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I'm worth more than you! Effects of reward interdependence on performance, cohesion, emotion and effort during team competition

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Abstract

Objectives. To examine the effects of reward structures on the performance of a motor task. We evaluated the effects of reward interdependence on performance, cohesion, emotion, and effort during intergroup (team) competition.

Design. An experimental design was used to compare the effects of reward interdependence (no, low, high) on performance of a strength and endurance task.

Method. Participants (N = 111) performed a 3-min handgrip task as a member of a team of four under three reward interdependence conditions (no; low, with an even split of prize money; high, with an uneven split of prize money) in head-to-head competitions against another team. Task performance was assessed using the cumulative force production total. Task-related cohesion, enjoyment, anxiety and effort were measured using self-report scales.

Results. Performance was better with rewards than no reward, and better with high than low reward interdependence. Team cohesion was highest with low reward interdependence. Effort was greater with rewards than no reward. Anxiety and enjoyment did not vary among the reward conditions. Mediation analyses indicated that increased cohesion mediated improvements in performance from no reward to low reward interdependence conditions, and increased effort mediated improvements in performance from no reward to both low and high reward interdependence conditions.

Conclusion. Performance of a simple physical task in team competition was facilitated by rewards, with optimal performance associated with unequal rewards (i.e., performance-related pay). The benefits of performing with rewards compared to no rewards were explained by increased cohesion and effort. Social interdependence theory can help explain performance of simple motor tasks during team-based competitions. The findings have implications for the pay structures adopted by sports teams.

Introduction

"*All for one and one for all, united we stand divided we fall*"

The Three Musketeers, Alexandre Dumas (1844)

Competition is one of the most studied topics in sport psychology (Kavussanu et al., 2021). Early studies, reviewed by Martens (1975), suggested that competition impaired performance on complex and novel motor tasks but improved performance on simple and familiar tasks as well as strength and endurance motor tasks. Later studies, reviewed by Stanne et al (1999), established that pure competition, where an individual seeks to perform a task better than everyone else, improved the execution of a variety of motor skills compared to individual *do your best* task performance. However, recent studies (Cooke et al., 2011, 2013; Tauer & Harackiewicz, 2004) have shown that performance is best during team (intergroup) competition. In this structure, the individual belongs to a team that competes with other teams to try and achieve opposing goals and, at the same time, cooperates with teammates to try and achieve their collective team goal. In other words, *winner takes all* outperforms *do your best*, but *all for one and one for all* is optimal. Research to date has yet to consider whether the reward structure of sport competitions (i.e., equal pay versus contribution-based pay for players) influences the relationship between team competition and motor performance. The current study aimed to fill this gap in the literature.

Social interdependence theory and reward interdependence

Social interdependence theory (Deutsch, 1949; Johnson & Johnson, 1989; Johnson & Johnson, 2005) proposes that the goal structure of a task influences performance. The theory describes three modes of social interdependence. With negative interdependence, one's goal can only be achieved if others fail to achieve their goal, which occurs when we compete with others. With positive interdependence, one's goal can be achieved if others'

also achieve their goal, which occurs when we cooperate with others. With no interdependence, one's goal can be achieved regardless of whether others' achieve their goal. The reward structure of a task can also influence interdependence and performance (Johnson & Johnson, 2005). This is especially interesting in the context of team competition, which mixes negative (i.e., beat the opposing team) and positive (i.e., collaborate with teammates to achieve the team goal) social interdependence.

Another aspect of the context that may affect performance is reward interdependence, which concerns the extent to which one's reward depends on the rewards of others. In team competition, this is determined based on how the reward is distributed among members of the team (Wageman, 1995). High reward interdependence occurs when rewards are distributed unequally among teammates based on their individual contributions (e.g., performance-related pay). Low reward interdependence occurs when rewards are distributed evenly among teammates regardless of their individual contributions to the team (e.g., equal appearance money for all players). Previous investigations have considered the impact of reward interdependence on team performance, but most aggregated studies of reward interdependence alongside studies of feedback and goal interdependence tend to focus on an overarching outcome interdependence (i.e., participants influence each other's outcomes) theme (Courtright et al., 2015; Evans & Eys, 2015; Evans et al. 2012). This approach could mask any specific effects of reward and thereby leaves a gap in the literature for research directly investigating the effects of reward interdependence on team performance in sport.

In a review of reward interdependence research in non-sport contexts, DeMatteo et al (1998) suggested that low reward interdependence increases team cohesion and solidarity, whereas high reward interdependence increases team performance. For example, performance on an error recognition task was better with high than low reward

interdependence. This could be because high reward interdependence may incentivize individual team members to invest maximal effort and reduce incidences of social loafing or free-riding (Wageman & Baker, 1997). However, some researchers have argued that high reward interdependence elevates the risk of conflict among teammates, reduces cooperative behaviors, and may harm collective output (Allen et al., 2003). This mixed evidence for the impact of reward interdependence on non-motor tasks suggests that its effect on sport performance could be positive or negative. Sport is replete with examples of low reward interdependent (e.g., the amateur soccer team that pays all its players the same match fee and the same win bonus) and high reward interdependent (e.g., the professional soccer team that pays individual goal bonuses for any player who scores) teams and the impact of such organizational structures can be a burden on performers (e.g., Woodman & Hardy, 2001). This highlights the need for research to more closely investigate the precise effects of reward interdependence in team sport.

