



## Run for the team: An analysis of effort gains in track and field relays

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### ABSTRACT

**Objectives:** We studied whether effort gains in relay as compared to individual swimming competitions generalize to 4 × 400 m track and field relays.

**Design:** We employed a 4 (indispensability levels) × 2 (relation of team performance and team outcomes) design.

**Method:** German national squad runners ( $N = 23$ ) were surveyed on their effort expenditure. In our main study, we tested within-person performance differences ( $N = 397$ ) between individual and relay competitions relying on archival data from major track and field championships. We operationalized the indispensability of one's own contribution via relay positions and the relation of team performance and outcomes via medal chance.

**Results:** Athletes reported effort gains in relay as compared to individual competitions. The archival study revealed effort gains for later positions if the relay had a high medal chance. These effort gains showed an unexpected quadratic pattern across the relay with smaller effort gains at the last position.

“In the relay, you always give a few extra percentage points”, Laura Müller (second runner of the German relay) after winning silver in the 4 × 400 m competition of the European Athletics Championships for athletes under 23 years in 2017.

Teamwork is often, yet not always, motivating. The resulting effort gains (i.e., team members expend more effort in team versus individual work) have been documented in laboratory (Kerr & Hertel, 2011) and field settings (e.g., Hüffmeier et al., 2017; Hüffmeier & Hertel, 2011; Osborn, Irwin, Skogsberg, & Feltz, 2012).<sup>1</sup> The latter studies found effort gains in relay swimming as predicted by the Collective Effort Model (CEM; Karau & Williams, 1993). Swimming at later relay positions increased the perceived indispensability of the own contribution to the team performance. Parallel effort gains were observed, but only if the team performance was instrumental for obtaining valuable team outcomes.

In the current study, we extend prior research in two ways: First, we examine *subjective effort* in team as compared to individual sports among professional track and field athletes. Previously, the equivalence of self-report and objective effort measures was typically assumed, but not tested (Hüffmeier et al., 2017; Osborn et al., 2012). Testing our assumptions with subjective and objective effort measures increases the

validity of the conclusions regarding effort gains in field settings. Second, past field studies on effort gains have focused on swimming competitions. We aim to study effort in teams in another context, that is, in 4 × 400 m track and field relays. Thereby, we test the generalizability of past findings. In sum, we not only test the replicability of a recent finding in times of the replicability crisis (Open Science Collaboration, 2015), but also examine whether the athletes' objective performance is mirrored by their experienced effort.

### 1. The Collective Effort Model

We base our research on the CEM (Karau & Williams, 1993), which builds on Vroom's VIE model (Vroom, 1964) and specifies it for the team context. While the CEM originally focused on explaining effort losses (e.g., social loafing),<sup>2</sup> the model offers a theoretical framework to explain both effort gains and losses. The CEM includes three factors that determine the effort of individual team members: Expectancy (i.e., the perceived relation between individual effort and individual performance), instrumentality (i.e., “the degree to which high-quality performance is perceived as instrumental in obtaining an outcome”, Karau & Williams, 1993, p. 685), and valence (“the perceived importance [...] of that outcome”, Hüffmeier et al., 2017, p. 1674, ). The CEM

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<sup>1</sup> Following Hüffmeier et al. (2012), we use the term “effort gains” rather than “motivation gains”, as effort encompasses the intensity and persistence of behavior, while motivation also entails the direction of behavior. Because we do not study the direction, effort is the more precise term for our research.

<sup>2</sup> Due to space limitations we restrict our overview of pertinent research to effort gains. For an overview on effort losses, see Karau and Williams (1993).

decomposes instrumentality into three separate contingencies: the perceived relations between (i) individual and team performance, (ii) team performance and team outcomes, and (iii) outcomes for the team and the focal team member (Karau & Williams, 1993). The product of these five components is assumed to determine the effect of teamwork on members' effort.

Past research suggests that a strong relation between individual and team performance (i.e., first instrumentality contingency, also termed *social indispensability*; Weber & Hertel, 2007) is crucial for the emergence of effort gains. Especially team members working at later positions in sequential teamwork (e.g., athletes starting at the last relay position),<sup>3</sup> should have such perceptions, as the chances for compensation by other team members are perceived to decrease at later serial positions (Hüffmeier et al., 2017; Hüffmeier & Hertel, 2011).

