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Estratégia de prova, variação do humor e percepção de esforço em competição simulada de mountain bike cross country

Rio de Janeiro

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Dissertação apresentada, como requisito parcial para obtenção do título de Mestre, ao Programa de Pós-Graduação em Ciências do Exercício e do Esporte da Universidade do Estado do Rio de Janeiro. Área de concentração: Aspectos Biopsicossociais do Esporte.

Orientador: Prof. Dr. Tony Meireles dos Santos

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Adicionalmente, um grande obrigado a todos que de alguma forma contribuiu, positiva ou negativamente para o processo: você foi fundamental na minha evolução.

RESUMO

VIANA, Bruno Ferreira. *Estratégia de prova, variação do humor e percepção de esforço em competição simulada de mountain bike cross country*. 2015. 50 f. Dissertação (Mestrado em Aspectos Biopsicossociais do Esporte) – Instituto de Educação Física e Desportos, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2015.

Apesar de descrito em diversos esportes, as estratégias de prova não foram descritas em uma prova de mountain bike cross country (XCO). Em conjunto, uma melhor compreensão das respostas emocionais e cognitivas contribui para um melhor entendimento do esporte. A presente dissertação tratará desses dois temas em dois diferentes artigos. O artigo 1 teve como objetivo comparar e classificar as estratégias de prova adotadas por sujeitos com diferentes níveis de desempenho num teste de desempenho simulado (TDS) O objetivo do estudo 2 foi descrever a resposta do humor ao longo do TDS, além de analisar o relacionamento da percepção subjetiva de esforço (PSE) em função da distância completada e da potência média produzida a cada volta (W_{SPT}). No artigo 1, ciclistas de nível nacional e regional de XCO (n=20, 32,3±6,5 anos, 175.7±5,9cm, 69,2±5,6kg, 297,6±21,8Wmax e 65,7±5,4mL.kg.min) participaram de uma competição simulada em um cicloergômetro eletrônico (Computrainer ™), composta por 4 voltas em um circuito. Os atletas foram divididos em dois grupos (alto e baixo) baseados no tempo de desempenho e instruídos a realizarem o percurso o “mais rápido que pudessem.” Não houve interação para o tempo da volta (P=0,169) potência produzida absoluta (P=0,719) e relativa (P=0,607), PSE (P=0,182) e frequência cardíaca (P=0,125). No artigo 2, ciclistas de nível nacional e regional de XCO (n=19, 32,2±6,5 anos, 174,9±5,4cm, 67,8±6,5kg, 295,8±21,1Wmax e 65,3±4,9mL.kg.min) realizaram a mesma simulação de desempenho descrita no método do estudo 1. No último km de cada volta foi utilizada a escala de perfil de estado de humor (POMS) e a escala CR100 para a quantificação da PSE. Foram observadas a diminuição no vigor (P=0,049) e aumento na fadiga (P=0,000) e no distúrbio total de humor (DTH) (P=0,014). Além disso encontramos boa correlação entre a PSE e a distância percorrida (r=0,999 P=0,000), o %tempo (r=0,999 P=0,000) e a W (r=0,969 P=0,030). Concluímos a partir dos nossos resultados que o nível de desempenho não afetou a estratégia, e que o humor foi afetado negativamente em nível competitivo, confirmado pelo aumento do DTH assim como pelo aumento do cofator fadiga do POMS e da PSE ao longo do TDS.

Palavras-chave: Ritmo de prova. Regulação de exercício. Estado de humor.

ABSTRACT

VIANA, Bruno Ferreira. Pace strategy, mood changes and perceived exertion on *mountain bike cross country* race. 2015. 50 f. Dissertação (Mestrado em Aspectos Biopsicossociais do Esporte) – Instituto de Educação Física e Desportos, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2015.

Despite described in many sports, pace strategy have not been described in mountain bike cross country race (XCO). Together, a better comprehension of cognitive and emotional responses contribute for a better understanding of sport. This dissertation will address these two issue on two different articles. The purpose of article 1 was to compare and classify the pace strategy adopted by subjects with different levels of performance on a simulated performance test (SPT). The purpose of article 2 was to describe the mood responses over a SPT, in addition to analyze the relationship of rating of perceived exertion (RPE) against distance covered and mean power output of each lap (W_{SPT}). On the article 1, cyclists of regional and national level of XCO (n=20, 32,3±6,5 anos, 175.7±5,9cm, 69,2±5,6kg, 297,6±21,8Wmax e 64,9±4,8mL.kg^{-1}.min^{-1}), participated of a simulated race on a bike fixed at an electronic ergometer (Computrainer ™), composed by 4 laps on a circuit. The athletes were divided in two groups (high and low) based on finish time and instructed to perform the circuit "as fast as they can". No interaction was found to lap time (P=0,169) absolut power output (P=0,719) and relative (P=0,607), RPE (P=0,182) e heart rate (P=0,125). On the article 2, cyclists of regional and national level of XCO (n=19, 32,2±6,5 anos, 174.9±5,4cm, 67,9±6,3kg, 295,8±21,1Wmax e 65,3±4,9mL.kg.min), perform the same SPT described on the article1. On the last km of each lap was used the profile of mood state (POMS) and the CR100 scale to quantify the RPE. Were observed a decreased on the vigour (P=0,049) and an increase of fatigue (P=0,000) and total mood of disturbance (TMD) (P=0,014). In addition, we found a nearly perfection correlation between RPE and distance covered (r=0,999 P < 0,001), the %time (r=0,999 P=0,000) e a W (r=0,969 P=0,030). In conclusion our data suggests that performance level did not affect the strategy, and the mood was negatively affected in competitive level, confirmed by the rise of TMD as well as by the increase of POMS fatigue factor and PSE during the SPT.

Keywords: Pacing strategy. Exercise regulation. Mountain bike. Mood state.

LISTA DE SIGLAS

MTB.	Mountain bike
XCO.	Mountain bike cross country
RPE.	Rate of perceived exertion
CGM.	Central governor model
LP.	Low performance
HP.	High performance
LT.	Lactate threshold
OBLA.	Onset of blood lactate accumulation
W_{max}.	Potência máxima atingida em um teste progressivo máximo
VO_{2max}.	Consumo máximo de oxigênio
HR.	Heart rate
SPT.	Simulation performance test
W_{SPT}.	Mean power of each lap of Simulation performance test
RPE.	Rate of perceived exertion
POMS.	Profile of mood state
TMD.	Total mood disturbance

SUMÁRIO

INTRODUÇÃO

O mountain bike cross country (XCO) é uma prova ciclística com característica *multi-lap*, realizada em circuitos formados por trilhas com florestas, descidas técnicas, caminhos e obstáculos formados por rochas, com distâncias entre 5 a 9 km e duração entre 1 h 45 min e 2 h 30 min (Internationale, 2012). Já foi reportado que para o sucesso no XCO é fundamental que o atleta se posicione entre os primeiros colocados logo no início do evento, a fim de evitar a diminuição da velocidade causada por retardatários dificultando a ultrapassagem especialmente nos *single tracks* e onde for impossível, perigoso ou demandar um alto custo energético (F. Impellizzeri, Sassi, Rodriguez-Alonso, Mognoni, & Marcora, 2002; F. M. Impellizzeri & Marcora, 2007; Macdermid & Morton, 2012). Nesse sentido, a intensidade reportada no início desse tipo de evento é bastante alta, atingindo valores próximos ao máximo. Em alguns casos, a potência mecânica produzida chega a 1000 W (Stapelfeldt, Schwirtz, Schumacher, & Hillebrecht, 2004), caracterizando assim uma estratégia composta por largada rápida (F. M. Impellizzeri & Marcora, 2007), o que resultaria num elevado consumo de O_2 (Jones, Wilkerson, Vanhatalo, & Burnley, 2008).

Descrição dos tipos de estratégia

Conceitua-se como estratégia de prova a variação da velocidade, potência (W), tempo ou gasto energético durante eventos competitivos (Abbiss & Laursen, 2008). Essas variáveis são reguladas de maneira contínua, objetivando antecipar um ajuste ótimo para o melhor desempenho durante uma atividade ou competição com intensidade máxima (D. A. Baden, Warwick-Evans, L. and Lakomy, J,, 2004; Tucker, 2009). Este processo possui dois objetivos: a) que a tarefa seja completada no menor tempo possível; e b) para evitar a ocorrência da fadiga antecipada a ponto da insustentabilidade da intensidade do exercício (St Clair Gibson et al., 2006). Apesar de diversos trabalhos científicos serem produzidos com a temática investigativa da estratégia, apenas alguns se preocuparam em descrever ou normatizar a estratégia observada (Abbiss & Laursen, 2008; St Clair Gibson et al., 2006). Nesse sentido, (Abbiss & Laursen, 2008) descreveram em sua revisão as principais estratégias observadas nos esportes de endurance:

Estratégia negativa

É observado o uso da estratégia negativa, quando o atleta aumenta sua velocidade gradativamente durante a competição. A estratégia negativa (Figura 1) é principalmente observada em eventos onde os atletas estão cientes do ponto final (*endpoint*).

