

# Investigating Changes in Cognitive Ability in Athletes with Repeated Measurements During One Year

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## ABSTRACT

The purpose of this study is to investigate the cognitive changes that have been made in athletes who regularly exercised for a year. The method of this study was that cognitive ability was measured before starting exercise, then after 6 months and after 1 year cognitive ability test was taken from the same people in order to have the possibility to check their changes in one year. This study was conducted on 44 people, 24 of whom were women and 20 of whom were men, and the available sample was a non-random volunteer. The results showed that inhibitory control, selective attention, planning and decision-making had the most change, and social cognition did not change, and flexibility and sustained attention had the least change, and in general, their cognitive ability increased after one year, and the relationship between sports and cognitive ability is significant, and there is no difference in the acquisition of cognitive ability in sports in the analysis of gender, women and men.

## **1. Introduction**

Cognitive abilities include the neural processes involved in the acquisition, the (theoretical) abilities of 2010 to process, store and use information, cognitive is the interface between behavior and brain structure and a wide range of abilities (planning, attention, response inhibition, problem solving, simultaneous tasks and includes cognitive flexibility). The mentioned items are only a part of the cognitive abilities that are based on logic. These abilities are called cold cognition. The basis of another part of cognitive abilities, which are known as warm cognition and play a role in experiencing rewards and punishments, regulating social behaviors, and making decisions in emotional states, are desires, beliefs, and emotions. (Madrigal 2008). The indicators related to cognitive abilities in our research include memory, inhibitory control and selective attention, decision making, planning, sustained attention, social cognition and cognitive flexibility. Cognitive executive functions include cognitive processes that integrate and control other cognitive activities. Cognitive abilities include several categories, which we focus on 7 categories in this research and examine them in athletes.

1. Inhibitory control, also called response inhibition, is a cognitive process, and more specifically, an executive function that allows a person to inhibit their impulses and natural, normal, or dominant behavioral responses to stimuli in order to engage in more appropriate behavior that meets The realization of their goals is compatible, to choose. Self-control is an important aspect of inhibitory control. (Rahmani 2014)

2. Selective attention is the ability to choose among factors or stimuli in the environment and focus only on what is desired. Humans are constantly exposed to a number of stimuli or environmental factors every day, but your brain naturally focuses on it by choosing a specific aspect of a factor. Selective attention basically allows us to be able to choose what we want to pay attention to. Selective attention is not only not paying attention to external factors, but also paying attention to internal factors such as unrelated thoughts. (Nusratabadi 2019)

3. Decision-making, identification and selection of alternatives are based on the values and preferences of the decision-maker; Decision-making implies that other alternatives should be considered, and in such a case, we want to identify as many of these options as possible and choose the one that includes 2 features: First, the most likely to be successful or effective. have; Second, it best suits your goals, desires, lifestyle and values. There are two important ideas here; First, there must be real options to choose from. Decision-making is the process of reducing uncertainty and doubt about other options so that the decision-maker can choose the right option among them; This definition emphasizes the function of gathering information for decision-making. (Rahmani 2014)

4. Planning is the process of thinking about the necessary activities to achieve the desired goal. Planning is the first and most important activity necessary to achieve desired results. Depending on the activities, each plan can be long-term, medium-term or short-term. For managers seeking external support, the plan is the most important, key, and easiest document to develop. Planning can play an important role in helping to avoid mistakes or spotting hidden opportunities. Planning helps predict the future and make the future somewhat conceivable. It is a bridge between where we are and where we want to go. Planning looks into the future. Planning means thinking in advance. Experts from various angles have provided several definitions for planning, some of which are as follows; Determining the goal, finding and building a way to reach it, deciding what to do, envisioning and designing the ideal situation in the future and finding and building ways and means to achieve it, designing an operation that will achieve an object or a subject. Change based on a predefined method. (Rahmani, 2014)