Mechanisms underlying effects of reward interdependence on performance

The reasons underlying any effects of reward interdependence on motor performance have yet to be evaluated. Nonetheless, there is a broader literature that can inform our understanding of the processes underlying performance in this context. Potential mechanisms that may be relevant involve emotion (Tauer & Harackiewicz, 2004), effort (Triplett, 1898) and cohesion (Carron, et al., 2002).

A first emotional mechanism is offered by anxiety. Theoretical (e.g., Wine, 1971) and meta-analytic (e.g., Woodman & Hardy, 2003) evidence make a case for anxiety as a key contributor to performance in evaluative settings such as when striving for rewards or partaking in team competition. High levels of anxiety can impair performance by consuming attention and directing resources away from the task at hand (Wine, 1971). Additionally, several studies suggest that performance in team environments is also mediated by

enjoyment, whereby greater enjoyment leads to better performance (Cooke et al., 2011, 2013; Tauer & Harackiewicz, 1999, 2004). These findings can be explained by positive emotion theory (e.g., Fredrickson, 2004), which argues that experiencing positive emotions (e.g., enjoyment) elevates ones' interest in the task/activity, helping to broaden their skillset and boost their performance.

There is also evidence that the effects of team competition on performance are mediated by effort, whereby better performance during team competition is due to greater endeavor (Cooke et al., 2011, 2013). These findings can be explained by a model of energized motivation, where competition primes individuals to devote more resources to task performance than would ordinarily be available (i.e., in non-competitive environments) (Triplett, 1898).

Cohesion has yet to be investigated as a mechanism in the context of task structure and sport performance. However, meta-analytic evidence suggests that high team cohesion is associated with improved performance (Carron, et al., 2002; Evans & Dion, 2012). This finding makes a case for cohesion as an additional candidate mediator of the effects of team competition on performance. Cohesion could also play a role in the team competition and performance relationship via its effects on the emotion and effort variables considered above. For example, research has argued that increased cohesion may elicit beneficial effects on performance by reducing anxiety (Prapavessis & Carron, 1996), elevating enjoyment (Fox, et al., 2000), or by promoting increased effort (Bray & Whaley, 2001).

Based on the above theorizing and research, there is a rationale for analyses testing the separate roles of anxiety, enjoyment, effort, and cohesion (i.e., to examine their unique contributions) as candidate mechanisms of the effects of rewards and resource interdependence on performance in team competition. There is also rationale for analyses investigating serial mediation pathways involving cohesion, emotion, and effort as sequential

mediators of performance. We perform analyses to investigate all these mediation models in the current experiment. We also examine whether the mechanisms to explain variance in performance (e.g., emotion, effort, cohesion, or serial) are influenced by the reward or interdependence climate in which the performer is operating. For instance, increases in effort can be stimulated by rewards (Hubner & Schlosser, 2010) and by increases in identifiability (i.e., the extent to which contributions of individual team members are highlighted) (Roberts, et al., 2019). Accordingly, it seems reasonable to assume that increased effort could mediate improvements in performance in both low and high reward interdependence conditions. Moreover, the additive effects of reward and high identifiability that are present in high reward interdependence conditions could render high reward interdependence conditions especially likely to support an effort-based mechanism of improved motor performance.

If equal pay (i.e., low reward interdependence) increases team cohesion (DeMatteo et al., 1998), we expect that team cohesion will emerge as a positive mediator of the effects of reward interdependence on performance, especially in low reward interdependence conditions. Following this line of thought, we can also predict that the aforementioned serial cohesion-emotion-effort mediation pathway is most likely to facilitate performance in low reward interdependence conditions.

Current study

We had two study purposes. Our first study purpose was to investigate the effects of reward interdependence on performance, cohesion, emotion and effort. Based on the abovementioned theory and evidence, we expected that high reward interdependence would optimize team performance and that low reward interdependence would optimize team cohesion. Our second study purpose was to investigate cohesion-, emotion- and

effort-based mechanisms underlying the effects of reward interdependence on performance. Based on the abovementioned theory and evidence, we expected that increased anxiety would impair performance, whereas increased cohesion, enjoyment, and effort would aid performance. We also expected that cohesion, emotion and effort mechanisms as well as serial mechanisms (i.e., cohesion – emotion – effort) would all be likely to mediate changes in performance from no reward to low-resource interdependent conditions. Lastly, we forecast that an effort-based mechanism of performance would be most likely to account for additional changes in performance in conditions of high reward interdependence.

Method

Design

Using a within-participants experimental design, participants were required to complete the handgrip task under three reward interdependence conditions: no reward, low reward interdependence, high reward interdependence.

