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THE PERSONALITY OF ELITE ATHLETES AND THE CONSEQUENCES OF DOPING ON PSYCHOMOTOR FUNCTIONING - NEUROPSYCHOLOGICAL APPROACHES AND PSYCHOLOGICAL INTERVENTIONS

SUMMARY

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TESTING A PSYCHOLOGICAL INTERVENTION FOR IMPROVING THE PSYCHOMOTOR CONSEQUENCES OF DOPING IN ELITE ATHLETES: THE MODERATING ROLE OF PERSONALITY

1. Introduction

Doping in Athletes

Doping is one of the long-standing issues in the world of sports. Statistics suggest alarming and concerning rates in various countries, with doping ranging from 5% to 31% (Momaya, Fawal, & Estes, 2015). Although significant organizations and institutions (e.g., World Anti-Doping Agency - WADA) are making efforts to stop and prevent this phenomenon, which has particularly negative long-term effects on athletes' health, doping prevalence is still rather increasing (Momaya et al., 2015).

Elite sports represent the peak level in the sports industry, including any athlete or team competing at an international or national level. This encompasses both Olympic and non-Olympic sports, individual and team sports (e.g., baseball, soccer, etc.), as well as emerging sports (e.g., surfing; Sotiriadou & De Bosscher, 2018). Elite sports involve a comprehensive process that includes attracting athletes, maintaining/transitions, and developing them within the sports system (Green, 2005; Sotiriadou & Shilbury, 2009). In this process, a large number of organizations or other key actors provide opportunities through creating competitions, training facilities, coaching, skill development, talent identification, selection, development, and transitioning to higher levels of competition (Rees et al., 2016). When we refer to elite sports, we often mean those elite athletes who participate in various international competitions or high-caliber national events. This category includes both adults and juniors, depending on the age groups they compete in (De Hon, Kuipers, & van Bottenburg, 2015). It is worth noting that doping issues are more frequently encountered at elite levels, and research on performance-enhancing substances has been fueled by athletes' desire for success, despite the fact that the practice is firmly banned at nearly all levels of play.

Causes of Doping in Athletes

One of the (easily intuitive) reasons that drive athletes to dope is the desire to achieve outstanding performances. Besides this reason, Anshel (2015) highlights other causes. For example, the intense social pressure placed on athletes to win. With the increasing media coverage of sports events, this pressure has intensified. Whether this pressure comes from parents, friends, coaches, teammates, or the general public, it can push athletes to use performance-enhancing substances either directly (by increasing muscle mass) or indirectly, by enhancing endurance for physical effort, thus facilitating participation in more intense training. Additionally, behavioral modeling falls into the category of social factors. For instance, the media coverage of the effects of certain substances can lead other athletes to use them as well to achieve similar performances (e.g., using anabolic steroids for muscle development).

Another cause relates to athletes' ability to cope with pain and injuries and to rehabilitate. For example, performance athletes and others may ingest various drugs and substances to cope with psychological discomfort and to accelerate recovery after injury (English, 1987). Athletes may often feel that the medical treatment they are following is not sufficient to alleviate their pain, and thus they seek to acquire and use other medications or drugs to relieve their pain, often without a medical prescription.

Psychological factors can also contribute to the decision to use banned substances in sports. In terms of personality, certain personality traits can be significant antecedents of susceptibility to doping. For instance, dysfunctional perfectionism or the need for social approval can be predictors. Stress and anxiety can also be causes that need to be mentioned. The need to control anxiety or other undesirable emotions has been known in the sports world for a long time, but these artificial means (i.e., substance use) of controlling such states and emotions offer those who use them an unfair advantage in terms of sports performance. Personal problems faced by athletes can also be significant causes (e.g., poor school grades, dysfunctional personal and family life). In such cases, drugs may represent a way for athletes to cope with personal difficulties (Gardner & Moore, 2006). Boredom can lead some athletes to turn to drugs. Especially on weekends, when boredom is more prevalent, whether because teams travel or because team activities are unplanned and left to chance (Anshel, 1991). Low self-esteem can also contribute to such practices. Often, athletes with low self-esteem may doubt their abilities or become anxious when comparing their own skills with the perceived superior abilities of their opponents (Williams, 2015).

