

**Effects of cooperation and competition on performance, emotion and effort: Goal and means interdependence**

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Effects of cooperation and competition on performance, emotion and effort:

Goal and means interdependence

Abstract

1 Social interdependence theory proposes that task structure influences performance via
2 social interaction. Using this framework we examined sport performance. Fifty-six males
3 performed a basketball task under four conditions: as an individual (individual, perform your
4 best) and as a member of a team of two (cooperation, where teammates sought to better
5 their individual performance; means independent competition, where two teams competed
6 sequentially to outperform the other team; means interdependent competition, where two
7 teams competed simultaneously to outperform the other team). Task performance (points)
8 was better during means independent competition than other conditions. Anxiety and effort
9 peaked during the competitions and enjoyment was greater during competition and
10 cooperation than during the individual condition. Emotions, effort and actions are discussed
11 as explanations for the performance effects. Social interdependence theory provides a
12 valuable framework to understand emotion, motivation and performance. Team competition
13 can be used to promote effort and enhance performance in sport.

14

Introduction

The role of situational and personal factors on performance in sport has attracted attention from researchers and theorists wishing to explore and explain the psychology of action. Research in sport and performance psychology has demonstrated that athletic performance can be influenced by the structure of the task, such as the number and availability of competitors, together with the emotions experienced and personal effort expended by athletes (for review see Kavussanu et al., 2021). A well established social psychology theory that could explain some of these effects and be of value to sport and performance psychologists is social interdependence theory (Deutsch, 1949a, 1949b; Johnson, 1974; Johnson & Johnson, 1989; 2005). It proposes that the structure of tasks influences social interaction, which, in turn, influences performance.

In its original guise, social interdependence theory focused upon goal interdependence, and was used to shed light upon the effects of cooperative and competitive environments on behavior (Deutsch, 1949a, 1949b). The theory defines three modes of goal interdependence: positive (one's goal can be achieved if others also achieve their goal; this occurs when we cooperate with others), negative (one's goal can only be achieved if others fail to achieve their goal; this occurs when we compete with others), and null (one's goal can be achieved regardless of whether others achieve their goal; this occurs when we perform as individuals). In its more recent iterations, social interdependence theory has evolved to consider other aspects of interdependence, such as means interdependence, which considers the extent to which goal achievement is dependent upon resources, roles, and tasks (Butera & Buchs, 2019; Johnson & Johnson, 2005). The current experiment manipulates goal interdependence and means interdependence to examine the merits of social interdependence theory as a framework for understanding emotion, motivation and behavior in sport.

1 *Goal interdependence*

2 To date, most research on the effects of task structure on performance of motor skills
3 has concentrated on goal interdependence, namely, the effects of pure competition (i.e.,
4 negative goal interdependence) and pure cooperation (i.e., positive goal interdependence)
5 on performance (for review see Stanne et al., 1999). The study of competition in sport has a
6 long and illustrious history beginning with Triplett's (1898) seminal research. He designed
7 the first sport psychology experiment and compared the times taken to complete a reel
8 winding task that moved a flag around a track under individual and competitive conditions.
9 These data provided suggestive, rather than definitive, support that negative goal
10 interdependence (contesting with a rival) encouraged better performance than null goal
11 interdependence (termed more simply as 'goal independence' from here on; performing
12 alone). He explained this finding by arguing that competition motivates performers to invest
13 additional effort, stating "*the bodily presence of another contestant participating simultaneously in*
14 *the race serves to liberate latent energy not ordinarily available*" (Triplett, 1898, p. 533).

15 Over a hundred years on from Triplett's seminal work, a meta-analysis of 64 motor
16 performance experiments concluded that performance of motor skills was better during
17 pure competition (i.e., 'winner takes all', where one individual seeks to perform a task
18 better than everyone else, such as a running a 100 m race, or contesting track cycling's
19 head-to-head pursuit race, where the winner is awarded the gold medal) and pure
20 cooperation (i.e., where individuals work together to perform a task, such as a guide runner
21 helping a blind runner to run 100 m, or a group of road cyclists sharing workload by taking
22 equal turns as the front rider during a training session) compared to individual (i.e., 'do your
23 best' at the task, such as running 100 m or cycling laps of the velodrome alone to try and
24 achieve a personal best time) task structures (Stanne, et al., 1999). Research has also
25 provided some evidence to support Triplett's (1898) assertion that the beneficial effect of

1 competition compared to individual goal independent climates can be explained, in part, by
2 additional effort invested during competition (e.g., Cooke et al., 2011). Meanwhile, the
3 beneficial effect of cooperation compared to individual goal independent climates have been
4 attributed to prosocial support behaviors that often emerge between team mates in
5 cooperation climates (e.g., Evans & Eys, 2015). In sum, there is evidence that, negative goal
6 interdependence and positive goal interdependence are both superior to individualistic goal
7 independent task structures.

8 Stanne et al.'s (1999) meta-analysis also revealed some more nuanced outcomes.
9 Specifically, it revealed that performance was worse overall during competition (negative
10 goal interdependence) than cooperation (positive goal interdependence). One explanation
11 for this finding is that the prosocial support behaviors among team mates that emerge
12 during positive goal interdependence conditions may yield stronger performance benefits
13 than those yielded by the increased effort associated with competition (Johnson, Bjorkland
14 & Krotee, 1984). Alternatively, competition conditions are likely to provoke more anxiety
15 than cooperation, which could divert attention away from task-relevant processes and limit
16 performance during competition (Eysenck et al. 2007; Wine, 1971). While these putative
17 mechanisms shed some light on how cooperation could support superior performance than
18 competition, the supposed benefits of cooperation over competition are tempered by two
19 important points.

20 First, Stanne and colleagues (1999) identified half a dozen studies that were neither pure
21 competition nor pure cooperation, and instead included a combination of cooperative and
22 competitive structures. This amalgamated goal interdependent structure is commonplace in
23 sport, namely, team (intergroup) competition. In team sport, teammates cooperate to try
24 and achieve their collective goal (i.e., positive goal interdependence), but they also compete
25 with other teams to try and achieve their conflicting goals (i.e., negative goal

1 interdependence). Stanne et al. (1999) classified these studies of team competition under
2 the cooperation heading for the purposes of their meta-analysis. However, Tauer and
3 Harackiewicz (2004) argued that the studies employing this hybrid goal structure showed
4 that motor performance was better during team competition than pure competition and
5 pure cooperation. Using a basketball free-throw shooting task, Tauer and Harackiewicz
6 (2004) found that participants made more baskets during team competition (two individuals
7 versus two individuals) than during individual competition (one individual versus one
8 individual) and team cooperation (two individuals trying to outperform their combined
9 individual scores). Mediation analyses indicated that the benefits of team competition were
10 explained by elevated enjoyment (i.e., a positive affective state, characterized by pleasure
11 and happiness brought on by success in or simple satisfaction with an activity) during this
12 social climate. This is in accordance with theories such as the broaden and build theory of
13 positive emotion (Fredrickson, 2004), which argues that individuals experiencing positive
14 emotions, such as enjoyment, experience greater interest in what they are doing, thereby
15 helping to broaden their skillset and elevate their performance. Accepting this argument
16 implies that we need to reconsider the interpretation of Stanne et al.'s (1999) meta-analytic
17 findings.