Participants

One hundred and eleven male undergraduate students aged 18 to 20 years old enrolled in a sports science degree course, participated in the experiment. Individuals were excluded if they had any injury or illness. Participants all had previous experience of competitive sport (M = 10.34 SD = 3.39 years) at club-level or higher. Their main sport was varied; for 80% of participants this was a team sport (most popular were soccer, rugby and field hockey) and for 20% of participants this was an individual sport (most popular were athletics, swimming and gymnastics). Power calculations using GPower 3.1.5 (Faul, et al., 2007) software indicated that with a sample size of 111, the current study was powered at .80 to detect significant (p < .05) differences among the three conditions using repeated measures analyses of variance corresponding to a small-to-medium (f = .12) effect size (Cohen, 1992). The current sample size also exceeded those recruited for previous experiments that

compared the effects of social interdependence on a handgrip endurance task (Cooke et al., 2011, 2013). The study was approved by the local research ethics committee.

Self-Report Measures

Anxiety. Task anxiety was measured using the "I was anxious while working on this task" item from the Intrinsic Motivation Inventory (Ryan, 1982). Participants were initially presented with five-items (e.g., "I was anxious while working on this task", "I felt pressured during the task", "I felt very tense while doing this activity") representing the Pressure/Tension subscale of the Intrinsic Motivation Inventory (Ryan, 1982) and responded on a 7-point scale, anchored by 1 (*not at all true*) to 7 (*very true*). We used scores from the single "I was anxious" item to index anxiety because this represents a more targeted measure of anxiety than the aggregate of the five-items, which represents the broader concept of pressure. Single-item scales are widely used to measure anxiety (e.g., Krane, 1994). The mean scores on the single-item measure were slightly lower than the mean scores of the five-item subscale, but the results of statistical analyses reported in the results section were identical when we used the single-item versus the five-item score as the dependent variable. This demonstrates high-compatibility between the single-item and the multi-item measure and endorses the statistical integrity of the single-item approach.

Enjoyment. Task enjoyment was measured using the Enjoyment subscale of the Intrinsic Motivation Inventory (Ryan, 1982). Participants were presented with seven items (e.g., "I enjoyed it very much") and provided ratings on a 7-point scale, anchored by 1 (*not at all true*) to 7 (*very true*). The mean rating provided a measure of enjoyment. The coefficient alphas were good (α = .87-.89) in the current study.

Effort. Task effort was measured using the Effort subscale of the Intrinsic Motivation Inventory (Ryan, 1982). Participants were presented with five items (e.g., "I put a lot of effort into this task") and provided ratings on a 7-point scale, anchored by 1 (*not at all true*)

to 7 (*very true*). The mean rating provided a measure of effort. The coefficient alphas were good (α = .93-.95) in the current study.

*Cohesion***.** Team cohesion was measured using the Team Cohesion subscale of the Youth Sport Environment Questionnaire (Eys et al., 2009). Participants were presented with eight statements about their feelings towards their team (e.g., "As a team, we are united") and provided ratings on a 7-point scale, anchored by 1 (*strongly disagree*) to 7 (*strongly agree*). The mean rating provided a measure of team cohesion. The coefficient alphas were good (α = .94-.97) in the current study.

Performance Measures

Participants performed a force production task (described in the Procedure section) and therefore we measured force as our index of task performance. Two levels of force measure were obtained:

Maximal Voluntary Contraction; (MVC). As a preliminary measure, we established each participant's MVC. They were seated and used their dominant hand to hold a bespoke handgrip dynamometer (Radwin et al., 1991), which was supported so that their arm was flexed at approximately 100 degrees. Three maximal handgrip contractions were initially performed with the dominant hand, each separated by one minute of rest (Padilla et al., 2010). To ensure that we captured a true maximum, after three contractions were completed, we checked if the second largest contraction was within 5% of the largest contraction. If this condition was not satisfied an additional contraction was required. Force (N) was measured using a strain gauge connected to an amplifier and was recorded using a Power1401 (CED) and computer running Spike2 (CED). Signals were digitized at 2500 Hz with 16-bit resolution. MVC was classified as the largest of the three or four contractions (MVC *M* = 484, *SD* = 91 N). This preliminary measure was required to allow computation

of our main outcome measure of performance (i.e., Force Produced) – this is described next.

Force Produced. The primary measure of task performance for this experiment was force produced during a series of 180 s force production tasks (described in Procedure). During each of these tasks we calculated force produced, expressed as % MVC per second (i.e., mean force output relative to maximum per second = total cumulative force output relative to maximum / 180 seconds). Higher scores indicated better performance.

Procedure, Force Production Task and Experimental Manipulations

Participants attended a 90-min testing session in groups of eight individuals.[1] First, informed consent was obtained, and demographics were recorded. Each participant was then assigned to one of eight testing stations, arranged in straight line adjacent to a wall, in the laboratory. One experimenter was responsible for two stations, with an additional experimenter responsible for overall coordination (e.g., instructions and explanation about the task and conditions). Once on a testing station, participants were told that their first task was to use a handgrip dynamometer to establish their maximal grip strength. We proceeded to measure MVC as described in the Performance Measures section above. After the MVC had been obtained, participants remained seated at their station and were told that they would now complete the main force production task.

