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How do mood states change in a multi-stage cycling competition?

Comparing high and low performers

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Abstract

Aim. Our purposes were to investigate: (a) differences in mood states between high and low performers at the beginning and end of the Girobio 2012 cycling race, and in respect to both actual and perceived performance; and (b) whether the participants' mood states predicted actual and perceived performance. *Methods.* Profile of Mood States (POMS) of 72 elite cyclists were assessed the day prior to the first (T0) and last stage (T1). At the end of the race, we created two rankings, one based on the total time spent to complete the race (actual ranking) and one based on the average of self-evaluations provided at the end of each stage (perceived ranking). We compared high and low performers, considering both rankings, using a general measure of mood; i.e. the Total Mood Disturbance. *Results.* Total Mood Disturbance differed among high and low performers. In particular, high performers' mood disturbance did not differ between T0 and T1, whereas low performing cyclists showed higher levels of mood disturbance at the end of the race. Furthermore, we found that mood disturbance at T0 did not predict either actual or perceived performance. *Conclusions.* The cyclists' mood states at the beginning of the race are not reliable predictors of performance throughout the race. High performing cyclists maintained a more positive mood profile than their low performing counterparts at the beginning and end of a multi-stage race.

Introduction

Intensive physical activity may lead to changes in mood states, especially when not accompanied by proportional recovery[1-4]. To this extent, a multi-stage cycling race is an example of a situation in which sustained rigorous physical activity may not be sufficiently accompanied by recovery. For instance, there is evidence that cyclists experience an imbalance between stress and recovery demands during a multi-stage race[5]. However, there remains a gap in the literature about how mood states change throughout multi-stage cycling competitions, and whether these changes are related to performance. Accordingly, in the present study, we investigated mood fluctuations among high and low performers throughout a multi-stage cycling race.

Mood States

Mood has been defined by Lane and Terry[6] as *"a set of feelings, ephemeral in nature, varying in intensity and duration, and usually involving more than one emotion"* (p. 16). Noteworthy, mood and emotion have been used interchangeably in the sport and exercise psychology literature. However, these constructs represent distinct phenomena[7]. Emotions are the consequence of specific stimuli, are relatively short in duration and high in intensity. Conversely, mood states are not necessarily linked to a specific cause or event and are more prolonged and lower in intensity[8,9]. In the present study we were interested in mood states, which last longer than emotions, and represent a more reliable assessment of one's psychological state during prolonged tasks, such as endurance cycling.

It is important to note that mood states in sport settings have been primarily assessed through the Profile of Mood States (POMS)[10]. This psychological inventory was initially

developed by McNair, Lorr and Droppleman to assess mood states in clinical psychology[10-11]. It has subsequently been used in sport and exercise psychology research[12]. The POMS assesses five negative dimensions (anxiety, anger, depression, confusion, fatigue) and one positive dimension (vigor). The sum of the negative dimension scores subtracted by the vigor score represents an estimate of *total mood disturbance*. Seminal research on this topic suggests that successful athletes have lower scores on the negative dimensions and higher scores on vigor, when compared to population norms. This typical "high vigor profile" has been named *the iceberg profile*[6, 12, 13].

Training Load, Mood States, and Performance in Sports

The link between mood states and performance in sports has been extensively examined through Morgan's classic studies on the iceberg profile[14-18]. In essence, Morgan noted that mood state disturbances are negatively related to training load. Further research has confirmed the association between training load, mood state disturbance, and performance decrement. In a recent review, Urhausen *et al.*[4] concluded that continued training stress may lead to physical exhaustion, psychological fatigue, and severe performance decrement. There is also empirical evidence pertaining to the association between training load, mood, and performance in sports[19,20]. For instance, Dupuy *et al.*[21] found that, after an overtraining period, a large and systematic increase in fatigue and decrease in vigor occurs. Di Corrado, Agostini, Bonifazi and Piercivalle[22] found that salivary cortisol levels, a physiological marker of fatigue, was positively correlated with the five negative mood scales and negatively correlated with vigor in water polo elite players. Overall, the link between physiological markers, such as cortisol, and mood states

has been seen as evidence that the POMS can serve as an effective tool for monitoring athletes' performance cycles[1,2,23].