18 *Means interdependence*

19 A second important consideration arising from Stanne et al.'s (1999) meta-analysis was
20 that the effects of the different goal structures on performance appear to have been
21 moderated by means interdependence. Specifically, the conclusion that cooperation
22 outperformed competition appeared to hold for means-interdependent tasks only. Means
23 interdependent tasks typically require all parties involved in task performance to coordinate
24 their resources to optimize performance outcomes. For example, the means-
25 interdependent tasks utilized by the studies in Stanne et al.'s (1999) meta-analysis included

1 tasks such as pulling objects out of a container when its opening only permits one object at
2 a time and building a tower with a limited number of blocks available. It is easy to imagine
3 how the positive goal interdependence that is fostered by cooperation would have been
4 important for successful performance of such tasks, and how the negative goal
5 interdependence that is fostered by competition could have caused conflict (e.g., rivals
6 impeding each others' progress in an attempt to "win"). For studies employing means-
7 independent tasks, such as picking up pegs from separate areas and completing separate
8 finger mazes, Stanne et al. (1999) found that performance in cooperation and competition
9 conditions was equivalent. In sport, examples of means independence versus means
10 interdependence include cycling on the velodrome track alone (means independent) versus
11 with other cyclists around who take up space on the track (means interdependent), rowing
12 along a river alone with any route available (means independent) versus rowing with other
13 boats on the same stretch of the river taking up space in front (means interdependent), and
14 shooting baskets alone (means independent) versus shooting with defenders taking up space
15 near the goal/basket where attackers would like to stand or pass through (means
16 interdependent).

17 *Summary and Rationale for the Current Study*

18 Taken together, the previous findings indicate the following **four** points. First, positive
19 goal interdependence and negative goal interdependence task structures both encourage
20 superior performances to goal independent structures (for further evidence of this finding
21 see also Roseth et al., 2008). Second, positive goal interdependence structures may support
22 superior performances to negative goal interdependence structures for means
23 interdependent tasks only. Third, the hybrid positive and negative goal interdependence
24 structures fostered by team competition may yield the best outcomes of all. **Fourth, the**
25 **effects that these social climates have on emotions (e.g., enjoyment, anxiety), effort, and**

1 interactions with others could explain the observed performance outcomes. These findings
2 should be of considerable relevance to sport. However, the studies included in Stanne et
3 al.'s (1999) meta-analysis focused upon motor performance in a very general sense, as
4 illustrated by some of the exemplar tasks described above. As a consequence, the extent to
5 which these findings hold for specific sport skills remains to be established. More
6 importantly, scant research has considered the effects of means interdependence on
7 performance during mixed positive and negative goal interdependence structures such as
8 team competition, where teammates cooperate together to compete against opponents.
9 This is important to investigate given the potential importance of means interdependence as
10 a moderator of the competition and performance relationship. To the best of our
11 knowledge, no research has evaluated the importance of means interdependence in the
12 context of team competition and sport performance.

13 To address this gap in the research, the current study was designed to investigate the
14 effects of goal and means interdependence on emotions, effort and performance in a real-life
15 team sport task, basketball shooting. We hypothesized that performance during team
16 cooperation and team competition would be superior to performance during the individual
17 condition, and that performance would be greatest during means independent team
18 competition (Stanne et al., 1999; Tauer & Harackiewicz, 2004). To explain these
19 performance effects, we also hypothesized that participants would feel more emotion and
20 expend more effort during the team-based conditions (Cooke et al., 2013).

21

22

Method

Participants

24 Fifty-six male¹ undergraduate students enrolled in a sports science degree course, with a
25 mean age of 19.5 ($SD = 0.9$) years, participated in the experiment. We excluded individuals

1 who played competitive basketball for a club or team at any time (i.e., currently or
2 previously). The sample therefore comprised individuals without specific basketball
3 expertise. Accordingly, they were expected to be of relatively similar ability at the task.
4 Participants were also excluded if they had any current injury or illness. The study protocol
5 was approved by the local research ethics committee. All volunteers, who were recruited
6 from our school participant pool, provided written consent prior to participation. No
7 rewards or incentives were offered.

8 Power calculations using GPower 3.1.5 (Faul et al, 2007) software indicated that with a
9 sample size of 55, the study was powered at .80 to detect significant ($p < .05$) differences
10 among the four conditions using repeated measures analyses of variance for effect sizes
11 exceeding $f = .16$ (small-to-medium) (Cohen, 1992). Previous research studies have found
12 medium-to-large effects of competition on emotion, effort and performance (Cooke et al.,
13 2011, 2013); if similar effects emerge here our analyses are sufficiently powered to detect
14 them.

15 *Study Design*

16 Using a within-participants (repeated measures) experimental design, participants were
17 required to perform the task under four conditions: individual, cooperation, means
18 independent competition, and means interdependent competition (see Figure S2,
19 Supplementary Material). In brief, the individual condition represented a do your best
20 structure, the cooperation condition represented an intragroup pure cooperative structure,
21 and both competition conditions represented an intergroup cooperative and competitive
22 structure.

23 *Task*

24 Participants completed a 3-min basketball free-throw shooting and rebounding task.
25 They were required to throw an adult size 7 (diameter = 0.23 m) basketball (Nike Baller)

1 through a standard size hoop (diameter = 0.46 m) positioned 3.05 m from the ground. The
2 apparatus (Powerhoop) comprised a base, pole, backboard (1.20 × 0.90 m), and hoop. The
3 two shooting positions, which were marked by spots (Shot Spotz), were placed on the
4 ground, 4.88 m from the rim, either side of the backboard at an angle of 25 degrees (see
5 Figure S1, Supplementary Material). Similar tasks have been used in previous sport
6 psychology experiments (e.g., Al-Yaaribi et al., 2018; Ring et al., 2019; Tauer &
7 Harackiewicz, 2004). The task was designed to be simple to understand and perform but
8 required effort to perform well. It was performed outdoors with the apparatus adjacent to
9 exterior walls of a building to ensure balls always bounced back into the shooting zone
10 (Figure S1). The task duration was measured using a countdown timer. The researcher
11 announced when 90, 60 and 30 s of the task remained.

