Original Paper

Testing a Psychological Intervention in Elite Athletes to Alleviate the Psychomotor Consequences of Doping: The Moderating Role of Personality

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ABSTRACT: This study aimed to evaluate a psychological intervention intended to reduce the psychomotor effects of doping. The research also examined how conscientiousness and emotional stability moderated the intervention's effectiveness. The intervention was developed based on the literature and included two components: biofeedback and mental imagery/rehearsal. Athletes reported higher scores post-intervention in coordination, sports skills, overall physical condition, strength, flexibility, endurance, and general self-esteem. Similar results have been observed in previous studies related to biofeedback and mental imagery. According to the results, athletes with higher conscientiousness benefited more from the intervention in terms of coordination, flexibility, and endurance. The data support the idea that emotionally stable athletes benefit more from the intervention in terms of overall physical condition and general self-esteem. Theoretically, the studies highlight the importance of psychological interventions in enhancing athletes' psychomotor performance and the interaction between these interventions and individual differences among participants. The findings are relevant for sports psychology practitioners, as they provide additional evidence for the use of biofeedback and mental imagery with athletes.

KEYWORDS: *Doping, sport, psychomotor performance, emotional stability, biofeedback, mental imagery.*

Introduction

Doping - A Major Issue in the World of Sports

Doping remains a critical challenge in the realm of sports today, with data indicating alarming prevalence rates across different nations, varying between 5% and 31% [1,2].

To classify a substance as prohibited, it must satisfy at least two of three key criteria: it should have the capacity to boost athletic performance, present potential health hazards, or breach the integrity and values inherent in sportsmanship-specifically, it must breach the principle of Olympism, characterized by values such as ethics, adherence to laws and rules, honesty, health, and respect for oneself and other athletes [3].

Causes and Consequences of Doping

The intuitive causes driving athletes to dope include the desire for exceptional performance and the intense social pressure to win.

With the increasing media coverage of sporting events, this pressure has intensified.

Whether this pressure comes from parents, friends, coaches, teammates, or the general public, it can drive athletes to use performance-enhancing substances either directly (by increasing muscle mass) or indirectly (by enhancing endurance, thus facilitating participation in more intense training).

Another cause relates to athletes' ability to cope with pain and injuries and to rehabilitate.

Elite athletes, and others, may use various drugs and substances to psychologically manage physical discomfort and to accelerate recovery after injuries.

Psychological factors may also contribute to the decision to use banned substances in sports.

Dysfunctional perfectionism or the need for social approval can be predictors.

Stress and anxiety can also be causes.

Personal issues faced by athletes (e.g, poor academic performance, dysfunctional personal and family life) can be significant factors as well, with drugs potentially serving as a coping mechanism [4].

Boredom may drive some athletes to use drugs, particularly on weekends when boredom is more pronounced due to team travel or unplanned team activities [5].

Low self-esteem can also contribute to such practices.

The consequences or reactions caused by doping can vary depending on numerous

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variables (e.g, type of substance, amount ingested).

The use of anabolic steroids can lead to urogenital problems, acne, or hepatic and cardiovascular diseases [2,6,7,8].

In men, steroid use may disrupt testosterone production, which can result in impotence.

In women, it has been linked to menstrual disturbances and the development of masculine features, such as reduced body fat, smaller breasts, a deeper voice, excessive hair growth, irreversible scalp hair loss, and clitoral enlargement.

Steroids have also been connected to prostate cancer [9], fatal liver cysts, liver damage, and liver cancer [10,11].

The misuse of anabolic androgenic steroids has been associated with a range of psychiatric and behavioral issues, from socially accepted irritability to extreme aggression, hostility, and even depression or mania [2,12].

Amphetamines, by masking the body's physical limits, can lead to an overestimation of endurance, while also diminishing the sensation of pain from injuries [13].

In athletes, these substances increase the risk of heatstroke and cardiac arrest during intense physical exertion, with several fatal incidents reported, particularly among cyclists

Meta-analytic results suggest that functional deficits may be underpinned by structural alterations, with reductions in gray matter identified in the insular cortex and superior frontal gyrus in cocaine users [14].

Chronic cocaine use over the long term can be profoundly detrimental to athletes, leading to deterioration in health both physically and socially [15,16].

Excessive cannabis use affects the synthesis and release of dopamine, leading to neurochemical imbalances that sustain consumption [17].

Research has shown that cannabis users exhibit lower gray matter density in brain regions like the amygdala, striatum, hippocampus, thalamus, cerebellum, and prefrontal cortex [18].

This effect is especially pronounced with high doses or prolonged use [17,19,20].

Doping and Psychomotor Skills

The speed with which simple, repetitive actions are performed can be affected by benzodiazepines [21].

Concerning cannabis, various studies have demonstrated that this drug impairs cognitive performance as well as psychomotor performance, slowing reaction time, motor coordination, and altering short-term memory and concentration [22].

The immediate impact of cannabis on psychomotor abilities can involve delayed braking response, shifts in lane positioning, increased following distance between the subject's vehicle and the one ahead, impaired performance in tasks requiring tracking and multitasking, along with slower reaction time and reduced speed [23].

Psychological Interventions for Alleviating the Psychomotor Consequences of Doping

Biofeedback is a method that teaches individuals how to control specific physiological functions, such as heart rate, blood pressure, and even skin temperature, by using feedback from an electronic device [24].

Psychophysiological research has shown a relationship between psychomotor efficiency and physiological activity [25,26].

Over the past decade, heart rate variability biofeedback (HRVB) has gained significant attention, particularly for its role in enhancing performance [27].

This practice is often referred to as heart rate variability biofeedback (HRV-BFB) or, when performed consistently, HRV-BFB training.