## 2. Prior field studies

Various field studies relied on archival data from swimming competitions to study effort in team as compared to individual work (Hüffmeier et al., 2012, 2017; Hüffmeier & Hertel, 2011; Neugart & Richiardi, 2013; Osborn et al., 2012; Skorski, Etxebarria, & Thompson, 2016). These studies compared performances in individual and relay (i.e., sequential teamwork) competitions, after correcting for different starting procedures.

Hüffmeier et al. (2011, 2012, 2017) demonstrated the influence of different instrumentality contingencies: Hüffmeier and Hertel (2011) documented effort gains when the first instrumentality contingency was strong. Hüffmeier, Krumm, Kanthak, and Hertel (2012) replicated this finding and observed a moderating effect of the second instrumentality contingency: Effort gains only occurred if the team performance was strongly related to valuable team outcomes.

Notwithstanding the evidence for effort gains in competitive swimming, there is some debate on the most accurate correction for the different starting procedures in individual (gun starts) versus relay competitions (gun starts for the first and flying starts for the later three positions; Hüffmeier et al., 2017; Hüffmeier & Krumm, 2018; Neugart & Richiardi, 2013; Skorski et al., 2016). Moreover, Fonseca, Louro, Costa, and Conceicao (2017) emphasized in their literature review that the effect of relay starts on overall relay swimming performance is unclear. A conceptual replication in another domain—as provided here—thus contributes to the question of whether effort gains in field settings are a trustworthy and robust finding.

## 3. Present study

Based on past research (Hüffmeier et al., 2011; 2012), we expect an increase in perceived indispensability across the relay (Hypothesis 1a) and related effort gains at later positions of sequential work (Hypothesis 1b). In line with Hüffmeier et al. (2012; 2017), this effect should be moderated by the second instrumentality contingency (Karau & Williams, 1993): Effort gains should only emerge if a strong contingency between team performance and valuable team outcomes exists (e.g., for relays with high medal chance; Hypothesis 2).

## 4. Pilot study

We conducted a pilot study to examine (a) professional athletes' indispensability perceptions regarding their individual contribution to their team's performance (Hypothesis 1a) and (b) their subjective effort expenditure (Hypothesis 1b). Thereby, we aimed to improve the understanding of perceived indispensability and subjective effort in

sequential teamwork. Further, as the International Association of Athletics Federations (IAAF) does not publish starting times—which are necessary to correct for differing starting procedures in individual and relay competitions—we asked professional athletes to provide related estimates. Specifically, we (c) asked the athletes to estimate the time difference for each starting position caused by different starting procedures in individual (crouch start) and relay competitions (crouch start at the first, followed by flying starts at subsequent positions). Finally, we (d) collected estimates of potential coordination losses due to baton passing.

### 4.1. Methods

#### 4.1.1. Participants

Twenty-three athletes from the German national squad (400 m distance;  $n = 10$  females;  $M_{(age)} = 21.57$  years; response rate: 69.7 percent of the invited runners) took part in this study. They have been engaged in competitive running for a mean duration of  $M = 5$  years and were not compensated for their participation.

#### 4.1.2. Measures

We asked the athletes to imagine taking part in an important relay competition and subsequently to be starting from each of the four relay positions, while responding to the related questions (see Hüffmeier & Hertel, 2011). The athletes indicated the perceived indispensability of their contribution to the relay outcome ("How well can a bad performance on your part be compensated for by other athletes of your relay?"; see Hüffmeier & Hertel, 2011). The item was rated on a 7-point scale ranging from 0 (not at all) to 6 (very well). To improve interpretability, we recoded this item (i.e., higher numbers represent more indispensability). Further, we asked the athletes to indicate their effort ("How much effort would you expend in a relay as compared to an individual competition?" and "How much dedication do you show in a relay as compared to an individual competition?"). Both items were rated on a 7-point scale ranging from  $-3$  to  $+3$  (from "much less (...)") to "much more than in an individual competition") and were strongly correlated for all positions ( $r_s \geq 0.90$ ).