Force Production Task. We instructed participants that they would complete four repetitions of a 180 second force production task, each separated by at least 12 mins of recovery. Their individual goal was to squeeze the hand dynamometer as hard and as continuously as possible in order to produce as much force per second as possible over each 3-min recording period. The first run of the force production task was always performed in an individual *do your best* condition. This allowed participants to practice and

[1] We tested 14 groups of eight participants, however, the force data of one participant were not recorded, hence our reported sample of 111.

familiarize themselves with the task demands. At the conclusion of this initial *do your best* condition, each participant's performance was used to assign them to one of two groups: the red team comprised the first, fourth, fifth and eighth best performers, whereas the blue team comprised the second, third, sixth and seventh best performers. Once informed of their team, participants stood up and moved to their performance-based station; their seat was turned round approximately 170-190 degrees to face a large monitor (123 cm × 65 cm) located approximately 3 m from each participant on the other wall of the laboratory. The eight seats were re-positioned into a gentle arc shape arrangement (see Figure S1, Supplementary Material). The team allocation process took approximately 10 min.

Next, participants were reminded that they would repeat this main force production task three more times, but it was emphasized that in each of these remaining attempts they would be in a team competition (i.e., red team versus blue team). Their individual goal was still to produce as much force per second as possible over each 3-min contest. However, they also had the additional team goal of producing a grand total cumulative force output (aggregated over the four members of each team) to exceed that of the other team in each competition. The winning team was the one with the highest grand total cumulative force output at the end of each separate contest. To coordinate team performance, the force signal from each of the eight individual computer stations (see above) was split and co-recorded on a master computer. This computer was connected to the large screen which displayed the current force production (% MVC) and total cumulative force production (% MVC × seconds) for each of the red team members across the top of the screen and for each of the blue team members across the bottom of the screen (see Figure S2, Supplementary Material). The large screen also displayed the grand total cumulative force production (% MVC × seconds) for each team in the middle of the screen, with the blue team's total above the red team's total. The red team's data were displayed in red text

whereas the blue team's data were displayed in blue text. Finally, the screen also displayed the following information in black text on the screen: the time elapsed since the start of the task (0-180 s) on the left middle, the time remaining until the end of task (180-0 s) on the right middle, and the word GO on the top right during the task. The text (size, brightness) was easy to read for all participants.

After these instructions, participants proceeded to complete the force production task in each of the following experimental conditions:

No reward. In the no reward condition, no financial rewards were offered for winning[2].

Low reward interdependence. In the low reward interdependence condition, participants were told that each member of the winning team would earn an equal financial reward. Specifically, a £15 prize fund was to be distributed equally among the four members of the winning team, with each receiving £3.75 (25%)[3].

High reward interdependence. In the high reward interdependence condition, participants were told that each member of the winning team would earn a different financial reward. Specifically, a £15 prize fund was to be distributed unequally among the four members of the winning team. The teammate who produced the most, second most, third most, and least force (i.e., mean force output relative to maximum per second) would receive £8 (53%), £4 (27%), £2 (13%), and £1 (7%), respectively[4].

[2] While we name this condition *no reward* for the purposes of our experiment, if readers prefer to adopt the interdependence typology advanced by Evans et al. (2012), this condition could equally be labelled as *cooperative interdependence* on account that team members performed the task without interacting, that the group outcome was important, and that their individual rank within the team was of little importance.

[3] While we name this condition *low reward interdependence* for the purposes of our experiment, if readers prefer to adopt the interdependence typology advanced by Evans et al. (2012), this condition could equally be labelled as *cooperative interdependence* on account that team members performed the task without interacting, that the group outcome was important, and that their individual rank within the team was of little importance. This is the same as our *no reward* condition because the typology adopted by Evans et al. (2012) focuses on outcome interdependence and does not account for conditions that differ in reward provision in the way we manipulated here. This is a main reason why we used our own condition labels instead of adopting previous terminology.

[4] While we name this condition *high reward interdependence* for the purposes of our experiment, if readers prefer to adopt the interdependence typology advanced by Evans et al. (2012), this condition could equally be labelled as *collective interdependence* on account that team members performed the task without interacting,

The order in which these head-to-head team competitions were completed was counterbalanced as far as possible across each pair of teams. For instance, if the order of conditions for the eight participants attending the first data collection session was no, low, high, the order of conditions for the eight participants attending the second data collection session was high, low, no, and so on. There were a total of six condition orders, meaning that each possible order was used in at least two testing sessions, and two of the six orders were used in three testing sessions.

Participants sat and rested for 5-min before completing each task condition. Each task was followed by a 5-min recovery period, during which they completed the self-report measures to assess how they felt *during* the previous task. This sequence (i.e., rest, instruction, task, recovery) was repeated in each condition. In line with past studies using a similar task (e.g., Cooke et al., 2011, 2013), this arrangement ensured that participants had at least 12 min between tasks (i.e., 5 min recovery + 5 min rest + 2 min instruction); we have found the task-to-rest ratio to be sufficient to allow recovery from the task. At the end of the session, participants were thanked, debriefed, and asked not to disclose information of the experiment.