Imagery involves mentally visualizing a desired performance in an upcoming scenario, whether during training or in actual competition.

Mental rehearsal refers to repeatedly practicing an action or sequence of events within the mind.

Engaging in mental rehearsal can act as a motivational tool, helping athletes remain focused and ready for the next day's performance.

Moreover, it can boost an athlete's confidence, as such mental exercises are linked to positive thinking, which is crucial for optimal performance.

Confidence may grow as a result of the positive imagery formed in preparation for competition [28].

Hypotheses

Thus, based on the positive effects these techniques can have in tandem (e.g, biofeedback; imagery and mental rehearsal) on psychomotor skills, we propose the following hypothesis:

Hypothesis 1

There are significant differences in psychomotor performance before and after the intervention.

Personality as a Moderator

Often, the success (or failure) of interventions depends on various individual variables (i.e, individual differences), in this case, focusing on personality traits that individuals or athletes possess.

It is therefore important to explore the moderating effect of athletes' personality traits to determine for whom these forms of intervention might be beneficial (or less beneficial).

Identifying potential moderators that could influence the direction or magnitude of intervention effects (i.e, biofeedback and mental imagery) on the outcome (i.e, psychomotor performance) is practically important, providing valuable information to practitioners in the field.

One of the most important models describing human personality through personality factors is the Big Five model [29].

This model, developed in the 1980s, includes five major personality factors, which we describe below.

Openness to Experience

Openness to experience reflects a broad appreciation for art, emotions, adventure, unconventional ideas, imagination, curiosity, and diverse experiences.

Individuals who exhibit high levels of openness tend to be intellectually inquisitive, emotionally receptive, attuned to beauty, and eager to explore new opportunities.

In contrast to those who are more closed-off, they are generally more creative and more in touch with their emotions.

They may also be inclined to hold nontraditional beliefs.

While high openness can sometimes be seen as unpredictability or a lack of concentration, it also correlates with a greater likelihood of engaging in risk-taking behaviors.

Additionally, people with elevated openness often seek self-fulfillment through the pursuit of intense and euphoric experiences [29].

Conscientiousness

Conscientiousness refers to the inclination to exercise self-discipline, fulfill responsibilities, and pursue goals, even in the absence of external pressures.

It pertains to how individuals manage, regulate, and guide their impulses.

High levels of conscientiousness are sometimes interpreted as stubbornness.

On the other hand, low conscientiousness is linked to adaptability and spontaneity, but may also be viewed as irresponsibility and unreliability [30].

A strong conscientiousness score reflects a tendency to favor structured, planned actions over spontaneous ones.

Extraversion

Extraversion is characterized by a wide range of activities, with extraverts gaining energy from external environments and experiences.

This trait reflects a strong connection with the outside world, where extraverted individuals thrive on social interactions and are often viewed as lively and energetic.

They are typically enthusiastic and action-driven, enjoying conversations and frequently taking the lead in group settings.

Extraverts tend to assert themselves more in social situations compared to their introverted counterparts.

On the other hand, introverts engage less socially and have lower energy levels in such environments.

They are generally more quiet, reflective, and reserved, preferring less stimulation and valuing time spent alone.

It’s important to note that an introvert’s reduced social involvement does not necessarily indicate shyness or depression, but rather a preference for solitude and contemplation [29].

Agreeableness

Agreeableness represents the extent to which individuals prioritize social harmony.

People who score high in agreeableness typically get along well with others and are often seen as kind, generous, trusting, helpful, and willing to put others' needs ahead of their own.

They tend to have a positive outlook on human nature.

In contrast, individuals low in agreeableness are more likely to prioritize their own interests over those of others.

They may show little concern for others' well-being and are often skeptical, which can make them seem suspicious, uncooperative, or unfriendly.

Low-agreeableness individuals tend to be more competitive and may come across as argumentative or less trustworthy [29].

Neuroticism

Neuroticism is characterized by a tendency to experience negative emotions like anger, anxiety, or depression and is sometimes referred to as emotional instability.

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Eysenck's personality theory (1967) associates neuroticism with a low tolerance for stress or unpleasant stimuli.

As a long-established trait of temperament, neuroticism was studied extensively before becoming part of the Big Five personality model.

Individuals with high neuroticism scores are emotionally reactive and more susceptible to stress, often perceiving everyday situations as threatening.

They may find minor frustrations especially difficult to cope with, and their negative emotional responses tend to last longer than usual, leading to a persistently negative mood.

For instance, neuroticism is linked to a pessimistic outlook on work, a belief that work interferes with personal relationships, and heightened anxiety due to work-related pressures [29].

In this study, we will specifically focus on conscientiousness and neuroticism among these personality traits.

Previous research has explored how these traits relate to various relaxation techniques, such as mindfulness.

A meta-analysis examining the connection between personality and mindfulness found the strongest correlations for neuroticism (r=-0.45) and conscientiousness (r=0.32) [31].

Because conscientious individuals are more organized and self-disciplined (i.e, they are more likely to practice biofeedback or mental imagery techniques at a specific time of day), they are more likely to achieve higher psychomotor performance.

At the same time, because emotionally unstable individuals are more prone to rumination [29] and exhibit more pronounced avoidance behavior than emotionally stable individuals [32], and are more likely to be in a negative state (i.e, which could block the positive effect of biofeedback techniques on achieving a state of relaxation that allows mental imagery techniques to be performed in a beneficial context), we believe that individuals with a high level of emotional stability may achieve higher psychomotor performance [33].

Thus, we propose the following hypothesis:

Hypothesis 2

Conscientiousness and emotional stability moderate the relationship between the proposed interventions (i.e, biofeedback and mental imagery) and psychomotor performance.

