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Abstract

Whereas negative effects of groups on individual motivation have been reported for many years, recent research has begun to show when and why working in a group can produce motivation gains compared to individual work. So far, this evidence has been limited to laboratory settings and rather simple tasks. Using data from swimming competitions at the 2008 Olympics, evidence is presented that motivation gains in groups also occur in field settings with more complex tasks. Based on an instrumentality x value approach, we expect that late positions in a relay trigger motivation gains in groups due to an increase in perceived indispensability for the group outcome. This idea has been initially tested in a pilot study with competitive swimmers, demonstrating that perceived indispensability for the relay outcome indeed increases with later serial positions in a relay. Moreover, the main study with data from the 2008 Olympics revealed performance times consistent with this pattern of indispensability perceptions: While starting swimmers in the swimming relays performed at similar levels as in their individual competitions, swimmers at the later positions showed higher performance in the relay compared to their individual competition heats.

Key words: motivation gains in groups; group potential; motivation in groups; performance in groups

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When the Whole is More Than the Sum of Its Parts: Motivation Gains in the Wild

"Relays are exciting for me, I love team sports (….)
That's why I have always done well in relays in the past."
(Jason Leszak, anchor of the gold medal winning US 4 x 100 meter freestyle relay at the 2008 Olympics, after the victory)

People are often quite enthusiastic about working in groups. However, is working in a group indeed more motivating than working individually?[1] This question was among the first to be addressed by scientific psychology (e.g., Triplett, 1898). Indeed, some early studies (e.g., Köhler, 1926; Moede, 1914) suggested that groups can trigger higher motivation than individual work, illustrating what later has been defined as "motivation gains in groups". While these early studies have been long neglected, researchers in recent years have started again to systematically explore motivation gains in groups, often using laboratory settings with "minimalistic" groups (i.e., dyads with members who barely know each other and perform rather meaningless tasks for a short period of time with no common past or future) for reasons of experimental control. While such an approach has many advantages, replications and extensions are necessary with larger groups and more complex tasks. So far it is not clear whether motivation gains in groups are restricted to laboratory settings, and whether the resulting performance of the team can be higher than the summarized performance of its members when working alone. The current study addresses these questions using performance data from competitive relay swimmers at the Olympics.

Empirically, it has been shown that group members increase their effort when competing with members from another group as compared to mere interindividual competition (Moede, 1914; Tauer & Harackiewicz, 2004). This motivation gain during intergroup competition seems to be due to various processes, among them social support from

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fellow group members (Hüffmeier & Hertel, 2010), social identification and social responsibility for the group (see Wittchen, van Dick, & Hertel, 2010, for a review). Despite the various theoretical explanations, the overarching prediction would be that inter*group* competition yields higher effort among ingroup members not only compared to working alone, but also compared to inter*individual* competition (Hypothesis 1).

In the tradition of instrumentality x value approaches, research on the "indispensability effect" (e.g., Hertel, Kerr, & Messé, 2000; Hertel, Niemeyer, & Clauss, 2008; Kerr, Messé, Seok, Sambolec, Lount, & Park, 2007; Weber & Hertel, 2007) has repeatedly demonstrated motivation gains in groups when persons perceive their contribution as highly instrumental for the group's success. In previous research, perceptions of indispensability for the group outcome have been mostly operationalized based on a combination of task demands and team members' relative capabilities. In particular, working as the weaker member in a conjunctive task (i.e., the overall group performance is determined by the weakest individual performance, Steiner, 1972) has been the standard paradigm of experimental research on the indispensability effect (Weber & Hertel, 2007).

However, perceptions of indispensability for the group outcome are not limited to weak group members and conjunctive tasks, but can also be triggered by the group members' position in consecutive group tasks (Au, Chen, & Komorita, 1998; Wittchen, Schlereth, & Hertel, 2007). For instance, Au et al. (1998) argue that the perceived criticality of individual contributions tends to increase with the position in a sequential public goods dilemma because later group members perceive their contribution as necessary for the provision of the public good. Not contributing, in contrast, is perceived as non-compensable and thus preventing the provision of the public good. Similarly, we expect that perceived indispensability of individual contributions to the group outcome increases with the position in a consecutive group task (such as a relay) because compensation of poor performance is increasingly difficult at later positions, even when the general structure of the group task is additive (i.e., the group performance is determined by the sum of all individual contributions; Steiner,

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1972). In particular, group members performing at the final position should perceive the highest level of indispensability because a poor performance on their part would ruin the whole group result. On the other hand, group members at the final position have the clearest opportunities for final corrections of the group performance. For instance, the final swimmers in a tight relay competition most likely perceive that their effort determines victory or defeat of their team. Accordingly, we predict that group members' effort should increase with later serial positions in a group task (Hypothesis 2).

