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The effect of simultaneous physical and brain endurance training on fatigue and exercise tolerance in active people

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Abstract

Background and Aim: It seems that the combination of brain endurance training and physical endurance training can increase more endurance exercise performance throughout decrease rating of perceived exertion. **Materials and Methods:** 20 healthy volunteers (14 men and 6 women) were assigned into two groups as: physical endurance training + brain endurance training and physical endurance training. Both groups trained on a tolerance in active people. Maximal oxygen consumption during cycle ergometer for 60 minutes at 60-75 heart rate reserve. Whilst cycling, the brain endurance training group performed a mixed model analyze of variance and significant level was set as $p<0.05$. Rating mental exertion on a computer. Both groups trained 3-4 times a week for 24 sessions. Maximal oxygen consumption and exercise tolerance with constant load exhausting test were measured at pre and post training. Data were analyzed using an incremental test and heart rate were recorded every two minutes during time to exhaustion test. **Results:** The results of this study provide evidence that the endurance training group compared to the physical endurance training group indicated significant reduction on the rating of perceived exertion during time to exhaustion variable it showed more increasing in the brain endurance training and physical endurance training than physical endurance training group (p = 0.01). Brain endurance training and physical endurance training can increased perceived exertion during time to exhaustion test (p = 0.01 in both groups (p = 0.01); however, for time to exhaustion variable it showed more increasing in the brain endurance training group compared to the physical endurance training group (p = 0.01). **Conclusion:**

Key words: Brain training, Rating of perceived exertion, Time to exhaustion, Mental fatigue.

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Simultaneous effect of physical and cerebral endurance training on fatigue and sports endurance of active people

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Abstract

Background and Purpose: It seems that the combination of brain training and physical training reduces exercise perception due to a decrease in stone perception during endurance performance. Physical is only more effective. Accordingly, the purpose of this study was to investigate the effect of physical endurance training along with brain training on fatigue and athletic endurance of active people.**Research Methods:** Twenty healthy volunteers (14 men and 6 women) were divided into two groups: physical endurance training + brain endurance training and physical endurance training. The two groups cycled on a tachometer wheel for 60 minutes in each session with an intensity of 60-75% of the reserve heart rate. The group also performed a brain exercise while cycling a mental stone with a computer. The two groups practiced 3 to 4 sessions per week for 24 sessions. Maximum oxygen consumption was measured using an incremental test and exercise tolerance was measured before and after the training period using a depleting test with a constant load. Perceptions of stone and heart rate were recorded during the exhaustion time test. Data were analyzed by analysis of variance with intergroup factor at a significance level of 0.05 Decomposed case and p Were analyzed. **findings:** Maximum oxygen consumption in both groups increased significantly (= 0.01)Nevertheless, the time of arrival.) P Exhaustion in the group of physical endurance training + brain endurance training increased significantly more than the group of physical endurance training (0.01 =In addition, physical endurance training + brain endurance training compared to physical endurance training alone.) P Significantly reduced the perception of stone in the exhausting test (= 0.01) .) p**Conclusion:** The results of this study show the composition Brain and physical training is more effective in increasing endurance performance than physical training by reducing the perception of more stones.

Keywords: Brain training, stone perception, time to reach exhaustion, mental fatigue.

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Introduction

Performance limitations during sports activities depend on various physiological and psychological factors. One of these important factors is fatigue, which is a psycho-physiological phenomenon[1] (Enoka[2] Et al., 2016). Sports scientists define fatigue as a decrease in physical and mental ability and efficiency, which is divided into two categories: physical and mental fatigue (Tanaka[3] Et al., 2012). Exercising leads to physical fatigue (Tanaka et al., 2012) and prolonged mental activity causes mental fatigue that is associated with feelings of lethargy and decreased energy levels (Baxem[4] Et al., 2008). Mental and physical activities involve the joint nerve pathways (Mehta and Parasuraman[5], 2014). There are also common neural pathways between mental and physical fatigue, including facilitative neural circuits[6] And restraint[7] And doing both at the same time may increase the indicators. The facilitation pathway includes parts of the limbic system, regulatory ganglia[8], Orbitofrontal cortex[9] And the anterior cingulate cortex[10] (ACC;) And an inhibitory circuit consisting of an insular cortex[11] (And belt cortex) IC (Is (Ishii) PCC[13] Et al., 2014; Tanaka et al., 2012). Research shows that physical activity (Joanne[14] Et al., 2009) and mental (Cook[15] Et al., 2007) Boredom increases the activity of these pathways, which has been accompanied by an increase in the report of fatigue by the subject (Ishi et al., 2014). According to reports, performing 45 minutes of mental activity simultaneously with the physical protocol of cycling for 45 minutes with an intensity of 65% of maximum output power, significantly increased indicators such as perception of stroke during activity, cortisol, prolactin and NASA questionnaire indicators.[16] After the activity, cycling is only (controlled) compared to one session of physical activity (Amoozi, 2018). Mahata and Parasuraman (2014) have also shown that performing a mental activity simultaneously with a maximal contraction of the hand muscles reduces oxygenation of the frontal lobe and increases fatigue indices (cortisol and NASA questionnaire indices). It is compared to the time when only one sub-maximal contraction of the hand muscles is performed. Et al. (2018)[17] have also shown that performing high and low mental activity during quadriceps contraction (with an intensity of 15% of maximum maximal force) reduces exercise tolerance compared to quadriceps contraction session (control mode). Is. All these studies show that doing mental and physical activity simultaneously, due to the existence of common neural pathways, causes more stress in one activity session and improves fatigue indices than physical activity alone.