It is observed that the use of banned substances does not necessarily have the specific aim of increasing performance—often, they are used recreationally or for managing emotional difficulties more or less related to professional activity.

Physical factors can also influence athletes to use banned substances, such as altering body mass (weight loss or muscle development) or specific physical abilities (increasing endurance, muscle relaxation, etc.). These factors do not act independently of each other but often interact in various ways from person to person, either facilitating or, conversely, hindering their use.

Doping and Psychomotor Skills

Skills are considered to be a class of "mediating processes" identified through a combination of experimental and correlational research (Fleishman & Bartlett, 1969). It is suggested that a skill leads to observed consistency in performance, achieved after variations in stimuli and response requirements. An important distinction is made between skill and ability. Skill is more general regarding performance across different tasks, while ability refers to the level of competence achieved in a specific task. This competence may depend on a skill or a combination of skills. Skills are viewed as relatively stable psychological and physical attributes or characteristics, allowing individuals to perform various activities. When discussing skills, we immediately think of individual differences. These individual differences can have a psychological substrate, or alternatively, refer to physical or cognitive skills (Fleishman, 1975).

Skills can be of several types, best classified in Fleishman's taxonomy (Fleishman & Reilly, 1992). This taxonomy resulted from important studies conducted on human skills in the late 1960s and early 1970s. It is one of the most important taxonomies based on scientific evidence ("evidence-based" taxonomy). In this classification, 73 skills are grouped into 5 major categories: (1) cognitive skills – memory capacity, attention, arithmetic ease, etc.; (2) psychomotor skills – manual dexterity, movement synchronization, etc.; (3) physical skills – static strength, body balance, etc.; (4) sensory/perceptual skills – color vision, auditory attention, etc.; (5) social skills – behavioral flexibility, persuasion, etc. (Fleishman & Reilly, 1992). Of interest for us in this paper are psychomotor skills. We will describe some essential psychomotor skills required for performance in various sports.

Over time, many studies have shown that various drugs can negatively affect athletes or people in general, especially from a psychomotor perspective. For example, one study aimed to see how benzodiazepines (i.e., a class of psychotropic drugs with a chemical structure featuring a benzene ring fused with a diazepine ring) might affect psychomotor performance. One of the authors' conclusions was that the speed at which simple repetitive acts are performed can be affected by benzodiazepines (Wittenborn, 1979).

Regarding other drugs such as cannabis, various studies have shown that this drug affects cognitive performance as well as psychomotor performance, slowing reaction time, motor coordination, and altering short-term memory and concentration (Ashton, 2001; Prini et al., 2020; Maynard et al., 2023). In one study, authors showed that cannabinoid substances reduced peak performance in ten physically healthy male cyclists. Additionally, another study on 161 athletes who were administered THC (215 mg/kg orally) observed a general decrease in standing stability, simple and complex reaction times, and psychomotor skills (Eichner, 1993). A significant risk can also occur in motor sports (e.g., Formula 1, MotoGP, etc.). For example, one study aimed to examine the effect of cannabis on psychomotor skills in drivers. The authors showed that the acute effects of cannabis on psychomotor performance might include increased latency in braking, variations in lateral positioning, leaving a larger distance between the subject's vehicle and the car in front, poor performance in tracking and divided attention tasks, as well as reduced speed and reaction time (Armentano, 2013).

Even though the influence of inhaled cannabis on psychomotor skills is likely less severe than the influence of alcohol consumption (including even relatively small amounts of alcohol), driving under the acute influence of cannabis is still associated with an increased risk of accidents in certain situations. This increased risk is dose-dependent and appears most likely to manifest in situations involving an unexpected change in the driving environment (and requiring a complex psychomotor response). The highest-risk drivers are likely those who are inexperienced cannabis users, who are less tolerant to the effects of the substance. Thus, it is plausible that orally consumed cannabinoid substances, such as cannabis-infused foods, may exert a greater influence on psychomotor skills for longer periods. However, this issue has not yet been subjected to rigorous study (Armentano, 2013).