12 *Task Conditions*

13 *Individual.* Each participant was given the goal of scoring as many points as possible. Two
14 researchers, one who acted as a timer and one who acted as a scorer, accompanied one
15 participant outside. The participant was tested individually to prevent overt social evaluation
16 by, and social comparison with, the other three participants. A third researcher remained
17 inside with the other three participants. In this condition, the participant attempted a free
18 throw, ran to collect the rebounding ball, and passed it to the researcher (timer) who stood
19 adjacent to the shooting spot and held it for 4 s before giving it back to the participant to
20 throw again (see Figure S2). This delay mimicked the inter-shot interval experienced by the
21 participant in the other three conditions (see below) when their teammate was shooting,
22 rebounding and passing the ball.²

23 *Cooperation.* Participants were given the team goal of scoring more points combined
24 than their previously combined score from the individual condition (see Tauer &
25 Harackiewicz, 2004). Two researchers (i.e., timer and scorer) accompanied one team of two

1 participants outside, while the third researcher remained inside with the other team of two
2 participants. These two participants were instructed to take turns to shoot the ball at the
3 hoop, run and collect their own rebound, and pass the ball to their waiting teammate so
4 that they could shoot, rebound and pass the ball back to their waiting teammate (see Figure
5 S2). Upon completion of the condition they were told if they achieved their goal (i.e., scored
6 more than their combined individual scores).

7 *Means independent competition.* Participants were given the team goal of scoring more
8 points combined than the other team. The three researchers (i.e., timer, scorer, observer)
9 accompanied both teams outside. The two teams performed the task separately: one team
10 performed while the second team watched (see Figure S2). A coin toss decided which team
11 started. The first team's score was announced during a 2-min rest that separated the two
12 teams. After both teams had completed the condition, they were told if they achieved their
13 goal (i.e., scored more than the other team).³

14 *Means interdependent competition.* The three researchers (i.e., timer, first scorer, second
15 scorer) accompanied both teams outside. One team lined up at the shooting point to the
16 left of the basket and used an orange basketball, whereas the second team lined up at the
17 shooting point to the right of the basket and used a blue basketball (see Figure S2). The two
18 teams performed the task concurrently. Participants were given the team goal of scoring
19 more points combined than the other team. After both teams had completed the condition,
20 they were told if they achieved their goal (i.e., scored more than the other team).

21 *Measures*

22 *Performance.* Task performance was assessed using a score calculated using a categorical
23 points-based system developed by Hardy and Parfitt (1991): complete miss (0 points),
24 backboard and out (1 point), rim and out (2 points), backboard and in (3 points), rim and in
25 (4 points), and clean basket (5 points). A score was created by summing the points for each

1 participant. This measure provided a more comprehensive examination of performance
2 compared to the number of baskets achieved. The total number of shots was also recorded.

3 *Effort.* Perceived effort was measured using the effort subscale of the 16-item Intrinsic
4 Motivation Inventory (McAuley et al., 1989). Participants were presented with four items
5 (e.g., “I put a lot of effort into this task”) and provided ratings on a 7-point scale, anchored
6 by 1 (not at all true) to 7 (very true). The mean rating provided a measure of effort in each
7 task condition (α 's = .89–.91).

8 *Enjoyment.* Enjoyment was measured using the enjoyment/interest subscale of the 16-
9 item Intrinsic Motivation Inventory (McAuley et al., 1989). Participants were presented with
10 four items (e.g., “I enjoyed it very much”) and provided ratings on a 7-point scale, anchored
11 by 1 (not at all true) to 7 (very true). The mean rating provided a measure of enjoyment in
12 each task condition (α 's = .72–.87). *Anxiety.* We inferred anxiety from the pressure/tension
13 subscale of the 16-item Intrinsic Motivation Inventory (McAuley et al., 1989). Participants
14 were presented with four items (e.g., “I was anxious”) and provided ratings on a 7-point
15 scale, anchored by 1 (not at all true) to 7 (very true). The mean rating provided a measure
16 of anxiety in each task condition (α 's = .73–.90).

17 The 16-item Intrinsic Motivation Inventory is well used in sport settings (Clancy et al.,
18 2017) and its validity, reliability and high internal consistency (typical α = .85) are well
19 established in the context of sport (e.g., Clancy et al., 2017; McCauley et al., 1989). In the
20 current study, items were presented in subscale blocks.

21 *Procedure*

22 Participants attended a 2-hour testing session. Four participants attended each session.
23 All four participants waited together indoors with an experimenter before individually being
24 taken to the outdoors basketball shooting setup by two experimenters. Each participant
25 completed 20 practice free-throws (data not reported here). After the points-based scoring

1 system (see above) was explained, the participant completed the individual condition.
2 Performance in the individual condition was completed first to allow us to assign
3 participants into teams of comparable ability (see Cooke et al., 2013; Tauer & Harackiewicz,
4 2004). Specifically, one team comprised the two participants with the first and fourth best
5 individual scores whereas the second team comprised the two participants with the second
6 and third best individual scores. The participants did not know each other. Participants then
7 completed the three team conditions, which were counterbalanced across groups.
8 Participants completed the Intrinsic Motivation Inventory measures after completing each
9 condition, before the performance outcomes were announced by the experimenter. A 10-
10 min rest followed each condition to allow recovery.

11 *Data Analysis*

12 The dataset contained no missing values, and no issues with outliers, skewness, and
13 kurtosis were found in relation to the assumptions for ANOVA and regression. No order
14 effects were detected.⁴ To investigate our hypotheses, we examined the effects of
15 Condition on performance, enjoyment, anxiety, and effort, by conducting a 4 Condition
16 (individual, cooperation, means independent competition, means interdependent
17 competition) within-participant (i.e., repeated measures) MANOVA, which showed a
18 multivariate effect for condition, $F(18, 37) = 19.45, p < .001, \eta_p^2 = .90$. This was followed by
19 separate 4 condition repeated measures ANOVAs and post-hoc comparisons for each
20 variable. We have reported the results of the multivariate solution for these analyses (Vasey
21 & Thayer, 1987). Partial eta-squared (η_p^2) is reported as a measure of effect size, with values
22 of .02, .13 and .26 representing small, medium and large effect sizes, respectively (Cohen,
23 1992).

24 To push beyond our hypotheses and explore whether any effects of Condition on
25 performance were explained by changes in enjoyment, anxiety or effort, we used MEMORE

1 2.1, model 1, to perform within-participant mediation analysis (Montoya & Hayes, 2017).
2 More detail on these analyses and their outcomes are presented in the supplementary
3 online material. We are presenting these analyses in the supplementary material rather than
4 the main results section because we acknowledge that our experiment ($N = 55$) was only
5 powered to detect large effects via mediation (Kenny, 2017). Despite the reduced power,
6 we believe these analyses can provide suggestive detail about potential relations between
7 the measures obtained in this experiment, and in presenting the full outcomes in the online
8 material, we provide readers with the opportunity to formulate their own interpretations of
9 this explorative modeling.