Sports scientists are always looking for new training methods to further improve the performance of athletes in the short term. Brain endurance training is a new method of training that can create mental fatigue[18] Increase the resistance of people to fatigue during a physical or cognitive activity in each session and the resulting adjustment (Markura[19] Et al., 2015). Mental fatigue with a complex mental task[20] It is created and its characteristics express feelings[21], Fatigue[22] And energy shortages (Baxem et al., 2008). Mental stones, which cause mental fatigue, also increase the activity of the areaResponsible for determining stone perception during activities (ACC They become endurance (Williamson[23] Et al., 2001) and as a result, the degree of perception of stone during endurance exercise increases more than the control conditions and endurance performance decreases (Pajavoo[24] Et al., 2014).

Based on various theories of endurance performance under the influence of physiological factors of heart rate, stroke volume and muscle energy level [25] And psycho-biological factors[26] Perceptions of motivation (Markura et al., 2008; Novax)[27], 2000). Due to the fact that doing a mental stone during endurance exercise increases the activity of the areaResulting in increased stone perception and increased ACC Fatigue indicators in each session compared to one session of endurance exercise alone and according to the principle of general adaptation syndrome[28] It is possible to repeat these sessions in a training period

1. Psychophysiological
2. Enoka
3. Tanaka
4. Boxing
5. Mehta & Parasuraman
6. Facilitation
7. Inhibition
8. Basal ganglia
10. Anterior cingulate cortex 9. Orbitofrontal cortex
11. Insular cortex
12. Posterior cingulate cortex
13. Ishii
14. Jouanin
15. Cook
16. NASA questionnaire
17. Chatain
18. Brain fatigue
19. Marcora
20. Demanding cognitive task
21. Subjective feeling
22. Tiredness
23. Williamson
24. Pageaux
25. Musculoenergetic
26. Psychobiologic
27. Noakes
28.General adaptation syndrome

Make it more compatible; The aim of this study was to evaluate and compare the simultaneous effect of a period of physical and cerebral endurance training simultaneously with the effect of physical endurance training only on the endurance performance of active individuals. The hypothesis of this study is based on the fact that performing a course of physical endurance training improves endurance performance by improving aerobic capacity and cardiovascular system indices (Bajramovich).[1] Et al., 2018), and because the structure and function of the brain in response to aerobic exercise (Columbus[2] Et al., 2006) and brain training only changes (Deng[3] Et al., 2019); It is likely that a combination of endurance and brain training can further enhance exercise tolerance by reducing the perception of stamina and mental fatigue.

Research Methods

The present study was a quasi-experimental study with a pretest and posttest design. The subjects of this study included 20 (14 males and 6 females) physical education students of Shahid Beheshti University of Tehran with an average age of 2±20 years, height 8±171 cm, weight 10 ±71 kg and oxygen consumption 4 ± They were 33 ml / min / kg who voluntarily participated in this study as subjects. First, the subjects were examined physically and mentally by a doctor and it was determined that none of them had any specific disease. For the subjects, all stages of the research, protocols and research plan were explained orally and in writing, and they were informed about the benefits and risks of performing the tests, and finally, they signed a written consent. This research has observed all the ethics in the research and Has a moral codeFrom Shahid Beheshti University of Tehran 97IR.SBU.ICBS / 1033 Is. Also, in order to design the research proposal of the present study, pilot studies (pilot[4]) A lot was done.

One week before the start of the training period, the subjects were called to the laboratory in two separate sessions with an interval of 72 hours. In the first session, anthropometric indices including height and weight with Ska's gauge and scales[5] Was measured. Maximum output power[6] And maximum oxygen consumption[7] Were determined on the tachometer wheel. In the second session, the time to exhaustion was measured during a test with a constant load of 75% of the maximum output power on the treadmill. Then, based on homogenization, the subjects were divided into two groups of physical endurance training + training based on the time to reach exhaustion.

Brain endurance and endurance exercise alone were divided. Both groups practiced for 24 sessions with a break of at least one day and 72 hours after the last training session, the evaluations were repeated in the same conditions as before the training.

Determine the maximum output power: One week before the start and 72 hours after the end of the training period, the subjects to determine the maximum output power, determine the intensity of the exhausting test and the maximum oxygen consumption; They were called to the laboratory and implemented the relevant protocol. In particular, the subjects after heating on the model Monark's treadmill model For Sweden -839They cycled for 50 minutes with a working load of 50 watts, and then, for every 2 minutes, 50 watts was added to the resistor to exhaust the subjects. The test was stopped when, despite the examiner's encouragement, the pedaling speed reached less than 60 rpm. Then from the Coopers equation[8]
It was used to calculate the maximum output power (Kupers et al., 1985). Before the incremental test, the seat height was adjusted and recorded for each subject, and in subsequent sessions, this height was used again for each subject. Also to determine the maximum oxygen consumption of the self-recording method using a gas analyzer[9] Used with the help of software, MetaLyzer3B index The result was recorded on a computer.