The combined administration of cannabis and alcohol usually has an additive influence on psychomotor performance, which can lead to significantly reduced performance and increased chances of accidents. Thus, drugs such as cannabis can be very risky, especially in dangerous sports that require a clear mind, quick reactions, or split-second timing (Campos et al., 2003). Regarding the mechanism through which cannabis acts at the psychomotor level, cannabinoids have a high lipid/water partition coefficient. Thus, they can be stored in body fat and excreted slowly through urine. Additionally, cannabinoids inhibit the release of acetylcholine in the hippocampus, which is the CNS region responsible for cognitive activities such as learning and memory. Moreover, the release of norepinephrine is also inhibited in the cerebral cortex and cerebellum regions, which are responsible for vigilance and motor coordination, respectively (Campos et al., 2003).

Other drugs can also affect psychomotor skills. For example, one study examined the effects of drugs (e.g., ethanol, pentobarbital) on psychomotor performance using laboratory tests. Each selected test had both motor and cognitive components. It is important to note that the tasks used in the study did not measure all parameters of psychomotor performance. Results showed that ethanol and pentobarbital reduced performance on computer tasks, card sorting, and circular light tasks. In card sorting tasks, pentobarbital induced increases in sorting time (about twice the sorting time observed after ethanol administration; Pickworth, 1997).

Psychological Interventions for Mitigating the Psychomotor Consequences of Doping

As we can observe, drugs that athletes might ingest can have a negative impact on psychomotor performance. Therefore, an important goal in sports psychology is to enhance athletes' performance, with sports psychologists employing various psychological techniques to achieve this.

The term "intervention" generally refers to the types of engagement that sports psychologists may have with an athlete, but occasionally also with a coach, a team, or a family (Dosil, 2006). Interventions developed and implemented by psychologists can generally be classified as psychological, social, or psychosocial in nature, which we describe as any action or process that alters the functioning and/or performance of athletes through changes in thinking and behavior, social factors, or a combination of individual thinking, behavior, and social factors (Brown & Fletcher, 2017).

In various team and individual sports, regulating and improving motor skills and psychomotor processes is a requirement for success. In dynamic sports (e.g., basketball, soccer, handball, etc.), which require extensive training, it is necessary to address the high demands that athletes face. For example, basketball requires specific defensive and offensive maneuvers, such as blocking, rebounding, dribbling, passing, and shooting (Ziv & Lidor, 2010). Among these, shooting can be considered the most critical skill for determining the outcome of a game (Malone et al., 2002). Self-confidence and concentration help the player to make the shot in a relaxed state. In various team sports, delayed decision-making (slow reactions) will hinder skill performance, and this can ultimately predict the outcome of the game. Since different actions such as shooting or kicking at the goal require the ability to move quickly, players must react as quickly as possible to execute the shot. Executing a perfect shot or kick requires processing multiple relevant cues and signals simultaneously, so a player must respond as quickly as possible to more than one stimulus (Paul et al., 2012).

Since drugs can affect athletes mentally or psychologically (e.g., increasing levels of depression, irritability, aggressiveness, or sluggishness; Bushman, 1993) and not just psychomotorically (causing delayed reactions), we propose a combination of biofeedback techniques (i.e., to induce relaxation in the athlete) and mental imagery techniques (i.e., to improve psychomotor performance). We will describe these techniques in more detail.

Biofeedback is a technique involving teaching individuals to control certain bodily functions, such as heart rate, blood pressure, and even skin temperature, by responding to feedback their body provides through an electronic instrument (Quick et al., 1997). Psychophysiological research has shown a relationship between psychomotor efficiency and physiological activity (Bazanova & Shtark, 2007; Bazanova et al., 2007). Biofeedback can be used as a method to support the learning process during training for developing cognitive and psychomotor skills (Paul et al., 2012). In recent years, there has been substantial support for heart rate variability biofeedback (HRVB), particularly for performance enhancement (Gevirtz, 2013). Although classical meditation or yoga techniques allow practitioners to reach an almost resonant state, biofeedback routines are necessary to achieve optimal results (Malone et al., 2002). Such practice is called heart rate variability biofeedback (HRV-BFB) or, when practiced regularly, HRV-BFB training.

Typically, athletes are prone to regularly dealing with stress due to successive competitions. It is very common to see players in high-pressure situations where they fail to perform at a certain point in the game due to nervousness (Paul et al., 2012). Furthermore, athletes who use drugs may suffer even more in this regard, as drugs act as an adjunct, further stimulating levels of nervousness, irritability, or aggressiveness.