Additional research in sport and exercise psychology has examined the relationship between athletes' POMS and performance measures, with the aim to discover whether mood can predict performance outcomes, both in terms of actual (e.g. win/loss or final ranking) and subjective performance (self-evaluation). Although studies on this topic exist, the predictive validity of the POMS remains a controversial issue. Specifically, the predictive validity of the POMS might dependent on the study's design (e.g., pre, during, or post assessment) and target sample (e.g., sport type; high and low performers)[24-28]. In the present study, we aimed to advance research on the predictive validity of the POMS by comparing the performance experiences of the high and low cyclists at both the beginning and end of a multi-stage cycling race. We were particularly interested in cycling given the minimal research on mood profiling in arduous endurance sports[5].

Endurance Cycling and Mood Fluctuations

Although proper periodization is paramount to optimal performance in cycling, the influence of training load on cyclists' psychological states in general, and mood states in particular, has been addressed by a few studies with markedly small sample sizes[29]. For instance, Slivka *et al.*[30] investigated the effects of three weeks of intensified training on the mood states of only eight cyclists. Slivka *et al.* did not find significant changes in total mood disturbance but observed an early decrease (from day 1 to day 4) of vigor for the three weeks of intensified training. Contrary to findings from Slivka *et al.*, Halson *et al.*[31] found that intensive training

influenced total mood disturbance, in comparison to both "normal training weeks" (i.e., non-intensive) and "recovery weeks".

A more recent study examined the mood disturbance of twenty-four cyclists assigned to two different experimental conditions: "high intensity training" and "tapering". The results showed that mood disturbance increased for the high-intensity group but decreased for the tapering group. Overall, the lack of tapering and proper recovery in general is typical of long lasting endurance competitions[5,32]. In the present study, we advanced research on the particular relationship between mood fluctuation and endurance cycling by examining whether mood states predicted actual and subjective performance.

The Present Study

The current literature reveals a lack of studies about how participants' mood states change during a multi-stage cycling race. Furthermore, to the best of our knowledge, there is no empirical evidence regarding mood sates differences between high and low performers in cycling. Accordingly, in an attempt to provide original evidence regarding the changes in mood states of athletes engaged in a multi-stage cycling race, we monitored a sample of elite cyclists during a ten-stage race. In particular, our aims consisted in examining (a) differences in mood states between high and low performers at the beginning and at the end of the race, and in respect to both actual and perceived performance; and (b) whether the participants' mood states predicted actual and perceived performance.

Materials and Methods

Participants

We collected data during the Girobio 2012, an international multi-stage cycling competition. Of the 136 cyclists (age M=22.4 years, SD=1.6) who entered the race, 72 (age M=22.6 years, SD=1.7) completed the race and all phases of the present study. All participants were male athletes registered in the Under 23 and Elite categories of the *Union Cycliste Internationale* (UCI). The majority of the participants were Italian (90.3%; n = 65). The remaining seven cyclists being were different nationalities but all fluent in the Italian language. All participants had extensive international experience and trained between 16 and 22 hours per week. Participation was voluntary and the cyclists signed an informed consent sheet prior to entering the study. All data were collected in agreement with the Helsinki declaration.

Measures

Psychological measures

We used a psychometrically validated Italian version of the POMS questionnaire to assess the cyclists' mood states at the beginning and end of the race. The POMS consists of 65 adjectival items (e.g., tense, worried, muddled, nervous), measuring one positive (vigor) and five negative (anxiety, depression, anger, confusion, and fatigue) mood dimensions. The questionnaire starts with the probe question "How have you been feeling over the past week including today?" The participants responded to each item using a Likert scale ranging from 0 ("Not at all") to 4 (Extremely").

Noteworthy, it is possible to compute scores for each dimension of the POMS as well as a general measure, namely *total mood disturbance* (TMD). To calculate the TMD, scores for

vigor were subtracted from the total sum of the five negative dimensions (i.e., Tension, Depression, Anger, Fatigue and Confusion). Higher TMD scores indicated negative mood, whereas lower TMD scores indicated positive mood. In the present study, this TMD was used as a measure of mood state disturbance.

