existent at all, can only take place with temporal delay. Whereas opportunities to increase task interdependence (Mitchell & Silver, 1990) are rather limited due to physical and temporal separation, outcome or goal interdependence can be easier to establish in distributed groups even if the group task is organized sequentially. The latter strategy allows for reduction of loafing effects while retaining the benefits of task independent group work, such as time flexibility and low coordination demands. As for its prevalence, sequential cooperation is likely to occur in daily work life at least as often as synchronous cooperation, particularly during distributed cooperation, making it an effective element of virtual work.

In contrast to motivation losses found in groups, research has recently demonstrated that group members sometimes exhibit greater effort (i.e., show motivation gains) compared to when working alone (for an overview see Hertel, 2000). Motivation gains in groups are particularly likely when a group member's contribution is indispensable for the outcome of the group. For instance, in studies by Hertel et al. (2000), high importance of personal effort for the group's success led to increased motivation and performance in individual group members. Initial evidence for this "social indispensability"-effect in computer supported groups has been provided for simultaneous work in the laboratory (e.g., Hertel, Deter, et al., 2003; Hertel, Niemeyer, & Clauss, in press). In the present study, these initial results were extended to sequential work settings under high anonymity conditions on the Internet. Systematic reduction of evaluation potential provides insight into the processes underlying social indispensability effects. If individuals increase their efforts mainly because they strive to create a good impression of themselves, motivation gains should decrease or vanish when individuals are no longer personally identifiable. On the other hand, if collectivistic motives underlie indispensability effects (cf. Hertel, Kerr, Scheffler, Geister, & Messé, 2000), these motivation gains should not depend on the level of anonymity of the working conditions.

Social Indispensability

Due to social comparison processes, performance heterogeneity within work groups can enable both motivation gains and losses (Stroebe, Diehl, & Abakoumkin, 1996). If the task or outcome is perceived as unimportant, performance differences within the group might lead to motivation losses by more capable group members. However, if the task or outcome is considered important, performance differences in groups might lead to motivation gains in that low performing members feel compelled to overcome interindividual differences by increasing their efforts. Both of these processes depend on task-related self-efficacy being sufficient in motivating group members.

Motivation gains and losses due to mere comparison effects can be expected both when individuals work interdependently as a group and when they work alone with mutual performance feedback. Motivation gains that exceed mere comparison effects, however, should occur during group work when individual effort is important not only for personal outcomes but for other group members as well. Under these conditions, increased instrumentality of personal efforts should lead to a corresponding increase of motivation, particularly if individuals care for the group they belong to. For less capable group members, instrumentality is increased when the group task has a *conjunctive* structure (Steiner, 1972), i.e., the group's performance depends on the lowest individual contribution. For instance, a group undertaking a polar expedition cannot reach its destination faster than its slowest member (unless the group decides to leave him or her behind, of course). This person's performance is therefore highly instrumental for the group's success, resulting in a constellation termed *social indispensability* (e.g., Hertel et al., in press). In contrast to conjunctive tasks, responsibility for the group outcome in *additive* tasks is not assigned to a certain group member because individual contributions are pooled. Thus, low contributions of group members can be compensated for by other members, who are more capable and/or exert extra effort. Consequently, the contribution of less capable members is not as essential for the group's success on an additive task as compared to performance on conjunctive tasks.

Indispensability effects due to a conjunctive task structure were demonstrated initially by Otto Köhler (1926). In these studies, members of a rowing club showed higher effort and increased performance when they were the less capable group members in a conjunctive weightlifting task that could be performed only as long as both group members persisted. More recent studies replicated the indispensability effect in various physical and cognitive tasks insuring its applicability (Hertel, Kerr, & Messé, 2000; Hertel, Kerr, Scheffler et al., 2000; Messé, Hertel, Kerr, Lount, & Park, 2002). Hertel et al. (in press) also demonstrated that mutual performance

feedback is an important precondition for motivation gains because it provides information about the relative performance that is necessary for the less capable member to realize that her/his performance is crucial for the group's success. In the present study, we focus on two additional conditions affecting motivation specifically in distributed work groups: sequential task structure, and increased anonymity.

Simultaneous versus Sequential Cooperation

Earlier studies on motivation gains in computer mediated group work demonstrated indispensability effects for simultaneous cooperation on physical and cognitive tasks. In an initial study by Hertel, Deter, et al. (2003), indispensability effects were demonstrated for computer supported cognitive tasks in laboratory experiments with participants working simultaneously in different rooms of the same building. However, the effect's applicability to distributed work with the temporal separation of group members was not examined.

Sequential cooperation occurs when team members postpone intermediate results to other group members for further consideration, or when individual contributions are put together consecutively. Sequential cooperation can provide the simulation of an important aspect of working conditions especially in distributed or "virtual" teams (e.g., Hertel et al., 2005; Lipnack & Stamps, 1997), where cooperation is expected to be predominantly asynchronous due to physical separation and the relatively low degree of face-to-face communication and mutual feedback. Desynchronization might also arise from inherent task characteristics because tasks given to distributed teams are characterized by relatively low degrees of visibility and task interdependence (i.e., tasks that can be divided into subtasks that require a low degree of coordination between group members). Although task interdependence has been demonstrated to be associated with motivation gains especially at the beginning of teamwork (Hertel, Konradt, & Orlikowski, 2004), modularity in terms of task independence can also have considerable advantages, which might apply to both distributed and co-located team work. First, motivation losses due to lack of identifiability of individual contribution (i.e., social loafing) can be avoided, as well as performance impairment due to coordination losses. Moreover, task independence simplifies group goal setting because conflicts between individual and group goals are less likely to occur (Crown & Rosse, 1995). Finally, flexibility regarding time, place, and working procedures inherent to virtual work can lead to additional motivation gains and increased performance (Hertel et al., 2005).