5. Sustained attention is the ability to focus on a specific task or task for a relatively long period of time without distraction. Constant attention is what you probably understand from words like "attention", "concentration", "care". Listening to a lecture, reading a book, playing a video game, or repairing a car are examples that require sustained attention. Maintaining this type of attention for a relatively long period of time without distraction can be challenging. Therefore, your level of sustained attention is often variable. He may have focused very well, and after a brief distraction,

he regained your attention. Therefore, an important aspect of sustained attention is the ability to refocus after distraction

6. Social cognition includes a set of processes that describe our understanding of others and how we know humans in the world. Social cognition is the study of mental processes that are involved in our understanding of others, remembering different things, thinking and paying attention. They play a significant role in our social world. Social cognition is an approach that includes things like, the reasons we pay attention to certain information about the social world, how we store this information in memory, and how we use this information to interact with other people. Social cognition is a key ability, which humans need in order to succeed in social interactions in daily life. Social cognition means how people think about their own and others' thoughts, feelings, views, motives and behaviors. This recognition includes the perception of feelings and emotions from the way they speak and the words that others use, and from their faces and the way they stand and their body movements. More complex social cognitive skills include the ability to justify and analyze mental states, empathy and subtleties. Social cognition refers to people's understanding of social relationships and the role of themselves and others in the social context. Social cognition is related to the understanding of mental representations and processes that play a role in human judgment and social behavior. According to Flavell and Miller, social cognition consists of cognition and knowledge about people and their actions. Social cognition is precisely related to the social and psychological world, not to the physical and logical world of mathematics, although these worlds clearly influence people. In general, social cognition is a child's or a person's perception of the world, social phenomena, how to organize them, as well as cognitive-social processes through which social experience, perception and social knowledge are obtained. Social intelligence is the ability to recognize people and the ability to act creatively in human relationships. (Rabiei, 2020)

7. Cognitive flexibility refers to the ability and skill of people's brains to switch from one concept to another; In addition, in transferring between different subjects, such as switching between the object's color and its shape, the faster a person is, we can say that he has a high level of cognitive flexibility; In other words, people who do not have cognitive flexibility are not mentally capable enough to switch between two different subjects and can hardly carry out both tasks at the same time, so they have rigid thinking; Such people are afraid to adapt themselves to new stimuli and are very weak against changing their way of thinking based on various changes in their environment. Cognitive flexibility is defined as the ability to change thinking (cognition) or a set of thoughts to adapt to new situations. Accordingly, we can say that people whose minds easily switch between different situations have high cognitive flexibility. In general, cognitive flexibility, while helping people to better manage unexpected situations, helps them learn new things, easily replace new learning with old information in their minds, and discard old learning. We often call the ability to change thoughts between multiple concepts, cognitive flexibility; In general, cognitive flexibility is the ability of a person to maintain biological and psychological balance in dangerous situations (Madershahian 2020). Cognitive flexibility can sometimes refer to the ability of people to think about several elements at the same time; Also, when faced with thoughts or problems that are more complex than usual, cognitive flexibility can help to divide and analyze the complex structure of thoughts or problems into smaller parts; In other words, the ability of people to move between specific elements (options) that are related to larger problems and try to solve them is an example of cognitive flexibility. Some people also believe that cognitive flexibility is the ability to consciously understand all possible options and choices in a specific scenario. (Jalilund, 2020)

The hypothesis of the present work is that exercise can be fully used in its potential as focused exercises for the training of cognitive abilities, especially in the field of cognitive training for chronic patients. Indeed, the literature shows that different sports (eg, individual or team-based) affect and possibly enhance cognitive abilities such as focused and divided attention, working memory, under time constraints. In addition, providing training for cognitive abilities, the exercise experience may be an opportunity to discover, teach, and directly enhance those abilities. A study titled *The Potential Role for Cognitive Training in Sports: More Research Is Needed* by Courtney C. Walton et al., 2018 It was done and the following results were obtained. Sports performance at the highest level requires a multitude of cognitive functions such as attention, decision-making, and