Participants in the Three Studies

The sample consisted of 30 athletes practicing different sports such as athletics, weightlifting, canoe-kayak, and Greco-Roman wrestling, who were members of Romanian sports clubs.

They were either suspected of doping or confirmed for doping.

Participants' personal details remained confidential to protect their privacy due to the sensitive nature of the topic.

Ethical approval was obtained from the 'Football Club Association' Dinamo Bucharest, no. 128/2018.

To test the psychometric properties of the Physical Self-Efficacy Scale, a sample of 208 athletes, former athletes, and amateur athletes was utilized.

Among them, 99 (47.6%) were female and 109 (52.4%) were male. Participants had an average age of 33.97 years with a standard deviation of 9.03.

Procedures

The first component of the psychological intervention was psychoeducation.

Participants were introduced to the primary substances used by athletes in doping and the motivations identified by scientists for athletes' use of these substances.

Additionally, individual differences (e.g, personality factors) that predispose certain athletes to doping were discussed.

Each session included two types of activities: biofeedback and imagery/ mental rehearsal.

Heart rate variability biofeedback (HRV-BFB) was used to develop the capacity for voluntary relaxation [27].

The athletes were instructed to mentally rehearse a specific action or series of events multiple times.

Such repetitions are beneficial for athletes, helping them to recall how they should perform.

Study participants were also instructed to visualize an attitude they should adopt and other behaviors that might be considered appropriate.

Before the intervention began, participants completed a personality test to later test the moderation hypotheses.

The 30 athletes completed items regarding their levels of conscientiousness and emotional stability prior to starting the intervention.

Instruments

Psychomotor performance was measured using the short form of the Physical Self-Description Questionnaire [34].

Personality was assessed using the IPIP Big Five Inventory [35].

Physical self-efficacy was measured with the Physical Self-Efficacy Scale [36].

Participation in the intervention was operationalized as a categorical variable of "pretest measurement" (coded as 1) and "posttest measurement" (coded as 2).

Results

Descriptive Analysis of Variables from the First Study

The descriptive analyses (number of participants, mean, standard deviation, and standard error of the mean) for the variables in the first study, both before (T1) and after the intervention (T2) (Tables 1-3).

Table 1. Descriptive Analysis of Variables in the First Study.

	N	Mean	SD	SEM
Health T1	30	3.76	2.02	.37
Health T2	30	3.80	1.91	.35
Coordination T1	30	3.56	1.90	.34
Coordination T2	30	4.36	.71	.13
Activity T1	30	3.53	1.71	.31
Activity T2	30	4.06	1.20	.21
Overweight T1	30	1.60	.62	.11
Overweight T2	30	1.56	.56	.10
Sports Skills T1	30	3.43	1.63	.29
Sports Skills T2	30	4.26	1.01	.18
Overall Physical Condition T1	30	3.20	1.58	.28
Overall Physical Condition T2	30	4.33	.71	.13
Physical Appearance T1	30	3.40	1.52	.27
Physical Appearance T2	30	3.40	1.67	.30
Strength T1	30	3.33	1.60	.29
Strength T2	30	3.93	.69	.12
Flexibility T1	30	3.30	1.62	.29
Flexibility T2	30	3.96	.61	.11
Anduranta T1	30	3.46	1.63	.29
Anduranta T2	30	4.16	.69	.12
General Self-Esteem T1	30	3.60	1.65	.30
General Self-Esteem T2	30	4.66	.84	.15

Table 2. Correlations between variables at Pretest

	1	2	3	4	5	6	7	8	9	10	11
1. Health T1											
2. Coordination T1	-.16										
3. Activity T1	.11	-.10									
4. Overweight T1	-.21	-.03	.20								
5. Sports Skills T1	.12	.12	.02	.01							
6. Overall Physical Condition T1	-.07	-.06	-.18	-.23	-.12						
7. Physical Appearance T1	.10	-.05	-.04	.06	-.07	-.14					
8. Strength T1	-.32	.20	-.09	-.13	-.05	.04	.11				
9. Flexibility T1	.10	-.15	.07	-.01	-.22	.27	.10	.11			
10. Endurance T1	.12	-.26	-.21	-.25	.21	**.37 ***	-.11	-.16	.17		
11. General Self-Esteem T1	.03	**.49 ****	**.39 ***	.27	.06	-.19	.02	.20	.07	-.35	

Note: * p < .05, ** p < .01, *** p < .001

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Table 3. Correlations between variables at the Posttest.

	1	2	3	4	5	6	7	8	9	10	11
1. Health T2											
2. Coordination T2	-.09										
3. Activity T2	-.12	-.10									
4. Overweight T2	.24	.06	-.10								
5. Sports Skills T2	.09	.33	-.18	-.03							
6. General Physical Condition T2	-.27	.09	-.02	.28	.06						
7. Physical Appearance T2	.09	-.06	-.09	-.13	.17	.14					
8. Strength T2	**.45 ***	-.22	.13	.27	-.26	.11	.05				
9. Flexibility T2	-.03	.10	-.13	-.04	**.45 ***	**.42 ***	.18	-.16			
10. Endurance T2	.23	-.12	.19	-.24	-.11	-.04	-.02	.02	.33		
11. General Self-Esteem T2	-.12	-.13	-.24	.19	-.09	.01	-.09	.02	-.22	.31	

Note: * p < .05, ** p < .01, *** p < .001

Differences between Pretest and Posttest measurements in the first study

Table 4. Differences Between Pretest and Posttest for the Studied Variables.

	t	df	p	Mean	SEM	Cohen's d
Health T1	-.29	29	.76	-.03	.11	-.05
Coordination T1	-2.28	29	.03	-.80	.35	-.41
Activity T1	-1.23	29	.22	-.53	.43	-.22
Overweight T1	.27	29	.78	.03	.12	.05
Sport Skills T1	-2.13	29	.04	-.83	.39	-.39
Overall Physical Condition T1	-3.61	29	.00	-1.13	.31	-.66
Physical Appearance T1	.00	29	1.00	.00	.34	.00
Strength T1	-2.06	29	.04	-.60	.29	-.37
Flexibility T1	-2.21	29	.03	-.66	.30	-.40
Endurance T1	-2.19	29	.03	-.70	.31	-.40
General Self-Esteem T1	-3.02	29	.00	-1.06	.35	-.55

Notă. Student's t-test.