Initial evidence for the effects of sequential position on cooperation can be found in social dilemma research. In these studies, group members do not decide simultaneously whether or not to contribute to the provision of the public good, but make their decisions consecutively (Au, Chen, & Komorita, 1998; Chen, Au, & Komorita, 1996; Erev & Rapoport, 1990; Rapoport, 1988; Rapoport & Eshed-Levy, 1989). These findings showed that a later position in a sequential order led to increased perceived instrumentality of individual contribution for the provision of the public good, and consequentially to increased work investments (i.e., higher cooperation) in co-located groups. More specifically, cooperation rates increased with the increasing certainty about the instrumentality (or indispensability) of one's individual contribution for the group's success.

Another potential influence of sequential group work on motivation is perceived normative pressure regarding reciprocity norms (Gallucci & Perugini, 2003). *Positive normative reciprocity* refers to the tendency to reciprocate friendly behavior, such as high performance of other group members and contribution to the group outcome, and thus might be involved in motivation gains especially of group members performing later in the sequential order. *Negative normative reciprocity* refers to the tendency to reciprocate behavior that is perceived as aggressive or unfair, such as holding back one's contribution to the group product. Thus, negative reciprocity might also be related to motivation losses of group members performing later in the sequential order. However, effects of reciprocity on motivation need not always derive from normative pressure. *Strategic reciprocity*, i.e., beliefs in reciprocity as an instrument to maximize individual utility (Eisenberger, Cotterell, & Marvel, 1987), might also be involved in motivation gains in sequential tasks when group members performing on early positions exert extra effort in order to increase subsequent group members' motivation to cooperate.

In order to test whether motivation gains can be demonstrated during group work with temporal separation of group members, we conducted an initial study that employed a sequential task structure. Because all participants worked as the lower performing member on the second position of a two member team, we focused on positive reciprocity as a potential moderator of motivation gains. Additionally, negative and strategic reciprocity tendencies were measured for exploratory reasons.

Anonymity during Group Work

Earlier research (e.g., Hertel, Deter, et al. 2003; Hertel et al., in press) demonstrated that motivation gains in groups based on social indispensability effects are possible even when individuals work with an anonymous team partner, i.e., when group members do not meet each other before the experiment, work in separate rooms,

and are informed prior to group work that group members will neither meet after the experiment nor be told each other's names. Although these motivation gains were lower than during face-to-face work, the assumption was supported that impression management toward the partner is not a necessary precondition for indispensability effects to occur (cf. also Hertel, Kerr, Scheffler et al., 2000). However, since participants in these studies were instructed face-to-face by an experimenter, impression management concerns can not be ruled out completely. Therefore, we addressed this aspect in the present study by recruiting part of the participants anonymously in the Internet. These participants did not have any face-to-face contact with an experimenter. The other participants completed the experiment in the laboratory with an anonymous team partner as well, but had face-to-face contact with an experimenter in the beginning and at the end of the experiment. Comparison of these two settings might provide some evidence whether personal contact with an experimenter and related impression management concerns are a crucial part of indispensability effects in groups.

Internet Experiments

Internet experiments provide several advantages compared to laboratory research (e.g., Birnbaum, 2000; Reips, 2002). They allow for economic data collection and access to large samples, including specific sub-samples with certain age, socio-economic background or other variables of interest. Online research can also help increase the ecological validity of experimental data due to participants working in their normal environment and (in many cases) at their own desk. Moreover, due to increased anonymity, social desirability and experimental biases can be reduced and thus the quality of questionnaire data can be enhanced.

On the other hand, reduced experimental control due to physical distribution and lack of standardized experimental environment might increase the risk for participants: (1) not following experimental instructions, or (2) being disturbed by external factors. Especially when financial incentives are announced, a considerable number of participants might try to maximize their reward by merely "clicking through" the experiment without reading instructions thoroughly. Analyses of response times and error rates are useful instruments in order to determine invalid cases. Conclusions on the effects of external disturbance can be drawn by recent research on different levels of standardization in laboratory and Internet settings (Ollesch, Heineken, & Schulte, 2006), providing evidence that Internet-based experiments lead to similar results as experiments in laboratory and campus settings. These findings support the notion that the internal validity of results provided by Internet studies is comparable to those yielded by laboratory research. Further potential problems related to Internet experiments are limited internal validity due to systematic *drop-out*. Drop-out rates might increase in Internet experiments compared to the laboratory, and it may not always be possible to decide whether drop out is caused by technical or motivational problems. Since this endangers internal validity particularly when confounded with experimental manipulation, drop-outs should be logged and analyzed for systematic bias.

Finally, external validity can be limited due to *sampling errors*. Although nearly half of the German population is documented as having Internet access (Faas, 2003), online studies might still lead to selected samples and result in limited generalizability of findings attained in online research (Couper, 2000; Hauptmanns & Lander, 2003). Similar arguments, however, might apply to traditional laboratory studies limited to samples of college students as well. In fact, Internet studies might even provide access to less restricted samples than traditional laboratory research, especially when measures are taken to prevent sample bias, such as establishing multiple site entry (Reips, 2002).

Hypotheses

Whereas group members worked synchronously and at the same place in earlier studies on motivation in computer support groups (e.g., Hertel, Deter, et al., 2003; Valacich, Dennis, & Nunamaker, 1995), in the present study a sequential task structure was implemented along with increased anonymity both toward their team partner *and* toward the experimenter. Thus, both temporal and physical distribution of team members in the current study was used to more closely simulate distributed team work. Based on findings regarding social indispensability effects, we expect motivation gains in less capable group members in conjunctive tasks (social indispensability of personal contribution for the group) to exceed motivation gains in comparable individual work with mutual performance feedback (no impact of personal contribution for others) and in additive tasks (low impact of personal contribution for the group). Secondly, we expect similar indispensability effects to occur during computer supported cooperation in the laboratory and on the Internet since impression management concerns or evaluation apprehension from the experimenter were not expected to be major underlying factors.

Method

Participants

The present study was conducted to investigate whether social indispensability effects could be demonstrated during sequential Internet based group work, and whether these effects are affected by increased anonymity due to the virtual (instead of physical) presence of an experimenter. Recent meta-analytic findings suggest that research on indispensability effects requires control for gender effects because group work involving social responsibility and indispensability of own contribution for others seems to produce motivation gains less consistently with male than with female participants. In order to keep sample size at a practicable level, we decided to implement the complete experimental design for female participants, and to include a male sample in the online setting only in order to enable an analysis of gender effects within the Internet sample.