The present research extends existing research in several ways. In the main study, we demonstrate group motivation gains in a complex field setting, using existing groups with more than two members performing a meaningful task. Moreover, in contrast to previous research, we assess performance of both inferior and superior group members, enabling us to analyze the performance of the whole group in addition to individual performances. The empirical data of this study come from competitive freestyle swimmers (either 100 or 200 meters) at the 2008 Olympics in Beijing. These data provide excellent conditions to compare persons' performance under individual and group conditions because many of the swimmers performed the same activity (freestyle swimming) both individually and in a relay team.

However, one disadvantage of analyzing existing performance data is that it is not possible to collect additional data on subjective processes, such as perceived indispensability as underlying process of the assumed moderation process. Thus, before continuing with the results of the main study in more detail, we first report a pilot study that was conducted to ensure that the assumed implications of the serial relay position on perceptions of indispensability are correct.

Pilot Study

In this pilot study, we tested the assumed effect of swimmers' starting position in a relay on perceptions of indispensability for the relay group's overall success. This precondition has to be fulfilled in order to interpret performance differences at different starting positions as indicator for motivation differences due to indispensability perceptions.

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In accordance with Hypothesis 2, we expect that swimmers feel increasingly indispensable as they move from the first over the second and third to the final position of a relay.

Method

Participants. Twenty-nine competitive swimmers (12 women and 17 men; mean age $M = 16.03$) from two local sports clubs took part in this study. The athletes were engaged in competitive swimming sports for a mean duration of $M = 6.86$ years.

Measures. The swimmers were asked successively to imagine starting from the four positions in an important relay competition. For each starting position, they indicated the perceived indispensability of their individual contribution for the relay group ("How well can a bad performance on your part be compensated by the other swimmers of your relay?"). The item was rated on a 7-point scale ranging from 0 (very well) to 6 (not at all).

Results

A one-factorial repeated-measures ANOVA on participants' indispensability ratings with position (first vs. second vs. third vs. fourth swimmer in the relay) as within-subject factor revealed the expected significant linear contrast, $F(1, 28) = 11.85$, $p < .001$, $\eta^2 = .30$. Corresponding with our theorizing, participants perceived their individual contributions to the relay' performance to be increasingly less compensable with later serial position ($M = 2.71$, $SD = 1.57$; $M = 2.78$, $SD = 1.31$; $M = 3.09$, $SD = 1.25$; $M = 4.22$, $SD = 1.69$; for the first to fourth position). More specifically, compensation at the fourth position was perceived as significantly less possible than at the second and third position ($M = 2.93$, $SD = 1.22$), $t(28) = -3.88$, $p \leq .001$.

Discussion

The pilot study demonstrates that group members' perceived indispensability in fact increases continuously with later serial positions in the relay. In accordance with other research (Au et al., 1998; Wittchen et al., 2007), these data show that indispensability perceptions increase when the number of persons decrease who might be able to compensate

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poor performance. In accordance with Hypothesis 2, this change in perceived indispensability with later starting position provides an important precondition for the expected motivation gains in relay teams, which we will assess as differences between swimming performance times in individual and relay heats in the main study. Following our hypotheses and the supporting data of the pilot study, we expect to find motivation gains of relay swimmers (as compared to their individual races) in particular for later serial positions in the relay--and these motivation gains should be reflected in faster performance times.

Main Study

Method

Participants. Sixty-four athletes from 21 countries (29 women and 35 men; mean age M = 23.2) who competed both in the individual and relay freestyle competitions over either 100 meters (30 athletes) or 200 meters (34 athletes) at the 2008 Olympics were included in this study.