Data analysis

Main Analyses. First, to investigate our first study purpose, we examined the effects of reward interdependence condition on performance (i.e., force produced), anxiety, enjoyment, effort, and cohesion via a 3 reward condition (no reward, low reward interdependence, high reward interdependence) within-participant MANOVA. Next, to probe this effect, we conducted separate 3 condition ANOVAs followed by post-hoc comparisons for each variable. We have reported the results of the multivariate solution for these analyses (Vasey & Thayer, 1987). Partial eta-squared (η_p^2) is reported as a measure of

that the group outcome was important, and that their individual rank within the team was also important in determining the reward structure.

effect size, with values of .02, .13 and .26 representing small, medium and large effect sizes, respectively (Cohen, 1992).

Second, to investigate our second study purpose, we used MEMORE 2.1, model 1, to perform within-participant mediation analysis (Montoya & Hayes, 2017). In brief, these analyses evaluate the within-participant change in process variables (e.g., anxiety, enjoyment, effort, cohesion) between two-conditions as mediators of the within-participant change in the outcome variable (i.e., performance). Accordingly, we first evaluated three sets of mediation models to examine mediational pathways for each combination of between-condition comparisons in our experiment (i.e., high reward interdependence – no reward; low reward interdependence – no reward; high reward interdependence – low reward interdependence) and each potential mediator separately. In all cases, we entered the pair of performance scores as the outcome variable (e.g., high reward interdependence force, no reward force) and the pair of scores of the potential mediator variable (e.g., high reward interdependence anxiety, no reward anxiety). These analyses were designed to establish the unique contribution of each candidate mediator. To test our hypotheses, we focused on any indirect effects of condition on performance via each mediator.

A second set of exploratory mediational models were employed to examine the candidate cohesion-emotion-effort sequential mediation pathway. We entered the pair of performance scores as the outcome variable, and the pairs of cohesion scores, anxiety scores, enjoyment scores and effort scores as the first, second, third and fourth mediator variables, respectively. We ran serial mediation models for each combination of between-condition comparisons, and we focused on the indirect effect of condition on performance via the four-level (cohesion, anxiety, enjoyment, effort) serial mediator pathway.

We used 10,000 bootstrap samples to compute percentile 95% confidence intervals (*CI*); an effect was significant when the intervals did not cross zero. We report the partially

standardized indirect effect (MacKinnon, 2008), measuring the effect in terms of the *SD* of the outcome variable.

Supplementary Analyses. In addition to testing our primary hypotheses concerning the effects of interdependence on individual performance, we also employed independent samples t-tests to explore the effect of competition outcome (i.e., whether the team won or lost) on ratings of emotion, effort and cohesion in each of the experimental conditions. Moreover, based on evidence that the relationship between cohesion and performance could be bi-directional (Mathieu et al., 2015), we also performed a final-set of mediation models where the pair of cohesion scores were entered as the outcome variable, and the pair of performance scores were entered as the potential mediator. The outcomes of these analyses are reported in the supplementary online material.

Results

Direct effects of reward interdependence on performance, emotion, effort and cohesion

Our first study purpose was to investigate the effects of reward interdependence on performance, emotion, effort and cohesion. A 3 reward condition (no reward, low reward interdependence, high reward interdependence) within-participant MANOVA confirmed a multivariate effect for condition, $F(10, 101) = 3.00$, $p = .002$, $\eta_p^2 = .229$. The means and 95% confidence intervals for each condition and their statistical comparison are presented in Table 1. As can be seen in this table, the amount of force produced per each 3-min task was greater with rewards than no reward, and greater with high than low reward interdependence; anxiety and enjoyment did not differ among the task conditions; effort was higher during the two reward conditions than the no reward condition; and task cohesion was greater during the low reward independence condition than the no reward condition.

Indirect effects of reward interdependence on performance via cohesion, emotion, and effort

Our second study purpose was to investigate emotion, effort, and cohesion as mechanisms underlying the effects of reward interdependence on task performance. Only three indirect effects were noted in these within-participant mediation models. The relative performance benefit of low resource interdependence compared to no reward was explained by an indirect effect via effort, b = 0.41, 95% CI = 0.02, 0.93, PSIE = .06, and an indirect effect via cohesion, b = 0.31, 95% CI = 0.01, 0.81, PSIE = .05. The relative performance benefit of high resource interdependence compared to no reward was explained by an indirect effect via effort, b = 0.54, 95% CI = 0.07, 1.28, PSIE = .08. The high versus low interdependence comparison yielded no indirect effects. The sequential mediation models yielded no multi-level indirect effects. In sum, our results provided support for an effort mechanism and a cohesion mechanism, but no support for either emotion mechanism nor the proposed sequential cohesion-emotion-effort mechanism to explain the effects of reward interdependence on task performance during intergroup (team) competition.