Table 4 presents the results of the paired-samples t-test.

Thus, there were no significant differences between the two measurements for health (t=-.29, p=.76, Mdif=-.03), activity (t=-1.23, p=.22, Mdif=-.53), overweight (t=.27, p=.78, Mdif=.03), and physical appearance (t=.00, p=1.00, Mdif=.00).

Athletes reported higher post-intervention scores for coordination (t=-2.28, p=.03, Mdif=-.80, d=-.41), sports skills (t=-2.13, p=.04, Mdif=-.83, d=-.39), overall physical condition (t=-3.61, p < .01, Mdif=-1.13, d=-.66), strength (t=-2.06, p=.04, Mdif=-.60, d=-.37), flexibility (t=-2.21, p=.03, Mdif=-.66, d=-.40), endurance (t=-2.19, p=.03, Mdif=-.70, d=-.40), and general self-esteem (t=-3.02, p <.00, Mdif=-1.06, d=-.55).

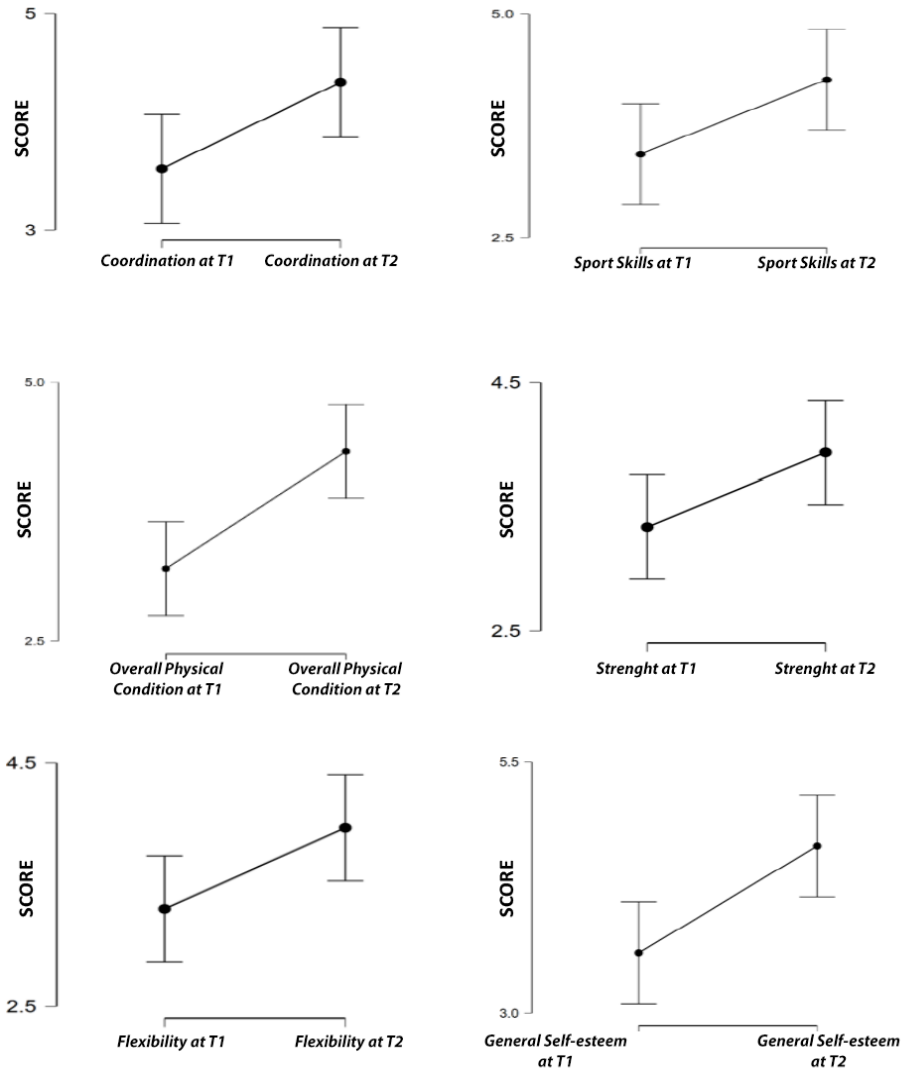

Figure 1. Differences between pretest and posttest for the studied variables.

Figure 1. Represents graphically the differences between pretest and posttest measurements for the variables that showed statistically significant results.

The figure you provided consists of six panels, each showing a comparison between measurements taken at two time points, labeled as "T1 (pretest)" and "T2 (posttest)."

The measurements cover different aspects of physical skills and self-esteem.

Here's a summary of each graph, along with some observations:

1. Coordination at T1 vs. Coordination at T2:

Trend: The score increases from T1 to T2, with error bars suggesting a moderate level of variability in both time points.

Interpretation: There is an improvement in coordination from T1 to T2.

The increase in scores indicates a positive change, suggesting that participants improved their coordination skills over time.

2. Sport Skills at T1 vs. Sport Skills at T2:

- Trend: A steady increase is observed in sports skills from T1 to T2, with moderate error bars.

- Interpretation: Similar to coordination, sports skills also show an improvement over time, suggesting positive development in participants' athletic abilities.