To obtain an estimate for the time difference between the starting procedures in relay and individual competitions, athletes indicated the average time difference for each relay starting position ("Please indicate how much slower/faster the start in a relay competition is on average [across several relay competition starts that turned out well and not so well] for each relay position as compared to an individual competition. Please note the time difference in seconds"). Further, athletes indicated potential time losses due to required coordination when passing the baton to the next athlete ("When passing the baton to the subsequent athlete, both the preceding and the subsequent athlete need to coordinate. Please estimate the average additional time the baton exchange takes for the preceding athlete as compared to an individual competition without such a passing. Please note the time difference in seconds").<sup>4</sup>

### 4.2. Results and discussion

As athletes' indispensability ratings were not normally distributed, we conducted a Friedman's ANOVA, a non-parametric test for repeated measures designs, with relay position (first vs. second vs. third vs. fourth) as a within-subjects factor. Indispensability ratings of athletes changed significantly across relay positions,  $\chi^2(3) = 13.68$ ,  $p = .003$  (cf. Table 1). To follow up on this finding, we applied bootstrapped, paired  $t$ -tests and adjusted the alpha-level to  $\alpha = .013$  based on the Bonferroni-correction (given four comparisons). We test the first versus

<sup>3</sup> We focus on sequential teamwork in this research. Simultaneous teamwork (e.g., basketball or handball) has different dynamics and our assumptions might not hold there.

<sup>4</sup> The survey included further measures. For a full overview, please see the online supplement.

**Table 1**  
Descriptive Statistics and Results of the Pilot and Main Study.

	Relay Position			
	1	2	3	4
<b>Pilot Study</b>				
Indispensability <sup>a</sup>	Mean (SD)	3.23 (1.11)	2.86 (0.71)	4.73 (1.49)
Self-reported effort <sup>b</sup>	Mean (SD)	0.78 (1.03)	0.98 (1.03)	1.15 (1.30)
	t (df) <sup>c</sup>	3.64** (22)	4.31** (22)	4.25** (22)
Average time gain due to different starting procedures <sup>c,d</sup>	Mean(SD)	0.33 (0.55)	0.27 (0.56)	0.33 (0.67)
Coordination losses due to baton exchange <sup>a</sup>	Mean(SD)	-0.04 (0.23)	-0.56 (0.38)	-
<b>Main Study</b>				
Performance differences (individual minus corrected relay performance; all observations)				
HMC	Mean (SD)	-0.22 (0.83)	0.53 (0.88)	0.18 (0.85)
	t (df) <sup>c</sup>	-1.99 (56)	4.32** (53)	2.74* (166)
LMC	Mean (SD)	-0.34 (0.81)	-0.20 (0.73)	-0.61 (1.51)
	t (df) <sup>c</sup>	-1.53 (12)	-0.39 (8)	-2.4* (34)
Performance differences (individual minus corrected relay performance; random selection of observations to ensure data independence)				
HMC	Mean (SD)	-0.27 (0.69)	0.45 (0.79)	0.18 (0.76)
	t (df) <sup>c</sup>	-2.14* (29)	2.54* (19)	2.06* (71)
LMC	Mean (SD)	-0.28 (0.56)	-0.34 (0.75)	-0.39 (1.24)
	t (df) <sup>c</sup>	-1.21 (5)	-1.43 (9)	-1.55 (23)

Note. The upper part of Table 1 shows descriptive statistics (means and standard deviations) of the pilot study (N = 23). Additionally, it presents t-tests (against 0) to test for self-reported effort gains (and losses, respectively). The lower part of Table 1 presents descriptive statistics and t-tests (against 0) for the dependent variable of the main study (z-standardized time differences between individual and relay competitions, corrected for different starting procedures). Positive (negative) values indicate performance gains (losses). HMC = high medal chance; LMC = low medal chance.  
<sup>a</sup>We conducted t-tests against null to test for significant gains or losses.  
<sup>b</sup>p < .05. <sup>\*\*</sup>p ≤ .001

<sup>a</sup> The item was rated on a 7-point scale ranging from 0 (not at all) to 6 (very well).