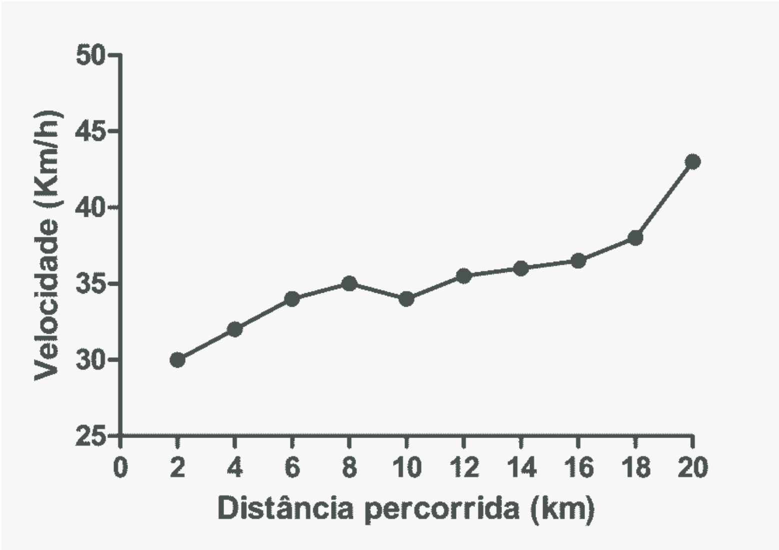

Figura 1. Descrição gráfica da estratégia negativa numa prova de 20 km

Estratégia máxima ou *all-out*

A estratégia máxima ou *all-out* (Figura 2) caracteriza-se por ser realizada em máxima intensidade. Esta estratégia possui os maiores valores de força e potência produzida nos momentos iniciais, já que a velocidade possui valores próximos de zero. Um exemplo disso seriam provas com curta duração, onde os maiores valores de potência são observados na largada do atleta.

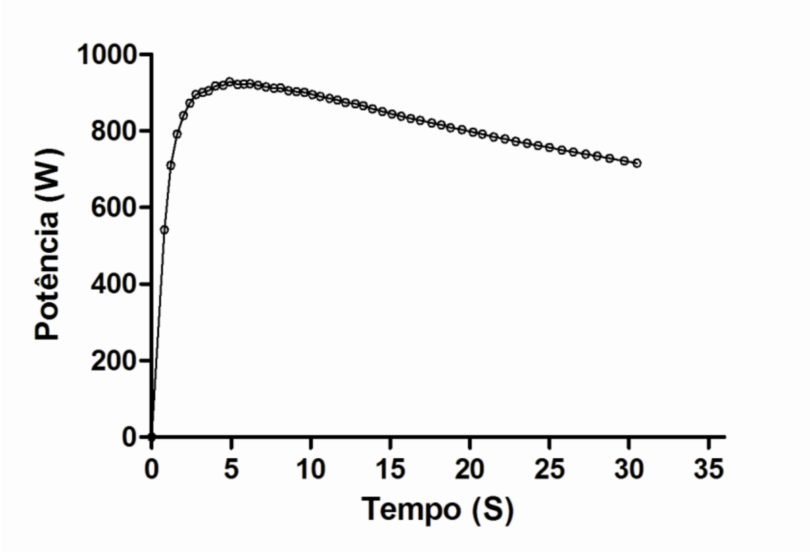

Figura 2. Descrição gráfica da estratégia *all out*

Estratégia positiva

A estratégia positiva (Figura 3) é caracterizada pela diminuição gradual da velocidade do atleta durante a competição. Atletas de nível mundial têm adotado esse modelo de estratégia em provas de *mountain bike cross country* (F. Impellizzeri et al., 2002; B. Viana, Impellizzeri, Inoue, & Santos, 2012).

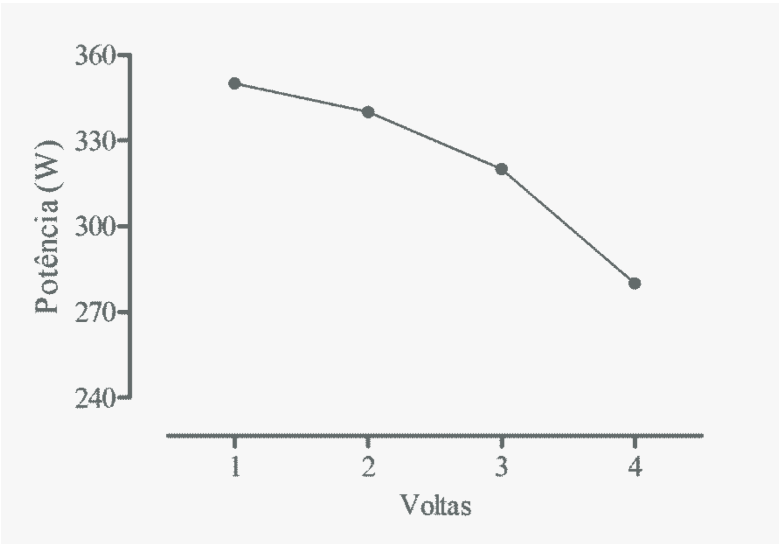

Figura 3. Descrição gráfica da estratégia positiva.

Estratégia contínua

Na estratégia *even-pace* o atleta propicia a mínima variação na velocidade durante a competição. Essa estratégia é largamente encontrada em provas com distâncias maiores como o recorde da hora no ciclismo de pista (velódromo).

Importância do ponto final

As estratégias de prova diferenciam-se primeiramente de acordo com o modelo do exercício: com ou sem a presença de um final (tempo ou distância) conhecido (St Clair Gibson et al., 2006). Essa diferença seria tecnicamente classificada como exercício de tarefa aberta (*open-loop*), quando não se tem conhecimento do ponto final, ou exercício de tarefa fechada (*close-loop*), quando o indivíduo possui conhecimento do ponto final. A maioria das competições em esportes de endurance possui a característica do modelo close loop. Exemplos desse modelo seriam todas as provas de natação, atletismo e ciclismo, isso porque todas elas possuem um ponto inicial e um final pré-determinado. Modelos de exercício sem um final conhecido podem ser exemplificados pelos testes laboratoriais de tempo até a exaustão ou tempo limite (Tlim) (Billat & Koralsztein, 1996).

Devido às diferenças entre os modelos descritos acima, estudos anteriores mostraram que o fato de não haver o final conhecido levaria a uma maior variação do desempenho alcançado em dois testes, com distâncias de 5 e 1,5 km (5 km close-loop, 5 km open-loop, 1500 m close-loop, 1500 m open loop) respectivamente (CV% 2,0, 15,1, 3,3, 13,2) (Laursen, Francis, Abbiss, Newton, & Nosaka, 2007). Essa maior variação de desempenho pode ser sustentada pela ideia de uma maior imprecisão ou variabilidade da estratégia por *endpoints* errados estabelecidos autonomamente. Isso ocorreria devido ao fato de que como não há um fim conhecido, o cérebro, ainda que de maneira subconsciente, criaria seu próprio ponto final e, dessa forma, quando o indivíduo atingisse o desempenho ou esforço equivalente a esse fim gerado, o exercício seria interrompido (Kayser, 2003). Esse modelo teórico também é descrito por Brehm (Brehm & Self, 1989; Gollwitzer & Bargh, 1996) como intensidade motivacional, o qual assume que as pessoas se esforçam em uma determinada tarefa até atingirem o nível máximo de esforço que estão dispostas a investir para o seu sucesso. Isso sustentaria também a ideia da criação de um ponto final a partir do cérebro em exercícios sem um final conhecido.

Esse final hipotético criado pelo cérebro, em modelos de exercício *open-loop*, parece ser influenciado pelo mecanismo de aprendizagem (Albertus et al., 2005) de maneira que uma vez exposto a tal condição de esforço máximo, um novo limite é criado, muitas vezes em um patamar de maior demanda, aproximando-se cada vez mais a um limite fisiológico real (Foster et al., 2009; Mauger, Jones, & Williams, 2009). Dessa forma é importante que o atleta tenha vivenciado diferentes situações de desconforto decorrente da alta intensidade do exercício a fim de aumentar sua capacidade de tolerar maiores intensidades e, consequentemente, obter um melhor desempenho.

Regulação central do esforço – modelo do governador central

O modelo denominado Govenador central (MGC), foi proposto com o intuito de explicar o fenômeno da fadiga (Noakes & St Clair Gibson, 2004; Noakes, St Clair Gibson, & Lambert, 2005; St Clair Gibson et al., 2003; St Clair Gibson & Noakes, 2004) com uma abordagem e um entendimento diferente ao que vinha até então sendo proposto (Fitts, 1994). O CGM propõe que o exercício seja regulado por uma estrutura neuronal subconsciente, denominado "*subconscious brain*". Este regularia a potência mecânica (estratégia) ao longo do exercício modulando o recrutamento de unidades motoras, objetivando a manutenção da homeostase. Complementarmente, o modelo redefiniu o sentido da palavra fadiga, de um termo que representava a diminuição da produção de força e potência no exercício para uma sensação ou emoção (Weir, Beck, Cramer, & Housh, 2006). Esse modelo proposto vem em certa medida refutar o modelo de regulação periférica do exercício (Noakes, 2011). O argumento central vem da incapacidade dos modelos que se apoiam no lactato em explicar a fadiga ou atém mesmo à interrupção voluntária do exercício.

Entretanto, cabe destacar que esta proposta não está isenta de críticas (Hopkins, 2009; Shephard, 2009a, 2009b; Weir et al., 2006), principalmente pelo fato destes defenderem o modelo de limitação do esforço sob a ótica da fisiologia periférica. Apesar disso a comunidade científica com o passar do tempo, parece reconhecer a importância do modelo, demonstrando quebra de paradigma (Pires, 2012).

Regulação antecipada do esforço – A chave para uma estratégia adequada

Os atletas regulam seu esforço de maneira antecipada (Tucker, 2009), baseado em sua percepção de esforço (PSE) (G. A. Borg, 1982; St Clair Gibson et al., 2003), experiência prévia (Baron, Moullan, Deruelle, & Noakes, 2011; Foster et al., 2009; Mauger et al., 2009) estresse térmico (Tucker, Marle, Lambert, & Noakes, 2006; Tucker, Rauch, Harley, &

Noakes, 2004) , estado nutricional (Baldwin et al., 2003) e tempo ou distância remanescente (D. A. Baden, McLean, Tucker, Noakes, & St Clair Gibson, 2005; D. A. Baden, Warwick-Evans, & Lakomy, 2004).