Discussion

Grounded on social interdependence theory (Deutsch, 1949; Johnson, 1974; Johnson & Johnson, 1989; 2005), we evaluated the effects of reward interdependence on motor task performance as well as feelings of cohesion within the team and emotions and effort. Specifically, we evaluated the direct and indirect (via cohesion, anxiety, enjoyment, and effort) effects of three reward interdependence conditions (no, low, high) on feelings, thoughts and actions during a simple strength and endurance task.

Effects of reward interdependence on performance

Our first study purpose was to investigate the effects of reward interdependence on performance during intergroup (team) competition. Performance was better during high reward interdependence than low reward interdependence, and better during low reward interdependence than no reward. These findings agree with some previous reports concerning the influence of reward interdependence on non-motor tasks (e.g., DeMatteo et al., 1998; Wageman & Baker, 1997). However, they contradict the findings of other studies (e.g., Allen et al., 2003). In cases where high reward interdependence has been argued to harm group performance, this has been explained by teammates reducing cooperative behavior in such conditions. For instance, if soccer teammates are offered individual bonuses for scoring goals, this could elicit bias where the default option when in possession of the ball becomes a shot at goal, at the expense of potentially better options (e.g., pass to teammate) for the team. In the present experiment, task interdependence was low as participants performed at individual stations and their individual contribution to the team was not contingent on interactions with their teammates in the same way as it would be in cross country running, where runners from the same team individually contribute points to the team based on their individual finishing positions in the race, and the collective points determines the overall team outcome (Evans et al. 2012). The current findings thereby argue that in team conditions that do not require high coordination and interaction between teammates, the offer of rewards yields superior outputs than no-rewards, and high-reward interdependence in the form of performance-related pay may promote the highest collective outcomes.

This experiment represents the first investigation of the effects of reward interdependence on motor performance during intergroup competitions. It is highly relevant to sport because team competitions and variability in reward interdependence across sport teams (e.g., equal versus unequal pay for players) are common in the sport domain. Previous

findings already make a case for the benefits of team competition; the performance of simple motor tasks was optimized by team competitions, compared to pure competition, pure cooperation and individual task structures (e.g., Cooke et al., 2011, 2013; Tauer & Harackiewicz, 2004). The novel findings of this experiment indicate that adding rewards to intergroup competitions can enhance performance even further, with the best performances occurring when reward interdependence was high. In terms of application to sport, our findings imply that if optimal performance is the sole concern of sports teams, then the financial rewards afforded to individual players should be linked to their performance (i.e., higher rewards for the top performing players). However, we can only make this recommendation with confidence for team sports with low task interdependence. Evans et al. (2012) provide a good example of soccer, where players interact in set formations and share a single ball.

This so-called collective interdependence scenario (Evans et al. 2012) is similar to the high reward interdependence condition in this experiment.

It remains to be seen whether the performance benefit of high reward interdependence displayed here persists in other team environments, particularly those requiring high levels of interaction among teammates as occurs in traditional team sports (e.g., soccer, basketball). The effects of reward interdependence may also change as teams evolve over time with established sports teams who have formed close bonds between teammates over many years behaving differently (and potentially favoring low-reward interdependence) compared to newly formed teams like we used for the current experiment (e.g., Mathieu et al., 2015). These are interesting avenues that are ripe for investigation by future research.

Another aspect of our first study purpose was to investigate the effects of reward interdependence on cohesion, emotion and effort. We found that during competition, participants felt closest to and most connected with their teammates when the prize money

being competed for was due to be split evenly (i.e., when reward interdependence was low). Therefore, while the unequal distribution of rewards in the high reward interdependence condition led to optimal performance, low reward interdependence (pay equality) was optimal for team cohesion. This finding can be interpreted via the arguments already presented regarding teammate interactions (e.g., Allen et al. 2003). In brief, although there was little need for the teammates to interact during task performance in the current experiment, the equal pay condition did provide grounds for participants to support and encourage their teammates to increase their chances of obtaining the shared reward. Engaging in supportive prosocial behavior can elevate cohesion (Al-Yaaribi & Kavussanu, 2017). Although not formally recorded, we observed less evidence of supportive behavior between teammates in the high reward interdependence condition where teammates were trying to outperform one another. Since most sport organizations strive for both high performance and high team cohesion, our findings could be used to make a case for hybrid pay structures, where rewards are linked to individual performances, but with a cap to limit the discrepancies between the highest and the lowest earning team member. However, further research is required before we can generalize this recommendation to any sports teams who differ from the newly formed collective interdependence typology (i.e., low inter-individual interaction) of group that we studied here (Evans et al. 2012).

Concerning the other process variables, we observed that participants reported more effort when there was prize money to be won, regardless of its distribution within the team. Accordingly, the promise of some pay for winning was more motivating than the prospect of no pay at all, but the manipulation of even versus uneven pay had little impact on effort. Finally, we found no differences across conditions in either positively-valenced or negatively-valenced emotions. Previous research has revealed greater anxiety and enjoyment during team competitions compared to other social climates (Cooke et al., 2013), noting that team

competition elicits emotion. The null findings here indicate that the addition of financial rewards to team competition has no further impact on the emotions experienced. In sum, the emotions experienced during competitions are elicited by the competition process irrespective of the rewards on offer, while effort and feelings of cohesion with teammates during competition are influenced by reward structures.