Performance measures

Actual performance represented the total time the athletes needed to complete the entire race, which mirrors the official final ranking of the race, named hereafter referred to as "actual ranking". Perceived performance represented the average of each athletes' self-evaluations at the end of each stage. The self-evaluations could range from 1 ("not satisfied at all") to 10 ("totally satisfied"). The self-evaluations reported by each athlete were organized into a ranking, named hereafter as "perceived ranking". Given the athletes' tactical role in a cycling multi-stage race (e.g., all-rounder, climber, sprinter), the perceived ranking may be very different from the actual ranking. Indeed, according to the teams' strategies, some cyclists were required to help one or more teammates in specific phases of the race. Conversely, the other cyclists were given the goal to win a stage or a particular ranking (e.g., sprinters ranking, climbers ranking), without focusing on the official final ranking. Therefore, the perceived performance depended on how well each rider attended to his tactical role, rather than on the time spent to complete the race.

According to the actual and perceived rankings, we considered two categories of performers: "high" and "low". Based on an overarching percentile rationale, we categorized the 72 cyclists in six groups with 12 athletes according to their final actual ranking. We selected the

top-twelve cyclists that had completed both the pre-test and the post-test questionnaires and categorized them as *high performers*. We then selected the last twelve athletes of the same ranking who had filled both questionnaires, and considered them as *low performers*. Similarly, with regards to the perceived performance, we considered the first twelve athletes of the perceived ranking as *high performers*, whereas the last twelve athletes of the same ranking were classified as low *performers*.

Procedures

The participants competed in the Girobio 2012. This race consisted of ten stages throughout Italy for a total distance of 1361.70 kilometers. The participants completed the POMS questionnaire the evening prior to the beginning of the race (pre-test, T0). Prior to each stage, the participants were required to declare their tactical role in the forthcoming stage. At the end of each stage, the participants were asked to evaluate their performance, in the light of their tactical role. Finally, on the evening before the last stage, the participants were required to complete the POMS questionnaire again (post-test, T1). All data were collected in a quiet environment and without the presence of the coaches or other team members.

Data analysis

First, as a preliminary analysis, we checked for TMD differences between pre-test and post-test for all participants, without taking into consideration their actual and perceived performance rankings. Thus, we analyzed the data of the 72 cyclists who completed the race

using repeated measures ANOVA. Second, we compared the TMD scores of the high and low performers, before and after the race. Initially, we compared the high and low performers according to the actual ranking. Subsequently, we compared the high and the low performers according to the perceived ranking. In both cases, we applied a 2x2 repeated measures ANOVA (Time x Group). Post-hoc comparisons were examined through Bonferroni correction. Finally, we investigated whether the TMD assessed in T0 (TMD-T0) was predictive of actual and perceived performance by applying a series of linear regression analyses. In these analyses we set the TMD-T0 as the independent variable, and the following factors served as dependent variables: 1) actual ranking; 2) perceived ranking; 3) actual performance (order of arrival) for the first stage; and 4) perceived performance for the first stage.

Results

We present our results in regards to the primary and secondary purposes of this study. First, we present differences in the mood disturbance between high and low performers. Subsequently, we report on whether the participants' mood states at the beginning of the race predicted actual and perceived performance.

Total Mood Disturbance for high and low performers

In the preliminary analysis, considering all 72 cyclists who completed the race, we found that the TMD significantly increased between the pre-test and the post-test [$F(1, 71) = 65.663$; $p < .001$; $\eta^2 = .48$]. In particular, we were interested in examining whether this increase of TMD

was similar among the high and low performers, in terms of both actual and perceived performance.

