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EC NEUROLOGY

Mini Review

Central Fatigue as Performance Restrictor in Rehabilitation Programs?

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Received: January 17, 2017; **Published:** January 27, 2017

Abstract

Suggested that programs for neurologic patients with central fatigue should be developed based on the clinical findings and in accordance with the natural history of the disease addressed. In an attempt to a new interpretation of the physiological state of balance during exercise and according to the integrative model of central regulation of effort. It is suggested that there would be a balance of maintaining not only understanding the intensities indicating that the disengagement exercise happens without obvious flaw remains of organ systems. Research in this line of understanding can help in understanding the psycho-physiological phenomenon of disengagement / exhaustion as well as having relevant application in tasks that require motor performance.

Keywords: *Fatigue; Rehabilitation; Physical Performance; Exercise; Central Nervous System*

Abbreviations

DEM: Dynamic Equilibrium Model; GCM: Governor Central Model; CNS: Central Nervous System; RPE: Rate Perceived Exertion

Introduction

In recent studies suggested that programs for neurologic patients with central fatigue should be developed based on the clinical findings and in accordance with the natural history of the disease addressed [1]. The exchange of knowledge among professionals, the use of supportive and protective equipment, as well as psychological support, should be part of the proposed rehabilitation. Submaximal exercise therapy may contribute to a better control of muscle weakness and fatigue, improvement cardiorespiratory aptitude and walking pattern. We hereby propose that the data also supports the short communication.

One of the oldest models of exercise physiology, Dynamic Equilibrium Model (DEM), formulated by Hill and Lupton in the 20s of the twentieth century, assumes the end of the exercise, identified by reduced maintenance of a motor task, called fatigue or exhaustion, occurs due to accumulation of metabolites or the depletion of energy substrates [2,3]. Depending on the provision of this model there is an exercise intensity at which oxygen consumption (VO_2) remains stable, with no increase in blood lactate levels, even with the increase in the intensity or extending the motor task, suggesting a physiological state of equilibrium has been reached [4].

In addition, DEM assumes that the accumulation of metabolites would cause the collapse of negative body physiological systems and the disengagement / end of the motor task when exercises are performed above this acceptable intensity limit. Still, the disengagement / end could match the range of maximum values in the VO_2 and blood lactate concentration. However, in equal intensities or below "physiological limit", depletion of energy substrates, specifically, muscle glycogen, would cause the negative breakdown of body systems, hence the end of the year [4]. However, the decrease in muscle glycogen concentrations would be the cause of the disengagement exercise at intensities that have steady state [3,4]. Yet, despite the existing foundation of the DEM, this has limitations. It is supposed to be the presence of a complete balanced physiological state in intensity where blood lactate is stable [5]. Indeed, there appear to be differences between the behaviors of important physiological variables during exercise with steady workload.

In an attempt to a new interpretation of the physiological state of balance during exercise and according to the integrative model of central regulation of effort [2,3,5], it is suggested that there would be a balance of maintaining not only understanding the intensities indicating that the disengagement exercise happens without obvious flaw remains of organ systems. In this model, called Governor Central Model (GCM), to maintain balance in the physiological, variables investigated would be ensured by the actions of the central nervous system (CNS), which would use the perceived exertion (RPE) as a time to exhaustion marker the task [6]. Depending on this theoretical postulate, the subconscious brain, which is modulated by afferent signals of the peripheral and central systems, regulate the metabolic rate and produce the RPE as a strategy to ensure that the exercise is performed in safe limits to the body [2,3,5,7]. That is, the CNS would be the system which controls the physiological balance from the continued variation in metabolic rate during exercise [8].

Discussion

Studies have suggested that the engine performance can be centrally controlled from afferent information from the periphery that makes up the feelings / emotions [2,9,10]. This engine performance model is based on observations that the brain does not fully recruit motor unit(s) muscle(s) set(s) when they are performed exercises [9,11], suggesting that the brain operates to regulate the engine performance in a process reported by afferent-efferent neuromuscular signals [9]. It is noteworthy that these results indicate that the brain not only considers the physiological afferent information from the periphery, such as muscle pain, change in pH or respiratory distress, when you set the appropriate effort into self exercises set, but also considers psychological factors like perception effort / perceptual fatigue [12,14].

Some recent scientific findings are in line with MGC predictions. First, based the MGC exhaustion occurred on the presence of the physiological balance of the metabolic system areas, since the metabolic stability, and cardiopulmonary variables were the final 50% of the exercise. Second, unlike the fundamental theory of steady state, the disengagement of the year did not occur over a range of maximum values in important physiological variables, i.e. the disengagement in the metabolic field occurred when the VO_2, HR and lactate concentrations were between 57 - 82%, 81 - 91% and 16 - 56% of amounts recorded in disengagement point of a maximal exercise test, respectively.