10 **Results**

11 *Effects of task structure on performance, emotion and effort*

12 Our first study purpose was to investigate the effects of task structure on performance,
13 enjoyment, anxiety and effort. The means and standard deviations for each condition and
14 their statistical comparison are presented in Table I. In terms of performance, the number
15 of points scored was greater during the means independent competition condition
16 compared to individual, cooperation, and means interdependent competition conditions.
17 The number of points scored did not differ among the individual, cooperation, and means
18 interdependent competition conditions. Participants experienced more enjoyment during
19 the team conditions than the individual condition; they also felt more enjoyment during the
20 means interdependent competition compared to the means independent competition.
21 Moreover, participants reported feeling more anxious during the two competitions than
22 cooperation, and more anxious during cooperation than individual. In terms of effort,
23 participants reported expending more effort during the two competitions than cooperation,
24 and more effort during cooperation than individual. Effect sizes for the various between-
25 condition comparisons are summarized in Table SI in the supplementary material.

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Supplementary analyses

To facilitate comparison with previous research (e.g., Tauer & Harackiewicz, 2004), we also determined the effects of task structure on a secondary performance measure – the number of successful baskets (i.e., balls through the hoop). A 4 Condition within-participants (i.e. repeated measures) ANOVA revealed differences in the number of baskets among conditions, $F(3, 52) = 11.20, p < .001, \eta_p^2 = .39$. The number of baskets made was greater during means independent competition ($M = 11.38, 95\% CI = 10.60, 12.16$) than means interdependent competition ($M = 9.82, 95\% CI = 9.10, 10.54$), cooperation ($M = 9.78, 95\% CI = 8.83, 10.73$), and individual ($M = 8.69, 95\% CI = 7.74, 9.64$), conditions. In addition, more baskets were made during the means interdependent competition and cooperation conditions than the individual condition.

The number of shots taken by the shooter, which also represented the number of rebounds collected by the rebounder and returned to the shooter in the cooperation and competition conditions, was examined using a 4 Condition within-participants (i.e., repeated measures) ANOVA. The number of shots/rebounds differed among conditions, $F(3, 52) = 64.86, p < .001, \eta_p^2 = .79$, being greater during means independent competition ($M = 23.22, 95\% CI = 22.58, 23.86$) than means interdependent competition ($M = 21.27, 95\% CI = 20.69, 21.85$), cooperation ($M = 21.47, 95\% CI = 20.80, 22.15$), and individual ($M = 21.49, 95\% CI = 20.86, 22.12$), conditions.

Discussion

Based on social interdependence theory (Deutsch, 1949a, 1949b; Johnson, 1974; Johnson & Johnson, 1989; Johnson & Johnson, 2005), this experiment examined the effects

1 of both goal and means interdependence on emotions, effort and performance during a
2 basketball task.

3 *Effects of task structure on performance*

4 Our first hypotheses concerned the effects of task structure on performance.

5 Basketball task performance, measured in terms of total points scored (and number of
6 successful baskets), was better during means independent competition than individual,
7 cooperation, and means interdependent competition. These findings are in line with
8 previous reports that basketball free-throw performance is superior when teams of two
9 participants, in the absence of any task-related conflict for resources, compete rather than
10 cooperate or act individually (Tauer & Harackiewicz, 2004). Our findings provide further
11 evidence to support the suggestion that means independent competition is associated with
12 better performance than individual 'do your best' social structures (for review see Stanne et
13 al., 1999).

14 Importantly, we found that the introduction of means interdependence to team
15 competition reduced its benefit to the performer. This finding is consistent with previous
16 research demonstrating that means interdependent tasks can stifle performance in pure
17 forms of competition, namely, those with negative goal interdependence (Stanne et al.,
18 1999). Notably, this is the first time that this suppressor effect of means interdependence
19 has been extended to team competitions with their hybrid positive and negative goal
20 interdependence structure. It shows that while team competitions can foster superior sport
21 performance (Cooke et al. 2011, 2013; Tauer & Harackiewicz, 2004), the means
22 interdependence structure of the task matters, and team competitions are most likely to
23 promote superior performances in means independent tasks.

24 Finally, performance, measured by the number of baskets made, a secondary
25 performance measure, indicated that the cooperation condition and both competition

1 conditions were better than the individual condition. This result is compatible with the
2 large body of literature reviewed by Stanne et al (1999).

3 *Effects of task structure on emotion and effort*

4 **Our remaining hypotheses concerned** the effects of task structure on enjoyment, anxiety
5 and effort. We found that the team conditions, both competition and cooperation, elicited
6 greater enjoyment, anxiety, and effort than the individual 'do your best' condition.

7 Moreover, participants tended to experience more anxiety and effort, but not more
8 enjoyment, during competition than cooperation. These findings are mostly consistent with
9 previous studies of competition, cooperation and individual task structures that have
10 measured emotion and effort (Cooke et al., 2011, 2013; Tauer & Harackiewicz, 2004). It is
11 also worth noting that the current finding that competition elicits both positive and negative
12 emotions, such as enjoyment and anxiety, is in broad agreement with past studies (e.g.,
13 Cooke et al., 2011, 2013).

14 Our findings add to the extant literature by considering the role of means
15 interdependence, and we established a significant small-to-medium effect where the means
16 interdependent competition was rated more enjoyable than the means independent
17 competition. This finding, demonstrating that participants enjoy being in a team and going
18 head-to-head against another team, could go some way towards explaining the popularity of
19 means interdependent team competitions in recreational sport. Most competitive team
20 sports operate a head-to-head means interdependent structure, where teammates work
21 together, but rival teams can simultaneously obstruct goal progress.

22 **Previous studies of the effects of social interdependence on emotions and effort have**
23 **drawn from psychology theory (e.g., broaden and build theory, Fredrickson, 2004;**
24 **attentional control theory, Eysenck et al. 2007) to interpret variations in emotion and effort**
25 **as the mechanisms responsible for the different performances observed in individual,**

1 cooperative and competitive conditions. For example, increases in enjoyment have been
2 theorized to benefit performance by broadening one's skillset (Fredrickson, 2004) and
3 elevating intrinsic motivation (Tauer & Harackiewicz, 2004), while increased effort can
4 motivate the allocation of additional processing resources to a task (Eysenck et al. 2007;
5 Triplett, 1898). Meanwhile, elevations in anxiety could be detrimental to performance by
6 overloading attention or diverting resources away from task-relevant processes (Eysenck et
7 al., 2007; Wine, 1971).