3. Overall Physical Condition at T1 vs. Overall Physical Condition at T2:

- Trend: A significant increase from T1 to T2, with wider error bars at T1 compared to T2.

- Interpretation: The overall physical condition of participants improved notably over time.

The wider error bars at T1 indicate that there was more variability among participants at the

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start, but this variability decreased at T2, possibly due to more consistent training or intervention effects.

4. Strength at T1 vs. Strength at T2:

- Trend: Strength scores increase from T1 to T2, with error bars suggesting moderate variability.

- Interpretation: Strength improved over time, though the increase seems less pronounced compared to some of the other physical measures.

Still, the positive trend indicates that participants gained strength over the measured period.

5. Flexibility at T1 vs. Flexibility at T2:

- Trend: A clear improvement in flexibility is observed, though the error bars indicate variability.

- Interpretation: The increase in flexibility suggests participants enhanced their range of motion or physical flexibility between T1 and T2.

6. General Self-esteem at T1 vs. General Self-esteem at T2:

- Trend: The most substantial increase among the variables, with relatively wide error bars.

- Interpretation: There is a marked improvement in general self-esteem from T1 to T2, indicating that the participants felt more positive about themselves over time.

The larger error bars suggest some participants experienced greater changes than others, indicating individual differences in the response.

Overall Commentary: All six aspects-coordination, sport skills, overall physical condition, strength, flexibility, and self-esteem-show positive trends, indicating improvements from T1 to T2.

While the magnitude of improvement varies across different measures, the consistent upward trend in scores suggests the intervention (likely training or another activity) had a beneficial effect on participants' physical skills and self-esteem.

The error bars indicate that variability was present in each measure, especially at T1, which may reflect individual differences in baseline abilities.

However, in most cases, variability seems to decrease at T2, indicating more uniform improvements among participants.

The overall interpretation is that participants showed improvements across all measured variables, with notable gains in general self-esteem and physical condition, suggesting both physical and psychological benefits from the intervention or study period.

Analysis of the Moderating Role of Conscientiousness in the Second Study

The moderating role of conscientiousness in the effectiveness of the intervention was tested.

Given that data were collected from a single sample at two different time points and that dependent-sample t-tests do not allow for multivariate analyses, the following statistical approach was implemented.

A series of new variables were constructed by calculating the difference between the scores at the second measurement and the scores at the first measurement for each variable.

These new variables, representing the differences between posttest and pretest scores, were then correlated with conscientiousness.

If conscientiousness indeed plays a moderating role, a positive correlation is expected between it and the newly created variables, as an increase in conscientiousness would be associated with a greater difference between pretest and posttest measurements (indicating greater intervention effectiveness).

Given the small sample size, Spearman correlations were used.

The results are presented in Table 5.

There were significant positive correlations between conscientiousness and the difference between posttest and pretest scores for coordination ($r=.38$, $p<.05$), flexibility ($r=.43$, $p<.05$), and endurance ($r=.48$, $p<.01$).

The data support the notion that more conscientious athletes benefit more from interventions in these three variables.

Table 5. Correlations between conscientiousness and differences between measurements.

	Conscientiousness
Difference in Health	-.09
Difference in Coordination	.38*
Difference in Activity	.03
Difference in Overweight	-.20
Difference in Sports Skills	.04
Difference in Overall Physical Condition	.28
Difference in Physical Appearance	.13
Difference in Strength	.18
Difference in Flexibility	.43*
Difference in Endurance	.48**
Difference in General Self-Esteem	.04

Moderation Analysis for the Third Study

The moderating role of emotional stability in the effectiveness of the intervention was tested.

As in the previous study, given that data were collected from a single sample at two different time points and that dependent-samples t-tests do not allow for multivariate analyses, a statistical

approach based on the difference between scores at the two measurements was implemented.

A series of new variables were constructed by calculating the difference between scores at the second measurement and scores at the first measurement for each variable.

These new variables, representing the differences between posttest and pretest scores, were then correlated with emotional stability.

If emotional stability indeed plays a moderating role, a positive correlation is expected between it and the newly created variables, as an increase in emotional stability would be associated with a greater difference between pretest and posttest measurements (indicating greater intervention effectiveness).

Given the small sample size, Spearman correlations were used.

The results are presented in Table 6.

Significant positive correlations were found between emotional stability and the difference between posttest and pretest scores for overall physical condition (r=.41, p<.05) and general self-esteem (r=.39, p<.05).

The data support the notion that athletes with higher emotional stability benefit more from interventions concerning these two variables.

Table 6. Correlations between emotional stability and differences between measurements.

	Emotional Stability
Difference in Health	.19
Difference in Coordination	.27
Difference in Activity	-.21
Difference in Overweight	.19
Difference in Sports Skills	-.12
Difference in Overall Physical Condition	.41*
Difference in Physical Appearance	.07
Difference in Strengt	.14
Difference in Flexibility	.03
Difference in Endurance	-.19
Difference in General Self-Esteem	.39*

Psychometric properties of the physical self-efficacy scale

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 2 ("I have agile and precise movements.") with r=.61, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 3 ("My body is rather strong.") with r=.50, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 4 ("I can run fast.") with r=.64, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 5 ("I feel in control when taking dexterity tests.") with r=.64, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 6 ("I have weak muscle tone.") with r=.55, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 7 ("I am not proud of my sports abilities.") with r=.55, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 8 ("My speed has helped me get out of difficult situations.") with r=.54, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 9 ("I have a strong grip.") with r=.57, p<.001.