Moreover, the results observed in the RPE study of Pires., *et al.* [15], the GCM are based predictions, because the RPE has increased steadily and linearly to the end point of exercise on physiological fields. The progressive and linear increase in RPE can be interpreted as a mechanism used by the CNS to carry out the exercise within organic safe limits [2,3]. Other studies [15,16] confirm the GCM 's suggestion that the slope RPE during exercise can predict the time to exhaustion during the exercise [6], regardless of the physiological domain and experimental conditions investigated.

The GCM has similarities to the psychobiological model of performance [17-19], which is based on Brehm's Motivational Intensity Theory [20,21] to explain the phenomenon of motor performance. It uses two main constructs as a base: a potential motivation and motivational intensity. The potential motivation refers to the maximum effort in which the individual is willing to exert to satisfy an activity (eg, success in a motor task), while the motivational intensity is the amount of effort that the individual actually spends to accomplish a physical task [20].

The Brehm's Motivational Intensity Theory posits that individuals may engage or retain engaged in a motor task when: 1) potential motivation levels are not met; or 2) the motor task is still seen as possible to complete. That is, if individuals realize that the motor task is impossible to conclude, despite their maximum effort (motivational intensity), or when the effort required for the physical task exceeds the upper limit of what people are willing to do (motivation potential), the disengage individuals the task [20]. Consequently, the point of exhaustion can occur due to increased perceived exertion to critical levels for potential or motivation when individuals realize they are physically unable to stay on task, as they believe they are exerting maximum effort [22].

This model predicts that the increase in exercise tolerance should occur when the potential motivation is increased or when the RPE (defined as the feeling conscious of how hard, difficult and exhausting the driving task is) increases linearly and progressively [17,22]. In this situation, other factors, physiological and / or environmental, may indirectly affect exercise tolerance if this (these) factor (s) influence (in) the perception of how difficult the task is, or influence the motivation of potential individual [18,19].

In addition, the psychobiological model of performance gives greater attention to cognitive / motivational factors and their influence on the conscious decision-making and behavioral regulation compared to the existing engine performance models (steady state and GCM) [17,23]. In addition, this psychobiological model of performance explains exhaustion / disengagement exercise based on the (in) tolerance psychological exercise, unlike GCM, which explains the phenomenon disengagement of the year based on the anticipatory process and subconscious and / or physiological inability to maintain the physical task.

Just as the GCM, the psychobiological model of performance has the RPE as an essential element to explain the engine performance. However, for Marcora, Staiano and Manning [19] RPE is independent of afferent peripheral feedback signals, and the RPE and other sensation (pain, temperature, etc.) have different neurological mechanisms [23]. De Morre, Klein, Marcora [24] tested the hypothesis that the RPE is correlated with the magnitude of the central motor command during the exercise, from the RPE measurement and cortical potential related to moving 16 men physically active on a motor task involving unilateral elbow flexion in two strengths (20% and 35% of one repetition maximum), in which one of the conditions the muscles involved would be fatigued and the other would not. The results showed that the RPE in any of the manipulations increases due to an increase of the amplitude of the cortical potential. Furthermore, the only cortical potential that is shown in any increase in the amplitude of the corresponding manipulations was to Cz. In this sense, statistical analyzes confirmed the correlation between the PSE and the amplitude of the cortical potential related to the movement in the experimental manipulations. This study showed a possible direct neurophysiological mechanism that the potential amplitude related to the movement relates to the RPE.

Marcora, Staiano and Manning [19] measured the RPE and performance and physiological responses in endurance exercise after performing a cognitive task lasting 90 minutes. They noted that the implementation of the mental task was able to reduce significantly the time to exhaustion compared to the control condition. It is noteworthy that, in this study it was not observed any effect of cognitive task on the metabolic and cardiopulmonary responses during exercise, however, the end of the motor task the average values of HR and lactate concentration were significantly higher in the control condition (video documentary) compared to experimental condition (mental task). In this study, only the highest RPE reported by mentally fatigued individuals explained premature disengagement exercise.

In support of this model, a recent meta-analysis by Hagger., *et al*. [25], states that the depletion resulting from the efforts ego in a domain (cognitive or behavioral or emotional) has strong and consistent deleterious effects on subsequent tasks, whether those tasks are the same domain (emotional control - emotional control) or different domains (cognitive control - physical control / resistance). In this sense, research in this line of understanding can help in understanding the psycho-physiological phenomenon of disengagement / exhaustion as well as having relevant application in tasks that require motor performance.

Conclusion

The idea that the engine performance can be explained in part by cortical brain regions responsible for executive control functions (e.g., anterior and posterior cingulate cortex) is consistent with the outlook of exercise physiology, psychology and neuroscience to hypothesize the existence of a source of energy in the brain that governs the performance of tasks requiring the regulation of physical, emotional and cognitive effort. According to Strength or Ego Depletion Model (depletion model of ego or strength) [25-27], the self-regulating efforts of a task can decrease performance in later tasks provided that both tasks require some form of regulation of the physical and / or cognitive and / or emotional stress.

Conflict of Interest

The authors declare no conflict of interest.

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Volume 4 Issue 4 January 2017