A percepção de esforço é relatada como uma das mais importantes e fundamentais ferramentas de regulação do desempenho (Albertus et al., 2005; Esteve-Lanao, Lucia, deKoning, & Foster, 2008; Tucker, 2009)**.** Sendo o esforço percebido como uma sensação, este representa, ainda que indiretamente, a demanda metabólica realizada no exercício. Segundo Borg (G. A. Borg, 1982)**,** seria o melhor indicador único do estresse físico. É relatado no mesmo trabalho que tal indicador integraria diversos componentes, como os sinais provocados pelo trabalho músculo-articular, pela função cardiorrespiratória e pelo trabalho do sistema nervoso central. Tal indicador possui uma representação momentânea, precisando ser renovado continuamente durante o tempo remanescente do exercício. Juntamente com esse indicador, é gerado previamente ao exercício um "padrão" ótimo de percepção subjetiva de esforço, ao qual o indivíduo se referiria com fins comparativos para decidir sob a manutenção, aumento ou diminuição da intensidade da atividade. De acordo com Koning (de Koning et al., 2011), isso sugeriria que atletas continuamente comparam como eles se sentem num determinado momento da competição e como eles esperavam se sentir naquele momento. Isso suportaria a teoria da intensidade motivacional de Brehm (Brehm & Self, 1989) e no momento que tal ponto for alcançado, a diminuição da intensidade da atividade, ou mesmo sua desistência, seria inevitável. Em contrapartida, a literatura mostra que a decisão voluntária de interrupção do exercício é mediada por um sistema complexo de *feedback* mediado por uma variedade de receptores que monitoram a resposta fisiológica frente à demanda imposta por uma determinada intensidade de exercício (St Clair Gibson & Noakes, 2004; Ulmer, 1996). Entretanto, até o momento parece não haver um consenso na literatura acerca do assunto (Abbiss & Peiffer, 2010).

As sensações percebidas a partir do corpo humano, além de fornecerem um estado da condição física, fornecem também o estado psicológico (Craig, 2003)**.** Em exercícios realizados até a exaustão com interrupção voluntária, o desenvolvimento do elevado nível de esforço percebido é responsável pela diminuição progressiva do desejo de sustentação de tal intensidade (Baron et al., 2011). Tal mecanismo é suportado pelo modelo de integração central de esforço e fadiga durante o exercício em humanos ou modelo do governador central (St Clair Gibson & Noakes, 2004)**.**

O papel das emoções na regulação do exercício

As emoções surgem da interocepção das mudanças fisiológicas ocorridas no corpo (Baron et al., 2011; James, 1994). Descrita como o sentido da condição fisiológica do corpo (Craig, 2002, 2003, 2009), a interocepção teria uma possível conexão com a regulação do exercício regulada de forma central, mediada através da atividade tálamo-insular (Hilty, Jancke, Luechinger, Boutellier, & Lutz, 2011). Com abordagem apoiada na psicologia, já foram descritos dois níveis de experiências emocionais (Baron et al., 2011): o primeiro inclui a integração da ativação às respostas fisiológicas; o segundo possui uma avaliação consciente da integração das informações obtidas no primeiro nível, porém agora dentro de um contexto comportamental. Nesse sentido, o entendimento das respostas emocionais durante o exercício parece contribuir para um melhor entendimento de como elas influenciam na estratégia. Isso é demonstrado pelo questionamento feito por Baron e colaboradores (Baron et al., 2011) em sua revisão, que seria a forma que o MGC integraria as respostas fisiológicas direcionadas ao sistema nervoso central com as diferentes sensações que surgem ao longo do exercício.

No âmbito competitivo, experiências prévias acumuladas ao longo da vida, associadas à habilidade de lidar com as emoções durante uma prova, podem contribuir para o desempenho. Adequadas estratégias de prova são realizadas por atletas que desenvolveram um padrão de desempenho (*template*) (Foster et al., 2009) estável, para um determinado tempo / distância e com um perfil específico de potência mecânica (Hettinga, De Koning, Broersen, Van Geffen, & Foster, 2006). Dados prévios (Foster, Green, Snyder, & Thompson, 1993) sugeriram que a habilidade de regular adequadamente o esforço ao longo do exercício (estratégia de prova) poderia ser algo aprendido, e por isso emoções adquiridas por experiências decorrentes do treinamento poderiam fazer parte desta habilidade.

Lacuna e Objetivos da Dissertação

A partir dos elementos expostos, observa-se a necessidade de um melhor entendimento de como os atletas de XCO regulam seus desempenhos ao longo de uma competição. Isso poderia auxiliar os atletas, técnicos e fisiologistas do exercício definindo as melhores estratégias para o treinamento e competição. Além disso, faz-se necessário uma melhor compreensão das respostas emocionais de atletas de XCO durante uma prova de desempenho simulado. Assim, os objetivos desta dissertação foram:

(a) Caracterizar e classificar as estratégias de prova adotados por atletas de XCO, baseados em modelos previamente descritos na literatura (Abbiss & Laursen, 2008);
(b) Comparar as estratégias de prova adotadas por atletas com alto e baixo nível de desempenho;
(c) Descrever as respostas de humor antes, durante e após o TDS;
(d) Analisar a relação da PSE com a distância percorrida e com a potência média de cada volta;

Apresentação

A presente dissertação foi estruturada no formato de dois artigos científicos, tratados em dois documentos separados em formato final para publicação. Para os dois artigos, foram utilizadas a mesma amostra e os mesmos procedimentos. Os dados utilizados fizeram parte da dissertação do Prof. Me. Allan Inoue, egresso do programa de Pós Graduação em Ciências do Exercício e do Esporte da UGF, intitulada "*Índices fisiológicos aeróbios e anaeróbios predizem o desempenho no mountain bike cross-country (2011).*"

O primeiro artigo intitulado "*Pacing strategy during a simulated mountain bike race*" trata da descrição da estratégia de prova em TDS, além de comparar a estratégia adotada entre atletas com diferentes níveis de desempenho. O segundo artigo objetivou verificar as respostas emocionais e de PSE durante o TDS, que possui uma característica de múltiplas voltas. O segundo artigo está intitulado como "*Emotional responses of multi-lap off-road cycling test*".

1 ESTUDO 1 – PACING STRATEGY DURING SIMULATED MOUNTAIN BIKE RACING

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ABSTRACT

Cross-country mountain biking (XCO) is a high-intensity endurance event. However, the pacing strategy of XCO has not been purposefully examined. The aim of this study was to examine the pacing strategies adopted during a simulated XCO race by cyclists with different performance levels. Regional and national level cyclists from Brazil performed an XCO race

simulation. The simulation consisted of four laps (9.9 km and a 0-10% grade each). No group x time interactions were found in lap time (P = 0.169), absolute (P = 0.719) and relative (P = 0.607) power output, rated of perceived exertion (P = 0.182) and heart rate (P = 0.125). The the riders decreased power output in all laps by 0.3 $W.kg^{-1}$, which resulted in a loss of 1.6 min per lap. However, the power output associated with the OBLA seemed to adequately represent the mean power necessary to perform at the initial stage of the event, although it declined over the simulation. These results showed that performance level did not affect the strategies adopted by the groups in this study. Both groups used the strategy of fast starting followed by positive pacing, and a linear decrease in performance was observed at every lap.

INTRODUCTION

Cross-country mountain biking (XCO) is a high-intensity endurance event, as previously documented (F. Impellizzeri et al., 2002; F. M. Impellizzeri & Marcora, 2007). In real events, athletes reach an average heart rate of approximately 90% of their maximum, and at many moments during the race, they reach close to their maximum values(Corbett, Barwood, Ouzounoglou, Thelwell, & Dicks, 2012; Hagberg & Coyle, 1983; Kuipers, Verstappen, Keizer, Geurten, & van Kranenburg, 1985; Rose & Peters-Futre, 2010) (F. Impellizzeri et al., 2002). The workload demands required by XCO have been described previously, and the authors reported a power profile with a high variance (≈69%) and a range of 50 to 400 watts, with a mean power of 208 watts and isolated values of up to 1000 watts at the start of the race (Stapelfeldt et al., 2004). These studies have all indicated a high intensity at the beginning of the race because of the necessity of a fast start strategy. Despite the beginning portion of the event having a high intensity, as the race progresses, the intensity lessens, and the time spent per lap increases (F. Impellizzeri et al., 2002; Wingo et al., 2004).

During endurance events such as XCO, the athletes pace themselves, considering the competitive environment (Corbett et al., 2012), their previous experiences (Mauger et al., 2009) and a strategy based on the endpoint (Albertus et al., 2005). Continuous changes in the setting force the athletes to adjust their strategies (Tucker, 2009; Tucker & Noakes, 2009). The aims of this regulation are to allow the athletes to reach the finish line in the shortest time possible and to avoid prematurely high levels of fatigue (St Clair Gibson et al., 2006). Thus, athletes with different performance levels can adopt different pacing strategies.