There was a statistically significant positive correlation between Item 1 ("I have excellent reflexes.") and Item 10 ("Due to my agility, I have been able to do things that others cannot.") with r=.57, p<.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 3 ("My body is rather strong.") with r=.38, p <.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 4 ("I can run fast.") with r=.71, p<.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 5 ("I feel in control when taking dexterity tests.") with r=.65, p<.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 6 ("I have weak muscle tone.") with r=.71, p <.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 7 ("I am not proud of my sports abilities.") with r=.69, p<.001.

There was a statistically significant positive correlation between Item 2 ("I have agile and precise movements.") and Item 8 ("My speed has helped me get out of difficult situations.") with r=.57, p<.001.

Other correlations are presented in Table 7.

Table 8 presents the minimum, maximum, mean, and standard deviation values for the items of the scale.

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Table 7. Correlations Between Items of the Scale.

	1	2	3	4	5	6	7	8	9	10
1. I have excellent reflexes.										
2. I have agile and precise movements.	.61 ***									
3. My body is rather strong.	.50 ***	.38 ***								
4. I can run fast.	.64 ***	.71 ***	.32 ***							
5. I feel in control when taking dexterity tests.	.64 ***	.65 ***	.42 ***	.73 ***						
6. I have weak muscle tone.	.55 ***	.71 ***	.43 ***	.65 ***	.66 ***					
7. I am not proud of my sports abilities.	.55 ***	.69 ***	.41 ***	.63 ***	.66 ***	.79 ***				
8. My speed has helped me get out of difficult situations.	.54 ***	.57 ***	.28 ***	.63 ***	.50 ***	.49 ***	.56 ***			
9. I have a strong grip.	.57 ***	.60 ***	.35 ***	.61 ***	.57 ***	.49 ***	.60 ***	.65 ***		
10. Due to my agility, I have been able to do things that others cannot.	.60 ***	.49 ***	.38 ***	.49 ***	.51 ***	.49 ***	.57 ***	.55 ***	.61 ***	

Note: * p < .05, ** p < .01, *** p < .001

Table 8. Descriptive analysis for the scale items.

Item	Minimum	Maximum	Mean	Standard Deviation
1. I have excellent reflexes.	1	5	3.80	1.183
2. I have agile and precise movements.	1	5	3.89	1.098
3. My body is rather strong.	1	5	3.86	1.235
4. I can run fast.	1	5	3.76	1.098
5. I feel in control when I take dexterity tests.	1	5	3.96	.967
6. I have poor muscle tone. (R)	1	5	3.65	1.093
7. I am not proud of my sports skills. (R)	1	5	3.71	1.165
8. My speed has helped me out of difficult situations.	1	5	3.50	1.138
9. I have a strong grip.	1	5	3.71	1.096
10. Due to my agility, I was able to do things others cannot do.	1	5	3.40	1.376

The internal consistency of the scale was Cronbach's Alpha=.92.

Table 9 presents the item loadings on the general factor after the correlated error between Item 6 and Item 7 was included in the model.

Table 9. Item Loadings on the General Factor.

Items	Loadings
1. I have excellent reflexes.	.89
2. I have agile and precise movements.	.89
3. My body is rather strong.	.61
4. I can run fast.	.89
5. I feel in control when I take dexterity tests.	.78
6. I have poor muscle tone. (R)	.82
7. I am not proud of my sports skills. (R)	.91
8. My speed has helped me out of difficult situations.	.82
9. I have a strong grip.	.81
10. Due to my agility, I was able to do things others cannot do.	.92

The final model, with the correlated error between Item 6 and Item 7 included, shows good fit indices.

The model is presented in Figure 2.

Table 10 shows the fit indices.

According to the results, the instrument has a good, unifactorial factorial structure.

Table 10. Item loadings on the general factor.

	χ^2	df	CFI	TLI	RMSEA	SRMR
One-factor model	1399.98	45	.93	.91	.08	.05

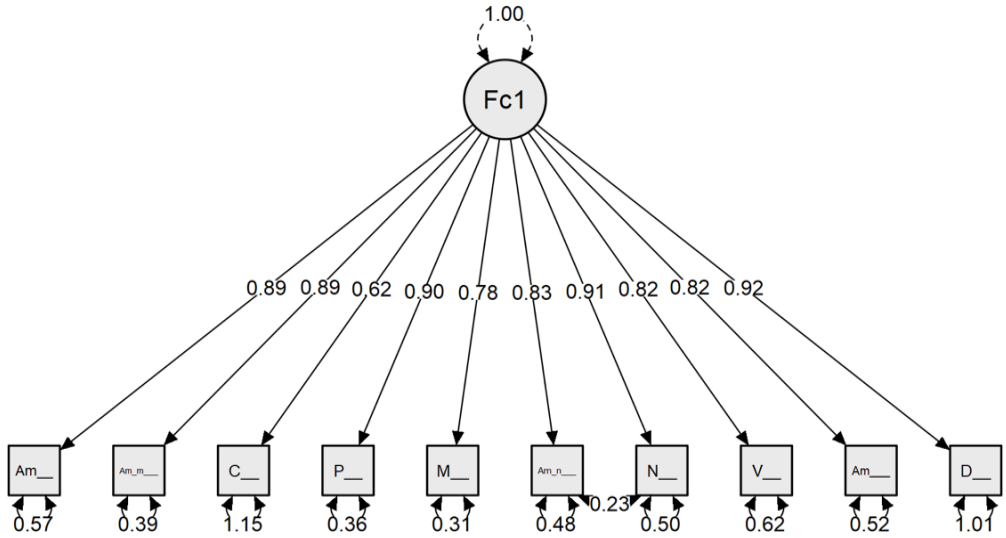

Figure 2. Final Factor Model.

Discussion

The aim of this study was to evaluate a psychological intervention designed to mitigate the psychomotor effects of doping.

Additionally, the study explored how conscientiousness and emotional stability influenced the success of the intervention.