Currently, studies on the potential benefits of HRV-BFB training in athletes are still in their early stages (Lehrer et al., 2006). One study showed that HRV-BFB training can help athletes gain control over their psychophysiological processes, thus aiding an athlete to perform at their best. The study conducted on basketball players indicated that those who underwent HRV-BFB training showed a significant reduction in reaction time when making decisions and in movement time, compared to placebo and control groups, and this reduction persisted even one month later (Paul et al., 2012).

The protocol for HRV-BFB training is as follows. Individuals are asked to sit with their eyes closed on a chair for five minutes, with their hands resting on the chair, in a quiet room before starting HRV biofeedback training. In the first session, the subject is asked to breathe at varying respiratory rates for about two minutes each (6.5, 6, 5.5, 5, 4.5 breaths per minute), with the goal of determining the resonant frequency. At a certain respiratory frequency, the subject is provided with a stimulus. The subject is instructed to breathe at that special rate. The resonant frequency can be detected as a peak in the amplitude signal of the resonant frequency monitor on the biofeedback equipment. The subject is then asked to breathe at their resonant frequency and relax. BFB sessions can be given for 10 consecutive days (20 minutes per session; Paul et al., 2012). Heart rate can be increased through slow sympathetic activity or decreased through rapid parasympathetic (vagal) activity. The balance between these systems simultaneously creates an increase and decrease in heart rate, which produces an optimal state of relaxation. The most supported mechanism through which HRV-BFB training works is the reinforcement of homeostasis at the baroreceptor (Lehrer & Gevirtz, 2014).

Many athletes do not realize that they can perform various mental exercises away from the sporting context in preparation for competition. Imagery, also known as visualization, refers to various intentional actions and strategies that can help enhance actual performance. Athletes can imagine opponents, how they compete and behave, while also envisioning their own responses. Imagery refers to forming a mental image of a desirable performance in a future context, whether in training or in an actual competition. Mental rehearsal is the repeated practice of an act or a sequence of events in the mind. Such repetitions are useful for athletes, helping them remember how to perform. Additionally, these techniques can predict what athletes should expect and what should be done in various situations that may arise. An athlete can also imagine an attitude to have, the intensity of the game, being in control, and other behaviors that might be considered appropriate. The athlete (or the athlete with the sports psychologist) should schedule mental rehearsal sessions (when, how long, and where they should take place). A possible approach is to allocate training to late afternoons or evenings when the athlete is alone and relaxed. The time allocated could be 15 minutes per session (approximately 3 times a week, but there is no documentation regarding session frequency and duration, so the athlete will need to see what works best for them). It is also known that some individuals are much better at visualization than others (but there are various programs to improve concentration and visualization skills; Dosil, 2006).

The ability to create internal images related to performance and use specially designed mental rehearsal sessions can contribute in several ways (which have been more speculated about). Thoughts can trigger neural and muscular activity in corresponding parts of the body. Since a part of the body is imagined to be in action, neural activity increases in that area. Thus, in a way, the appropriate neural pathways for performing a particular movement are reinforced.

A mental rehearsal session can be a source of motivation, inspiring the athlete to be focused and prepared for performance the next day. Ultimately, it could also increase the athlete's confidence as such experiences are associated with positive thinking (relevant to performance). The level of confidence may increase as positive images are created in preparation for competition (Dosil, 2006).

Hypotheses

Thus, based on the positive effects that 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

Conscientiousness is a tendency to manifest self-discipline, act with respect, and make efforts toward achievements regardless of external expectations. It relates to how people control, regulate, and direct their impulses. High conscientiousness is often perceived as stubbornness, while low conscientiousness is associated with flexibility and spontaneity but can also appear as negligence and lack of confidence (Toegel & Barsoux, 2012). High conscientiousness scores indicate a preference for planned rather than spontaneous behavior.