The pace strategy adopted by cyclists in XCO has been previously described (Martin et al., 2012), but their approach used only velocity data from a satellite global positioning system (GPS) attached to the bicycles of the investigated athletes. As far as we know, no study has used the distribution of power produced by athletes during competition to determine pacing strategies. Understanding how XCO athletes regulate their performances over a competition could assist athletes, coaches and exercise physiologists in defining the best strategies for training and competition. The aim of this study was twofold: first, to characterise and classify the pacing strategies adopted based on the models previously described in the literature (Abbiss & Laursen, 2008); second, to compare the pacing strategies adopted by subjects with high (HP) and low (LP) performance. Our first hypothesis was that a fast start adopted by XCO athletes would determine the necessity to adopt a positive pacing strategy. Our second hypothesis was that XCO athletes with different performance levels would adopt different pacing strategies.

Methods

Subjects

Twenty male XCO cyclists who compete at the regional and national levels in Brazil participated in this study. They had training frequencies of six days per week for at least five years. Their general characteristics are presented in Table 1. The exclusion criteria were a history of recent injury or any other contraindication for competitive physical activity. The athletes were informed about all of the procedures of the experiment and its implications (risks and benefits) by signing a consent form. All of the procedures were approved by the ethics committee on research of the Gama Filho University (051.2010).

Experimental design

The athletes visited the laboratory three times. The first visit consisted of anthropometric measurements and an incremental exercise test. At the second visit, the athletes familiarised themselves with the simulation performance test (SPT) and completed the entire course, and at the third visit, they performed the SPT to determine their pacing strategies. The athletes performed the tests on different days separated by at least 48 h. All of the tests were performed in a temperature of $21^{o} \pm 1$°C, in the same place and at the same time of day (≈2 h). The subjects were asked to avoid solid food for three hours before the tests; throughout the trials, water intake was *ad libitum* (Rose & Peters-Futre, 2010). The subjects were asked not to perform high-intensity exercise for 24 h prior to the tests.

Procedures

Incremental exercise test. After a warm-up performed at 100 W for 10 min, the workload was increased by 30 W every 5 min until volitional exhaustion or until a cadence of ≥ 70 rpm could not be maintained by the athlete. The test was performed on a road bicycle fixed by the rear wheel (100 psi) to an electromagnetically braked ergometer (Computrainer™ Lab 3D, RacerMate, Seattle, WA, USA). For the calibration procedures, the manufacturer's specifications were followed**.** Throughout the incremental exercise test, gas exchange was assessed by a Vacumed Vista-Mini CPX metabolic analyser with Vista Turbo Fit software, version 5.1 (Ventura, CA, USA), and with an open circuit. Before each test, the gas analyser was calibrated following the manufacturer's specification. The maximum oxygen uptake (VO_{2max}) was determined using the highest 30 s value of oxygen uptake (VO_2) reached during the last stage of the incremental exercise test. The peak power output (W_{max}) was defined as the highest load completed by an athlete in a complete stage. When the stage load could not be sustained for an entire stage and the athlete reached exhaustion before finishing, W_{max} was determined using the equation previously described (Kuipers et al., 1985).

Heart rate (HR) was monitored continuously (Polar® RS 800 CX [Polar Electro, Oy, Finland]). The rate of perceived exertion (RPE) was measured during each trial at the specified times using the CR100 scale (E. Borg & Borg, 2002; E. Borg & Kaijser, 2006).

Determination of metabolic threshold. During the last 30 s of each stage, blood samples (25 µL) were collected from the earlobe and were measured with an automated analyser (YSI 1500; Yellow Springs Instruments, Yellow Springs, OH, USA). Before each test, the lactate analyser was calibrated following the instructions of the manufacturer. From the blood lactate concentration, two thresholds were identified: (a) lactate threshold (LT), as the power that caused an increase of 1 $mmol.L^{-1}$ in the blood lactate concentration beyond the values measured during exercise at 40-60% VO_{2max} (Hagberg & Coyle, 1983); and (b) the onset of blood lactate accumulation (OBLA), as the power associated with a fixed lactate concentration of 4 $mmol.L^{-1}$ (Sjodin & Jacobs, 1981).

Simulated performance test. The SPT was conducted in the laboratory under the same environmental conditions and with the same electromagnetically braked ergometer from the incremental exercise test. The road bicycle used was equipped with pedals and was fitted (saddle height and saddle setback) to meet the specifications of each subject. During the entire SPT, a fan was directed at the athlete, and the electronic ergometer was connected to a computer located in front of the athlete. Integrated 3D software, version 1.0 (RacerMate Inc.), was used to simulate the course. The software accounted for variables such as the body weight of the cyclist and the elevation course of the road to determine the speed and power that the athlete was able to produce. Before each test, a warm-up was performed for 10 min at 100 W. The SPT consisted of four laps on a course of 9.9 km with an elevation between 0% and 10% following a stochastic pattern (Figure 1). The distance and elevation were programmed for the athletes to complete the SPT at an average of 25 min per lap and for a total of 100 min. To resemble a real competition, the athletes were free to change gears and to determine their own cadence and when they should stand. Subjects were requested to "ride as fast as possible" and were not given any feedback other than their elapsed time. The SPT showed high external validity, with an interclass correlation of r = -0.84 ($P < 0.001$) with a real XCO competition and reliability with an ICC of 0.96 and TEM of 1.4% (unpublished data from our lab).

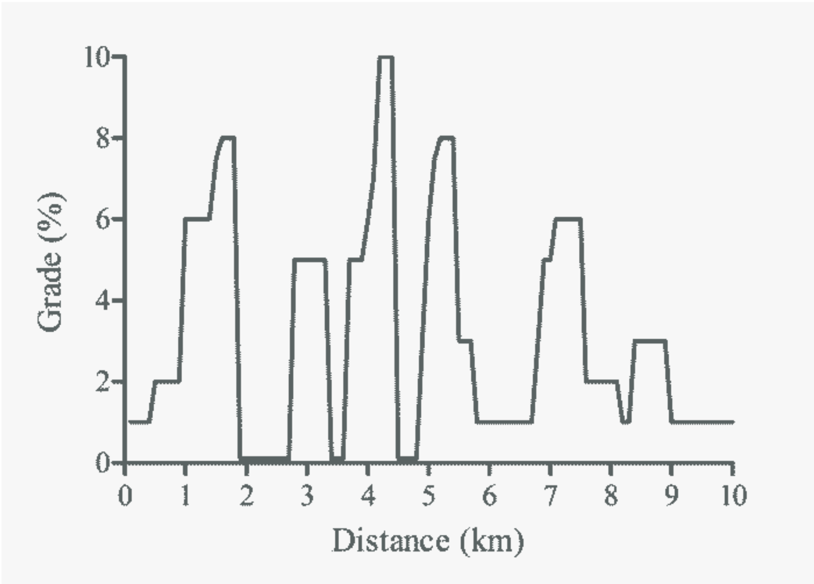

Figure 1. Elevation profile of the simulation performance test.

Statistical Analysis

The subjects were categorised into two percentiles based on the time taken to complete the simulated test. Athletes categorised into the 45th percentile were called the *lower-performance group* (LP, time > 104.6 min, n = 9), and those above the 55th percentile were called the *high-performance group* (HP, time < 100.3 min, n = 9). Two athletes who not were in above percentiles criteria were excluded from the sample. This procedure ensured that the HP and LP groups were significantly different (Table 1). Two-way ANOVA, followed by a Bonferroni *post hoc test* for comparisons within (lap) the groups (HP and LP), was performed during the race for the following variables: absolute mean power output for the simulation performance test ($SPT_{absolute\ mean\ power}$ [W)], mean power output relative to body mass for the simulation performance test ($SPT_{relative\ mean\ power}$ [$W.kg^{-1}$]), HR, RPE and time (min). Due to the sample size, we present the estimation of 95% confidence intervals. The analyses were performed using SPSS software, version 17.0 (SPSS Inc., Chicago, IL, USA), assuming a significance level of $P \leq 0.05$.

RESULTS

The anthropometric and physiological characteristics of the HP and LP groups are presented in Table I. No significant differences were found regarding age, body fat, W_{max} relative to body mass ($W.kg^{-1}$), VO_{2max} ($L.min^{-1}$), VO_{2max} relative to body mass ($mL.kg^{-1}.min^{-1}$) or lactate threshold relative to body mass LT ($W.kg^{-1}$). However, significant differences were found between the groups for the values of body mass (kg), height (cm), W_{max} (W), LT (W), OBLA (W) and time for the SPT (min).

Table I. Subjects characteristics for demographic, anthropometric, aerobic and time for simulated performance test.

Variables	LP (n = 9)	HP (n = 9)	Sig.	Total (n = 18)
	Mean ± SD	Mean ± SD	P	Mean ± SD
Demographic				
Age (years)	29.7 ± 2.0	35 ± 8.4	0.10	32.3 ± 6.5
Anthropometric				
Bodymass (kg)	66.4 ± 4.9	72.0 ± 4.9	0.02	69.2 ± 5.6
Height (cm)	172.5 ± 4.0	179.0 ± 5.9	0.01	175.7 ± 5.9
Bodyfat (%)	7.2 ± 2.7	7.9 ± 2.7	0.58	7.6 ± 2.7
Aerobic				
W_{max} (W)	279.6 ± 13.4	315.5 ± 10.3	0.00	297.6 ± 21.8
W_{max} ($W.kg^{-1}$)	4.2 ± 0.3	4.4 ± 0.3	0.36	4.3 ± 0.3
VO_{2max} ($L.min^{-1}$)	4.3 ± 0.4	4.6 ± 0.2	0.14	4.48 ± 0.3
VO_{2max} ($mL.kg^{-1}.min^{-1}$)	65.7 ± 5,4	64.1 ± 4.3	0.51	64.9 ± 4.8
LT (W)	198.6 ± 15.1	230.4 ± 22.8	0,00	214.5 ± 24.9
LT ($W.kg^{-1}$)	3.0 ± 0.3	3.2 ± 0.3	0.26	3.1 ± 0.3
OBLA (W)	240.2 ± 19.1	283.3 ± 19.1	0.00	261.7± 28.9
OBLA ($W.kg^{-1}$)	3.6 ± 0.4	3.9 ± 0.2	0.07	3.8 ± 0.3
Simulated performance test				
Time (min)	108.9 ± 2.5	95.5 ± 3.3	0.00	102.2 ± 7.4

LP - Low performance group, HP - High performance group, W_{max} - Peak power output, LT - Power output at the Lactate Threshold, OBLA - Power output at the onset of blood lactate accumulation.