TMD for the high and low performers based on actual performance ranking

The comparison between high and low performers according to the actual ranking revealed a significant main effect for Time [$F(1, 22) = 26.503$; $p < .001$; $\eta^2 = .55$], and the interaction Time x Group [$F(1, 22) = 5.583$; $p < .05$; $\eta^2 = .20$] (see Figure 1a). In regards to the variable Group, the analysis did not reveal a significant main effect. Due to the significant interaction, we further explored for any potential TMD differences between pre- and post-test in each group. The TMD increased significantly between T0 and T1 for the low performers' group, [$p < .001$], whereas no significant difference was observed for the high performers' group. Finally, we compared the two groups' scores before and after the race. No significant difference was observed in both occasions.

TMD for high and low performers based on perceived performance ranking

The comparison between high and low performers according to the perceived ranking revealed a significant main effect for Time [$F(1, 22) = 49.006$; $p < .001$; $\eta^2 = .69$], and a significant interaction Time x Group [$F(1, 22) = 6.198$; $p < .05$; $\eta^2 = .22$] (see Figure 1b). Moreover, we found a significant difference between the two groups [$F(1, 22) = 9.095$; $p < .01$; $\eta^2 = .29$]. Therefore, we further explored the TMD differences between pre- and post-test in each group, separately. Post-hoc comparisons revealed that in both the high [$p < .05$] and low performers [$p < .0001$] the TMD significantly increased from T0 to T1. Finally, we compared the

TMD of the two groups before the race and found no statistically significant difference. However, at the end of the race, we found a significantly higher TMD among the low performers compared to the high performers [$p < .005$].

Figure 1 about here

The findings reported herein indicated that the cyclists' mood state profile changed between T0 and T1 for both the high and low performing groups. In particular, in T1 the high performers exhibited an iceberg profile for perceived ranking and a "flat profile" for actual ranking, whereas the low performers exhibited a "reverse" iceberg profile at the end of the race for both the perceived and actual rankings (Figure 2).

Figure 2 about here

POMS and performance

The second aim of our study was to investigate the predictivity of the POMS. We examined whether mood states would predict actual and perceived performance for both the entire race and the first stage. With regards to the entire race, our findings indicated that both the actual ($p = .18$) and perceived ($p = .27$) rankings were not related to TMD scores for T0 (TMD-T0). Similarly, both actual performance (i.e., order of arrival; $p = .53$) and perceived performance ($p = .48$) for the first stage were not predicted by TMD-T0 scores.

Discussion

We assessed the TMD of cyclists engaged in a multi-stage race to examine differences between high and low performers in terms of actual and perceived performance. Moreover, we tested whether TMD scores would predict actual and perceived performance. Our results suggest that TMD varied differently between the first stage (T0) and the final stage (T1) for high and low performers in respect to both actual and perceived performance. For actual performance, TMD increased only among the low performing cyclists. For perceived performance and T1 only, TMD scores were significantly higher for the low performers compared to the high performers. Finally, our analysis revealed that mood states at the beginning of the race did not predict actual or perceived performance for either T0 or T1.

Altogether, our results are in line with previous evidence linking prolonged physical effort to mood disturbance[4, 21, 22]. Our results also corroborate the notion that high performing athletes suffer fewer mood disturbances during prolonged physical activity than their low performing counterparts. Specifically, we observed that the mood profile of high performing cyclists did not change significantly over the course of the Girobio. Conversely, the low performing group showed increased values of TMD from the beginning to the end of the race. Therefore, low performing athletes in particular could benefit from mental skills aimed at instilling mental resilience and coping skills such as attentional focus and arousal regulation. To this extent, Bertollo et al[33] has argued that athletes need to develop multi-action plans to effectively cope with negative mood states during arduous endurance tasks. Low performing athletes should also be encouraged to re-evaluate their periodization cycles to ensure that their mood fluctuations are not partially due to stress-recovery unbalance[5,32].

The fact that the high performers' vigor states did not differ from pre- to post-test is in agreement with Morgan's iceberg profile. There is a general agreement that high performing athletes are more likely than low performing athletes to exhibit a positive mood profile under highly demanding tasks. To advance research in this area, scholars should consider how different psychological factors influence the performance of endurance athletes participating in multi-stage competitions, such as cycling races. For instance, high performing individuals have been shown to have higher self-efficacy and greater mental toughness than their less skilled counterparts[34]. Accordingly, future research could examine the relationship among mood states, mental toughness, efficacy beliefs, and performance in endurance sports.