Data collection was conducted between July and December 2005. As an incentive for participation, performance related amounts of money were distributed among the participants in a lottery after data collection was completed. 599 individuals who had indicated interest in taking part during an earlier study were invited to the study via e-mail. Of these, 127 completed both pre-questionnaire and online experiment, resulting in a response rate of 21.4% for this sub sample. Demographic data about this sub sample was available in 544 cases (395 female, 149 male). Average age was 26 (SD = 8), 94% of the participants were qualified by degree for university admission, and 97% indicated they used the Internet at least twice a week. Panel participants received no additional direct or indirect incentives for participation in the study. Thus, the incentives offered to this sub sample were identical to those offered to the other participants.

A total of 338 participants were recruited using various methods (panel, Web sites, newspaper and blackboard announcement, personal recruitment). From those, 107 invalid cases were identified (drop out, technical problems, free answers in the final questionnaire, or error rates that indicated suspicion or violation of experimental instructions. Drop out occurred in 31 cases of the Internet setting (i.e., 9 % of the total sample), and was distributed about equally over task conditions, $\chi^2(3, N = 31) = 0.1, p = .99$.

Invalid cases due to technical problems, error rates, or disbelief of the cover story were distributed about equally across settings, $\chi^2(1, N = 47) = 1.72$, $p = .19$, and task conditions, $\chi^2(3, N = 47) = 2.45$, $p = .49$, for female participants. For male participants, invalid cases were distributed about equally across task conditions in the Internet setting, $\chi^2(3, N = 29) = 5.35$, $p = .15$. A total of twenty cases were excluded because of *technical problems*. In nine of these cases, duration of at least one work trial deviated more than 60 seconds from the intended duration of 600 seconds; in seven cases, missing data in forced choice-items indicated storage failure; and in the remaining four cases, participants had reported slowed Internet connection in at least one trial or had started the experiment several times before completing it. Forty cases were excluded because of *error rates* of more than 30 percent in at least one work trial, which indicated participants had not followed or not understood the task instructions. Finally, sixteen cases were excluded because participants' written comments at the end of the experiment revealed *suspicion* (e.g., "I thought the team partner was faked") or *misunderstanding of the task* (e.g., "During the first trial, I always chose single room and changed my strategy in the second trial when I realized that double room was the cheaper option").

Together, a sample of 231 cases resulted for the following analyses (159 female, 72 male). Participants were distributed randomly to the experimental conditions. Their average age was 26 (SD = 7), 97% had a degree that qualified them for university admission, and 97% indicated they used the Internet at least twice a week. Systematic differences regarding age and education occurred neither between laboratory and Internet setting, nor between task conditions within the two settings. Not surprisingly, participants in the Internet sample reported more frequent use of the Internet compared to the laboratory sample, $\chi^2(3, N = 231) = 21.85, p < .01$.

Procedure

Main experiment. During the main experiment, a virtual travel agency selling package holidays on customer request was simulated. For a test version of the study see http://www.abo.psychologie.uni-wuerzburg.de/ds2006/. If you are interesting in using the experimental program in your own study, please visit http://www.abo.psychologie.uni-wuerzburg.de/virtualcollaboration/tools.php for a free download of the MotiSim toolkit.

Pre-test. About one week before the main experimental session started, participants completed a pre-questionnaire that included demographic data and two scales measuring personality traits (see Figure 1 for an overview of the experimental procedure). The pre-questionnaire was presented online with identical material

used in the laboratory and Internet conditions. *Social comparison tendency* (Gibbons & Buunk, 1999) was measured because social comparison processes can be involved in motivation gains in groups particularly of inferior group members (cf. Hertel et al., in press). For the social comparison scale, Cronbach's Alpha coefficient was .79. In addition, a combined scale measuring *reciprocity* including items from two existing scales (Gallucci & Perugini, 2003; Eisenberger, Cotterell, & Marvel, 1987) was presented in a German translation. This scale was constructed based on a pilot study and included four items on positive normative reciprocity (i.e., "I go out of my way to help somebody who has been kind to me before"), four items on negative normative reciprocity (i.e., "If somebody puts me in a difficult position, I do the same to him/her"), and two items on strategic reciprocity (i.e., "It generally pays to let others do more for you than you do for them"; reversed item). All items were rated on verbally anchored five-point scales ranging from "not at all" to "very much". Cronbach's Alpha coefficients for the positive and negative normative reciprocity subscales were both .68, which can be considered sufficient given the item number per scale and the initial stage of this research (cf. Cortina, 1993; Lance, Butts, & Michels, 2006). Moreover, the average item intercorrelation for each scale was satisfactory, $r(N = 231) = .37$, $p < .01$ for positive reciprocity and $r(N = 231) = .31$, $p < .01$ for negative reciprocity. The intercorrelation of the two items on strategic reciprocity was $r(N = 231) = .58$ ($p < .01$).