Measures. For each swimmer, we collected swimming times from both types of competition (i.e., individual and relay) from the website http://www.swimrankings.net/. We focused our analysis on the data from the semi-finals to obtain a reasonable sample-size.[2] If a swimmer did not advance to the semi-finals in the individual competition, we included her/his individual performance time from the first heats.[3] We corrected both performance times for the swimmer's respective reaction time by subtracting the time the athlete spent on the starting block after the starting signal (also retrieved from the webpage above). This was done to control for differences in the starting procedure in individual and relay swim competitions. Please note, however, that previous research did not find any differences between individual and relay competition after a swimming distance of ten meters (McLean, Holthe, Vint, Beckett, & Hinrichs, 2000). Thus, faster swimming times for relay swimmers are unlikely to be merely due to differences in the starting procedure.

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The corrected times were z-transformed separately for the 100 and 200 meter competitions. Complying with the required non-interdependence of data in the statistical analyses below, we excluded two data sets of swimmers who performed both in the 100 and 200 meter freestyle competitions. The swimming distance (100 vs. 200 meters) did not cause main or interaction effects so that we accumulated the data across swimming distance.

Study Design and Statistical Analysis. The analysis followed a 2 (individual vs. relay competition) x 4 (position: first vs. second vs. third vs. fourth swimmer in the relay) x 2 (gender: female vs. male) design with the first factor as a within-subject factor. As weaker swimmers qualify less frequently for individual competitions at the Olympics than stronger swimmers, unequal cell sizes occurred (see Table 1). However, the applied ANOVA analysis can be considered as robust against violations of normality (e.g., Stevens, 2002). Assumptions of homogeneity of covariance matrices are assessed using Box's *M*-Test (1949), and potential disruptive effects of unequal cell sizes are considered by adjusting the *p*-value with the Welch test (Welch, 1947).

Results

An insignificant Box's *M*-Test resulted, $F(18, 1113{,}43) = .74$, *ns.*, which indicates similarity of the variance-covariance matrices between groups. The 2 (individual vs. relay) x 4 (position) x 2 (gender) ANOVA on the reaction-time corrected and standardized swimming times revealed a significant main effect of the first factor, $F(1,56) = 11.46$, $p \leq .001$, $\eta^2 = .17$ (see Table 1, for means and standard deviations), which corroborates Hypothesis 1 by reflecting an overall process gain in the relay compared to the individual competitions. Moreover, the analysis revealed a significant main effect for position in the relay, $F(3,56) = 4.28$, $p < .01$, $\eta^2 = .19$, identifying the fourth swimmers as strongest swimmers on average. More interestingly, the main effects were qualified by a significant interaction, $F(3,56) = 8.11$, $p < .01$, $\eta^2 = .30$. Consistent with Hypothesis 2, the performance advantage of the relay increased with later relay positions (see Figure 1). While the a priori contrast between

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individual and group performance conditions revealed slight and non-significant process *losses* for the starting swimmers in the relay, $t(26) = -1.64$, $p = .11$, the following swimmers showed significant process *gains* in the relay compared to the individual performance times. Second, third, and last swimmers swam significantly faster in the relay than in the individual competition, $t(14) = 2.60$, $p \leq .01$, $t(4) = 2.23$, $p < .05$, and $t(16) = 4.24$, $p \leq .001$, respectively (for the raw swimming scores, see Table 2). Further confirming Hypothesis 2, process gains shown by swimmers at the second and third position ($M = .38$, $SD = .51$) were less pronounced than process gains shown by the anchor swimmers ($M = .71$, $SD = .69$), $t(35) = 1.68$, $p \leq .05$, all tests one-tailed. Finally, a marginally significant gender main effect occurred, $F(1,56) = 2.78$, $p = .10$, $\eta^2 = .05$, indicating that male swimmers tended to swim faster than female swimmers. However, gender showed no interaction effects with the other factors.

General Discussion

While the pilot study showed that perceived indispensability for the relay group increases with later positions in a relay, the main study reveals performance data that nicely correspond with the assumed motivational processes. Indeed, the data of the main study demonstrate significant process gains in four-person groups compared to individual performance, using a complex and meaningful task in a field setting. Consistent with our hypotheses, these process gains seem to result from two different sources, i.e. intergroup competition and social indispensability. As expected in Hypothesis 1, a significant main effect of the individual vs. relay factor suggests that performing as part of a relay team generally increases effort and (average) swimming speed compared to individual competitions. Moreover, the results support Hypothesis 2 predicting that motivation in the relays increases with later serial positions due to higher perceived indispensability for the team. Indeed, while the relays' starting swimmers swam as quickly in the relay as in the individual competition, the three later swimmers showed significant process gains.