Exhaustion test: The subjects They were called back to the laboratory 72 hours after the first test. After adjusting the treadmill seat for three minutes with a working load of 40% of the maximum output power, the subjects warmed up and then, with a constant working load of 75% of the maximum output power, they cycled. Gauge wheel based on hyperbolic method[10] Adjusted and the pedal speed was freely selected between 60 to 120 rpm by the subject. Subjects received no feedback on elapsed time, heart rate, or running time. Exhaustion time was calculated from the start of pedaling at a constant load of 75% of the output power until the pedaling speed reaches less than 60 rpm for 5 seconds (Markura et al., 2009). During the activity, the pulse rate and heart rate were recorded every three minutes.

Brain training: To perform brain exercises from the stimulus of mental fatigue used. Mental fatigue can be caused by prolonged cognitive activity (mental stone). In the present study of two activities

1. Bajramovic
2. Colcomb
3. Deng
4. Pilot study
5. Seca
6. Peak power output
7. Maximum oxygen consumption
8. Kuipers
9. Gas analyzer
10. Hyperbolic

Cognitive AX-CPT[1] And Flanker[2] It was used to create mental fatigue in each session and perform endurance brain training. These two mental activities increase the activity of the area, The brain and thus the ACC They cause mental fatigue (Carter[3] Et al., 1998; Darling[4] Et al., 2015).

Cognitive activity : AX-CPT This cognitive activity is required Awareness is working memory and inhibitory response and has been successfully used to induce mental fatigue in sports studies (Markura et al., 2009). The test involves answering a series of letters displayed on a computer screen using the right or left mouse click[5] is. Test performance Automatically based on AX-CPT reaction time and accuracy Answers are recorded. The test is in the form of sequences from the tracker - a sign in which the letter As a sign of A[6] And letters As X Are trackers. The remaining letters of the alphabet are used as invalid symbols and non-target tracers, except lettersWhich removes Y and K be; Because in appearance to the letterThey are similar. Sequence of letters to X Pseudo-random forms are presented; So that target experiments With probability (AX)70% and non-target tests occur with a 30% probability. Non-target experiments consist of three stimuli that are presented equally (10% each). 1)Contains: BX An invalid sign (no Before the goal;) A2) Has a sign: AY Valid followed by an invalid tracker (no ; And) X3) Contains: BY An invalid mark followed by an invalid tracker (no .) X and A To make the test thicker, two white letters (each letter except the letters Between the sign and the tracker which are red) Y and A, K, X Are, shown. All letters (uppercase) in the center of the page with a black background for 300 milliseconds with 24 fonts[7]) Are provided. The time interval between the presentation of the letters is 1200 milliseconds. Subjects should respond to the target stimulus by right-clicking and to the non-target stimulus by left-clicking the mouse.

Flanker Cognitive Activity: In Cognitive Psychology, the Flanker Test A set of inhibitory response tests[8] Is used to assess the ability to suppress responses that have a specific theme. The purpose of the test can be a direct response to the goal (consonant), The answer is opposite (inconsistent) or neutral (neutral / flanker). In these tests, the target response (usually left or right) is centered (Eriksen)[9] Et al., 1974). Different types of these tests are used to measure selective information processing and attention. The stimuli presented in this test consist of 3 modes: 1) consonant (<<<<<or <<<<<); 2) inconsistent (<<<<<Or <<<<<)); And3) Neutral (- - <- - or - - <- -). Each set contains 5 unequal entities. In this test, subjects should respond to stimulation according to the direction of the middle generality, which is to the left or right. The test is that each stimulus is displayed in white (size 34) for 200 milliseconds on a black background. The distance between the stimuli is 1000, 1200, 1400 or 1600 milliseconds, which are variable and random. Subjects must respond quickly and accurately to the desired direction of the unequal middle part, regardless of the two side parts (Van Katsem[10] Et al., 2017). In order to evaluate the Flanker test, accuracy (correct and incorrect answers) and reaction time are desired. For example, when the stimulus <<<<<<is displayed on the screen, the right is displayed as the correct response, and when the stimulus <<<<<<is presented, the left is displayed as the correct response, and when the stimulus - - < - - To be presented, the left as the correct answer must be selected.

Training period: Both groups They performed 24 sessions of cycling activity, each session lasting 60 minutes with a 48-hour break between each session (the protocol was developed by the researcher). Intensity of activity in sessions 1-8 with 65-60% of maximum reserve heart rate[11], In sessions 9-16 with 65-70% of the maximum reserve heart rate, and in sessions 17-24 with 75-70% of the maximum reserve heart rate was considered. From the formula of Carvonen[12] (1957) was used to calculate the target heart rate. Physical endurance training group + brain endurance training during physical activity (described above), with the help of a monitor placed in front of them, periodically in each session one of the mental blocksAnd AX-CPT They did Flanker. During all sessions, the tester's perception of stone was recorded every 10 minutes by the examiner.

Statistical Methods: Data using statistical software SPSS version

1. AX- cotinuous performance test
2. Flanker
3. Carter
4. Darling
5. Mouse
6. Cue-probe
7. Ahelvetic
8. Inhibition response
9. Eriksen
10. Van Cutsem
11. Maximum reserve heart rate
12. Karvonen

22 were analyzed. First, to determine the normal distribution of data from the Shapiro-Wilk test[1] used. To compare the mean parameters of time to exhaustion and maximum oxygen consumption between the two groups and to compare the changes in each group, the statistical method of analysis of variance with repeated measures 2 * 2 with intergroup factor[2] And for the parameters of the perception of stone and heart rate in the test sessions, the statistical method of analysis of variance with duplicate measurements of 2 * 7 with intergroup factor (using coding) and finally, for the perception of stone during the training sessions of the statistical method Size analysis of variance

2 * 24 duplicates were used with intergroup factor. Significance level for all statistical analyzes <0.05Was considered p **findings**

Based on the results of analysis of variance with repeated measures 2 * 2 with intergroup factor, the amount of maximum oxygen consumption after the intervention period increased significantly compared to before (0.01 =But this) p The difference between the two groups was significant (= 0.01 ، P0/66 = Absence (Figure) F1).