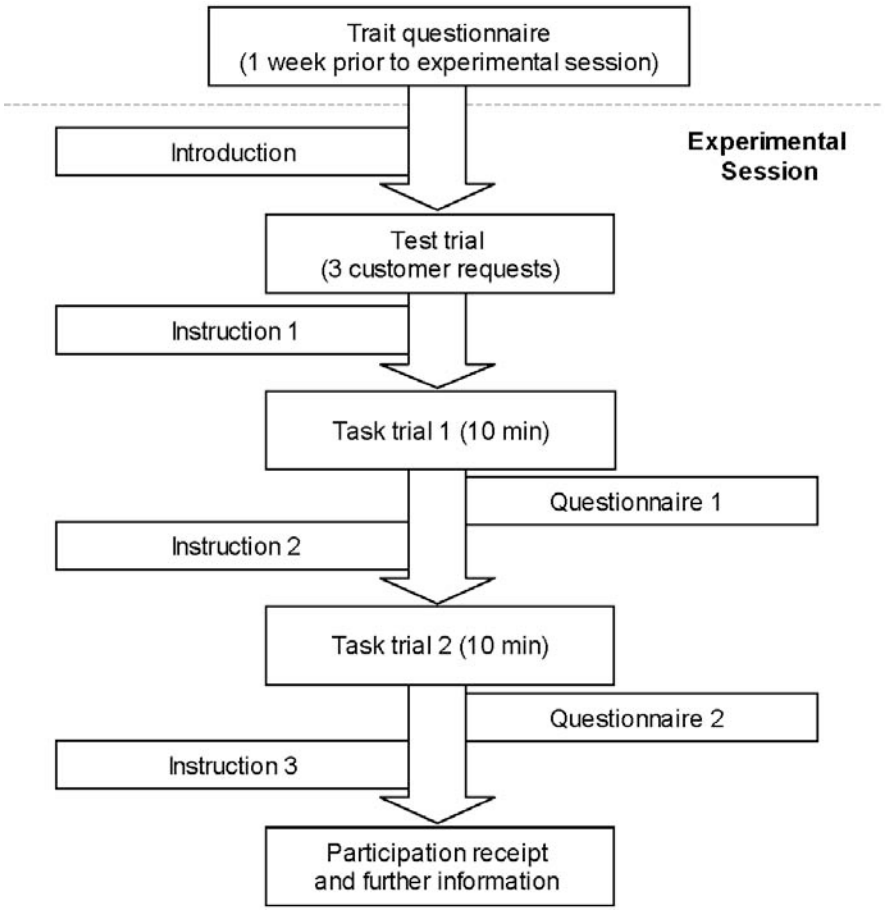

Figure 1. Overview of the experimental procedure. Depending on the experimental condition, participants either received an e-mail including an invitation to the online experiment or attended the laboratory session one week after completion of the online trait questionnaire.

The trait scales were presented about one week prior to the experiment in order to reduce the risk of priming effects on experimental data. In the Internet conditions, participants were invited to take part in the main experiment after they had completed the online questionnaire. About one week later, those who had agreed received an invitation e-mail including a personal access link which expired after the experiment was completed. Thus, in order to reduce potential effects on perceived anonymity, multiple participation was prevented unobtrusively by establishing password secured access. In order to further increase anonymity, the personal access code was a computer generated ten-digit combination of numeric and alphabetic characters. In the laboratory conditions, participants were sent an e-mail including a personal link to the online questionnaire about one week before the appointed date of the laboratory experiment.

In the experimental task, an Internet travel agency selling package holidays according to incoming customer requests was simulated. In the beginning of the experiment, participants were instructed to complete travel packages consisting of accommodation (double room, single room, apartment or bungalow) and meals (all inclusive, full board, half board or accommodation only) according to two simple rules. In order to complete a customer request correctly, participants had to include a customer preference for either accommodation or meals. For the remaining component participants had to choose the least expensive option. Since package options switched position on the screen with the appearance of each customer request, participants basically worked on a vigilance task. A close relation between motivation and performance was expected because there was only one obviously correct solution for each customer request and no specialized skills, such as mental arithmetic, were required. Moreover, the experimental task constitutes a simplified version of a task that was pilot-tested and used in previous studies (e.g., Hertel, Deter, et al., 2003), suggesting a monotonous relation between motivation and performance indicators. We therefore used the number of travel packages each participant completed correctly as an indicator of participants' effort.

At the beginning of the experiment, all participants in the study were informed that they could earn money through their performance. After data collection was finished, one sixth of the participants was picked randomly and paid 15 ct per customer request completed correctly during the experiment. Altogether, participants could win up to 50 Euro.

Experimental manipulation. Hypotheses were examined using a 3 (conjunctive vs. additive vs. feedback only) x 2 (Internet vs. laboratory) x 2 (Trial 1 vs. Trial 2) experimental design (see Figure 2). The first factor was manipulated by a variation in the task structure, i.e., social indispensability of individual performance due to a conjunctive task structure, low instrumentality of individual performance due to an additive task structure, and partner related performance feedback only. The second factor was manipulated by implementing all task conditions in a laboratory experiment and on the Internet, using an identical experimental procedure in both settings. In order to explore motivation gains compared to individual work, each participant completed two task trials, one individual trial where no partner related performance feedback was presented, and one group trial with partner related performance information. Each work trial lasted 10 minutes. The experimental manipulation was presented after the first trial. In order to control for learning/fatigue and other time related effects, additional control groups were used both in the Internet and laboratory settings. Controls completed two consecutive identical individual trials (see Hertel, Deter, et al., 2003, for a similar procedure).

	Laboratory Experiment	*Internet Experiment*	
	Female Sample	*Female Sample*	*Male Sample*
Conjunctive Group Task	Individual Trial Group Trial	Individual Trial Group Trial	Individual Trial Group Trial
Additive Group Task	Individual Trial Group Trial	Individual Trial Group Trial	Individual Trial Group Trial
Feedback Only	Individual Trial Individual Trial	Individual Trial Individual Trial	Individual Trial Individual Trial
Control	Individual Trial Individual Trial	Individual Trial Individual Trial	Individual Trial Individual Trial

Figure 2. Overview of the experimental design.

Before the second trial was started, the task structure was manipulated by informing participants in the group conditions that while they would complete accommodation/meal packages, their partner would work on a similar task completing destinations and means of transportation for the same travel packages. A conjunctive task structure was implemented by informing participants that only customer requests completed correctly by both

partners would count for the group outcome (see Hertel, Deter, et al., 2003, for a similar procedure). In the additive conditions, participants were informed that the group outcome was determined by the sum of individual performances. In the "feedback only" conditions, participants worked for the same individual incentives as in the first trial, but received only performance information about another person, without any group context or group outcome being mentioned.

During both trials, feedback about participants' performance was provided contemporaneously. During the second trial, participants additionally received information after every fourth incoming customer request about how many requests their (alleged) partner had completed at this point of the trial. Partner feedback was predefined in order to keep context conditions comparable and implied that the partner was always between one and three customer requests ahead. The same holds true for the "feedback only" condition.