Neuroticism refers to the tendency to experience negative emotions such as anger, anxiety, or depression. It is sometimes referred to as emotional instability. According to Eysenck’s (1967) theory of personality, neuroticism is linked to low tolerance for stress or aversive stimuli. Neuroticism is a classic temperament trait that has been studied long before being included in the five-factor model. Individuals with high neuroticism scores are emotionally reactive and vulnerable to stress. They are more likely to interpret ordinary situations as threatening and may perceive minor frustrations as unbearable. Their negative emotional reactions tend to persist for unusually long periods, meaning they often have a bad mood. For instance, neuroticism is associated with a pessimistic approach to work, the certainty that work impedes personal relationships, and high levels of anxiety due to workplace pressures (Costa & McCrae, 1992).

In this study, we will focus on conscientiousness and neuroticism. Various studies have examined these traits in relation to other techniques (e.g., mindfulness) aimed at relaxing individuals. For example, a meta-analysis that investigated the relationship between personality and mindfulness found that the strongest relationship with mindfulness was found for neuroticism ($r = -0.45$) and conscientiousness ($r = 0.32$) (Giluk, 2009). Since conscientious individuals are much more organized and self-disciplined (i.e., they are more likely to practice biofeedback or mental imagery techniques at a specific time of the day), they are more likely to achieve higher psychomotor performance. Additionally, because emotionally unstable individuals have a greater tendency to ruminate (Costa & McCrae, 1992) and a more pronounced avoidance behavior compared to emotionally stable individuals (Lommen et al., 2010), they are more prone to having a negative state (i.e., one that blocks the positive effect of biofeedback techniques in achieving a relaxation state that allows for the performance of mental imagery techniques in a beneficial context). Therefore, we hypothesize that individuals with higher emotional stability may achieve higher psychomotor performance (Nyklíček & Irrmischer, 2017). 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.

Physical Self-Efficacy Scale

Self-efficacy is conceptualized by Bandura (1986, 1997) as beliefs about one's capabilities to execute actions successfully. Self-efficacy is positively associated with task acceptance, effort, and persistence in the face of failure or adverse situations (Bandura, 1986). Studies have highlighted that self-efficacy is both an important determinant and a consequence of physical activity (McAuley & Blissmer, 2000). Although self-esteem and self-efficacy can be viewed as related constructs of the "self," they are not identical. As Bandura (1997) noted, there is no well-established relationship between beliefs about one’s abilities (self-efficacy) and self-esteem. A person may lack confidence in a specific task without negative effects on self-esteem, simply because their self-worth is not evaluated based on that task (Bandura, 1997).

Self-efficacy pertains to an individual's ability to perform a specific task, while self-esteem is the product of comparative processes (Marsh, Walker, & Debus, 1991). To fully understand how these two constructs function as psychological processes, they must be measured in a faithful and valid manner. For example, measuring self-efficacy should accurately reflect the specific task or behavior (McAuley & Mihalko, 1998).

The Physical Self-Efficacy Scale (Ryckman, Robbins, Thornton, & Cantrell, 1982) has been used as a measurement tool for physical self-efficacy. Existing data indicates that the scale has acceptable levels of reliability and validity (Baldwin & Courneya, 1997; McAuley, Mihalko, & Bane, 1997). However, the Physical Self-Efficacy Scale has received some criticism in the literature. Some criticisms are related to the psychometric properties of the scale. Motl and Conroy (2000) questioned the factorial structure of the scale.

Other criticisms have related to the scale being a general measure of physical self-efficacy, which violates the assumption that self-efficacy is task- or situation-specific. Feltz and Chase (1998) pointed out that the scale does not include items related to persistence in the face of difficulties and adverse situations. Other authors believe there is high conceptual overlap between self-efficacy and self-esteem (Fox & Corbin, 1989). However, there are no studies comparing the two constructs to investigate the difference between them. Existing studies have generally assessed the relationship between physical activity and self-esteem and found statistically significant correlations ($r = .53$, $r = .65$, $r = .70$; Baldwin & Courneya, 1997).

For the athlete population in Romania, there are no tools to measure physical self-efficacy. Therefore, sport psychology practitioners do not have tools available to assess athletes' physical self-efficacy and monitor their progress following psychological interventions. The aim of this study is to evaluate the psychometric properties of the Physical Self-Efficacy Scale. We will investigate the correlations between items, internal consistency of the scale, and the factorial structure of the scale through confirmatory factor analysis. Theoretically, this study investigates physical self-efficacy in the athlete population in Romania. Practically, the study provides specialists with a tool for assessing Romanian athletes to inform psychological sports interventions in a valid manner.