8 Statistical mediation analyses provide a means of testing such mechanistic hypotheses
9 (Montoya & Hayes, 2017). While our experiment was low on power for mediation analyses,
10 we proceeded to tentatively examine some exploratory mediation models in the
11 supplementary material. These analyses revealed little support for putative anxiety and
12 (perceived) effort-based mechanisms. They revealed slightly more encouragement for an
13 enjoyment-based mechanism to explain some of the observed effects of task structure on
14 performance. Indirect effects from the mediation analyses indicated that variations in
15 performance from the individual to the cooperation, from the individual to the
16 interdependent competition, and from the cooperation to the interdependent competition
17 condition were explained by changes in enjoyment. The cooperation and the means
18 interdependent competition tended to be more enjoyable than the individual condition, and
19 the means interdependent competition tended to be more enjoyable than cooperation, and
20 in all cases additional enjoyment was associated with improved performance. We therefore
21 tentatively add to the evidence that supports an enjoyment-based account of performance
22 (Cooke et al., 2011, 2013; Tauer & Harackiewicz, 2004). However, enjoyment could not
23 explain the peak performance in the means independent condition, and all these significant
24 (and non-significant) mechanistic links must be treated with caution due to our limited
25 statistical power for performing mediation tests.

1 In addition to emotion and effort, we can also draw upon behavioral observations to
2 interpret the effects of condition on performance. Notably, the means independent
3 competition provoked participants to take more shots compared to the other condition.
4 This likely goes some way to explaining why the highest point scores were achieved in this
5 condition. The drop in performance from the means independent to the more enjoyable
6 means interdependent competition could additionally be explained by differences in how
7 access to resources were structured in the two tasks. Importantly, tasks with high means
8 interdependence provide participants with the opportunity to interfere with each other's
9 progress. We observed instances where this occurred during our experiment, with
10 participants from rival teams jostling for position and blocking their opponent, in the means
11 interdependent competition. These interference effects, which could have stifled
12 performance in the interdependent competition, did not occur in the means independent
13 competition.

14 *Applied Implications*

15 We found that all the team-based conditions were associated with more enjoyment
16 and effort, and in the case of means independent competition, higher levels of performance,
17 when compared to individual conditions. Therefore, coaches and managers concerned with
18 promoting enjoyment, endeavour and high performance could consider reducing any
19 individual exercises and introducing more group-based and competitive exercises into
20 training sessions. For example, instead of assigning individual penalty-kicking drills for the fly-
21 halves in rugby, all the squad members who play this position could have their kicking
22 practice structured as a means independent team competition. Our data provide little
23 encouragement for the use of individual conditions with one notable exception; the
24 individual condition elicited the least anxiety and so may benefit some extremely anxious
25 performers who could be overwhelmed in group conditions. It is also important to

1 recognize that although performance was better for a means interdependent competitive
2 setting compared to an individual setting, it is likely that elevated pressure in the competitive
3 setting may undermine skill learning among novices.

4 Second, given that the means interdependent competition provoked some behaviors
5 (e.g., physical contact between rivals) that could impair performance, sports coaches may
6 decide to use this type of training environment in moderation and commensurate to the
7 level of performers they are coaching. For example, if introducing novice learners to the
8 sport of basketball, both the independent and the interdependent competition tasks used
9 here could be applied, but a ratio favoring more frequent application of the means
10 independent task could be advised to hone the novices' shooting skill more quickly, while
11 limiting their opportunities to practice any unwanted behaviors that sometimes develop in
12 interdependent competition environments.

13 *Study strengths, limitations and future directions*

14 Our study design comprised a number of strengths, including a strong theoretical
15 rationale, conditions with distinct social climates of performance, a motor task that was easy
16 to understand and execute, and a clear analytic strategy. Nonetheless, our study findings
17 should be interpreted in light of potential methodological limitations. First, we measured
18 enjoyment, anxiety and effort using self-report measures that were completed in blocks
19 after the task. Future studies could also present the items randomly within the
20 questionnaire. The retrospective nature of these measures raises the possibility that they
21 were influenced by the event itself and how the participant performed during the task. The
22 definitive result of each condition was not known to participants when they rated their
23 emotion and effort as the winning team was not revealed until after the ratings were
24 complete. This should have gone some way towards preventing known performance
25 outcomes impacting emotion and effort ratings. However, to better address this concern,

1 which is a typical feature of experimental research in sport and performance psychology,
2 future studies could incorporate ambulatory psychophysiological recordings to help
3 corroborate the measures of enjoyment, anxiety and effort during the task (see Cooke et
4 al., 2011, 2013; Cooke & Ring, 2019).

5 Second, we concede that we measured anxiety using a subscale from the Intrinsic
6 Motivation Inventory that does not distinguish the distinct cognitive and somatic
7 components of state anxiety. These components could impact performance in different
8 ways. [Future studies could assess anxiety using a multidimensional approach that separately](#)
9 [captures the cognitive and somatic dimensions of anxiety, and in response to social](#)
10 [environments that more closely resemble sport.](#)

11 Third, participants always completed the individual condition first, raising the possibility
12 that the inferior performance of the task observed during that condition could be due to an
13 order effect. To counter this possibility, it is worth noting that direct effects of condition on
14 performance would be expected to emerge from the [exploratory](#) mediation analyses
15 involving the individual condition if order effects were present, but direct effects were not
16 widely forthcoming. Nonetheless, future studies could adopt fully counterbalanced designs
17 where possible. Future studies could also adopt an array of group sizes to examine whether
18 our findings hold for larger teams, that more closely resemble those seen in team sports.

19 Fourth, we concede that our sample comprised male basketball novices and the extent to
20 which our results generalize to [females, to higher-skilled performers, and to more](#)
21 [ecologically-valid sport settings where the athletes might give importance to successful task](#)
22 [execution \(which may produce different motivational and affective experiences that could](#)
23 [impact performance\) remain to be seen.](#) For example, the enjoyment evoked by both types
24 of competition studied here may not generalize to elite sport where the competitive
25 pressures are considerably higher, and any positive emotion may be delayed and be highly

1 contingent on performance outcome instead of being evoked by the competition process
2 per se (Uphill & Jones, 2007). Future research would also do well to recruit a larger sample
3 to ensure greater statistical power to test advance mediational hypotheses.

4 Finally, future research would do well to consider personality as a moderator of the
5 effects of task structure on performance. Recent research has highlighted that narcissism, a
6 trait associated with inflated self-beliefs, can moderate the relationship between task
7 structure and performance. Individuals high in narcissism invest more resources and thrive
8 in individual conditions that allow them to bask in individual glory than in team conditions
9 where they are expected to share any successes with their teammates (Roberts et al.,
10 2019). This perspective indicates that the aggregate effect of competition and cooperation
11 being superior to individual climates, and means independent team competitions being the
12 optimal climate, may not hold as a hard and fast rule for all.