No interactions were found for group x laps regarding the following variables: lap time (min) (P = 0.169), $SPT_{absolute\ mean\ power}$ (W) (P = 0.719), $SPT_{relative\ mean\ power}$ ($W.kg^{-1}$) (P = 0.607), HR (P = 0.125) and RPE (P = 0.182). These results showed that the performance level of the athletes did not affect their pacing strategies. Due to the fast start, the first lap of the SPT was different from the others for the variables $SPT_{absolute\ mean\ power}$ (W), $SPT_{relative\ mean\ power}$ ($W.kg^{-1}$) and time, as shown in Table II.

Table II. Significance results (P) for differences between 1st lap against 2nd, 3rd and 4th,during SPT

Variables	1vs 2	1vs 3	1vs 4
Power output			
Absolute (W)	0.008	0.000	0.000
Relative ($W.kg^{-1}$)	0.000	0.000	0.000
Time	0.000	0.000	0.000

Significance levels ($P \leq 0.05$).

The results showed a fast start, followed by the classic design of a positive pacing strategy with increases in lap time (Figure 2(A)) and in $SPT_{relative\ mean\ power}$ ($W.kg^{-1}$) and $SPT_{absolute\ mean\ power}$ (W) over the race (Figures 2(B) and 3, respectively). Both were linear (P < 0.001). The last lap was slower than the first (3.6 ± 0.4 min; [$CI_{95\%}$ 2.1,5.1]; P < 0.001), and $SPT_{absolute\ mean\ power}$ decreased in the last lap compared with the first (-46.5 ± 5.9 W; [$CI_{95\%}$-64.3, -28.7]; P < 0.001). Furthermore, we note that the athletes decreased $SPT_{relative\ mean\ power}$ ($W.kg^{-1}$) in all laps by 0.3 $W.kg^{-1}$, which resulted in a loss of 1.6 min per lap. The mean values of $SPT_{absolute\ mean\ power}$ (W) and HR (Figure 2(C)) obtained in the SPT were, respectively, 235.7 ± 19.7 W ($CI_{95\%}$ 228.2,243.2) and 172.6 ± 1.8 bpm; ($CI_{95\%}$ 170.1,175.1). We also observed a linear increase in RPE (29.44± 3.67; [$CI_{95\%}$18.39, 40.49]; P < 0.001) (Figure 2(D)).

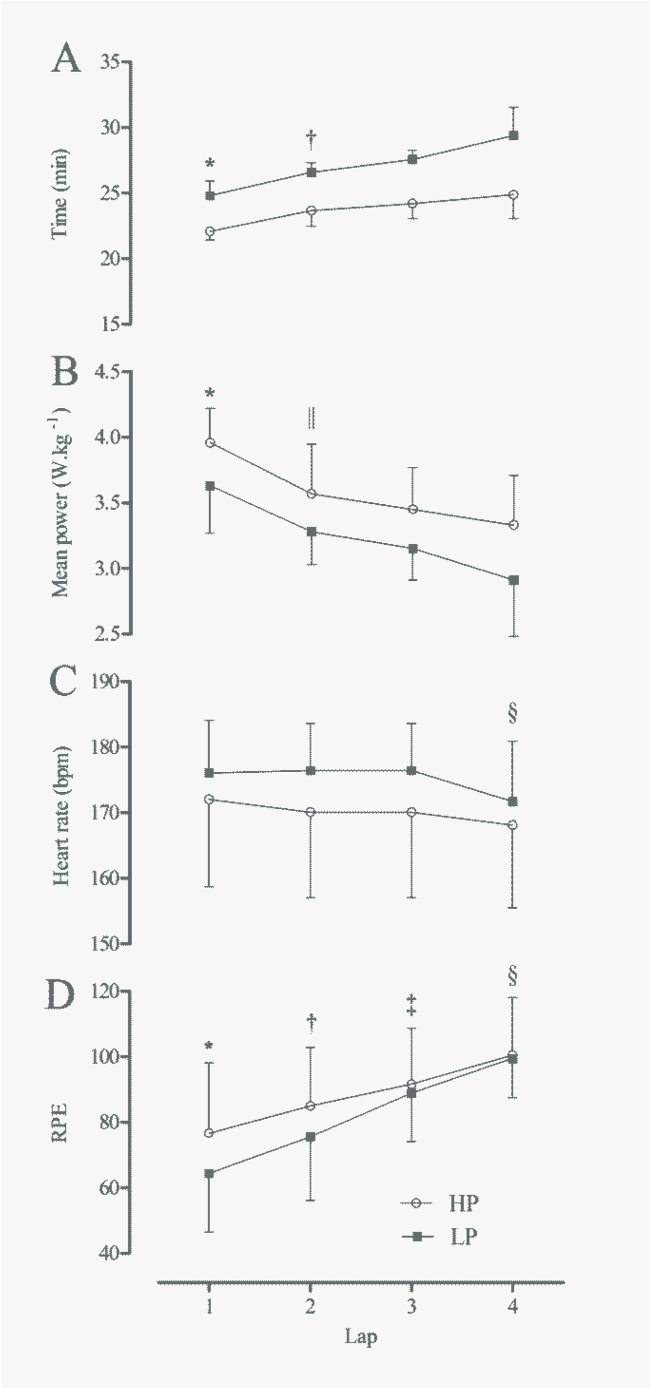

Figure 2. Differences between laps with regard to (a) time (min), (b) SPT relative mean power (W.kg^{-1}), (c) Heart rate (bpm) and (d) RPE (CR100). All significant differences were set at $P \leq 0.05$. *significant differences among laps 2, 3 and 4; † significant differences among laps 1, 3 and 4; ‡ significant differences among laps 1, 2 and 4; § significant differences among laps 1, 2 and 3; || significant differences between laps 1 and 4.

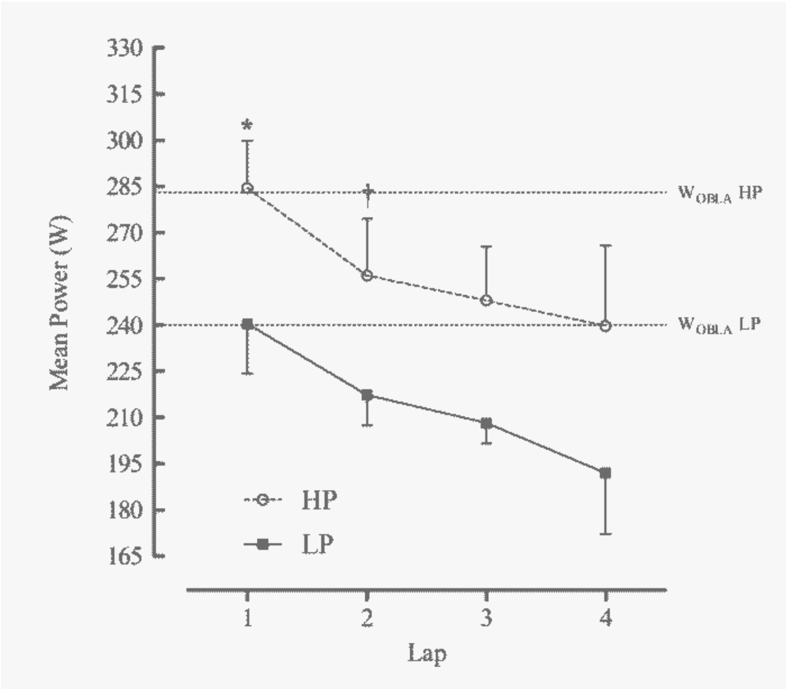

Figure 3. Differences between laps for absolute mean power (W) during the simulated performance test (SPT). Significant differences were set as $P \leq 0.05$. *significant differences among laps 2, 3 and 4; † significant differences among laps 1, 3 and 4; W_{OBLA} HP - Power output associated with the OBLA in the HP group; W_{OBLA} LP - Power output associated with the OBLA in the LP group.

DISCUSSION

The results of this study showed that performance level did not influence pacing strategy. Both groups used a fast start followed by a positive pacing strategy, with a linear decrease observed in performance in every lap. The lack of interaction between $SPT_{absolute\ mean\ power}$ (W) and time (min) indicates that the training orientations and pacing for both groups should consider the positive model identified. Although performance level did not influence pacing strategy, the HP group demonstrated significantly higher power outputs on the last lap (% W_{max}) than those observed for the LP group (76 ± 7% vs. 69 ± 6%, respectively, P = 0.017). Previous studies with amateur runners also found no differences in pacing strategies between groups with different performances (Lima-Silva et al., 2010).

The present results confirm the first hypothesis about the adoption of positive pacing in XCO performance, and they refute the second hypothesis regarding differences in pacing strategies between athletes with better and worse performance results. A pacing strategy consisting of a fast start followed by positive pacing, as found in the present study, resulted in greater VO_2 (Sandals, Wood, Draper, & James, 2006), a greater RPE (Thompson, MacLaren, Lees, & Atkinson, 2003), and greater accumulated fatigue earlier in the event (Thompson et al., 2003; Thompson, MacLaren, Lees, & Atkinson, 2004), which results in losses in performance (Foster et al., 1993).