<sup>b</sup> The items were rated on a 7-point scale ranging from -3 to +3 (from “much less (...)” to “much more than in an individual competition”).

<sup>c</sup> We excluded one outlier, as the athlete likely did not follow the instructions.

<sup>d</sup> All estimates are given in seconds.

second ( $t[21] = -0.96, p = .346$ ), second versus third ( $t[21] = 1.32, p = .197$ ), and third versus fourth relay position ( $t[20] = -5.78, p < .001$ ) for an increase between the relay positions, and the first versus fourth position for an overall increase ( $t[21] = -3.53, p = .003$ ).

Athletes' reported effort expenditure was again not normally distributed. A Friedman's ANOVA revealed that athletes' effort changed significantly across relay positions,  $\chi^2(3) = 14.12, p = .003$ . Again, we applied bootstrapped, paired  $t$ -tests and corrected the alpha-level accordingly. To test for an increase between relay positions, we report comparisons between the first versus second ( $t[22] = -1.89, p = .110$ ), second versus third ( $t[22] = -0.44, p = .692$ ), third versus fourth relay position ( $t[22] = -1.45, p = .167$ ), and between the first versus fourth position to test for an overall increase ( $t[22] = -3.01, p = .029$ ). Further, athletes reported effort gains at all relay positions as compared to the individual competition (i.e., as indicated by significant bootstrapped  $t$ -tests against 0; see Table 1). Finally, Table 1 gives an overview of (i) the average time differences between the starting procedures per position in relay and individual competitions and (ii) the average time losses per position due to coordination efforts resulting from the baton exchange.

The results mostly support Hypothesis 1a: For later serial positions, athletes reported increased indispensability perceptions (i.e., they perceived that it became increasingly difficult for their fellow team members to compensate for a potentially bad performance on their part). Further, athletes reported significant effort gains in relay as compared to individual competitions, which descriptively increased across the relay, thus partly supporting Hypothesis 1b. We also obtained an estimate for each relay position to correct for different starting procedures in relay and individual competitions. For a preferably conservative approach in the main study, we did not correct for coordination losses due to baton passing. Thus, we assume any remaining performance gains can be ascribed to effort gains in the relay.

## 5. Main study

### 5.1. Methods

#### 5.1.1. Participants

The sample was drawn from major track and field championships, such as the Olympics from 1920 to 2016, the World Championships from 1983 to 2017, and the Continental Cups from 1977 to 2006 (for an overview, please see Table A1 in the online supplement). Our sample consists of observations of all athletes who participated in both finals (400 m individual and 4 × 400 m relay competition) of a respective championship (e.g., the 2008 Olympic Games). The resulting sample consists of 169 observations from the Olympic Games, 141 from the World Championships, and 87 from the Continental Cups. Overall, this results in 397 observations (from 249 athletes; 143 male and 106 female athletes). Some athletes ( $n = 85$ ) were sampled more than once and for some relays more than one athlete matched our inclusion criteria. This led to violations of the independence of observations. Consequently, we provide two sets of analyses: (1) Analyses including all observations and (2) analyses with a sample of  $n = 197$  to ensure the complete independence of the observations (i.e., each athlete was only sampled once and each relay was only represented by one athlete).

#### 5.1.2. Measures

We obtained athletes' running times through official results lists or reports<sup>5</sup> (e.g., London 2012 Statistics Book for the Olympic Games, IAAF Communications Department, 2012). For all included athletes, we sampled the running times from the finals of 400 m individual

<sup>5</sup> The reports and results were published on the official homepage of the IAAF: [www.iaaf.org](http://www.iaaf.org).

competitions and the split times from the finals of the 4 × 400-m relay competition of the respective championship.<sup>6</sup>

To account for the different starting procedures, we added the estimates gathered in the pilot study to the relay split times to obtain corrected running times. As different performance levels (e.g., due to gender) exist in our data, we standardized the corrected running times separately for gender, type of championship (e.g., the Olympic Games), and time intervals (e.g., 1920–1941 etc.) to make them comparable. We standardized the individual and corrected relay-split times of each such cluster simultaneously to obtain a value of null as a shared reference point. Finally, we calculated a difference score (individual minus corrected relay-split time). Negative (positive) values indicate performance losses (gains) in the relay as compared to the individual competitions.