13 *Conclusion*

14 The present study showed that team-based competitive and cooperative social
15 structures exert stronger effects on performance, emotion and effort during a motor skills
16 task than an individual social structure. In terms of emotion, we found that negative emotion
17 was strongest and effort was greatest during team-based competitions regardless of means
18 interdependence, whereas positive emotion was strongest during means interdependent
19 team competition. While participants enjoyed means interdependent competition,
20 performance levels were somewhat impeded by conflict with rivals during this condition,
21 and performance was greatest during means independent competition. This finding makes a
22 novel addition to the extant literature by establishing that the full benefits of team
23 competition, like those of pure competition (Stanne et al. 1999), appear restricted to means
24 independent tasks. In sum, our findings indicate that social interdependence theory is a

1 valuable framework that can be used to help explain variations in performance in the
2 sporting arena.

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Notes

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1. We tested 56 participants but one participant's data were misplaced, leaving a sample of 55 for our analyses. The use of an all male sample can be justified based on evidence that the between-condition differences in social interdependence that we seek to investigate may be stronger in males than females (e.g., Vught et al., 2007), but we acknowledge that a drawback of this approach is that our findings may not generalize to females.
2. The 4 s delay used in the individual condition was based on pilot testing. In the experiment, the average inter-shot intervals in the individual, cooperation, resource independent competition, and resource interdependent competition conditions were 4.2, 4.2, 3.9, and 4.2 s, respectively.
3. Analyses of variance, with order as factor, confirmed no differences between teams that performed first and teams that performed second.
4. To evaluate potential order effects, we performed a MANOVA on the dependent variables: no order effects were detected, $F(4, 50) = 0.74$, $p = .57$, $\eta_p^2 = .06$, indicating that the order in which each team of four completed the conditions had little impact on the findings.

Table 1. Effects of task structure on task performance, emotion and effort

Measure	Task Structure Condition						
	Individual		Cooperation		Means Independent Competition		Int C M
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>
Performance (points)	53.16	11.75	53.29	10.33	58.62 ^{ab}	9.20	51.2
Enjoyment (1-7)	5.14	0.67	5.40 ^a	0.89	5.37 ^a	0.92	5.5
Anxiety (1-7)	2.27	0.94	2.58 ^a	0.89	3.02 ^{ab}	1.25	2.9
Effort (1-7)	4.36	1.05	5.05 ^a	1.17	5.34 ^{ab}	1.05	5.4

Note: Superscripts a, b and c indicate significant differences ($p < .05$) from the individual, cooperation, and means independent competition conditions, respectively. ** $p < .01$, *** $p < .001$.

Supplementary Material

Figure S1. Setup of the base-pole-backboard-hoop and shooting spots. The straight black lines represent the walls of a building.

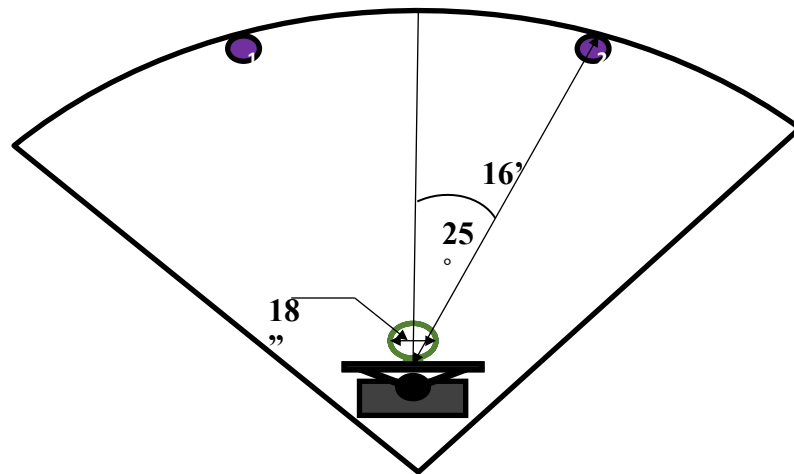


Figure S2. Positions of participants and experimenters in each of the four task structure conditions: individual (A), cooperation (B), means independent competition (C), and means interdependent competition (D). The experimenters are depicted in white, holding either a clipboard (scorer) or countdown timer (timer). During the individual condition, the timer also held the basketball before handing it to the participant. Participants in the two groups are depicted in blue (group one) or yellow and grey (group two).

