Effect of exercise duration and exercise withdrawal on memory consolidation trend

The beneficial effects of exercise on the physiologic systems, brain, and mental health are well-established. Also, the maintenance of a healthy central nervous system throughout life serves as an imperative public health goal. Evidently, exercise can help achieve this goal. Other studies have shown that exercise training (forced and voluntary) can increase the speed of learning, memory, brain plasticity and improvement of cognitive performance. Although, different types of exercise, aerobic exercises (such as running, cycling, walking) and anaerobic exercises (such as weight training, increase short-term muscle strength), have been reported to have different effects on physiologic systems. Some studies have demonstrated that exercise, particularly forced exercise such as treadmill running, acts as a stressor and it activates the stress hormone (corticosterone) secretion. Hence, it affects stress-related systems such as memory consolidation in the brain.

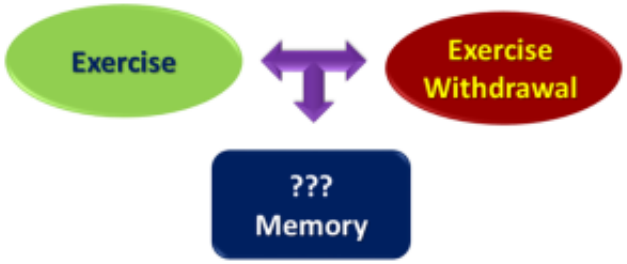

Fig. 1. Schematic diagram of exercise and exercise withdrawal on memory

Present study investigated the effects of different timing (21 and 42 days) of exercise (treadmill running) and 21-day exercise withdrawal after 21-day exercise on memory trend. In addition, stress hormone levels were evaluated in serum and hippocampus (as main memory region). In this research, rats (a kind of rodents) were forced to run on a treadmill for 1h/day at a speed 20-21 m/min. Memory function was evaluated in different intervals (1, 7 and 21 days) after learning that were based on recall of information.

Present findings showed that short-term and mid-term memories (1 and 7 days after learning, respectively) had significant enhancement compared to the unexercised group after the exercise withdrawal. While the long-term memory (21 days after learning) did not present this result after exercise withdrawal. Therefore, exercise withdrawal reduced cognitive improvements back to the baseline levels. In addition, it seems that stress hormone levels nearly returned to basal level in serum and hippocampus after stopping exercise.

The 21-day exercise without withdraw of it improved mid and long-term memories, whereas continuous exercise (42-day) improved all types short, mid and long-term memories, particularly

the mid-term memory consolidation. It seems that the 42-day exercises presented a progressive improvement on the memory compared to a 21-day exercise. Twenty-one and Forty-two days of exercise significantly decreased the serum and hippocampal stress hormone levels. Decrease in stress hormone level directly depends on the duration of the exercise, therefore the forced exercise was not as stressor. In addition, significant positive correlations were found between the serum and hippocampal stress hormone levels. In this study, it seems that the reduction of stress hormone concentrations in the hippocampus might have implications for memory changes following the exercise. Hence, the duration of exercise may be one of the most important factors influencing the brain function. Hence, it may have markedly different effects on learning and memory.

The present results confirm that although exercise promoted neuroprotective effects on the brain, the very long duration exercise period had direct progressive effects on memory improvements. Exercise results in a range of biochemical, behavioral, physiological and probably structural changes, playing a main role in the development and maintenance of memory. Previous studies reported that treadmill running is a significant factor which potentially alters the brain cell properties and cognitive functions in the hippocampus as main region of memory.

In conclusion, current findings confirmed that the duration and withdraw of exercise are important factors for the neurobiological aspects of the memory responses.Very long duration of exercise (over 21 days) probably promotes memory improvement. Since the regular treadmill running was performed using a constant intensity, it is suggested that the exercise must be performed progressively (i.e. beginning from a lower speed and duration to reach the higher ones).

Publication

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