working memory to function at optimal levels in stressful and demanding environments. While there is a substantial research base that focuses on psychological skills for performance (e.g., imagery) or therapeutic techniques for emotion regulation (e.g., cognitive behavioral therapy), there is little research that examines whether enhancing core cognitive abilities leads to improvement. Does it work or not? Sport. Cognitive training is a well-researched method of strengthening cognitive skills through repetitive and targeted exercises. In this article, the potential use of cognitive training in athlete populations with the view of supporting sports performance was described. In a research titled the study of cognitive adaptations in the field of sports: extensive or limited transfer, by Allen, Fiorato and McGeorge in 2011, these results were obtained. review research on the relationship between exercise and cognition and argue that publication bias may be an issue when studying cognitive adaptations as a function of exercise involvement. Implications for future research related to sport cognition are discussed. A research entitled the effect of regular exercise on the cognitive status of the elderly with overweight and type 2 diabetes was conducted by Farah Madershahian in 2011. These results were obtained.

The possible effects of exercise in preventing or delaying cognitive decline are unclear. In this study, the cognitive status of the elderly with overweight and type 2 diabetes with and without regular exercise was compared. The method was such that in this study, 120 men and women were selected with diagnosis. The result was that diabetes and overweight reduce the cognitive ability of the elderly, but regular exercise probably has a positive role in improving their cognitive status. A research entitled Difference in Spatial Working Memory as a Function of Team Sports Expertise: Corsi Block Hitting Task in Sports Psychological Evaluation was conducted by Philip Furley, Daniel Memmert, in 2010 and these results were obtained. Individual differences in visuospatial abilities were investigated in experienced basketball players compared to non-athletes. Most research shows that experts and novices do not differ on basic tests of cognitive ability. However, there are some equivocal findings that suggest differences in basic cognitive abilities such as attention. The purpose of this research was to investigate the spatial visual abilities of team ball athletes. 112 male students (54 basketball players, 58 non-athletic students) were tested on their spatial capacity with the Corsi block tapping task. No differences in spatial capacity were evident between basketball players and non-athlete college students. The results are discussed in the context of expert performance approach and individual difference research. A study titled Skill Acquisition in Sports: Research, Theory and Practice presented by Mark Williams, Nicola J. Hodges, in 2004 these results were obtained. Success in sports depends on the athlete's ability to develop and fine-tune a specific set of motor skills. A research was conducted in 1998 by Daniel Garland and his colleagues under the title of sports expertise: cognitive advantage, the purpose of this article is to show the importance of the cognitive system in sports expertise. Attention to visual perceptual abilities, along with cognitive factors and their relationship with sports expertise, shows that the level of sports performance can be reliably differentiated in several cognitive dimensions. Information is given on the cognitive demands of sports skills. It is argued that although visual perceptual abilities are intrinsic to all levels of athletic performance, cognitive factors are essential for athletic expertise. Previous researches showed that this issue has been important since the past years and proves that cognitive ability and exercise are two components that are related to each other. The importance and necessity of research in this field is that during The duration of these changes should be measured to see if it is stable or not. Also, the cognitive abilities should be separated and examined separately to understand more precisely which of the abilities can be increased by performing sports activities.

## **Research Methodology**

### **Cognitive abilities questionnaire**

This questionnaire was designed and standardized by Nejadi in 2012, which includes 30 items and 7 components (memory questions 1 to 6, inhibitory control and selective attention 7 to 12, decision making 13 to 17, planning 18 to 20, sustained attention 21 to 23, social cognition 24 to 26 and cognitive flexibility 27 to 30). which measures cognitive ability on a five-point Likert scale from 1 (almost never) to 5 (almost always). Questions 24, 25 and 26 have reverse scoring. In the conceptual