The intervention included two components: biofeedback and mental imagery/rehearsal.

Following the intervention, athletes reported improvements in coordination, sports skills, overall physical condition, strength, flexibility, endurance, and self-esteem.

These results align with previous research on biofeedback [27] and mental imagery [28].

The findings suggest that athletes who are more conscientious experienced greater benefits in terms of coordination, flexibility, and endurance, likely due to their higher levels of organization and discipline.

Conscientious individuals are more inclined to consistently practice biofeedback and mental imagery techniques, increasing their psychomotor performance.

Furthermore, emotionally stable athletes showed greater improvements in physical condition and self-esteem.

This may be because emotionally unstable athletes tend to ruminate [29] and engage in avoidance behaviors, which can lead to a negative emotional state that impedes the relaxing effects of biofeedback, ultimately limiting the effectiveness of mental imagery techniques.

Theoretical and Practical Implications

From a theoretical perspective, this research offers two significant contributions.

First, it underscores the importance of psychological interventions in enhancing athletes' psychomotor performance.

The study highlights that biofeedback and mental imagery are valuable psychological techniques for recovery following doping.

Second, the study contributes to the field by capturing the interaction between psychological interventions and individual differences among participants in these interventions.

From a practical standpoint, the results are relevant for sports psychology practitioners, providing additional evidence for the use of biofeedback and mental imagery with athletes who are suspected or confirmed of doping.

The second practical implication concerns the role of individual differences.

Practitioners can identify athletes with lower levels of conscientiousness and ensure they are required to perform psychological exercises at the sports club, where they are more likely to engage in interventions due to the absence of self-discipline required to follow the psychologist's instructions in their absence.

Simultaneously, sports psychologists will need to work with athletes who have lower emotional stability for longer periods, considering the difficulties they encounter in relaxing.

10.12865/CHSJ.50.03.06

Limitations and Future Directions

First, the sample was a convenience sample. Given the nature of the study and research ethics principles, personal data (age, gender, sport practiced) were not collected.

These sample characteristics limit the ability to generalize the results.

The results obtained from this sample may not be replicable in other samples due to factors such as age, gender, or sport practiced by participants.

Future research could consider different samples to verify whether the effects of the intervention can be reproduced.

Second, two psychological intervention techniques were used simultaneously.

Therefore, it is not possible to isolate the effect of each intervention to identify the source of the intervention's efficacy.

It is possible that one of the two methods used (biofeedback or mental imagery) is the primary reason for the observed effect.

Future studies could include three experimental groups: one receiving only biofeedback, one receiving only mental imagery, and one receiving both types of interventions simultaneously.

Another limitation of the study is the use of subjective measures.

Given that the results are based on self-report instruments, there may be distortions in the measurements.

Future research could consider more objective measures of the studied variables.

For example, psychomotor tests, physical exercise trials, or medical analyses could be used to capture variables such as physical strength, flexibility, endurance, or coordination.

A major limitation of this study is the absence of a control group.

The results observed in the experimental group cannot be compared with those of athletes who did not receive any intervention.

Finally, the study did not include a placebo group.

Future research could incorporate a control group to test alternative explanations and increase the validity of the research, as well as a group participating in an intervention that mimics a psychological program but has no actual effect.

Financial support

None declared.

Acknowledgements

This article contains data from the second part of the first author's doctoral thesis.

The thesis is titled Personality of High-Performance Athletes and the Consequences of Doping on Psychomotor Skills-Neuropsychological Approaches and Psychological Interventions (rom. Personalitatea sportivilor de performanță și consecințele dopajului asupra psihomotricității-abordări neuropsihologice și intervenții psihologice).

According to the 'Order of the Ministry of National Education,' No. 5110/ 2018, the 'Framework Contract for Doctoral University Studies' is governed by the provision stipulated in Article 8, paragraph g) of this contract, which explicitly states that the publication of an article, in this case as the first author, 'must include results derived from the content of the thesis.'

In other words, the personal scientific data/results from the thesis are to be incorporated into this article for publication.

Conflict of interest

None to declare

References

1. Momaya A, Fawal M, Estes, R. Performance-enhancing substances in sports: a review of the literature. Sports Med, 2015; 45 (4):517-531.
2. Coliță D, Coliță C. I, Hermann D. M, Coliță E, Doeppner ThR, Udristoiu I, Popa-Wagner A. Therapeutic Use and Chronic Abuse of CNS Stimulants and Anabolic Drugs. Curr. Issues Mol, Biol, 2022, 44:4902-4920.
3. World Anti-Doping Agency, 2024, Olympic&Paralympic Committees [online]. Available at: https://www.wada-ama.org/en [Accessed 05.06. 2024]. Gardner F, Moore Z. Performance impairment II. In Gardner F, Moore Z (Eds): Clinical sport psychology. Human Kinetics, 2006, Champaign, IL, 157-170.
4. Anshel MH. Cognitive and behavioral strategies for combating drug abuse in sport: implications for coaches and sport psychology consultants. Sport Psychol, 1991, 5:152-166.
5. Melchert R. B, Welder, A. A. Cardiovascular effects of androgenic-anabolic steroids. Med. Sci. Sports Exerc, 1995, 27 (9):1252-1262.
6. Rogol AD, Yesalis CE. Clinical review 31: Anabolic-androgenic steroids and athletes: what are the issues? J. Clin. Endocrinol. Metab, 1992, 74 (3):465-469.
7. Sullivan ML, Martinez CM, Gennis P, Gallagher EJ. The cardiac toxicity of anabolic steroids. Prog. Cardiovasc. Dis, 1998, 41(1):1-15.
8. Creagh T. M, Rubin A, Evans DJ. Hepatic tumours induced by anabolic steroids in an athlete. J. Clin. Pathol, 1988, 41(4):441-443.
9. Søe KL, Søe M, Gluud C. Liver pathology associated with the use of anabolic-androgenic steroids. Liver, 1992, 12:73-79.
10. Stimac D, Milić S, Dintinjana RD, Kovac D, Ristić S. Androgenic/Anabolic steroid-induced toxic hepatitis. J. Clin Gastroenterol, 2002, 35(4):350-352.