After the trial, participants completed a third questionnaire including items on subjective effort and perceived importance of their individual performance. At the end of the experiment, participants were asked to briefly describe if anything in the experiment struck them as important. This item served as a covered suspicion check. All other items were rated on verbally anchored seven-point Likert scales ranging from "not at all" to "very much".

At the end of the experimental session, participants were thanked, handed out a receipt including a personal code and information about the lottery, and were asked to visit the "winner Web site" at the end of the study in order to see whether their code number had won and to receive further information about the study. After the experiment was finished, every sixth code number was picked randomly and announced on the winner Web site which also included debriefing information about the aims of the study.

Results

Because the experimental design did not include a male laboratory sample, results are reported separately for gender. In order to avoid confounding with sample size and gender distribution, the hypotheses on setting and anonymity effects were tested for the female sample ($N = 159$) only. Subsequently, the results for the male sample tested in the Internet condition only ($N = 72$) are reported and compared to the female Internet sample in order to investigate whether gender effects occurred within the Internet sample. Potential effects resulting from the lack of a male laboratory sample are considered in the discussion section.

Manipulation Checks (Female Sample)

Performance discrepancy. In the present study, social indispensability was produced by providing instructions and performance feedback indicating that participants were the slightly less capable members of a dyad working on a conjunctive group task. In order to test if manipulation of the partner's achievement was successful, participants were asked to rate partner effort and ability. As expected, mean subjective ratings of perceived partner ability and effort at least equaled the scale midpoint in all experimental conditions, all ts > 2.9, $p < .05$.

Perceived anonymity. As expected, rated importance of impression management concerns decreased during the experiment in the Internet setting, $M = -.11$, $SD = 1.44$, $n = 79$, compared to the laboratory setting, $M = .23$, $SD = 1.14$, $n = 80$, $t(157) = -1.65$, $p = .05$. There were no initial differences between settings in the first trial, $t(157) = 1.01$, $p = .32$.

Preliminary Analyses (Female Sample)

Preliminary analyses were conducted in order to explore whether the experimental conditions were comparable in terms of interindividual differences (see Tables 1 and 2).

In order to identify mere fatigue or training effects on performance from the first to the second trial, we analyzed performance data in the control conditions (see Table 2). A 2 (setting: laboratory vs. Internet) x 2 (work trial: Trial 1 vs. Trial 2) ANOVA (second factor within subjects) on the number of requests completed correctly in the first and second trial revealed a significant training effect, $F(1, 39) = 87.08$, $p < .01$, $\eta^2 = .69$. This effect was further qualified by an interaction effect, $F(1, 39) = 5.19$, $p < .05$, $\eta^2 = .12$, indicating that training effects were slightly higher in the laboratory than in the Internet setting. Therefore, Trial 2 performance scores of all participants were corrected by multiplication with the ratio of the control group performances in the first to the second trial (see Hertel, Deter, et al., 2003, for a similar procedure), with correction factors computed separately for the female Internet sample, the female laboratory sample, and the male Internet sample.

Table 1
Performance and Subjective Ratings in the Experimental Conditions for Female Participants in Trial 1

Variable	Conjunctive task		Additive task		Feedback only	
	M	*SD*	*M*	*SD*	*M*	*SD*
			Laboratory setting			
	n = 18		*n* = 20		*n* = 22	
Performance in Trial 1[1]	104.28	30.51	101.00	26.63	114.73	22.70
Subjective Motivation in Trial 1[2]	3.72	1.30	3.90	1.42	4.32	1.00
Perceived Instrumentality in Trial 1[2]	2.72	1.27	2.70	1.66	2.95	1.25
			Internet setting			
	n = 18		*n* = 21		*n* = 19	
Performance in Trial 1[1]	104.44	25.85	103.95	24.17	105.11	16.55
Subjective Motivation in Trial 1[2]	4.08	1.26	4.02	1.16	4.16	1.30
Perceived Instrumentality in Trial 1[2]	2.98	1.41	2.67	1.16	3.47	1.43

[1]Number of customer requests completed correctly. [2]Scale ranges from 0-6.

Individual performance. Comparison of Trial 1 performance (number of customer requests completed correctly) revealed no significant initial differences between settings and experimental conditions regarding initial performance, all Fs < 1.41, p > .2 (see Table 1). Subsequently, we used performance difference scores (Trial 2 minus Trial 1) in order to examine motivation gains in groups compared to individual work.

Table 2
Performance in the Control Conditions (Number of Customer Requests Completed Correctly)

	Laboratory/female		Internet/female		Internet/male	
	M	*SD*	*M*	*SD*	*M*	*SD*
Trial	*n* = 20		*n* = 21		*n* = 22	
First trial	98.65	23.20	99.86	21.59	94.09	32.54
Second trial	120.75	20.70	113.29	24.35	111.86	34.37

Subjective motivation and perceived instrumentality. Comparison of Trial 1 ratings revealed no significant initial differences between settings and task conditions regarding subjective motivation, all Fs < 2.6, p > .2. The same holds for perceived instrumentality of individual performance for the group's outcome, all Fs < 2.5, p > .2. During subsequent analyses, we used difference scores (Trial 2 minus Trial 1) for both variables.

Correlation of performance and subjective motivation. In order to explore whether the performance scores in our experimental task paradigm correspond with subjective motivation ratings, we analyzed the correlation of performance difference scores (number of customer requests completed correctly in Trial 2 minus Trial 1) with difference scores of motivation ratings (Trial 2 minus Trial 1). Analyses revealed the expected significant positive correlation of subjective motivation and performance, $r(n = 159) = .37$, $p < .01$, which implies that performance in the experimental task can be used as an indicator of participants' motivation.

Social comparison and reciprocity tendency. The laboratory and Internet sample differed regarding social comparison and negative reciprocity tendency such that female participants' ratings were lower in the laboratory than in the Internet sample, $F(1, 151) = 6.19$, $p < .05$, $\eta^2 = .039$; $F(1, 151) = 4.39$, $p < .05$, $\eta^2 = .028$. However, and more importantly, there were neither significant differences between task conditions nor significant interaction effects. No significant differences in positive and strategic reciprocity occurred, both Fs < 1. Moreover, there were no significant positive correlations between the trait measures and our main dependent variable (performance differences between group and individual trials, see below), all rs < .1.