2. Methodology

Participants in the Three Studies

The sample consisted of 30 athletes from athletics, weightlifting, canoeing, Greco-Roman wrestling, members of Romanian sports clubs. They were either suspected of doping or confirmed for doping. The personal details of the participants remained confidential to protect their privacy due to the sensitivity of the topic addressed. The relationship with participants in studies involving interventions must be based on respect, trust, and honesty, according to research ethics standards. Ethical recommendations were followed to avoid harming the study participants through several measures. First, the potential benefits and risks associated with participation in the research were presented. Second, participants' decisions to take part in the study were not implicitly or explicitly influenced. The only measure taken was ensuring anonymity for participants. To ensure their identities were protected, no personal details were requested; instead, they were given a unique identification code consisting of four digits, which they used to complete the questionnaires before and after the intervention.

To test the psychometric properties of the Physical Self-Efficacy Scale, a sample of 208 athletes, former athletes, and amateur athletes was used. Of these, 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. The questionnaire was distributed in physical format, and the data were subsequently entered into SPSS. Each participant was randomly assigned a unique code number to protect their personal data.

Procedures

For the first study, participants completed the psychomotor performance instrument before and after the intervention. The 30 study participants were informed about the potential benefits of the study and about the protection of anonymity. They were assured that no personal data would be collected that could later identify them. Each participant was randomly assigned a unique four-digit code, which they used to complete the questionnaires before and after the intervention to compare scores at the two time points. Before completing the instruments, participants were given instructions on how to complete them. The 30 athletes were randomly divided into groups of 10 and participated for five weeks, once a week, in a 90-minute session with a psychologist who administered the intervention.

The first component of the psychological intervention was psychoeducation. Participants were introduced to the main substances used by athletes in doping and the motivations discovered by scientists for why athletes resort to using these substances. Additionally, individual differences (e.g., personality factors) that predispose certain athletes to doping were presented. The psychoeducational component was interactive, with participants contributing to the discussion by sharing opinions on why athletes dope and what individual differences lead athletes to this practice, based on personal experience and observations of other athletes throughout their careers.

Each session included two types of activities: biofeedback and mental imagery/repetition. The biofeedback component of the intervention involved using a method where athletes learned to control their heart rate by responding to feedback provided by their body through an electronic instrument (Quick et al., 1997). Psychophysiological research has shown a relationship between psychomotor efficiency and physiological activity (Bazanova & Shtark, 2007; Bazanova et al., 2007). Considering that biofeedback can be used as a way to develop cognitive and psychomotor skills (Paul et al., 2012), heart rate variability biofeedback (HRV-BFB) was used, especially to improve performance by developing voluntary relaxation capacity (Gevirtz, 2013).

In the protocol, athletes were asked to sit with their eyes closed on a chair for five minutes, with their hands resting on the chair, in a quiet room before starting the HRV biofeedback training. In the first session, athletes breathed at variable breathing rates, approximately two minutes each (6.5, 6, 5.5, 5, 4.5 breaths per minute), with the goal of determining the resonance frequency. At a certain breathing frequency, a stimulus was provided to the subject. The subject was instructed to breathe at that specific rate. The resonance frequency can be detected as the maximum point in the amplitude signal of the resonance frequency detector on the biofeedback equipment. The athlete was then asked to breathe at their resonance frequency and relax. Participants were asked to continue practicing the relaxation breathing exercises at home, exactly as they had done in the biofeedback sessions with the psychologist.

The second practical component of the intervention was imagery. Imagery refers to forming a mental image of a desirable performance in a future context, whether in training or in a real competition. Athletes were asked to repeatedly practice an act or a sequence of events in their minds. Such repetitions are useful for athletes, helping them recall how they should perform. Study participants were also instructed to imagine an attitude they should have and other behaviors that could be considered appropriate. These mental imagery exercises were performed after the biofeedback session, once athletes were relaxed. Participants were advised to practice mentally for 10 to 20 minutes, depending on the optimal duration identified by each. They were also explained the reasons why these interventions work. As previously stated, thoughts can trigger neuronal and muscular activity in corresponding parts of the body. Since a part of the body is imagined as being in action, neuronal activity increases in that area. Thus, the appropriate neural pathways for executing a specific movement are reinforced. Finally, participants were encouraged to use mental imagery exercises daily until the next weekly meeting. At the end, data from the two measurements were entered into the statistical program and differences between scores at the two measurements were analyzed.