However, being among the first positions in the initial phase of an XCO race is technically important because cyclists can avoid being slowed down by other riders, especially in single-track racing (F. Impellizzeri et al., 2002; F. M. Impellizzeri & Marcora, 2007). To support this information, longitudinal data from the XCO World Cup over the past 10 years provided a positive association ($R^2 = 0.64$) ($P < 0.01$) between an athlete's start and finish positions (Macdermid & Morton, 2012). These authors showed that for most competitors, the variations between positions at the start of the race and at the end would be approximately 15 positions for elite men and 10 for elite women. Thus, it would be very difficult for an athlete to finish the race with a high position in the final ranking and to have started the race in the back of the grid.

The previous results (Martin et al., 2012) identified the even pace strategy differed from the results of this study and from those previously suggested by several authors (F. Impellizzeri et al., 2002; F. M. Impellizzeri & Marcora, 2007; Stapelfeldt et al., 2004; Wingo et al., 2004). However, the strategy described by authors using GPS data does not seem to allow for a real interpretation of the effort made by athletes throughout a race. An example would be the dissociation between bike speed and power output, whereas if the analysis were made using the power produced (with a power meter), we would have observed the opposite results.

The ability to sustain a power output corresponding to the OBLA for prolonged periods of time is a prerequisite for competing at a high level (F. M. Impellizzeri & Marcora, 2007). Has been demonstrated that the intensity of exercise in XCO is high (F. Impellizzeri et al., 2002), with 82% of the total time of the test performed above the LT. It is important to consider that 82% of the total time of the competition was performed at 51% intensity between the LT and the OBLA and at 31% intensity above the OBLA. This indicator of body mass seemed to have a better correlation (r = -094, P < 0.001) with performance in XCO (F. M. Impellizzeri, Rampinini, Sassi, Mognoni, & Marcora, 2005). Similar results (r = -0.74; $P < 0.05$) were reported previously (Prins, Terblanche, & Myburgh, 2007). In addition to these findings, our results showed that regardless of group, HP or LP, the athletes performed every lap with HR values greater than 90% of maximal HR, confirming the findings of Impellizzeri et al. (F. Impellizzeri et al., 2002) and Inoue (Inoue, Sa Filho, Mello, & Santos, 2012). This study also showed that the $SPT_{absolute\ mean\ power}$ (W) of the first lap for both groups corresponded with their respective OBLA (W), and the HP group decreased its OBLA (W) by approximately 5%, while the LP group decreased its OBLA by 7% by lap. This finding demonstrates that the capacity to sustain the OBLA (W) is a strategy to be adopted in XCO, thus confirming the data of Impellizzeri and Marcora (F. M. Impellizzeri & Marcora, 2007).

Pacing strategy analysis using high-resolution data (Angus & Waterhouse, 2011; Tucker, Bester, et al., 2006) allows for inferences from data variability under the control of dynamic performance. Because the present study aimed only to describe the profiles of these strategies based on the models previously described (Abbiss & Laursen, 2008), this limitation did not seem to influence the results. A second limitation of this study was that it determined the pacing strategies from a laboratory-simulated competition. However, we observed a strong correlation (r = -0.84) between $SPT_{relative\ mean\ power}$ ($W.kg^{-1}$) and time (min) in a real XCO race (unpublished data from our lab), suggesting the same pattern of performance between the two conditions. This aspect of our search increases the external validity of this study.

CONCLUSION

The pacing strategy in an SPT characterised by a fast start involved positive pacing. The performance levels of the athletes (HP and LP) did not affect their pacing strategies, which differed only in the level of performance achieved. The HP group showed a smaller decrease in the OBLA (W) compared with the LP group. The OBLA (W) ended up being equal to the average power at the start of the race, complementing its importance in describing the performance on exercise that are typically aerobic. These findings allow us to infer that the attempt to maintain the power-associated OBLA throughout the race would be a better strategy to adopt in mountain bike competitions. Thus, it is recommended that training programs be conducted to increase the ability to maintain the OBLA (W) for prolonged periods of time. Together, these strategies seem to be relevant for practical applications and should be followed during training and competitions, and they should provide guidance for future investigations about the determinants of XCO performance.

2 ESTUDO 2 - EMOTIONAL RESPONSES OF MULTI-LAP OFF ROAD CYCLING TEST

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INTRODUCTION

Mountain bike cross country (XCO) is a cycling event characterized by a multiple lap, performed in forest roads, technical descents, rocky paths and obstacles, with a length between 5 to 9 km and 1 h 45 min to 2 h 30 min (Internationale, 2012). It has been reported that a success in XCO, the use of a fast start is technically important because the cyclist can gain the first positions avoiding to be slowed down by other riders, especially in the single tracks (F. Impellizzeri et al., 2002; F. M. Impellizzeri & Marcora, 2007; Macdermid & Morton, 2012). In this sense, the intensity reported earlier this type of event is quite high, reaching values up to 1000 Watts at the start of the race (Stapelfeldt et al., 2004) and also, previous studies indicate that the use of a fast start versus slow start would result in a higher VO_2 (Jones et al., 2008).

These variations of intensity, energy expenditure or even workload during the exercise is called of pacing strategy, and especially on the competitive environment, this have two key functions: allow the best performance and prevent of premature fatigue to occur before the endpoint (St Clair Gibson et al., 2006). The performance adjustment is performed at the unconscious level, integrating knowledge about endpoint and physiological responses due the selected intensity which result in conscious level, the perceived exertion (Tucker, 2009). These knowledge is developed with previous experience in the specific task, with the same duration or distance (Mauger et al., 2009), environment conditions (Tucker, Marle, et al., 2006) and nutritional status (Rauch, St Clair Gibson, Lambert, & Noakes, 2005). The pace strategy had a shape task dependent (Abbiss & Laursen, 2008). Considering for example a multidiscipline race like a triathlon (Parry, Chinnasamy, Papadopoulou, Noakes, & Micklewright, 2011): the perceived exertion show a linear increase for a multidiscipline event, it reported either a minor re-setting between disciplines. This re-setting can be hypothesized with a pace strategy performed by a near endpoint, which would be the end of the actual discipline instead of overall race endpoint. It suggest that in not-continued exercise, the perceived exertion could be influenced over the race because the interruptions.

Previous evidence indicates that the emotions have critical role on pacing strategy and endurance performance, providing information about how hard the exercise has been perceived and how well the athletes are (Baron et al., 2011). During exercise, positive emotions are associate with goal attainment, whereas negative emotions are associate with goal failure (Carver & Sheier, 1990). Based on that, the ability to handle emotions seems to be important to endurance performance. In addition, the rated of perceived exertion (RPE) has been described as a single indicator of effort (G. A. Borg, 1982) not only the physiological changes that occur in different metabolic systems, (Noakes & St Clair Gibson, 2004; St Clair Gibson & Noakes, 2004), but also of direct interpretation of affective loading (Baron et al., 2011). Just as emotions, perceived exertion appears to be associated with the exercise intensity (Lane, Wilson, Whyte, & Shave, 2011; Micklewright et al., 2009; Parry et al., 2011).

The research field involved multi-lap races, despite having been reported the physiological responses of XCO (F. Impellizzeri et al., 2002) and supercross BMX (Louis et al., 2012), mechanicals workloads (Macdermid & Stannard, 2012; Stapelfeldt et al., 2004) still resides in a gap in know emotional responses and of RPE in this type of event, thus improving the understanding of the sport. The aim of this study was describe mood responses pre-race, during and post-race in a simulated performance test (SPT) and analyze the relationship of RPE against distance covered and mean power output of each lap (W_{SPT}). Our hypothesis is that athletes pace themselves based on a final endpoint, so for this reason the RPE increase significantly over the SPT. Based on that, we further hypothesize that feelings about fatigue and total mood disturbance increase either, and in addition the feelings about vigour decrease over the trial.

METHOD

Participants

Nineteen male XCO cyclists with age (M = 32.2, SD = 6.5 yr), height (M = 174.9, SD = 5.4cm), body mass (M = 67.9, SD = 6.3 kg), body fat (M = 7.3, SD = 2.9 %), maximal aerobic power (M = 295.8, SD = 21.1 W) and VO_{2peak} (M = 65.3, SD = 4.9 $mL.kg^{-1}.min^{-1}$) who compete at the regional and national levels in Brazil participated in this study. They had training frequencies of six days per week for at least five years. The exclusion criteria were a history of recent injury or any other contraindication for competitive physical activity.

The athletes were informed about all of the procedures of the experiment and its implications (risks and benefits) by signing a consent form. All of the procedures were approved by the ethics committee on research of the Gama Filho University (051.2010).

Experimental design

The athletes visited the laboratory three times. The first visit consisted of anthropometric measurements and an incremental exercise test. At the second visit, the athletes familiarised themselves with the SPT and completed the entire course, and at the third visit, they performed the SPT to determine their affect responses. The athletes performed the tests on different days separated by at least 48 h. All of the tests were performed in a temperature of $21^{o} \pm 1°C$, in the same place and at the same time of day (≈2 h). The subjects were asked to avoid solid food for three hours before the tests; throughout the trials, water intake was *ad libitum* (Rose & Peters-Futre, 2010). The subjects were asked not to perform high-intensity exercise for 24 h prior to the tests.

Procedures

Anthropometry. The measurements were standards established by the International Society for the Advancement of Kinanthropometry – ISAK (Norton & Olds, 1996) were used to determine the following anthropometric factors: body weight (Filizola Scale, São Paulo, Brazil), height (wall scale) and skinfold (Slim Guide, Rosscraft, Surrey, Canada). Body composition (Jackson & Pollock, 1978; WE, 1961) were estimated from the collected data.