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As a consequence, intergroup competition *per se* was obviously not sufficient to elicit additional effort when compensation by other team members was viable. This finding extends previous research on intergroup competition (e.g., Erev, Bornstein, & Galili, 1993; Tauer & Harackiewicz, 2004) by suggesting that motivation gains during intergroup competition are not only a consequence of support by ingroup members or social identification, but can also be driven by perceived indispensability of individual contributions to the team outcome (cf. Wittchen et al., 2010). Thus, the present research is highly compatible with previous work showing indispensability concerns as trigger of motivation gains in groups in other settings (e.g., Hertel et al., 2000; Weber & Hertel, 2007). In fact, intergroup competition and high indispensability are often connected in previous research (e.g., a basketball player performing as a team representative) so that the relative impact of these two sources of motivation gains remains an open question.

A number of additional aspects of this research are noteworthy. This research is the first to show that the group's net effort, indicated in the performance data of the relay teams, was significantly higher than the combined effort of its members when swimming individually. Second, motivation gains at the Olympics are especially remarkable because athletes should be already maximally motivated in their individual competitions. Therefore, the opportunities for additional improvement should be rather small compared to other competitions (e.g., in training or in scientific laboratory studies) as well as compared to other instances of group work (e.g., in business organizations). Third, compared to earlier research on the indispensability effect (e.g., Weber & Hertel, 2007), the motivation gains found in the present research occurred regardless of gender and relative capability of individual group members.

Alternative explanations for our findings such as beneficial conditions in the swimming pool for later swimmers, fatigue or habituation to the Olympic atmosphere in the relay competitions are rather unlikely to explain our findings. Water waves caused by

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previous swimmers in a pool should worsen rather than improve swimming times. Moreover, the chronological order of the relay and individual competitions was opposed for the 100 and the 200 meter freestyle semi-finals, excluding order effects as plausible alternative explanation. The observed moderation effect of serial order within the relays also speaks against fatigue or habituation as alternative explanations for our results.

On the other hand, this research of course has several limitations. First of all, the sample size--at least for athletes filling the relay's third spot--is small. The limited sample size for this position is due to the specifics of international swimming championships such as the Olympics: The (relatively) weaker swimmers on a certain distance from one nation, who usually swim at the third relay position, cannot qualify for the individual competition as often as strong swimmers, but they can still be crucial members of their country's relays. One important aspect of our research makes us, however, confident that we observed valid findings even with this small sample size at the relay's third position: Our data pattern for the relay's third position is consistent across both reported studies and it accords exactly with our hypothesis. Nevertheless, the results for the third position have to be interpreted with caution and replications with data from other championships and larger samples are desirable.

Second, it is possible that the specific effect of this research is restricted to very tight competitions like the Olympics with relays performing at the same performance level. The perceived indispensability of the fourth swimmer might be quite different when the differences between the relays are more pronounced and the final outcome is clear even before the fourth swimmer starts. Third, we used performance data instead of subjective ratings as indicator of effort, similar to most other research on motivation in groups (e.g., Weber & Hertel, 2007). Although subjective ratings can be informative in many ways (cf. Hüffmeier, Dietrich, & Hertel, 2010), performance data are probably more valid measures of effort because they are less likely to be biased by limited accessibility, social desirability, etc. Nevertheless, the interpretation of performance differences in terms of motivation is a

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conjecture that should be further validated using different measures of motivation. To address these issues, future replications of the present research might combine behavior-related data (i.e., performance) with subjective ratings, allowing also to explicitly assessing perceived indispensability as mediator of the observed effects. Moreover, biological (lactate) and physiological data (heart rate) might cover additional aspects of motivational processes due to group performance.

Our research has important implications for the management of teams in different contexts. We could show that teams can actually generate significant motivation gains outside the scientific laboratory and exceed the group potential when the appropriate conditions are in place. In particular, perceived indispensability for the group seems to be a central process that is not restricted to conjunctive task structures as shown in earlier work (Weber & Hertel, 2007) but also works in additive group tasks affecting both weaker and stronger group members.

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Footnotes

1 Motivation generally refers to both effort and direction of behavior (e.g., Geen, 1995). In this research, we focus on motivation as effort, reflected in the intensity and persistence of behavior. To accord with existing terminological standards, however, we use the labels *motivation gains* and *effort increases in groups* interchangeably.

2 Focusing on the data from the finals would have minimized the sample size and allowed solely for an overall assessment of motivation gains. Analyses involving athletes' position in the relay would not have been possible.