It is also important to highlight that we did not find evidence supporting the notion that mood states assessed at the beginning of the race were reliable predictors of actual and perceived performance for neither the first nor the final stage. To this extent, there is an increasing need to assess bio-psycho-social states during (i.e. real-time assessments) rather than prior to or after competition[35]. Although mood states are more stable than emotions, fluctuations are likely to occur in long lasting competitions. Accordingly, future studies should consider assessments during the actual competition through the use of simple and reliable surveys.

The present study is not without limitations. First, seven of our participants were not Italian, and thus might have had difficulties in understanding the Italian version of the POMS. Given that the majority of our participants were Italian, the generalizability of the findings is limited in scope. Second, we were able to collect data only at the beginning and end of the race. Future research should include assessments throughout the entire race to better gauge how mood fluctuations may impact performance and vice versa. Future research should also test for the

potential moderating effects of gender, type of rider (all-rounder, climber, puncheur, sprinter), and nationality.

Conclusions

Our findings suggest that high performing cyclists maintained a more positive mood profile than their low performing counterparts at the beginning and end of a multi-stage race. Noteworthy, these findings hold true for both actual/objective and perceived/subjective performance criteria. Thus, mood fluctuations should be monitored by athletes and sport professionals aimed at reaching and sustaining peak performance. Finally, our analyses revealed that assessment of mood states prior to a multi-stage cycling competition may not be predictive of athletes' performance. Therefore, mid-race assessments should be considered by scholars and practitioners interested in studying high performance in endurance cycling.

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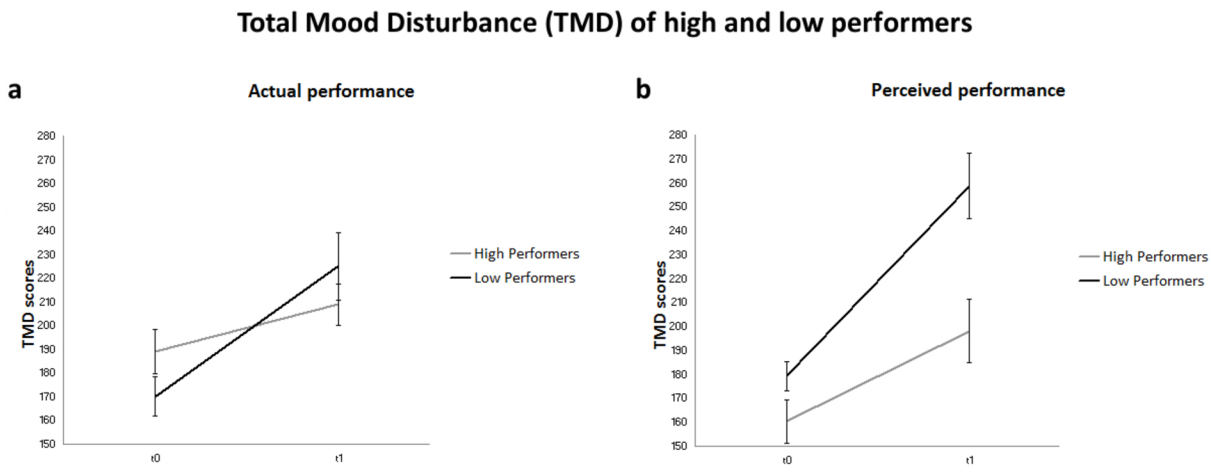
Figure captions

Figure 1. Total mood disturbance for the high and low performers, considering: a) actual performance ranking; and b) perceived performance ranking. Error bars indicate standard errors.

Figure 2. Profile of mood states at the beginning and end of the race for: a) high performers, considering the actual performance ranking; b) high performers, considering the perceived performance ranking; c) low performers, considering the actual performance ranking; and d) low performers, considering the perceived performance ranking.



Mood state profile of high and low performers