Analyses of Motivation Gains (Female Sample)

In order to test our hypothesis that motivation gains in groups compared to individual work should be highest under conjunctive task conditions, we first analyzed performance (i.e., number of customer requests completed correctly) difference scores within task conditions. One sample t-tests against zero revealed a significant performance increase from Trial 1 to Trial 2 in the conjunctive condition only, $t(35) = 2.07$, $p < .05$; all other ts < 1. Consistent with our expectations, significant performance improvement beyond mere training effects occurred only when participants worked as an inferior team member in a conjunctive task, replicating the basic social indispensability effect.

Subsequently, we compared performance difference scores between the experimental groups (see Table 3). A 4 (task structure: conjunctive vs. additive vs. feedback only vs. control) x 2 (setting: lab vs. Internet) ANOVA with customer requests completed correctly as the dependent variable revealed a significant main effect of task structure, indicating that performance increase, and thus motivation gains, in the conjunctive condition exceeded motivation gains in the additive and feedback only conditions, $F(3, 151) = 3.29$, $p < .05$, $\eta^2 = .06$. A planned contrast of performance difference scores in the conjunctive task compared to the average of the additive and feedback only conditions was significant, $t(155) = 2.83$, $p < .01$. As expected, there was neither a main effect of setting nor an interaction effect of task structure and setting, both Fs < 1.

Thus, both our hypotheses were supported. Motivation gains under conjunctive task demands exceeded motivation gains in the other experimental conditions both in the laboratory and in the Internet setting. Effect sizes for differences between experimental groups and controls were computed following the procedure proposed by Hedges and Olkin (1985), which incorporates group sizes and standard deviations within groups. For the conjunctive task condition, effect size *g* was .51 in the laboratory and .60 in the Internet study. For the additive and feedback only condition, effect size was .04 (laboratory) vs. .20 (Internet), and -.25 (laboratory) vs. -.07 (Internet), respectively.

Subjective Ratings (Female Sample)

Female participants' ratings of their efforts and the perceived instrumentality of their individual performance supplemented the analyses of performance measures. Similar to the analyses of performance data, we focus on difference scores of the ratings in the second and the first trials. Positive difference scores indicate gains in the second trial compared to the first (individual) trial (see Table 3).

Table 3
Means and Standard Deviations of Performance Scores and Subjective Ratings (Female Participants)

	Conjunctive		Additive		Feedback only	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
			Laboratory			
	n = 18		*n* = 20		*n* = 22	
Performance Difference Scores Corrected for Learning Effects[1]	5.83	20.83	0.02	12.76	- 5.22	10.78
Subjective Motivation (Difference Scores)	0.39	1.18	0.45	1.08	0.05	0.71
Perceived Instrumentality (Difference Scores)	0.28	1.45	0.40	1.31	0.36	0.90
			Internet			
	n = 18		*n* = 21		*n* = 19	
Performance Difference Scores Corrected for Learning Effects[1]	6.23	14.02	1.53	9.80	-1.42	11.55
Subjective Motivation (Difference Scores)	0.50	1.07	- 0.24	1.13	- 0.18	1.13
Perceived Instrumentality (Difference Scores)	0.83	1.47	0.00	1.14	- 1.11	1.52

[1]Number of customer requests completed correctly.

Subjective motivation. A 4 (task structure) x 2 (setting) ANOVA revealed a significant main effect of task structure on subjective motivation difference scores, $F(3, 151) = 2.61$, $p < .05$, $\eta^2 = .049$. A planned contrast of subjective motivation difference scores in the conjunctive condition compared to the average of the additive and feedback only conditions was significant, $t(155) = 1.71$, $p < .05$. As displayed in Table 3, subjective motivation gains in the conjunctive condition exceeded motivation gains in the other task conditions, which is consistent with the social indispensability hypothesis. In addition, there was a slight but non-significant effect of setting on subjective motivation difference scores, $F(1, 151) = 3.57$, $p < .10$, $\eta^2 = .023$, suggesting that subjective motivation increase was marginally higher in the Internet than in the laboratory setting.

Effect size *g* for subjective motivation differences between the conjunctive condition and controls was .19 in the laboratory study and .91 in the Internet study. For the additive and feedback only conditions, effect size was .25 (laboratory) vs. .43 (Internet) and -.14 (laboratory) vs. .30 (Internet), respectively.

Perceived indispensability. A 4 (task structure) x 2 (setting) ANOVA on perceived indispensability of personal effort for the team (difference scores Trial 2 – Trial 1) revealed significant effects of task type, $F(3, 151) = 5.35$,

$p < .01$, $\eta^2 = .096$, setting, $F(1, 151) = 5.63$, $p < .05$, $\eta^2 = .036$, as well as a significant interaction effect, $F(3, 151) = 4.46$, $p < .01$, $\eta^2 = .081$. As displayed in Table 3, a conjunctive task structure led to significantly higher difference scores of perceived importance of personal efforts compared to the other two task conditions. Accordingly, the correlation of performance increase with difference scores for perceived instrumentality of individual performance was significant only in the Internet setting ($r(n = 151) = .20$, $p < .05$). A planned contrast of perceived instrumentality difference scores in the conjunctive task compared to the average of the additive and feedback only conditions was significant, $t(155) = 2.42$, $p < .01$.

Effect size *g* for perceived instrumentality differences between the conjunctive condition and controls was .33 in the laboratory and 1.16 in the Internet setting. For the additive and feedback conditions, effect size was .46 (laboratory) vs. .57 (Internet) and .54 (laboratory) vs. -.38 (Internet), respectively. Thus, considerable motivation gains were found in the conjunctive condition compared to the other conditions, and in the Internet compared to the laboratory setting.