Incremental exercise test. After a warm-up performed at 100 W for 10 min, the workload was increased by 30 W every 5 min until volitional exhaustion or until a cadence of ≥ 70 rpm could not be maintained by the athlete. The test was performed on a road bicycle fixed by the rear wheel (100 psi) to an electromagnetically braked ergometer (Computrainer™ Lab 3D, RacerMate, Seattle, WA, USA). For the calibration procedures, the manufacturer's specifications were followed. Throughout the incremental exercise test, gas exchange was assessed by a Vacumed Vista-Mini CPX metabolic analyser with Vista Turbo Fit software, version 5.1 (Ventura, CA, USA), and with an open circuit. Before each test, the gas analyser was calibrated following the manufacturer's specification. The maximum oxygen uptake (VO_{2max}) was determined using the highest 30 s value of oxygen uptake (VO_2) reached during the last stage of the incremental exercise test. The peak power output (W_{max}) was defined as the highest load completed by an athlete in a complete stage. When the stage load could not be sustained for an entire stage and the athlete reached exhaustion before finishing, W_{max} was determined using the equation previously described (Kuipers et al., 1985).

Heart rate (HR) was monitored continuously (Polar® RS 800 CX, Polar Electro, Oy, Finland). The RPE was measured during each trial at the specified times using the Borg's CR100 scale (E. Borg & Borg, 2002; E. Borg & Kaijser, 2006).

Simulated performance test. The SPT was conducted in the laboratory under the same environmental conditions and with the same electromagnetically braked ergometer from the incremental exercise test. The road bicycle used was equipped with pedals and was fitted (saddle height and saddle setback) to meet the specifications of each subject. During the entire SPT, a fan was directed at the athlete, and the electronic ergometer was connected to a computer located in front of the athlete. Integrated 3D software, version 1.0 (RacerMate Inc.), was used to simulate the course. The software accounted for variables such as the body weight of the cyclist and the elevation course of the road to determine the speed and power that the athlete was able to produce. Before each test, a warm-up was performed for 10 min at 100 W. The SPT consisted of four laps on a course of 9.9 km with an elevation between 0% and 10% following a stochastic pattern. The distance and elevation were programmed for the athletes to complete the SPT at an average of 25 min per lap and for a total of 100 min. To resemble a real competition, the athletes were free to change gears and to determine their own cadence and when they should stand. Subjects were requested to "ride as fast as possible" and were not given any feedback other than their elapsed time.

Mood state measurements. Throughout this study, mood state was measured using Viana et al. (Miguel Faro Viana, 2001) shortened "right now" version of the Profile of Mood States Questionnaire (POMS). This POMS short form, adapted to Portuguese language, comprises 36 single-word mood descriptors, each with a 5-point Likert response scale, from which subscale scores for tension, depression, anger, vigour, fatigue and confusion could be calculated. The POMS was asked immediately before the SPT, between the eighth and ninth kilometer of each lap and 30 minutes after the end of the SPT. In the familiarization session and before the SPT, the *POMS* scale was carefully explained to a participant. In order to counteract the potential response bias associated with repeated POMS trials (pre-race, lap-by-lap and post-race), participants were instructed to answer the POMS honestly as possible by reflecting on they felt at the precise moment in time rather than attempting to provide answers based on any previous POMS responses that they may have remembered giving.

Statistical Analysis

A repeated measure one way anova followed a Bonferroni *post-hoc* test were carried out to analyze the differences between the moments of *POMS subscale scores* and changes in performance by W_{SPT} analysis in each lap. To verify the relationship between RPE against distance covered and W_{SPT} was used Pearson product moment correlation. The correlation coefficients were interpreted using the scale of magnitudes proposed by Hopkins (W.G. Hopkins, 2002) < 0.1, trivial; 0.1-0.29, small; 0.3-0.49, moderate; 0.5-0.69, large; 0.7-0.89, very large; >0.9, nearly perfect. Due to the sample size, we present the estimation of 95% confidence intervals. The analyses were performed using GraphPad Prism 5 (GraphPad software Inc., California, USA). An α level of 0.05 was used to indicate statistical significance and effect sizes are reported as eta-squared (η^2) and interpreted using Cohen's (Cohen, 1988) magnitude scale : ≤ 0.01, small; 0.01-0.06 medium; 0.06-0.1 large.

RESULTS

Mood responses

We found an increase on total mood disturbance (TMD) $F(5.18) = 9.92$, $P < 0.001$, $\eta^2 = 0.35$ and on POMS subscale sores of tension $F(5,18) = 2.35$, $P = 0.047$, $\eta^2 = 0.11$, anger, $F(5,18) = 2.59$, $P = 0.031$, $\eta^2 = 0.12$, fatigue $F(5,18) = 25.1$, $P < 0.001$, $\eta^2 =0.58$ and depression $F(5,18) = 2.58$, $P = 0.031$, $\eta^2 = 0.12$. It was found a decrease for vigour over the SPT $F(5,18) = 2.93$, $P = 0.017$, $\eta^2 = 0.15$. Despite it was not found differences between pre-race and post-race of POMS subscale confusion, it was found an increase from second to fourth lap $F(5,18) = 2.76$, $P = 0.022$, $\eta^2 = 0.13$. The mood responses to SPT are provided as mean (M) and standard deviation (SD) on the Table 1.

Table 1. Mood responses to Simulated performance test

POMS factors	Pre-race		Lap1		Lap2		Lap3		Lap4		Post-race	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Tension	4	3	4	4	4	5	4	4	5	6	3	3
Anger	0	2	1	4	1	4	2	5	2	5	1	3
Fatigue	2	2	5	3	7	4	10	5	12	6	7	5
Depression	0	2	1	3	1	3	2	4	1	4	1	2
Confusion	4	2	4	3	4	3	5	3	6	5	4	3
Vigour	15	4	14	5	14	5	13	5	11	6	13	6
TMD	97	13	103	19	106	21	111	23	117	30	105	20

M mean, *SD* standart deviation, *TMD* total mood of disturbance

Performance and RPE outcomes

The finish time (min) to SPT was (M = 102, SD = 7.23). The results showed a decrease in W_{SPT} (Figure 1) between laps 1 and 4 (M = 260.5, SD = 26.46 to M = 213.6, SD = 32.19), $F(3,18) = 35.73$, $P < 0.001$, $\eta 2 = 0.66$ and an increase in RPE (Figure 2) (M = 70.53, SD = 20.06 to M = 100.8, SD = 12.94), $F(3,18) = 41.88$, $P < 0.001$, $\eta 2 = 0.69$ over a SPT. There were a nearly perfect correlation between RPE and distance covered (Figure 3) (r = 0.999, P <0.001) and between W_{SPT} and RPE (Figure 4) (r = - 0.971, P = 0.028).

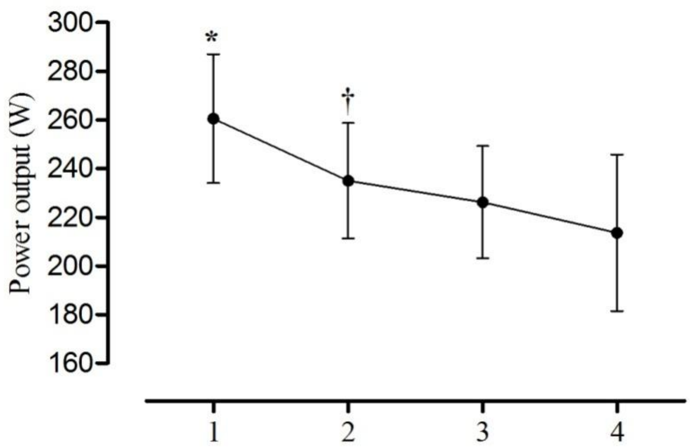

Figure 1. Differences between laps with regards to Power output over a SPT. Significant differences were set at *P < 0.05*. *significant differences among laps 2,3 and 4; † significant differences among laps 1 and 4;

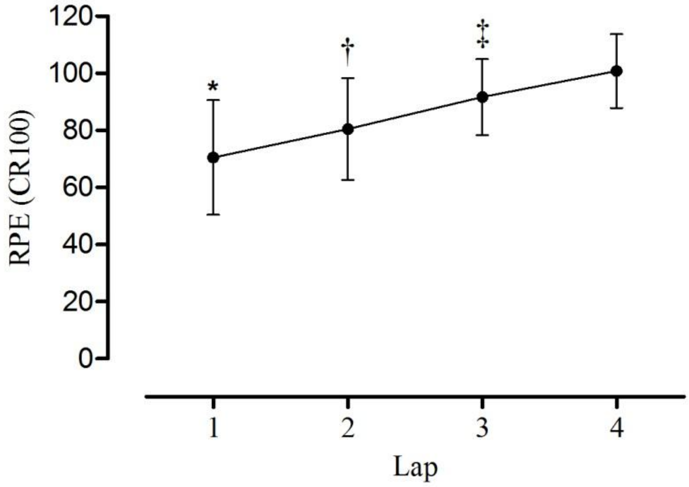

Figure 2. Differences between laps with regards to RPE over a SPT. Significant differences were set at $P < 0.05$. *significant differences among laps 2,3 and 4; † significant differences among laps 1, 3 and 4; ‡ significant differences among laps 1,2 and 4.