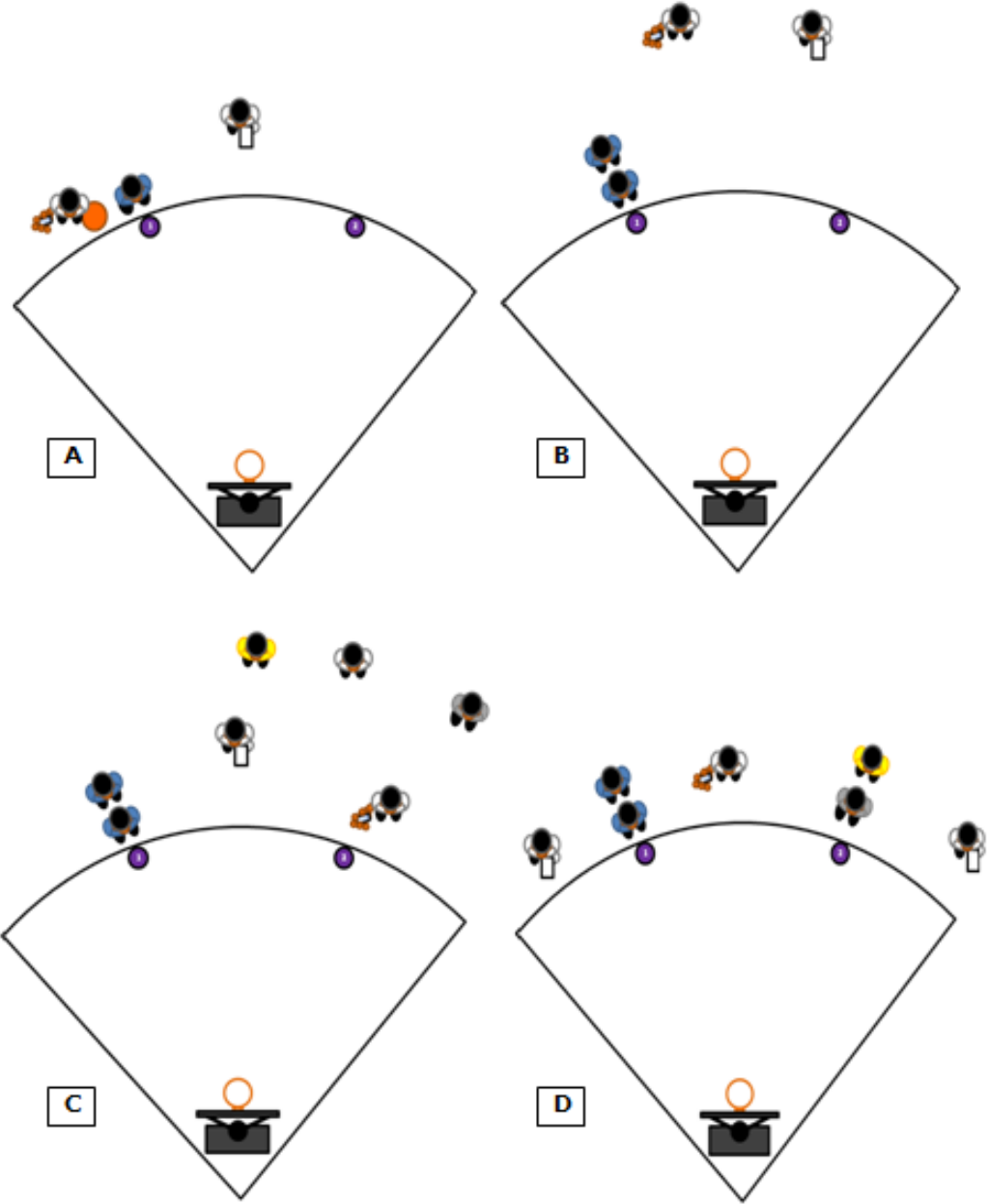


Table SI. Cohen's d effect sizes for dependent means for inter-condition comparisons

Measure	Comparison					
	Individual v Cooperation	Individual v Means Independent Competition	Individual v Means Interdependent Competition	Cooperation v Means Independent Competition	Cooperation v Means Interdependent Competition	Means Independent Competition v Means Interdependent Competition
Points	.01	.51	.19	.54	.22	.84
Enjoyment	.45	.31	.60	.12	.18	.29
Anxiety	.33	.68	.63	.41	.35	.06
Effort	.61	.93	1.02	.26	.38	.14
Baskets	.31	.83	.36	.49	.01	.56
Shots	.01	.73	.10	.71	.09	.85

Note: Cohen's d is reported as a measure of effect size, with values of .20, .50 and .80 representing small, medium and large effect sizes, respectively (Cohen, 1992).

Supplemental Results

Mediation Analyses

To examine potential mechanisms underlying the observed effects of condition on performance, we used MEMORE 2.1, model 1, to perform within-participant mediation analysis (Montoya & Hayes, 2017). In brief, these analyses evaluate the within-person changes in anxiety, enjoyment and effort between two-conditions as a mediator of the within-person change in the outcome variable (i.e., performance). While the use of difference scores in social psychology research remains a source of debate, this is the only approach to examine within-participant mediation to our knowledge, given the current sample and design. The procedures employed by MEMORE are well-cited and have been adopted by leading statisticians, with an increasing body of literature endorsing the validity of such approaches to within-subject analyses (Gollwitzer et al., 2014; Montoya & Hayes, 2017). We tested six mediation models to examine pathways for each combination of between-condition comparisons in our experiment (e.g., cooperation-individual). As our expectations concerning condition effects are stated *a priori* and to avoid inflating the rate of Type II errors, we have not corrected for multiple comparisons (Perneger, 1998). Instead, we present confidence intervals, so the reader is equipped to form their own interpretation of our results if desired. In line with theorizing that enjoyment and effort provoked by the different conditions could have a positive relationship with performance (e.g., Fredrickson, 2004; Tauer & Harackiewicz, 2004; Triplett, 1898), and that anxiety could have a negative relationship with performance (e.g., Wine, 1971), we focused on any indirect effects of condition on performance via these three variables. In brief, the reported indirect effects represent the basketball points difference between the two conditions in each model that is expected to occur a result of the effects of condition on the mediator and the subsequent effects of the mediator on basketball performance (Montoya & Hayes, 2017). Based on additional theorizing that both anxiety and enjoyment have a positive relationship with effort (e.g., Eysenck et al., 2007; Shi et al., 2021), we also reported the pathways between enjoyment and effort, and between anxiety and effort. We used 10,000 bootstrap samples to compute percentile 95% confidence intervals (CI); an effect was significant when the intervals did not cross zero.

The direct and indirect effects of the task structures on performance are summarized in Figure S3. The cooperation versus individual model confirmed indirect effects of condition on performance via enjoyment and anxiety (Figure S3A). The means independent competition versus individual model confirmed a direct effect of condition on performance and no indirect effects (Figure S3B). The means interdependent competition versus individual model confirmed an indirect effect of condition on performance via enjoyment (Figure S3C). The means independent competition versus cooperation model confirmed a direct effect of condition on performance and an indirect effect of condition on performance via effort (Figure S3D). The means interdependent competition versus cooperation model confirmed an indirect effect of condition on performance via enjoyment (Figure S3E). The means independent competition versus means interdependent competition model confirmed a direct effect of condition on performance and no indirect effects (Figure S3F).

Discussion

In sum, our mediation results provided some partial support of an enjoyment mechanism to explain the effects of task structure on performance. In three of the six models, the condition-induced increase in enjoyment was associated positively with the condition-induced change in performance. There was also evidence of increased anxiety from individual to cooperation conditions having a small adverse effect on performance, but this did not emerge in any of the other conditions. Therefore, evidence for an anxiety mechanism was weak. There was no evidence for the expected effort mechanism. Effort was a mediator of the relation between condition and performance in the interdependent versus cooperation model (Figure S3D), but this was in the opposite direction to what was expected, whereby each unit increase in effort was expected to yield a reduction in performance. Effort may be more likely to benefit performance in speed or endurance tasks such as those studied by Triplett (1898) rather than the accuracy task employed here. The presence of direct effects and the absence of indirect effects in all the models containing the means independent condition indicate that performance in that condition was explained by other factors than those included in the model, for example, the higher number of shots attempted in this condition. This is discussed in the main manuscript. Finally, inspection of the pathways between enjoyment and effort

yielded the expected positive relation in all cases. The expected positive relation between anxiety and effort emerged in only one of the six models. This may provide further encouragement for future researchers to consider the role of enjoyment in addition to or as an alternative to anxiety when modeling the relations between emotion, motivation and behavior in sport. Future researchers are also encouraged to replicate our experiment with a considerably larger sample in order to increase the statistical power and allow more confident interpretations of the mediational outcomes. The current mediation findings are only suggestive due to low power and await confirmation from more powered future research.

Figure S3. The direct effects (shown by the paths between the boxes) and indirect effects (shown by the paths inside the boxes) of task structure conditions on task performance scores via enjoyment, anxiety and effort. Unstandardized coefficients are reported, with 95% confidence intervals in brackets. Solid lines indicate significant paths; dashed lines indicate non-significant paths. Emotion/effort variables presented in bold indicate significant indirect (mediational) pathways; regular text indicates non-significant indirect pathways. Independent = means independent competition. Interdependent = means interdependent competition.