Male Sample

Subsequently, performance data and subjective ratings of male participants in the Internet setting were analyzed and compared to the data of female participants in the Internet setting in order to examine potential gender effects on motivation within the Internet conditions.

Manipulation Checks (Male Sample)

Performance discrepancy. For the male sample, mean subjective ratings of perceived partner ability and effort at least equaled the scale midpoint in all experimental conditions, all ts > 2.5, $p < .05$.
Perceived anonymity. As expected, male and female participants in the Internet setting did not differ in rated importance of impression management concerns during the first trial, $t(149) = 0.86$, $p = .39$, and in difference scores between the second and first trial, $t(149) = 0.77$, $p = .44$.

Preliminary Analyses (Male Sample)

Individual performance and subjective measures. Performance data and ratings of motivation and perceived instrumentality for male participants are presented in Table 4. Experimental groups significantly differed regarding Trial 1 performance, $F(3, 68) = 3.83$, $p < .05$, $\eta^2 = .145$, indicating differences in the overall task capability of participants between the experimental conditions. Trial 1 performance in the additive condition exceeded Trial 1 performance in the other two conditions. There were no group differences in Trial 1 regarding subjective motivation and perceived instrumentality of own performance, both Fs < 1.

Table 4
Means and Standard Deviations of Performance Scores and Subjective Ratings for Male Participants (Internet Sample)

Variable	Conjunctive		Additive		Feedback only	
	M	*SD*	*M*	*SD*	*M*	*SD*
	n = 17		*n* = 18		*n* = 15	
Performance in Trial 1[1]	102.53	24.32	121.44	20.90	105.47	20.33
Subjective Motivation in Trial 1[2]	4.17	1.26	4.69	1.17	4.50	1.25
Perceived Instrumentality in Trial 1[2]	3.06	1.35	3.22	1.35	3.20	1.61
Performance Difference Scores Corrected for Learning Effects	0.93	14.98	- 4.62	14.42	- 0.72	8.85
Subjective Motivation (Difference Scores)	0.09	1.29	0.33	0.45	0.27	0.65
Perceived Instrumentality (Difference Scores)	0.06	1.20	0.33	1.37	0.07	0.80

[1]Number of customer requests completed correctly. [2]Scale ranges from 0-6.

Correlation of performance and subjective motivation. Female and male participants showed similar correlations between performance (number of customer requests completed correctly) and subjective motivation ratings. For the male sub sample, the correlation between these two parameters was r ($n = 72$) = .37, $p < .01$.

Social comparison and reciprocity tendency. For the male sample, there were neither significant differences between task conditions nor significant interaction effects regarding trait measures, all Fs < 2. Moreover, no significant positive correlations occurred between trait measures and our main dependent variable (performance gains between group and individual trials, see below), all rs < .2, ns.

Analyses of Gender Effects on Motivation Gains

The comparison of female and male performance in the Internet sample revealed no significant gender effect on performance difference scores corrected for learning effects, $F(1, 143) = 1.76$, $p = .19$. Moreover, there was no significant interaction of gender and task type on performance, $F < 1$.

However, analyses separated for gender revealed a different performance pattern for male participants as opposed to female participants. For male participants, significant social indispensability effects occurred neither for performance measures nor for subjective motivation or perceived instrumentality, all Fs < 1. Effect size *g* for performance differences corrected for learning effects compared to controls was .19 in the conjunctive condition, -.02 in the additive condition and .11 in the feedback only condition. Effect size *g* for subjective motivation and perceived instrumentality compared to controls were .01 and -.31 for the conjunctive condition. For the additive condition, effect size compared to controls was .25 for subjective motivation and -.03 for perceived instrumentality. Finally, in the feedback only condition effect sizes were .17 for subjective motivation and -.38 for perceived instrumentality, respectively. Thus, unlike female participants, male participants did not show motivation gains in the conjunctive condition compared to the other experimental conditions.

Discussion

The main objective of this study was to examine whether motivation gains in groups due to social indispensability can be demonstrated even during anonymous cooperation on the Internet using a sequential task paradigm. While social indispensability effects have already been demonstrated in prior studies where the team partner was unknown to participants (e.g., Hertel, Deter, et al., 2003; Hertel et al., in press), there were no studies so far showing motivation gains in groups without face-to-face contact with an experimenter and under sequential task conditions. The current study explored motivation gains in groups due to social indispensability during anonymous group work with both *temporal* and *spatial* separation of team partners.

The results reported show that significant motivation gains were triggered when participants (allegedly) worked as part of an Internet-based group if their contribution was indispensable for the group outcome. This finding is particularly remarkable because participants worked under highly anonymous conditions. Not only was the cooperation partner unknown, but participants also worked without any face-to-face contact with an experimenter. However, lack of face-to-face contact with an experimenter in the Internet condition compared to the laboratory condition did not reduce motivation gains, which suggests that evaluation concerns are not a necessary component of social indispensability effects. This assumption received additional support in recent laboratory findings (Hertel et al., in press). Together, our findings demonstrate the robustness of social indispensability effects and the generalizability of laboratory findings to less standardized working conditions outside of the laboratory. In fact, indispensability effects on ratings of subjective motivation and perceived importance of individual performance were even stronger in the Internet setting compared to the laboratory setting. One potential explanation for this effect is provided by SIDE theory which applies to the various potential consequences of visual anonymity in computer-supported collaboration (e.g., Reicher, Spears, & Postmes, 1995). However, the overall implications of the theory's predictions for our study are ambiguous. On the one hand, SIDE theory predicts that visual anonymity increases the salience of social identity and, as a consequence, strengthens the influence of salient group norms. Consequently, motivation gains due to normative concerns (e.g., social responsibility) should be higher in the Internet compared to the laboratory setting. On the other hand, SIDE theory suggests that personal identifiability can enhance group members' tendency to act in a group-normative manner (Douglas & McGarty, 2001; Spears & Lea, 1994) and promote group oriented behaviour in favour of collective interests, which should lead to higher motivation gains in the laboratory compared to the Internet setting. A potential integration of these conflicting predictions must refer to the different processing paths underlying these effects, such as salience of norms due to anonymity and strategic considerations due to identifiability. Unfortunately, the results of the current study do not address this question in sufficient detail making further research desirable. The involvement of general social norms, such as social responsibility, might also account for the substantial effect sizes we found for the conjunctive conditions compared to controls. The considerable setting differences we found regarding effect sizes on subjective motivation and perceived instrumentality might result from reduced social desirability or from less artificial working conditions in the Internet condition, which might have led subjects to report motivational processes in a more valid way than in the laboratory. Although conclusions about the underlying processes require further research, the finding that an Internet setting can provide even clearer results regarding subjective data than an equivalent laboratory setting seems promising.