2.18

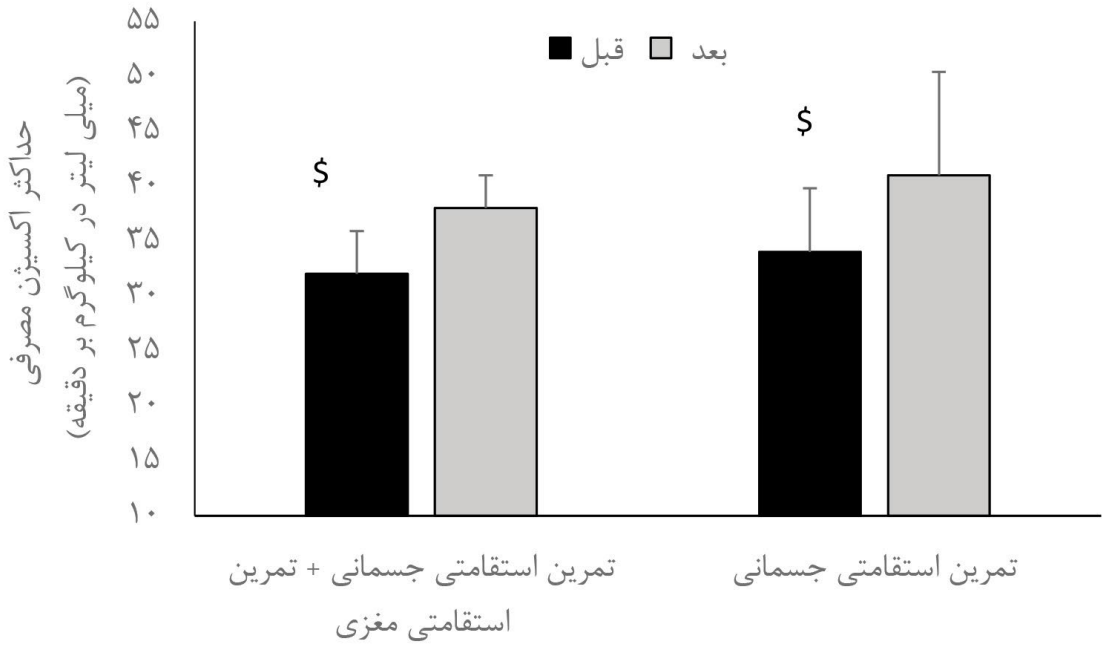

figure 1 . Comparison of maximum oxygen consumption in pre-workout compared to post-workout groups in two groups of physical endurance training + training Brain endurance and physical endurance training group $ Significant difference between the two groups at the level of 0.01 =.p

Based on the results of analysis of variance with repeated measures 2 * 2 with intergroup factor, the amount of time to reach fatigue after the intervention period compared to before, increased significantly; But the effect of exercise in the group of physical endurance training + Brain endurance training (176%) compared to physical endurance training group (86%), significantly (0.001 =، P 24/30 = Was more (Figure) F2).

2.18

1. Shapiro-Wilk
2. Mixed ANOVA

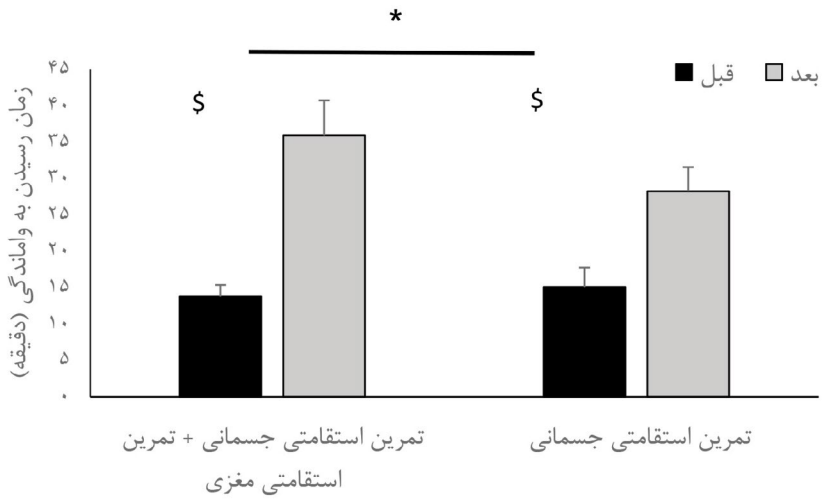

Figure 2. Comparison of the time to reach exhaustion in the pre-workout position compared to after the workout in the two groups of physical endurance training + brain endurance training and physical endurance training group. * Significant difference between the two groups at the level of 0.001 =; $ Significant difference sign before p Test and post-test at the level of 0.001 =.p