Figure S3

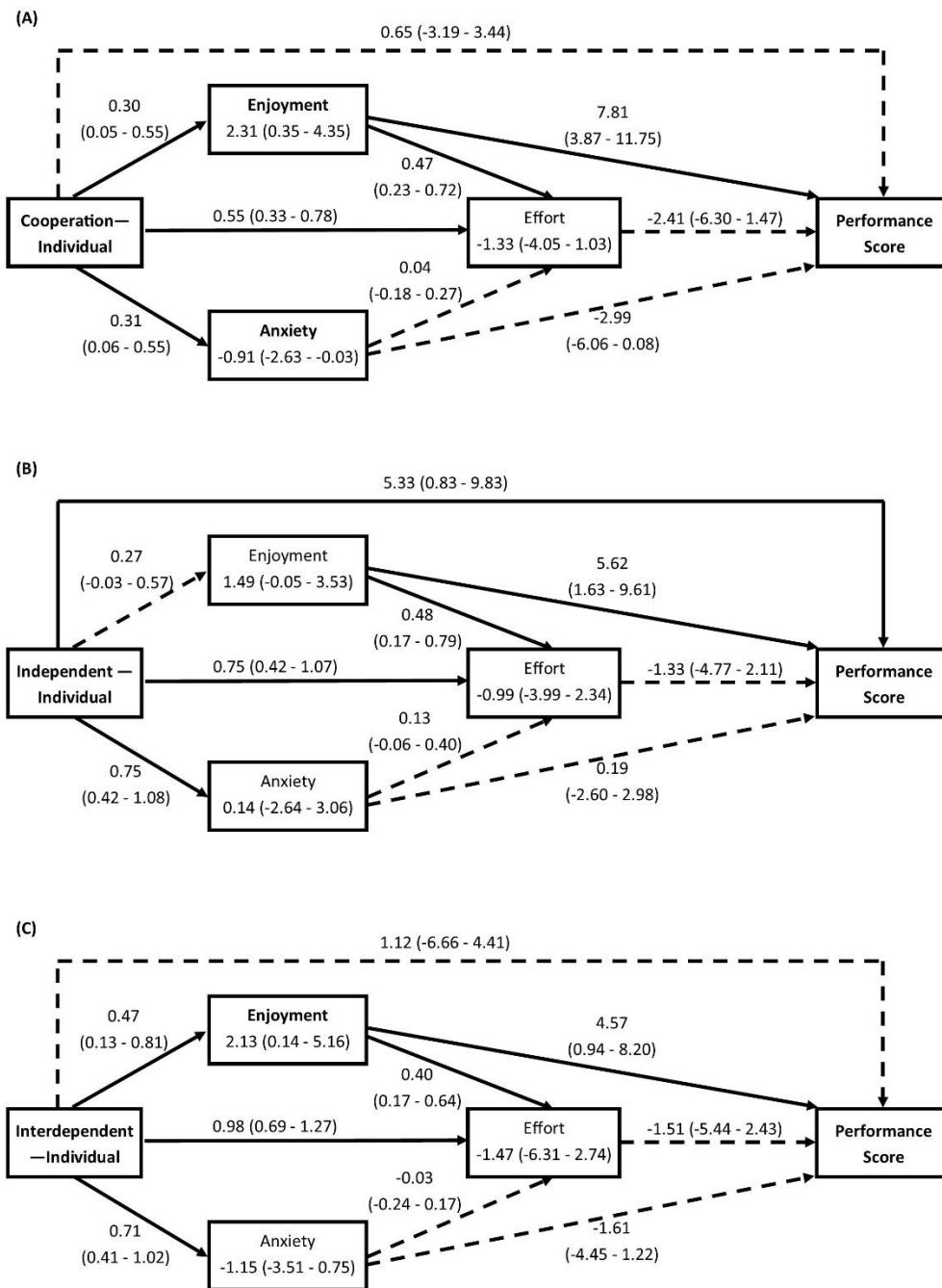
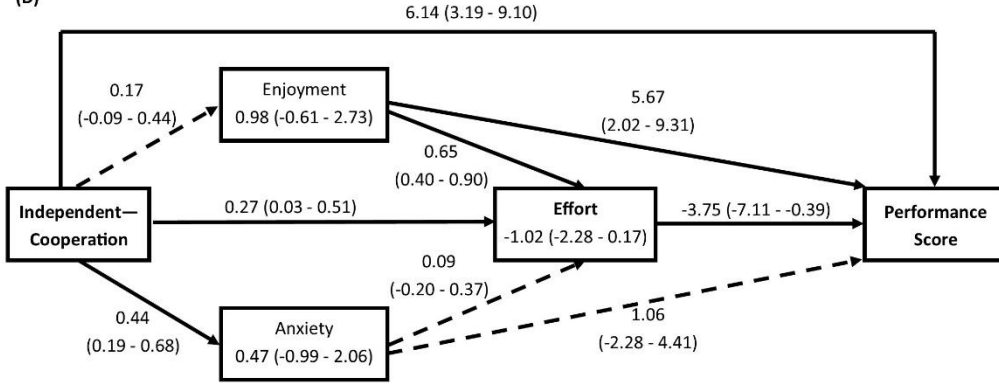
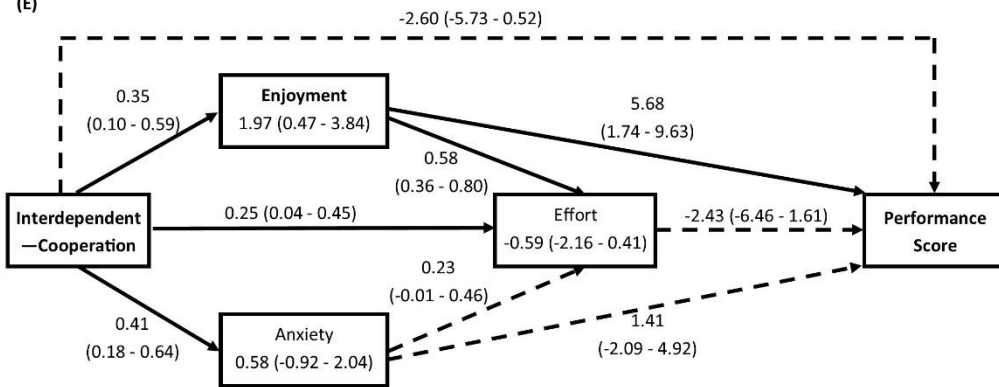


Figure S3 (cont)

(D)



(E)



(F)