#### 5.1.3. Operationalization and study design

We followed the approach of Hüffmeier et al. (2012) as closely as possible to test the replicability of their results. Thus, we analyzed two instrumentality contingencies as moderators of expended team member effort: First, we operationalized the relation of individual and team performance (i.e., the first instrumentality contingency) via relay starting positions in this sequential teamwork setting. Second, we operationalized the relation of team performance and team outcomes (i.e., the second instrumentality contingency) via relay medal chance, differentiating between high (i.e., relays ranked in the finals from the 1st to 4th place) and low (i.e., relays ranked from the 5th to 8th place) chances to win a medal.<sup>7</sup> Thus, our study had a 4 (relay position: first vs. second vs. third vs. fourth) × 2 (medal chance: high vs. low) design.

Paralleling prior studies (e.g., Hüffmeier et al., 2012; Osborn et al., 2012), our sample sizes varied across the different conditions (see Table 1): Athletes at the fourth position qualified on average 3.11 times more often for the finals of the individual competition than athletes at other relay positions. Thus, the strongest athletes appear to be mostly assigned to the fourth relay position. Not surprisingly, relays with strong athletes (i.e., who qualify for the finals in individual competitions) also have a better chance to win a medal (as reflected in the medal chance variable).

### 5.2. Results based on all observations

#### 5.2.1. Contrast analysis

To test the replicability of Hüffmeier and colleagues' (2012) results, we followed their data analysis approach and conducted a set of planned contrasts (Rosenthal & Rosnow, 1985) to test the predicted interaction. To test the hypothesized increase in effort across the relay in the high medal chance condition (Hypotheses 1b and 2), we employed the following linear contrast: In the high medal chance condition, we assigned contrast coefficients of  $-3$  to the first,  $-1$  to the second,  $1$  to the third, and  $3$  to the final position in the relay; in the low medal chance condition, we assigned a coefficient of  $0$  to the first, second, third, and fourth position  $[-3, -1, 1, 3, 0, 0, 0, 0]$ . We applied a reversed contrast to test whether later relay positions also have an effect on performance differences in the low medal chance condition  $[0, 0, 0, 0, -3, -1, 1, 3]$ . A Levene's test indicated inequality of variances,  $F(7, 389) = 4.72, p < .001$ . As expected, the analysis revealed a significant increase of performance across relay positions for the high

<sup>6</sup> To exclude potential alternative explanations, we also analyzed the competition order. Only for  $n = 20$  observations, relay finals took place before individual finals. Excluding these observations did not alter our results. Thus, we included these observations in the analyses reported here.

<sup>7</sup> Although this operationalization is based on information only known after the race, athletes can anticipate their potential outcomes realistically before the race (e.g., from their ranks in the semi-finals): In an exemplary sample (using the 4 × 400 m relay competitions of the World Championships from 2013 to 2017 and the Olympic Games from 2012 to 2016) semi-final and final rankings were very strongly related  $r_s = 0.84, p < .001$ .

medal chance condition,  $t(133.73) = 2.86, p = .005$ , and no such increase for the low medal chance condition,  $t[50.65] = -0.87, ns$ .

As the data descriptively indicated a quadratic trend, we conducted a post-hoc analysis to test for this possibility  $[-1, 1, 1, -1, 0, 0, 0, 0]$ : The Levene's test again indicated inequality of variances,  $F(7, 389) = 4.72, p < .001$ . The analysis revealed a significant quadratic trend across the relay positions for the high medal chance condition,  $t(189.76) = 5.29, p < .001$ , and no quadratic trend for the low medal chance condition,  $t(20.49) = 0.58, ns$ .

### 5.2.2. Comparisons against zero

Next, we tested for performance differences between individual and relay competitions, indicating effort gains or losses in the relay competition (Table 1). Athletes starting at the second to fourth relay positions in the high medal chance condition exhibited significant performance gains in the relay.