The results of analysis of variance with repeated measures of 2 * 7 with intergroup factor showed that in both groups the amount of stone perception during different times of the exhausting test after the intervention decreased significantly compared to before, but the effect of exercise on Perception of stones at times 1, 3, 5, 7, 9, 11, and 13 in the group, respectively Physical endurance training + brain endurance training 26, 41, 40, 42, 48, 43, and 45% and the physical endurance training group was only 17, 22, 22, 20, 22, 23, and 23%; Changes that were significant between the two groups (= 0.01 ، P16/50 = Was (Figure) F3). 2.18

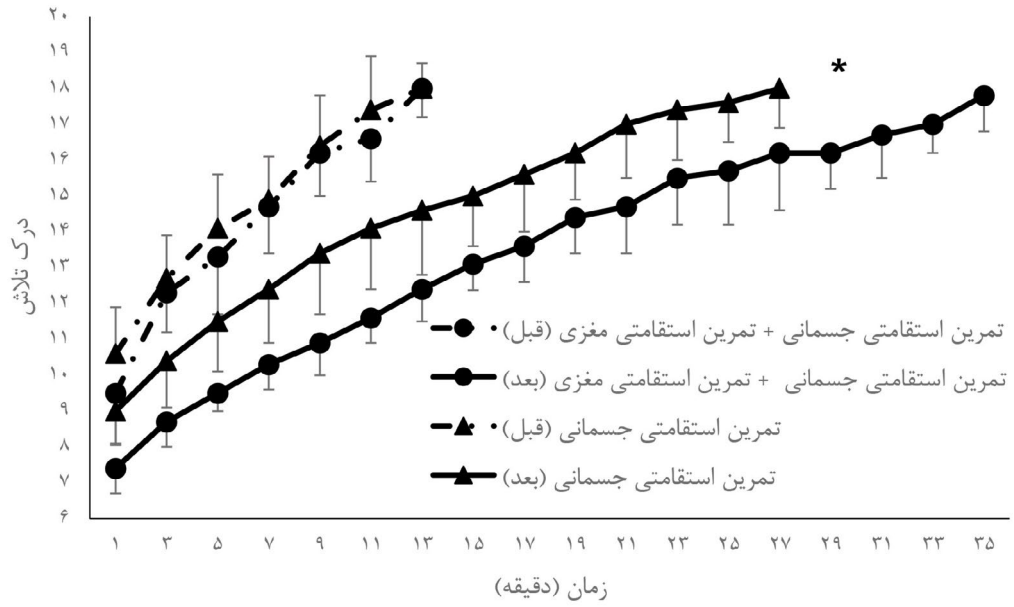

Figure 3. Comparison of perception of effort during the test of time to reach exhaustion in the pre-workout position compared to the post-workout in the two groups of physical endurance training + brain endurance training and physical endurance training group * Significant difference between the two groups at level 0 / 01 =.p

Based on the results of analysis of variance with repeated measures 2 * 7 with intergroup factor, a significant difference for heart rate data Difference between the two groups (= 0.39) ، P0/75 = 2.18 Not Found (Figure) F4).

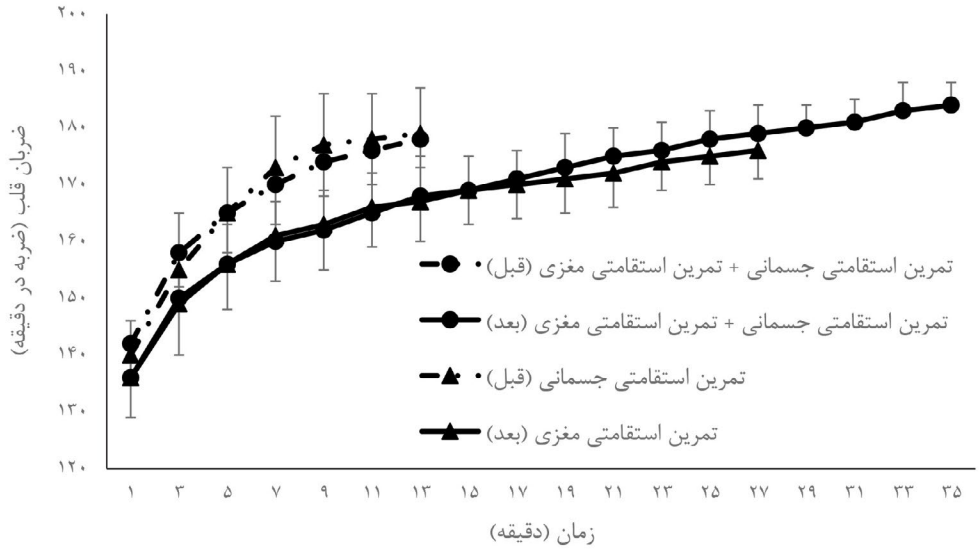

Figure 4. Comparison of heart rate during the time of exhaustion in the pre-workout position compared to the post-workout group in two training groups Physical endurance + brain endurance training and physical endurance training group.

Based on the results of analysis of variance with repeated measures 2 * 24 with intergroup factor, the mean perception of stone per session during the intervention between the two groups of physical endurance training + brain endurance training and physical endurance training only in all 24 sessions of the course Exercise was significantly different; This was while this difference was significant (= 0.01 ، P0/58 = 2.18 In the endurance training group) F Physical + brain endurance training was higher than the physical endurance training group alone (Figure 5).