definition, it should be said that cognitive abilities are neural processes Involved in the acquisition, processing, maintenance and use of information (Dox, 2004), human cognitive processes due to the necessity of solving ecological problems (Soll et al., 2007 and Knutka et al., 2008) and guiding complex social environments (Holkamp and Sakai, 2007) ) have evolved.Cognitive abilities are the interface between behavior and brain structure and include a wide range of abilities (planning, attention, response inhibition, problem solving, simultaneous tasks and cognitive flexibility). These cases only include a part of the cognitive abilities that are based on logic. These abilities are called cold cognition. The basis of another part of cognitive abilities, which is known as warm cognition and plays a role in experiencing rewards and pains, regulating social behaviors and making decisions in emotional states, are desires, beliefs and emotions (Madrigal and Hutt, 2008). In the operational definition, it should be said that cognitive ability is the score obtained by the subject in the cognitive ability questionnaire (Najati, 2013). The validity and reliability of the questionnaire in Nejadi's research (2012) was calculated by Cronbach's alpha method and the alpha coefficient was 0.834.Internal consistency of subscales for questions related to memory 0.755, inhibitory control and selective attention 0.0578, decision making 0.612, planning 0.578, sustained attention 0.534, social cognition 0.438 and flexibility Cognitive was shown to be 0.455. For this reason, the use of subscales alone is not recommended. To measure the concurrent validity of the test, the correlation between the academic grade point average and the test subscales of 395 students was used, except for social cognition, the other subscales had a correlation of <0.001 with the grade point average. In Pirani's research (2015), the Cronbach's alpha coefficient for the whole scale was 0.82.This research was carried out during one year with a repeated measurement test design in two groups of men and women, and 24 women and 20 men were selected as a sample from the available volunteers, and these people had no previous experience of exercising and never stopped exercising after starting and regularly. They continued to exercise and exercised three days a week for 1 hour. At first, before exercise, then 6 months after exercise and one year after them, the cognitive ability test was taken in three stages. This research was done with spss23 software and was analyzed in two sections of descriptive and inferential statistics.

**Data analysis**

In the table of descriptive statistics, the average and standard deviation can be seen along with the number of people, which is analyzed by gender. In the table below, in the average scores section, it can be seen that before the start of the exercise, the cognitive ability score was below 70, which means that there is a need for development. and after exercise, the scores are above 70, which is a sign that he is at a good level.

**Descriptive Statistics**

|          | gender | Mean  | Std. Deviation | N  |
|----------|--------|-------|----------------|----|
| befor    | man    | 63.67 | 12.716         | 12 |
|          | woman  | 57.63 | 16.026         | 8  |
|          | Total  | 61.25 | 14.052         | 20 |
| aftersix | man    | 67.50 | 14.933         | 12 |
|          | woman  | 62.38 | 18.181         | 8  |
|          | Total  | 65.45 | 16.048         | 20 |
| after    | man    | 73.00 | 17.756         | 12 |
|          | woman  | 72.63 | 25.099         | 8  |
|          | Total  | 72.85 | 20.363         | 20 |

Inferential statistics section with one-way variance test with repeated measurement, with a

significance level of 0.006, it can be seen that after one year, the cognitive ability of athletes has changed, but in the first 6 months, with a significance level of 0.49, it can be seen that there is a big change. It has not been achieved in the cognitive ability of people

**2. Multivariate Tests<sup>a</sup>**

| Effect             |                    | Value | F                  | Hypothesis df | Error df | Sig. | Partial Eta Squared |
|--------------------|--------------------|-------|--------------------|---------------|----------|------|---------------------|
| sixmonth           | Pillai's Trace     | .452  | 7.000 <sup>b</sup> | 2.000         | 17.000   | .006 | .452                |
|                    | Wilks' Lambda      | .548  | 7.000 <sup>b</sup> | 2.000         | 17.000   | .006 | .452                |
|                    | Hotelling's Trace  | .824  | 7.000 <sup>b</sup> | 2.000         | 17.000   | .006 | .452                |
|                    | Roy's Largest Root | .824  | 7.000 <sup>b</sup> | 2.000         | 17.000   | .006 | .452                |
| sixmonth<br>gender | * Pillai's Trace   | .080  | .742 <sup>b</sup>  | 2.000         | 17.000   | .491 | .080                |
|                    | Wilks' Lambda      | .920  | .742 <sup>b</sup>  | 2.000         | 17.000   | .491 | .080                |
|                    | Hotelling's Trace  | .087  | .742 <sup>b</sup>  | 2.000         | 17.000   | .491 | .080                |
|                    | Roy's Largest Root | .087  | .742 <sup>b</sup>  | 2.000         | 17.000   | .491 | .080                |

a. Design: Intercept + gender  
Within Subjects Design: sixmonth

b. Exact statistic

In Table 3, with the multivariate variance test, it can be seen that according to the mean difference, selective attention, planning, inhibitory control, and decision-making are the cognitive abilities that have had the greatest change in the mean. Social cognition can be seen with no change in the mean difference. Flexibility and stable attention can be seen with a small change in the mean in the table