3 The inclusion of these swimmers (N = 33) in our sample seems warranted because it cannot be assumed that athletes who practice for many years to have the chance to qualify for the Olympics intentionally show an inferior performance in this individual competition.

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Table 1. *Reaction-time Corrected and Standardized (z-transformed) Means and Standard Deviations of Swimming Times and Reaction-time Corrected Raw Swimming Scores as a Function of Individual vs. Relay Competition and Position in the Relay (N = 64).*

	Position in the relay	*N*	$M_{standardized\ swimming\ times}$	$SD_{standardized\ swimming\ times}$	$M_{raw\ swimming\ scores}$
Individual	1	27	-.07	.96	78.19
	2	15	.47	.77	87.30
	3	5	.92	1.12	87.73
	4	17	-.14	.82	87.40
Relay	1	27	.11	.99	78.38
	2	15	.09	.90	86.92
	3	5	.57	1.17	87.39
	4	17	-.84	.85	86.66

Note. Smaller numbers indicate faster swimming times.

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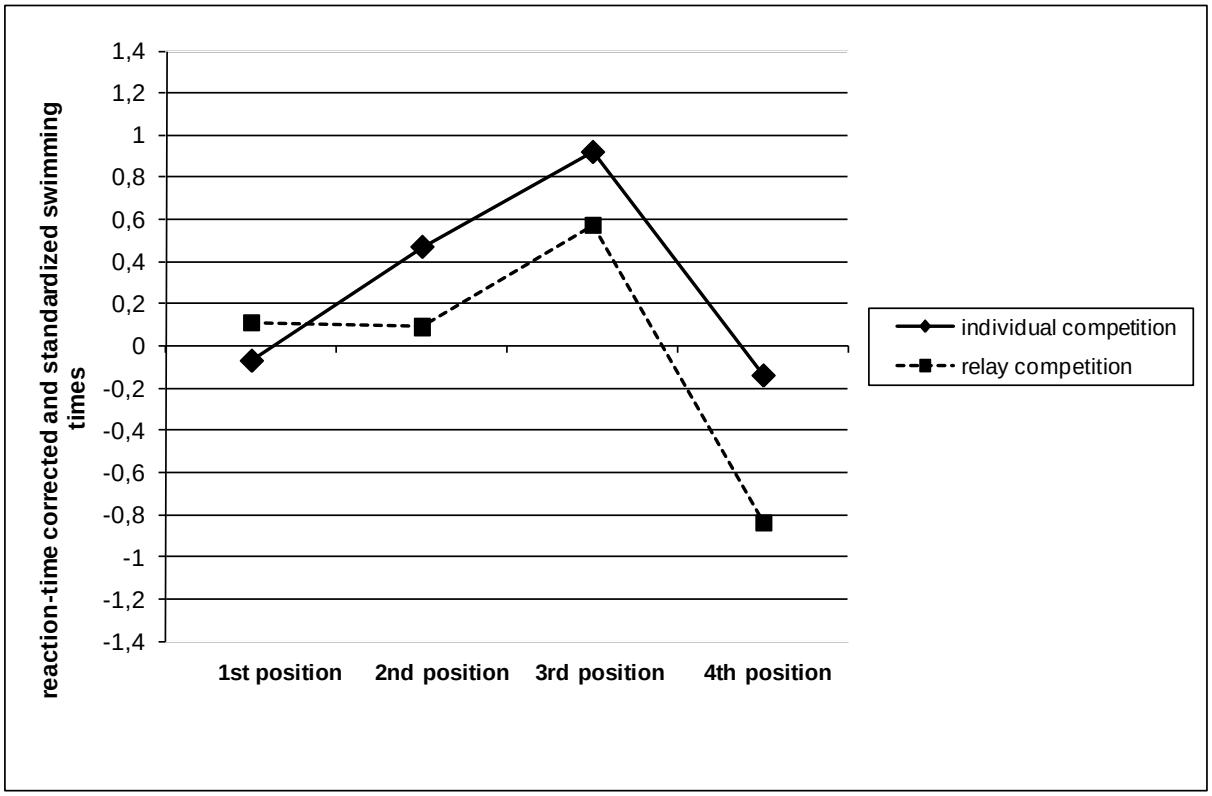
Figure 1. Reaction-time corrected and standardized swimming times as a function of individual vs. relay competition and position in the relay.



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