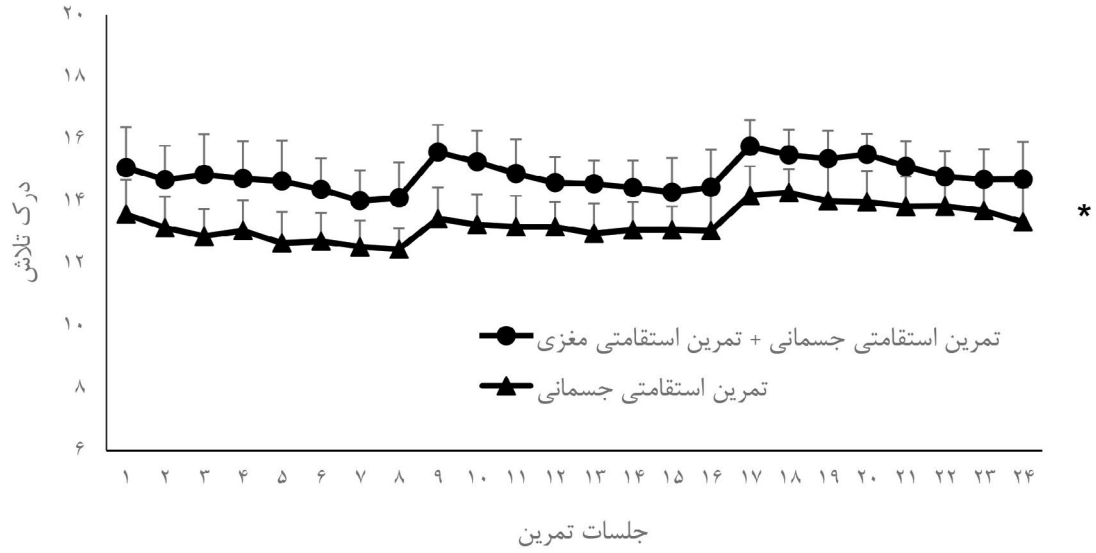

Figure 5. Comparison of perception of effort during the training period in two groups of physical endurance training + brain endurance training and endurance training group Physical * Signs of significant difference between the two groups at the level of 0.01 =.p

Discuss

The results of the present study showed that performing brain and physical endurance exercises simultaneously increases the time to exhaustion more than physical endurance exercises. This significant increase in endurance performance was associated with a significant reduction in stone perception in the group of physical endurance training + brain endurance training during strenuous endurance endurance activity. However, the heart rate index did not change significantly after these two interventions. In addition, the results of the present study showed that the time to exhaustion after 24 training sessions in both groups of physical endurance training + brain endurance training and physical endurance training, in the post-test, increased significantly compared to the pre-test; The change was 176% in the group of physical endurance training + brain endurance training and 86% in the group of physical endurance training.

The duration of exhaustion in a fixed-load test indicates endurance performance (Pajavou et al., 2018). There are two theories about endurance performance and time to exhaustion. According to physiological theory, vascular, metabolic, and neuromuscular parameters that play a role in muscle fatigue determine the time to exhaustion (Novax, 2000). On the other hand, psycho-biological theory (Markura et al., 2008) states that the time to reach exhaustion depends on the theory of motivation intensity.[1] (write[2], 1996) and the interaction between perception and motivation (Markura et al., 2008). According to this theory, any factor that decreases the perception of stone or increases the level of motivation, improves the time to reach exhaustion, and any factor that increases the perception of stone or decreases the amount of motivation, reduces the time to reach exhaustion. Will follow (Marcura et al., 2008). Doing aerobic exercise improves the function of the cardiovascular system and increases aerobic capacity and thus improves endurance performance (Holsten[3] Et al., 2011). Also, Peter Berg[4] Et al. (2006) have shown that performing a course of aerobic exercise compared to anaerobic exercise (stretching and flexibility) increases the volume of the white and gray parts of the brain (including And, consequently, performance improvement) ACC It becomes aerobic[5] Et al., 2006). An area of the ACC brain That is in deciding and determining the perception of stone during the activity Endurance is involved (Williamson[6] Et al., 2001). According to the scientific content and the improvement of endurance performance in the post-test in both groups compared to the pre-test, both physiological and psychological-biological theories about endurance performance are confirmed. However, the reason for the significant increase in the time to reach exhaustion in the group of physical endurance training + brain endurance training group compared to the group of physical endurance training, is considered a change in psycho-biological indicators (stone perception data during the fatigue achievement test).

The data on the amount of stone perceived recorded during each session of the intervention period show that the physical endurance training group + brain endurance training group has suffered more pressure in each session than the physical endurance training group. A higher understanding of the stone indicates that the mental activity used in each session in the brain training group caused mental fatigue (brain training stimulus). Mental fatigue increases exercise pressure by increasing the perception of stone during physical activity. Given that there are common facilitative and inhibitory neural pathways between physical activity (Tanaka et al., 2012) and mental activity (Ishii et al., 2014) in the brain; Doing physical and mental activity at the same time may have consumed more energy and activated more nerve pathways in each session. Inhibitory neural circuits of physical and mental activity, consisting of sectionsIC and PCC. Research on increasing IC and PCC activity During strenuous physical activity (Hilti[7] And others (2011) and mental (Coco et al., 2007). Increase activity Along with increased fatigue report by IC and PCC subjects (Cook et al., 2007; Ishi et al., 2014). On the other hand, increased neural activity due to mental stone increases energy consumption in the brain; A process that reduces the levels of energy reserves and increases the accumulation of adenosine in parts of the brain, especially , Is accompanied by (Pajhaw et al. ACC2014) and increases the understanding of the stone in each session. Increasing the concentration of adenosine also reduces the concentration of the neurotransmitter dopamine; A change that results in a decrease in motivation in each session (Murray [8] Et al., 2008). Brunsberger[9] Et al. (2013) have shown that mental stimulation (change of mental fatigue) causes changes in brain waves