### 5.3. Results with completely independent data

After randomly selecting one observation for each of the 85 athletes that had been sampled more than once, we randomly selected one athlete of each included relay and then applied the same analyses to the restricted sample ( $n = 197$ ). The findings paralleled the above results (i.e., a significant Levene's test,  $F[7, 189] = 2.50, p = .018$ , a linear performance increase across relay positions in the high medal chance condition,  $t[82.89] = 2.40, p = .019$ , and a non-significant linear contrast in the low medal chance condition  $t[26.79] = -0.76, ns$ . Again, a quadratic trend was found in a post-hoc analysis. Comparisons against zero also mirrored the above analyses [for details, see Table 1]).

## 6. General discussion

Whereas previous field studies on effort gains in sports teams have exclusively focused on data from swimming competitions, our study is the first to investigate effort gains in track and field competitions. We partly replicated past findings by Hüffmeier and colleagues on sequential teamwork (2011, 2012, 2017): In our pilot study, track and field athletes reported increasing indispensability across the relay and effort gains in teams at each relay position (partly confirming Hypothesis 1a and Hypothesis 1b). The results of our main study partly mirrored the reported effort gains (for positions 2, 3, and 4) if team performance was strongly related to valuable team outcomes (confirming Hypothesis 2). While subjective and objective effort measures converge in showing effort gains in the relay as compared to the individual competition, the overall pattern of the main study diverged.

A post-hoc test confirmed a quadratic pattern of expended effort in our main study, which might be due to the effect of the specific study context on perceived indispensability. Post-hoc, we identified two characteristics of  $4 \times 400$  m relays that likely affect perceived indispensability of the own contribution for the team performance, and thus might account for these results: First, deviating from swimming competitions and due to the specific competition rules (IAAF, 2017),  $4 \times 400$  m relay runners at the first to third position can ensure good starting conditions for subsequent athletes. This particularly applies for the second athletes (who descriptively showed the strongest effort gains), as they start in predefined lanes and determine their teams' overall position with their performance when switching on the inside lane after 200 m. A good position in the field then translates to reduced obstructions for subsequent athletes.

Second, the time difference to the leading relay runners over the course of a  $4 \times 400$  m relay adds up more strongly than in swimming relays: In an exemplary sample (relay competitions of the World Championships from 2013 to 2017 and the Olympic Games from 2012 to 2016) the time difference between the lead and other athletes was greater in track and field than in swimming competitions when the fourth athletes started,  $t(126.64) = -3.13, p = .002$ . This was true

although the overall times from the swimming ( $4 \times 100$  m relays) and running ( $4 \times 400$  m relays) competitions were similar. If the athletes at the fourth relay position in our study in fact had the impression that the competition was already decided when they started their split, they might have reduced their effort accordingly. A post-hoc test within the high medal chance condition of our sample supports this explanation: Exhibited effort of athletes running at the fourth position correlated negatively with their time difference (backlog) to the leading athlete in the field at the moment when these respective athletes started,  $r(55) = -0.36, p = .005$ . This effect was even more pronounced for their backlog to the medal ranks,  $r(12) = -0.74, p = .003$ . Thus, accumulated time differences across the relay likely influenced perceived indispensability (see also Larson, Bihary, & Egan, 2018) of one's own contribution and may explain the observed quadratic pattern of expended effort in our study.

A central shortcoming of our main study is the low number of cases within the low medal chance condition. Thus, the related results should be interpreted with caution. A second limitation concerns the correction estimates for the different starting procedures in individual and relay competitions. This correction is less accurate than individual reaction times would be. However, we tend to rather underestimate the observed effort gains due to our conservative approach (i.e., we did not correct for coordination losses due to baton exchanges).

We derive two practical implications: First, regular training in relays might be valuable, as it might also increase the expended effort during practice sessions and help to build up the required endurance for the 400 m distance. Second, to elicit effort gains in competitions, coaches can point out the indispensability of each athlete, for instance due to the specific characteristics of the relay position or the line-up of the closest rival.

In conclusion, although the results were not identical to previous swimming studies (Hüffmeier et al., 2017; Hüffmeier & Hertel, 2011), our study indicates the generalizability of the moderating effect of the first and second instrumentality contingencies of the CEM. Additionally, subjective effort tends to converge at least to some degree with observed performance. Finally, while effort gains in teams appear to be valid and robust, our results emphasize the necessity to account for the specific characteristics of the respective context.