Mechanisms underlying the effects of reward interdependence on performance

The second study purpose was to investigate cohesion-, emotion- and effort-based mechanisms underlying the effects of reward interdependence on performance. We found some evidence to support a cohesion-based mechanism to explain the effects of reward interdependence on performance. An indirect effect from the mediation analyses confirmed that variations in performance from the no reward condition to the low reward interdependence condition was explained by increased team cohesion when the reward was distributed equally. Meta-analytic research in sport shows that cohesion is associated with improved performance of a variety of tasks (Carron, et al., 2002). The current data indicate that team cohesion is more than just a correlate of high performance and endorse a cohesion-based mediation pathway. However, this only emerged in the model comparing no reward to low reward interdependence. The best performance in the current experiment (i.e., the high reward interdependence condition) was not fueled by cohesion. This indicates that increased cohesion can be of some benefit for performance, but team cohesion is not the key determinant of optimum performance. This finding is compatible with other research that cautions against the simple assumption of a positive relation between cohesion and group performance in every situation (Hardy et al., 2005). While previous research clearly demonstrates associations between cohesion and performance (Carron et al. 2002), few previous studies adopted mediation analyses to statistically test for causality. Our findings indicate that cohesion can mediate changes in performance depending on the

amount of reward interdependence. Future research is needed to determine the reason(s) that cohesion benefits performance, with a number of possibilities, such as better teamwork, cooperation, and coordination, worth exploring.

We found that effort was a more important determinant of the relationship between rewards and performance. Mediation analyses confirmed that increases in effort from the no reward condition to both the low reward interdependence and the high reward interdependence conditions explained the reward-induced improvements in performance. Our results are compatible with Triplett's (1898) effort mechanism to explain the effects of competition on performance. Previous studies have also noted that team competition can benefit performance of endurance tasks via increased effort pushing individuals closer to their physical limits (e.g., Cooke et al., 2011; 2013). Accordingly, for simple physical tasks, the literature indicates that manipulations of competition and manipulations of reward can both induce additional effort, and this has a facilitative effect on physical performance.

Contrary to expectations, we found no evidence to support enjoyment-based and anxiety-based mechanisms underlying the effects of reward interdependence on performance. This may be explained by the similar levels of enjoyment and anxiety that were experienced by participants across the three team competitions. Thus, while emotions appear to be important drivers of the effects of competition on performance (Cooke et al., 2013; Ring et al., 2020), neither enjoyment nor anxiety can explain changes in simple motor task performance evoked by financial rewards.

We also found no evidence to support the theorized serial cohesion-emotion-effort mediation pathway. Like studies of cohesion and performance, it should be noted that previous studies demonstrating relations between cohesion and emotion and between cohesion and effort are generally correlational and not causal (Fox, et al., 2000, although for an exception see Bray & Whaley, 2001). Therefore, it is possible that increased cohesion

coincides with but does not cause increases (decreases) in positive (negative) emotions. Studies have also highlighted the potential for opposite relations between cohesion and emotion than we predicted here. For example, Sagi et al. (1955) suggested that increased cohesion may elevate anxiety by making individuals perceive greater responsibility towards teammates. If this anxiety-eliciting effect of cohesion played out in some participants while our predicted anxiety-cathartic effect (e.g., Prapavessis & Carron, 1996) played out in others this could have contributed to the current null mediation. Alternatively, it is possible that this serial mediation model would only apply to more well-established teams who have developed their bonds and emotional connectedness over time. To examine this possibility the proposed serial mediation model should be re-tested in research involving more established groups than were employed here.

Study limitations and future directions

Potential methodological limitations should be born in mind when interpreting the current study findings. First, we measured emotion, effort and cohesion using self-referenced ratings that were completed after the competition tasks. Measuring retrospectively introduces the potential for these process variables to be influenced by the performance of both the individual and the group (e.g., win, loss). Although there was little impact of competition outcome on the emotion and effort measures, there was an impact on cohesion, which was higher in teams that won (see Supplementary Online Material). There were also reciprocal mediational relations between cohesion and performance (Supplementary Online Material) potentially adding further fuel to the suggestion that the temporal ordering of measurement could have impacted the cohesion mediation models. Future studies could add peer and third-party ratings to triangulate the measurement of our processes. These studies could also incorporate specialist multi-item scales to measure emotion (e.g., Jones et al., 2005) alongside video and physiological recordings to measure