7. Hilty
8. Morree
9. Brownsberger

4. Pittsburgh
5. Colcombe
6. Williamson

1. Motivational intensity theory
2. Wright
3. Hellsten

And the decrease in physical activity performed after mental stroke compared to the control group. They reported that doing 90 minutes of mental stone increases the amount of beta waves from the frontal lobe of the brain, and the amount of work done during pedaling activity decreases and the feeling of fatigue increases. It seems that this increase in training pressure according to the principle of adaptation syndrome, has caused more adaptation. In this regard, Deng et al. (2019) the effect of a course of cognitive training (brain training) on the degree of ductility[1] And examined the connections of parts of the brain. Subjects performed 24 sessions of cognitive training (brain training), each session lasting 60 minutes for 12 weeks. Analysis of magnetic resonance imaging data of the brain showed that this exercise improves neural connections in parts of the brain. Studies show that doing a course of aerobic exercise and cognitive (brain) training increases size , Becomes (Columbus et al. ACC2006; Deng et al., 2019). It is also shown that the rate of activity In the elderly ACC when performing a complex mental activity Active is less active than inactive elderly (Wong[2] Et al., 2015). These findings suggest that doing a course of physical and brain training can improve nerve function. This increase in neural efficiency (reduced neuronal activity and lower energy consumption) reduces the perception of stone and according to psychological theory

- Bio, endurance performance improves. Also, due to the insignificance of heart rate data and maximum oxygen consumption between the two groups in the post-test, it can be said that brain training significantly improves endurance performance without affecting cardiovascular physiological factors. According to reports, mental fatigue does not affect the physiological parameters of heart rate and oxygen consumption during endurance exercise. Markura et al. (2009) have shown that performing 90 minutes of mental stoning (Test Before an incremental activity, causes a decrease in tolerance) AX_CPT Exercise and reduce the time to reach exhaustion. This decrease in endurance performance was associated with a greater increase in stone perception during incremental activity than in the control session; While there was no significant difference between physiological indices (cardiovascular indices and musculo-energetic mechanisms) of the two sessions. In general, brain training seems to improve endurance performance without affecting maximal oxygen consumption and heart rate (physiological factors) and by affecting perceptual index (psycho-biological factors).

Conclusion: Brain training is a new way of training that with The use of mental fatigue stimulants in each session and the resulting adjustment increase the resistance of people to fatigue during a session of exercise. The results of the present study showed that the combination of a period of physical endurance training and brain endurance training can improve the time to achieve exhaustion in a test with a constant load (endurance performance). It seems that this type of exercise, by changing the structure, function and efficiency of the brain, causes changes in psycho-physiological parameters (perception of stone) of endurance performance and develops endurance function by reducing the perception of stone. It is noteworthy that one of the limitations of the present study is the lack of homogenization of subjects based on mental function, lack of sleep control, food and motivation of subjects.

Conflict of interest

None of the authors have contradictory contradictions in this research.

Appreciation and thanks

All the subjects who participated in this research are appreciated and thanked. We would also like to thank all the colleagues and officials of the laboratory of Shahid Beheshti University of Tehran.

Resources

•*Effect of mental exertion along with submaximal exercise on mental fatigue and exercise tolerance in men cyclist*.)**MSc Thesis, Department of sport biological scince, Faculty of physical education and sport scinces, Shahid Beheshti Amozei, H. (2018 University. [Persian]**

Bajramovic, I., Habul, C., Talovic, M., Likic, S., Nurkovic, N., & Mekic, A. (2018). Effects of 8 weeks long muscular endurance . 47-51,) 1 (20, *Homo Sporticus***.training with body weight in case of recreational athletes**

1. Plasticity
2. Wong

Boxem, MA, & Tops, M. (2008). Mental fatigue: costs and benefits. Brain Research Reviews, 59 (1), 125-139.

Brownsberger, J., Edwards, A., Crowther, R., & Cottrell, D. (2013). Impact of mental fatigue on self-paced exercise. . 1029-1036,) 12 (*International Journal of Sports Medicine, 34*

Carter, CS, Braver, TS, Barch, DM, Botvinick, MM, Noll, D., & Cohen, JD (1998). Anterior cingulate cortex, error . 747-749,) 5364 (*Science, 280*.detection, and the online monitoring of performance

Chatain, C., Radel, R., Vercruyssen, F., Rabahi, T., Vallier, JM, Bernard, T., & Gruet, M. (2019). Influence of cognitive load (6), e13343. *Psychophysiology, 56*.on the dynamics of neurophysiological adjustments during fatiguing exercise

Colcombe, SJ, Erickson, KI, Scalf, PE, Kim, JS, Prakash, R., McAuley, E.,. . . Kramer, AF (2006). Aerobic exercise *The Journals of Gerontology Series A: Biological Sciences and Medical*.training increases brain volume in aging humans . 1166-1170,) 11 (*Sciences, 61*