### Conflicts of interest

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.psychsport.2019.101567>.

### References

- Fonseca, A., Louro, H., Costa, A. M., & Conceição, A. (2017). Relay start in swimming: A review. In V. Reis, A. Silva, N. Batalha, F. Saavedra, C. Abrantes, A. Costa, ... H. Folgado (Eds.). *Proceedings of the International Congress of Research Center in Sports Sciences, Health Sciences & Human Development (2016)* (pp. 139). Motricidade. <http://dx.doi.org/10.6063/motricidade.12079>.
- Hüffmeier, J., Filusch, M., Mazei, J., Hertel, G., Mojzisch, A., & Krumm, S. (2017). On the boundary conditions of effort losses and effort gains in action teams. *Journal of Applied Psychology, 102*(12), 1673–1685. <https://doi.org/10.1037/apl0000245>.
- Hüffmeier, J., & Hertel, G. (2011). When the whole is more than the sum of its parts: Group motivation gains in the wild. *Journal of Experimental Social Psychology, 47*(2), 455–459. <https://doi.org/10.1016/j.jesp.2010.12.004>.
- Hüffmeier, J., & Krumm, S. (2018). No myth far and wide: Relay swimming is faster than

- individual swimming and the conclusion of Skorski et al. (2016) is unfounded. *Meta-Psychology*, 2, 1–9. <https://doi.org/10.15626/MP.2018.842>.
- Hüffmeier, J., Krumm, S., Kanthak, J., & Hertel, G. (2012). "Don't let the group down": Facets of instrumentality moderate the motivating effects of groups in a field experiment. *European Journal of Social Psychology*, 42(5), 533–538. <https://doi.org/10.1002/ejsp.1875>.
- IAAF Communications Department (2012). *Athletics statistics book: Games of the XXX Olympiad*. London.
- IAAF (2017). Competition rules: 2018-2019. Retrieved from <https://www.iaaf.org/about-iaaf/documents/technical>.
- Karau, S. J., & Williams, K. D. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology*, 65(4), 681–706. <https://doi.org/10.1037/0022-3514.65.4.681>.
- Kerr, N. L., & Hertel, G. (2011). The Köhler group motivation gain: How to motivate the 'weak links' in a group. *Social and Personality Psychology Compass*, 5(1), 43–55. <https://doi.org/10.1111/j.1751-9004.2010.00333.x>.
- Larson, J. R., Bihary, J. G., & Egan, A. C. (2018). Motivation gains on divisible conjunctive group tasks. *Group Processes & Intergroup Relations*, 21(8), 1125–1143. <https://doi.org/10.1177/1368430217702724>.
- Neugart, M., & Richiardi, M. G. (2013). Sequential teamwork in competitive environments: Theory and evidence from swimming data. *European Economic Review*, 63, 186–205. <https://doi.org/10.1016/j.euroecorev.2013.07.006>.
- Open Science Collaboration (2015). Estimating the reproducibility of psychological science. *Science*, 349(6251), 943–953. <https://doi.org/10.1126/science.aac4716>.
- Osborn, K. A., Irwin, B. C., Skogsberg, N. J., & Feltz, D. L. (2012). The Köhler effect: Motivation gains and losses in real sports groups. *Sport, Exercise, and Performance Psychology*, 1(4), 242–253. <https://doi.org/10.1037/a0026887>.
- Rosenthal, R., & Rosnow, R. L. (1985). *Contrast analysis: Focused comparisons in the analysis of variance*. Cambridge: Cambridge University Press.
- Skorski, S., Etxebarria, N., & Thompson, K. G. (2016). Breaking the myth that relay swimming is faster than individual swimming. *International Journal of Sports Physiology and Performance*, 11(3), 410–413. <https://doi.org/10.1123/ijsp.2014-0577>.
- Vroom, V. H. (1964). *Work and motivation*. New York: John Wiley & Sons.
- Weber, B., & Hertel, G. (2007). Motivation gains of inferior group members: A meta-analytical review. *Journal of Personality and Social Psychology*, 93(6), 973–993. <https://doi.org/10.1037/0022-3514.93.6.973>.