the process variables during the competitions (Cooke et al., 2011, 2013). They could also measure cohesion using measures with multiple subscales to better capture the influence of different aspects of cohesion in a team competition context. Second, the group-based nature of this research meant that we utilized a nested design where eight participants (i.e., two teams) were tested at once. Although participants were randomized to teams and the order in which they completed the conditions was as balanced as possible, there remains a possibility that the experience of some participants was influenced by grouping or order factors outside the reward interdependence features that we sought to investigate. Research requiring teams to visit the laboratory on multiple occasions to compete against a variety of rivals and experience a range of condition orders could be conducted to better control potential group or order effects in the future. Third, we only used one motor task. The current task was simple to understand and perform, familiar to participants, and required both strength and endurance, and, therefore, future studies could replicate our findings in tasks that are more complex, novel, and require fine motor skill, in order to confirm the generalizability of the observed effects. Future studies would do well to investigate the full spectrum of structural interdependence typologies, with a particular focus on task interdependence, to re-examine our effects in tasks and conditions where different levels of teammate interaction/coordination are required (Bruner et al., 2015; Evans et al. 2012). Fourth, we studied groups of four teammates. Since social loafing is more likely to occur as the group size increases (e.g., Ingham et al., 1974), future studies could repeat our manipulations in smaller and larger groups. Finally, we studied the effects of the experimental manipulations on groups of participants who were strangers. It would therefore be interesting to see whether the effects are the same in groups of participants who belong to existing teams (e.g., Voor et al., 1969). Future research could compare the effects of reward interdependence on performance of existing teams and ad hoc teams in a

variety of competitive and cooperative social climates. These studies could re-test the proposed cohesion-emotion-effort mediational pathway while also measuring other processes (e.g., social identity – Bruner et al. 2015) that capture further information to better understand the importance of group dynamics in this in a variety of interdependence scenarios.

Conclusion

The present study showed that performance of a simple motor task in team competition was better when teammates were incentivized by the promise of a cash reward for defeating their opponents, than when no rewards were offered. We also found that the distribution of rewards matters; performance was better when the prize money offered was contingent on individual contributions to the team (high reward interdependence) than when it was to be divided evenly (low interdependence) among teammates. These effects of reward interdependence on performance comprised consistent direct effects and occasional indirect effects. Specifically, we found some evidence that improved performances were facilitated by increases in cohesion when the distribution of rewards was even. We also found evidence that performance was mediated by increased effort, with optimal performances occurring in the high reward interdependence condition where participants were incentivized by performance-related pay. This indicates that prize money can be employed as an extrinsic reward to motivate participants to perform better on simple motor tasks performed in group competitions. In sum, we found evidence that the offer of financial rewards facilitates physical performance in team competitions, with equal pay helping teammates to stand united, but unequal (i.e., performance-related) pay promoting the highest team performances.

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Table 1

Effects of Reward Interdependence on Measures

	Reward Interdependence							
	No		Low		High		*F*(2, 109)	η_p^2
Measure	*M*	95% *CI*	*M*	95% *CI*	*M*	95% *CI*		
Force (% MVC / s)	27.38	26.08, 28.68	29.56 [a]	28.43, 30.69	30.63 [a, b]	29.48, 31.78	11.58 ***	.175
Anxiety (1-7)	3.07	2.79, 3.35	3.09	2.80, 3.38	3.15	2.86, 3.45	0.17	.001
Enjoyment (1-7)	3.71	3.49, 3.93	3.90	3.68, 4.13	3.91	3.67, 4.14	1.98	.035
Effort (1-7)	4.55	4.24, 4.85	4.82 [a]	4.53, 5.12	4.93 [a]	4.64, 5.23	3.13 *	.054
Cohesion (1-7)	4.18	3.96, 4.39	4.46 [a]	4.20, 4.71	4.40	4.15, 4.65	2.74	.048

Note: Superscripts a and b indicate significant differences ($p < .05$) from the no and low reward interdependence conditions, respectively.

* $p < .05$, *** $p < .001$.

Highlights

- The effects of reward interdependence on performance was examined to help understand rewards in sport
- Performance of a simple motor task during team competition was facilitated by rewards
- Optimal performance was associated with unequal rewards (i.e., performance-related pay)
- The benefits of performing with rewards compared to no rewards were explained by increased cohesion and effort
- Social interdependence theory can help explain performance of motor skills in sport

Supplementary Analyses

To test the possibility that competition outcome influenced our post-task ratings of cohesion, emotion, and effort, we performed independent samples t-tests to compare members of winning versus losing teams in each of the experimental conditions. In all three conditions, cohesion was rated significantly higher by participants who were part of winning teams (*M*s = 4.41 – 4.97, *SD*s = 1.08 – 1.40) compared to losing teams (*M*s = 3.93 – 4.01, *SD*s = 1.11 – 1.36), *t*'s(109) = 2.20 – 4.35, *p*'s = .000 - .030, *d*'s = 0.42 – 0.83. There were no significant effects of competition outcome on ratings of anxiety, enjoyment, or effort.

Mediation analyses investigating performance as a mediator of self-rated cohesion yielded evidence of mediation in the no reward versus low resource interdependent condition model; indirect effect via performance, *b* = 0.09, 95% *CI* = 0.01, 0.21, PSIE = .07. The main analyses already confirmed that increased cohesion contributed to higher performance in the low resource interdependent compared to the no reward condition. This latest mediation analysis indicates that this pathway is reciprocal, with higher performance also contributing to greater cohesion. There were no indirect effects in the other between-condition mediation models, indicating that causal effects of performance on cohesion break down as resource interdependence is increased.