11. Cattelan SL, de Brito MLO, Jesse CR, Boeira SP, de Gomes MG, Goes ATR, Fabbro LD, Machado F R, Prigol M, Nogueira CW. Involvement of Kynurenine Pathway in Depressive-Like Behaviour Induced by Nandrolone Decanoate in Mice. Steroids, 2020, 164:108727.
12. Avois L, Robinson N, Saudan C, Baume N, Mangin P, Saugy M. Central nervous system stimulants and sport practice. Br. J. Sports Med, 2006, 40(1): i16-i20.
13. Hall MG, Alhassoon OM, Stern MJ, Wollman SC, Kimmel CL, Perez-Figueroa A, Radua J. Gray matter abnormalities in cocaine versus methamphetamine-dependent patients: a neuroimaging meta-analysis. Am. J. Drug Alcohol Abuse, 2015, 41 (4):290-299.
14. Jones G. Caffeine and other sympathomimetic stimulants: modes of action and effects on sports performance. Essays Biochem, 2008, 44: 109-124.
15. Schwartz BG, Rezkalla S, Kloner RA. Cardiovascular effects of cocaine. Circulation, 2010, 122(24):2558-2569.
16. Weinstein A, Livny A, Weizman A. Brain imaging studies on the cognitive, pharmacological and neurobiological effects of cannabis in humans: evidence from studies of adult users. Curr. Pharm. Des, 2016, 22(42):6366-6379.
17. Cohen K, Weinstein AM. Synthetic and non-synthetic cannabinoid drugs and their adverse effects-a review from public health perspective. Front Public Health, 2018, 7:6:162.
18. Batalla A, Bhattacharyya S, Yuecel M, Fusar-Poli P, Crippa JA, Nogue S, Martin-Santos R. Structural and functional imaging studies in chronic cannabis users: a systematic review of adolescent and adult findings. PLoS One, 2013, 8 (2):e55821.
19. Yücel M, Solowij N, Respondek C, Whittle S, Fornito A, Pantelis C, Lubman DI. Regional brain abnormalities associated with long-term heavy cannabis use. Arch. Gen. Psychiatry, 2008, 65(6): 694-701.
20. Wittenborn, JR. Effects of benzodiazepines on psychomotor performance. Br J Clin Pharmacol, 1979, Suppl 1(Suppl 1):61S-67S.
21. Ashton CH. Pharmacology and effects of cannabis: a brief review. Br J Psychiatry, 2001,178:101-106.
22. Armentano P. Cannabis and psychomotor performance: a rational review of the evidence and implications for public policy. Drug Test. Anal, 2013, 5 (1):52-56.
23. Quick JC, Quick JD, Nelson DL, Hurrell JJJr. Preventive stress management: Principles and methods. In: Quick JC, Quick JD, Nelson DL, Hurrell JJJr (Eds): Preventive stress management in organizations, American Psychological Association, 1997, 149-162.
24. Bazanova OM, Shtark MB. Biofeedback in optimizing psychomotor reactivity: I. Comparison of biofeedback and common performance practice. Hum. Physiol, 2007, 33 (4):400-408.
25. Bazanova OM, Verevkin EG, Shtark MB. Biofeedback in optimizing psychomotor reactivity: II. The dynamics of segmental α-activity characteristics. Hum. Physiol, 2007, 33(6):695-700.
26. Gevirtz R. The Promise of Heart Rate Variability Biofeedback: Evidence-Based Applications. Biofeedback, 2013, 41(3):110-120.
27. Smoll FL, Smith RE. Enhancing Coach–Athlete Relationships: Cognitive-Behavioral Principles and Procedures. In: Dosil J. (Ed.): The sport psychologist's handbook: A guide for sport-specific performance enhancement, John Wiley & Sons, 2006, West Sussex, UK, 12-38.
28. Costa PT, McCrae RR. Normal personality assessment in clinical practice: The NEO Personality Inventory. Psychol Assess, 1992, 4 (1): 5.
29. Toegel G, Barsoux JL. How to become a better leader. MIT Sloan Manag Rev, 2012, 53(3):51-60.
30. Giluk TL. Mindfulness, big five personality, and affect: a meta-analysis. Personality and Individual Differences, 2009, 47(8), 805–811.
31. Lommen MJJ, Engelhard IM, van den Hout MA. Neuroticism and avoidance of ambiguous stimuli: better safe than sorry? Pers Individ Differ, 2010, 49 (8):1001-1006.
32. Nyklíček I, Irrmischer M. For whom does mindfulness-based stress reduction work? Moderating effects of personality. Mindfulness, 2017, 8 (4):1106-1116.
33. Marsh HW, Martin AJ, Jackson S. Introducing a short version of the physical self-description questionnaire: new strategies, short-form evaluative criteria, and applications of factor analyses. J. Sport Exerc Psychol, 2010, 32(4):438-482.
34. Iliescu D, Popa M, Dimache R. Adaptarea românească a Setului Internațional de Itemi de Personalitate: IPIP-Ro. Psihologia Resurselor Umane, 2016, 13 (1):83-112.
35. Hu L, McAuley E, Elavsky S. Does the physical self-efficacy scale assess self-efficacy or self-esteem? J. Sport Exerc Psychol, 2005, 27 (2):152-170.

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