This study provides the first demonstration of motivation gains during sequential team work on the Internet. Our conclusions on the effects of *sequential task structure* are twofold. First, data shows that sequential tasks enable

motivation gains even under high anonymity. This finding adds to results demonstrating increased cooperation in social dilemma situations with co-located groups with sequential protocols (i.e., group members do not decide simultaneously whether or not to contribute to the provision of the public good, but make their decisions consecutively; Au, Chen, & Komorita, 1998; Erev & Rapoport, 1990). Our second conclusion refers to the processes that might underlie motivation gains specifically in sequential group tasks. The fact that there were no significant correlations between positive reciprocity and motivation measures suggests that normative influence based on reciprocity norms were no major factors for the motivation gains observed. Propositions on processes underlying motivation gains in sequential tasks need to be further examined in follow-up studies. In this context, we would like to note that the distinction of normative effects and effects of perceived instrumentality refers to participants in later positions in the sequential order only. Individuals who perform first in a group might still be influenced by reciprocity *expectations* (i.e., motivation might be increased due to strategic reciprocity), which might lead to motivation gains as well. However, if participants increase their efforts strategically in order to convince the other group members to follow their example, they are not acting according to a prescriptive social or personal norm (Kallgren, Reno, & Cialdini, 2000), but trying to make use of reciprocity conventions in order to maximize the group's (and their own) outcome. This assumption, however, must still be tested in future studies, as in the present study participants' position in sequential order was not varied. Moreover, earlier research suggests that perceived instrumentality of individual performance for the group outcome increases with sequential position (e.g., Au, Chen, & Komorita, 1998). Thus, analysis of motivation gains in larger groups working on sequential tasks is desirable to explore not only the hypothesized differential effects of strategic and normative reciprocity, but also the effects of sequential position on perceived instrumentality of individual contributions for the group's success.

Exploratory Analyses of Gender Effects

Since significant motivation gains were found for female participants only, this study also provides some support for gender effects on indispensability based motivation gains although power might be an issue because of moderate sample sizes. However, our results are in line with recent meta-analytical results on gender differences in indispensability effects (Weber & Hertel, in press). These findings suggest that motivation gains based on social indispensability effects are more likely for female participants, whereas motivation gains based on social comparison are more often found for male participants. Provided that social comparison is the main mechanism triggering effort expenditure of male participants as suggested by Weber and Hertel (in press), it is surprising that in our study motivation gains of male participants in the additive condition were relatively low (see Table 4). However, this might be explained by ceiling effects, since Trial 1 performance of the additive condition significantly exceeded Trial 1 performance of the other experimental conditions in the male sample. Besides, social loafing might have diminished the overall motivation gains of participants in the second trial under additive task demands (see Hertel et al., in press).

Due to the lack of a male laboratory sample, the assumption can not be ruled out that a laboratory setting might be more suitable to produce indispensability effects of male group members, because increased identifiability might promote group oriented behavior. In fact, a recent laboratory study provides initial evidence for this assumption (Weber, Wittchen, & Hertel, 2007), suggesting that indispensability based motivation gains of male group members might depend more on strategic deliberations than indispensability effects of female group members. However, further process oriented research addressing this issue is required in order to clarify on the processes underlying gender effects on motivation gains in groups.

Limitations

In this study, the relative degree of the instrumentality of individual efforts for the group's outcome was manipulated by implementing different task structures, which is a procedure that has been proven effective in earlier studies on social indispensability effects. Outside of the laboratory, however, group tasks are rarely structured in either a conjunctive or additive way. Instead, team tasks are often more of a mixed structure or allow for the team members to decide themselves how the work will be structured. Therefore, it is relevant to explore and test other methods to produce social indispensability in order to further enhance the practical applicability of social indispensability effects (e.g., Hertel et al., 2004; Hertel, Niemer, & Herrmann, 2003).

One obvious limitation of the current study is that the simulated task environment and short task interval might restrict the generalizability of the results to organizational settings. Although motivation studies in the laboratory and in the field have often provided convergent results (e.g., Locke & Latham, 1990), it is important to replicate our results in field studies with existing distributed teams. Moreover, the participants in our study expected to work in ad hoc groups without future interaction, which further limits the examination of long-term group effects on motivation and performance. Longitudinal studies of existing distributed teams are therefore desirable in order to further illuminate the combined effects of perceived instrumentality and reciprocity. Thus, the

application of our findings to "real world" organizational settings needs to be tested. In particular, the prevalence of sequential group tasks in real life settings is left to be examined in field research. To our knowledge, there are no field studies addressing this topic so far. Information on how wide-spread sequential group work is in work organizations would be desirable because it would enable a more precise evaluation of the practical utility of related research.

Despite these limitations, our study provides supplementary support for existing explanations on motivation gains in groups, and extends them to a new type of task/work condition (sequential cooperation on the Internet), offering several avenues for future research as well as for applied settings.

Final Conclusion

Distributed work and sequential task decomposition facilitates virtual collaboration by reducing coordination requirements. At the same time, the risk of motivation losses might increase during distributed sequential work as a consequence of isolation and perceived anonymity. The results of our study demonstrate that motivation gains in groups can be achieved during distributed sequential work, provided that group members perceive their effort as indispensable for the group. Thus, the present research extends earlier laboratory findings on social indispensability effects on motivation in groups, and supports the assumption that the social indispensability effect on motivation and performance is a robust phenomenon that allows for motivation gains in groups even under spatial and temporal separation.

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