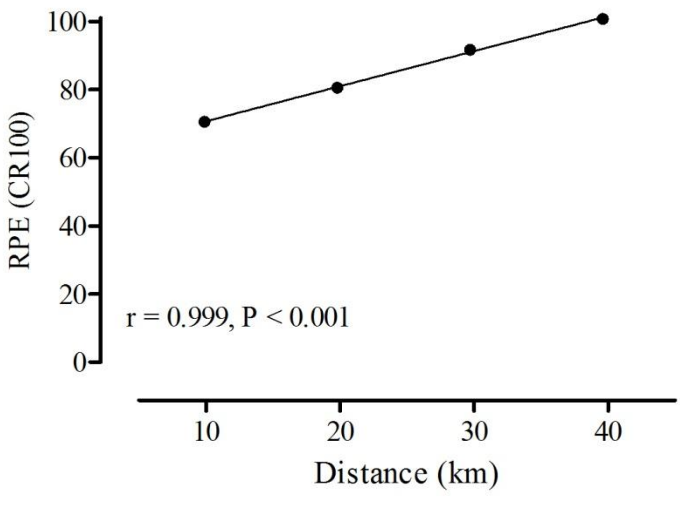

Figure 3. Correlation of RPE against distance covered.

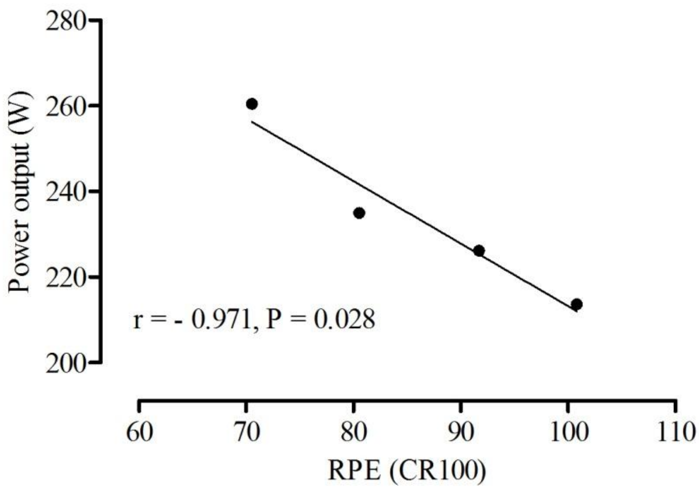

Figure 4. Correlation of Power output against RPE.

DISCUSSION

The aim of this study was describe emotional responses pre-during-post SPT and analyze the relationship of RPE against distance covered and W_{SPT}. The results showed negative responses for emotion, confirmed by increase on TMD and POMS subscale scores of tension, anger, fatigue, and depression. Furthermore it was found a decrease on vigour, supporting previous results found in a ultramarathon (Micklewright et al., 2009).

RPE. Fatigue can be evidenced by decrease of force production over the task or increase of perceived exertion (D. A. Baden et al., 2005). The present study report both, showing a nearly perfect inverse relationship between W_{SPT} and RPE ($r = - 0.971$, $P = 0.028$) over the SPT. This result could confirm our hypothesis of the athletes pace themselves at your best performance based an endpoint (D. A. Baden et al., 2005; St Clair Gibson et al., 2006; Tucker, 2009), however it would be the end of the SPT and not the end of each lap. This finding not indicate the presence of a re-setting mechanism of perceived exertion described by (Parry et al., 2011). This study, despite the methodological differences, presents himself as the only we can compare our results of perceived exertion.

Emotion changes. The feelings of tension had no differences from pre-race to first lap and over the SPT, however participants reported a decrease in feelings of tension from fourth lap to post race ($P < 0.05$). Previous studies reported similar results with no increases of tension before the ultramarathon race (Micklewright et al., 2009), however results which are contrary were reported by (Parry et al., 2011). These higher values of tension during the endurance exercise can be explained by an anticipatory affective state, due to conscious thoughts about task ahead. These conscious thoughts about the task that remains to be done, could be related to planning, or just pace strategy and could be evidenced by individual variability exemplified by the changes in standard deviation, increasing in the last lap followed by a decreasing after the race, but the exact nature of this phenomenon needs further investigation because in this study it was not specifically measured.

Many classic studies consider fatigue just as a specific physiological phenomenon (Fitts, 1994; Gandevia, 2001), but other consider the same phenomenon as a sensation resulted of complex and integrative system of feedback, responsible to maintain homeostasis during exercise (Noakes & St Clair Gibson, 2004; Noakes et al., 2005; St Clair Gibson et al., 2003; St Clair Gibson & Noakes, 2004). Our study use emotional measurements, and if we consider the concept of fatigue as a sensation, our results present an increase of this feelings over the race.

The results showed a significant increase in TMD from first to fourth lap ($P < 0.0001$), supporting previous findings which reported displeasure sensations with high intensity exercise (Ekkekakis, Parfitt, & Petruzzello, 2011; Kilpatrick, Kraemer, Bartholomew, Acevedo, & Jarreau, 2007).

Post-race POMS subscale scores recovery dynamics. Despite it was found a decreasing of POMS scores from last lap to post-race measurement for fatigue, confusion, depression and TMD. The post-race values are higher when compared to pre-race, even 30 min after the end of the race. The score of vigour had the same response, increasing from last lap to post-race but not reaching the pre-race values. In the ultramarathon of 73.4 km, the amount of time needed to recover POMS subscale scores from end of the race to baseline levels were 2 h and 22 min on average, but for some participants this time reach 4 h and 25 min (Micklewright et al., 2009).

SPT performance. The performance analysis showed a positive pacing strategy (unpublished data form our lab) with a fast start, it was suggested of athletes follow your performance template (Foster et al., 2009) acquired over the years of race experience. Had some evidence of this pace strategy with fast start represent successful performance on XCO race (F. Impellizzeri et al., 2002; Macdermid & Morton, 2012). It's evidenced because be on first positions on the initial part of the race is technically important for the success in XCO because the cyclists can gain the first positions for avoiding to be slowed down by other riders, especially in the single tracks (Macdermid & Morton, 2012; BF Viana, Inoue, & Santos, 2012).

The POMS has been used to investigate the relationship of mood and exercise (Berger & Owen, 1983; Lane et al., 2011; Micklewright et al., 2009), but many of these study use the pre-post procedure. Is not best of our knowledge so far, other study that has included the assessment of mood changes during exercise using POMS. Although the original instrument (Miguel Faro Viana, 2001) was not designed for this aim in your conception however, the results of present study seem be supported by previous studies (Lane et al., 2011; Micklewright et al., 2009; Parry et al., 2011) presenting increase on TMD and on POMS subscale scores of fatigue and a decrease of vigour.

CONCLUSION

The conclusion of present study is that emotions get worse over the SPT, increasing TMD and POMS subscale scores of tension, anger, fatigue and depression. In the future, should be investigated the influence of psychological techniques on these variables and it’s relation with performance. The athletes pace themselves based an endpoint that was the end of SPT, not presenting a re-setting mechanism after each lap.

CONCLUSÕES FINAIS

Os resultados do presente estudo nos permite concluir que o nível de desempenho não afetou a estratégia de prova dos atletas de XCO, apesar de influenciar no desempenho final e que a potência da fase inicial do evento está associada ao OBLA. Sendo assim, isso nos possibilita inferir que ser capaz de sustentar a potência associada ao OBLA ao longo de uma prova, parece ser uma estratégia adequada a ser adotada em provas de XCO. Foi observado também que as emoções e a habilidade do atleta lidar com elas antes, durante e após a competição, parece influenciar significativamente o desempenho. É possível que a manipulações dessas variáveis emotivas a fim de melhorar a capacidade do atleta em lidar com suas próprias emoções durante a competição, possam contribuir para potencializar o desempenho, porém são necessárias pesquisas futuras para uma melhor investigação dessa questão.

Recomendações práticas para a melhoria da consciência relacionada à estratégia

Considerando a estratégia como a forma consciente em que o indivíduo regula o esforço durante a atividade, exercício ou competição, destacamos alguns pontos que podem contribuir para a melhora dessa consciência. As recomendações aqui apresentadas carecem de evidências científicas e serão, muito provavelmente, tema de investigações futuras. Apesar disso, optamos por oferecer algumas recomendações práticas.

Recomendamos para os técnicos que permitam seus atletas a experimentarem as mais diversas formas de sensações associadas ao exercício, sejam elas desconfortáveis ou não, assim como diferentes terrenos, com e sem inclinação, condições ambientais diferentes, como frio, calor, chuva, sol, entre outras. Somente dessa forma é possível aumentar a variedade de condições experimentadas pelo atleta, permitindo a ele ter uma maior capacidade de tomada de decisão durante a competição sob aumentar, diminuir ou manter a carga.

Em relação a provas específicas, algumas recomendações complementares podem ser realizadas. A primeira delas seria um bom conhecimento do atleta acerca da tarefa a ser realizada. Por exemplo, tornar-se íntimo da distância da competição, fazer um bom reconhecimento do percurso, em especial para atletas *off road*, informar-se com outros competidores que já experimentaram a prova entre outras estratégias de acúmulo de informação. Dessa forma, os atletas poderão regular-se adequadamente durante a prova de forma antecipada. Sem a familiarização da distância ou do tempo de exercício a ser realizado, fica prejudicada a capacidade do indivíduo em regular o esforço da melhor forma possível, com base no ponto final.

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GLOSSÁRIO

Pace strategy.	Variação espontânea da potência mecânica produzida ou do dispêndio energético ao longo do exercício.
Modelo governador central.	Modelo de regulação do esforço realizado pelo sistema nervoso central de forma integrativa, dinâmica, antecipatória e não linear.
VO_{2max}.	Maior consumo de oxigênio alcançado em um teste com medidas das variáveis de troca gasosa respiratória.
W_{max}.	Maior potência associada ao VO_{2max} determinada no teste progressivo máximo.
Emoções.	Interocepção das mudanças fisiológicas do corpo.