Cook, DB, O'Connor, PJ, Lange, G., & Steffener, J. (2007). Functional neuroimaging correlates of mental fatigue induced . 108-122,) 1 (*Neuroimage, 36*.by cognition among chronic fatigue syndrome patients and controls

Deng, L., Cheng, Y., Cao, X., Feng, W., Zhu, H., Jiang, L.,. . . & Li, C. (2019). The effect of cognitive training on the brain's . 9033,) 1 (*Scientific Reports, 9*.local connectivity organization in healthy older adults

Medicine and Science in Sports and Exercise,.Enoka, RM, & Duchateau, J. (2016). Translating fatigue to human performance . 2228,) 11 (*48*

Eriksen, BA, & Eriksen, CW (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. . 143-149,) 1 (16,*Perception & psychophysics*

. 1-32,) 1 (*Comprehensive Physiology, 6*.Hellsten, Y., & Nyberg, M. (2011). Cardiovascular adaptations to exercise training

Hilty, L., Jäncke, L., Luechinger, R., Boutellier, U., & Lutz, K. (2011). Limitation of physical performance in a muscle fatiguing . 2151-2160 ,) 12 (*Human Brain Mapping, 32*.handgrip exercise is mediated by thalamo-insular activity

,) 4 (*Reviews in the Neurosciences, 25*.Ishii, A., Tanaka, M., & Watanabe, Y. (2014). Neural mechanisms of mental fatigue . 469-479

Ishii, A., Tanaka, M., Yamano, E., & Watanabe, Y. (2014). The neural substrates of physical fatigue sensation to evaluate . 60-67,) 1 (*Neuroscience, 261*.ourselves: a magnetoencephalography study

Jouanin, JC, Pérès, M., Ducorps, A., & Renault, B. (2009). A dynamic network involving M1-S1, SII-insular, medial insular, *Human Brain Mapping,*.and cingulate cortices controls muscular activity during an isometric contraction reaction time task . 675-688,) 2 (*30*

Annales Medicinae Experimentalis et.Karvonen, MJ (1957). The effects of training on heart rate: a longitudinal study . 307-315,) 3 (*Biologiae Fenniae, 35*

Kuipers, H., Verstappen, F., Keizer, H., Geurten, P., & Van Kranenburg, G. (1985). Variability of aerobic performance in the . 197-201,) 04 (*International journal of sports medicine, 6*.laboratory and its physiologic correlates

Marcora, S., Staiano, W., & Merlini, M. (2015). A randomized controlled trial of brain endurance training (bet) to reduce
(5S), 198. *Medicine & Science in Sports & Exercise, 47*.**fatigue during endurance exercise**

European?**Marcora, SM (2008). Do we really need a central governor to explain brain regulation of exercise performance**
. 9-29,) 5 (*Journal of Applied Physiology, 104*

Marcora, SM, Bosio, A., & de Morree, HM (2008). Locomotor muscle fatigue increases cardiorespiratory responses
American Journal of.**and reduces performance during intense cycling exercise independently from metabolic stress**
(3), R874-R883.*Physiology-Regulatory, Integrative and Comparative Physiology, 294*

*ournal of Applied***Marcora, SM, Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans. J**
. 857-864,) 3 (*Physiology, 106*

Mehta, RK, & Parasuraman, R. (2014). Effects of mental fatigue on the development of physical fatigue: a neuroergonomic
. 645-656,) 4 (*Human Factors, 56*.**approach**

Noakes, T. (2000). Physiological models to understand exercise fatigue and the adaptations that predict or enhance
. 123-145,) 3 (*Scandinavian Journal of Medicine & Science in Sports: Review Article, 10*.**athletic performance**

Progress in Brain Research,.**Pageaux, B., & Lepers, R. (2018). The effects of mental fatigue on sport-related performance**
. 291-315*,240*

Pageaux, B., Lepers, R., Dietz, KC, & Marcora, SM (2014). Response inhibition impairs subsequent self-paced endurance
. 1095-1105,) 5 (*European Journal of Applied Physiology, 114*.**performance**

,) 1 (*Neuroscience & Biobehavioral Reviews, 36*.**Tanaka, M., & Watanabe, Y. (2012). Supraspinal regulation of physical fatigue**
. 727-734

Van Cutsem, J., De Pauw, K., Buyse, L., Marcora, SM, Meeusen, R., & Roelands, B. (2017). Effects of mental fatigue on
. 1677-1687,) 8(*Medicine and Science in Sports and Exercise, 49*.**endurance performance in the heat**

Weng, TB, Pierce, GL, Darling, WG, & Voss, MW (2015). Differential effects of acute exercise on distinct aspects of
. 1460-1469,) 7 (*Medicine and Science in Sports and Exercise, 47*.**executive function**

Williamson, J., McColl, R., Mathews, D., Mitchell, J., Raven, P., & Morgan, W. (2001). Hypnotic manipulation of effort sense
. 1392-1399,) 4 (*Journal of Applied Physiology, 90*.**during dynamic exercise: cardiovascular responses and brain activation**

activation during dual-task processing is associated with cardiorespiratory fitness and performance in older adults.
Wong, CN, Chaddock-Heyman, L., Voss, MW, Burzynska, AZ, Basak, C., Erickson, KI,. . . Wojcicki, T. (2015). Brain
. 154,) 7 (*Frontiers in Aging Neuroscience, 12*

2nd Edition. Guilford Press.. *Brehm's theory of motivation as a model of effort and cardiovascular response*.)**Wright, RA (1996)**