**3. Examination of cognitive abilities by separating subgroups**

| Cognitive ability   | average scores before exercis | average scores after exercis |
|---------------------|-------------------------------|------------------------------|
| Inhibitory control  | 11.8                          | 13.95                        |
| selective attention | 11.55                         | 15.05                        |
| Planning            | 10.25                         | 13.65                        |
| Decision making     | 6                             | 8.15                         |
| Social cognition    | 7.2                           | 7.2                          |
| Flexibility         | 7.45                          | 9.15                         |

|                     |      |     |
|---------------------|------|-----|
| Sustained attention | 7.89 | 8.9 |
|---------------------|------|-----|

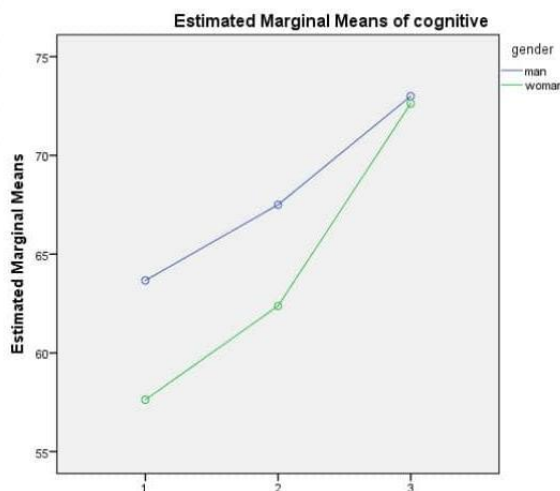
Table 4 can be seen that with a significance level of 0.61, gender does not have a great effect on the difference in cognitive change, and both groups have the same changes in their cognitive ability after exercise.

#### 4. gender

Measure: cognitive

| gender | Mean   | Std. Error | 95% Confidence Interval |             |
|--------|--------|------------|-------------------------|-------------|
|        |        |            | Lower Bound             | Upper Bound |
| man    | 68.056 | 4.683      | 58.217                  | 77.894      |
| woman  | 64.208 | 5.736      | 52.158                  | 76.259      |

In diagram 1. It can be seen that the cognitive ability changes were the same in both sexes. It can also be seen that the cognitive changes before exercise were below 70 and after the exercise, the cognitive ability scores reached above 70, which means that it is at a good level and does not need to be developed.



#### Discussion

In general, five results were obtained, which we will review in this way. First, among the seven mentioned cognitive abilities, inhibitory control, selective attention, planning, and decision-making are the cognitive abilities that have changed the most, and a very different average before and after exercise was observed in these four cases, which means that exercise strongly affects these cognitive abilities. Another result was that social cognition with the lowest mean difference showed that there was no change before and after exercise in one year. Another result was that flexibility and sustained

attention with a small average change showed that changes have been made during one year, but there is not a strong relationship between sports and these abilities like the first four cases, and little changes have been made. In general, cognitive ability during repeated measurements showed that people who exercise regularly for a year increase their cognitive abilities. Also, another result was that the difference in the change of cognitive ability in women and men was the same, or considering gender segregation, and there was no difference between their changes, which showed that there is no significant relationship between gender and exercise during one year, and the changes in women and Men are the same.

### **Suggestion**

It is suggested that there are more selected samples and the lost samples are taken into account.

It is suggested to be examined in different age groups such as minors and teenagers.

The effect of these changes should be checked in time intervals of more than one year.

It is suggested that disturbing variables such as the level of education or the level of intelligence of people should be investigated as a separate variable in addition to this research.

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