For the analyses in the second and third studies, participants completed the personality test before the intervention began, so that moderation hypotheses could later be tested. The 30 athletes completed items regarding their levels of conscientiousness and emotional stability before the intervention started. Finally, these were entered into the statistical program, and the moderating role of conscientiousness for the second study and the moderating role of emotional stability for the third study were analyzed.

Instruments Used in the Three Studies

Psychomotor performance was measured using the short form of the Physical Self Description Questionnaire (PSDQ-S; Marsh, Martin, & Jackson, 2010). This instrument includes 40 items measuring 11 factors. Based on the normative sample used for validating the long form of the instrument (1,607 Australian adolescents), a short form was developed. This short form was validated on five separate samples (708 Australian adolescents, 986 Spanish adolescents, 395 Israeli students, 760 Australian adults). The instrument measures 11 factors of the physical self-concept: health (the extent to which the respondent frequently becomes ill, how quickly they recover, etc.; 5 items), coordination (how good the respondent is at coordinating movements, fine motor skills, etc.; 5 items), activity (the extent to which the respondent is physically active, engages in regular physical activity, etc.; 4 items), overweight (the extent to which the respondent is overweight, exceeds optimal weight, etc.; 3 items), sports skills (the extent to which the respondent perceives themselves as good at sports, athletic, with high sports skills; 3 items), general physical condition (the extent to which the respondent has a positive perception of their overall physical condition; 3 items), physical appearance (the extent to which the respondent perceives themselves as looking good; 3 items), strength (the extent to which the respondent perceives themselves as strong, with high muscular strength; 3 items), flexibility (the extent to which the respondent perceives they can bend their body in different directions; 3 items), endurance (lack of fatigue during intense exercise, ability to cover long distances in running, etc.; 3 items), and general self-esteem (general positive feelings about oneself; 5 items). The score for each factor is calculated by summing the items specific to the factors and dividing the total by the number of items. Appendix 1 presents the instructions and items of the test.

Personality was measured using the IPIP Big Five Inventory (Iliescu et al., 2015; Goldberg et al., 2006). The IPIP Big-Five scales contain ten items for conscientiousness (e.g., "I am attentive to details.") and ten items for emotional stability (e.g., "I am relaxed most of the time."). Items are rated on a five-point scale (from 1 = strongly disagree to 5 = strongly agree). Scores for the two personality traits were obtained by summing the responses to the items and dividing the result by the number of items.

Physical self-efficacy was measured using the Physical Self-Efficacy Scale (Hu, McAuley, & Elavsky, 2005). It contains 10 items (e.g., "I have agile and precise movements."), on a scale from 1 (strongly disagree) to 5 (strongly agree).

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

3. Results

Differences Between Pretest and Posttest Measurements in the First Study

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 scores after the intervention for coordination (t = -2.28, p = .03, Mdif = -.80, d = -.41), sports skills (t = -2.13, p = .04, Mdif = -.83, d = -.39), general 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 7 graphically represents the differences between pretest and posttest measurements for variables where statistically significant results were identified.

Analysis of the Moderating Role of Conscientiousness for the Second Study

The moderating role of conscientiousness regarding the effectiveness of the intervention was tested. Given that data were collected from a single sample at two time points and that t-tests for dependent samples do not allow multivariate analyses, the following statistical approach was implemented. A series of new variables were created 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, were then correlated with conscientiousness. If conscientiousness indeed acts as a moderator, a positive correlation is expected between it and the newly created variables, as an increase in conscientiousness would lead to an increase in the difference between pretest and posttest measurements (i.e., the effectiveness of the intervention). Given the small sample size, Spearman correlations were used. The results are presented in Table 5. Significant positive correlations were found between conscientiousness and the difference between posttest and pretest 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 regarding these three variables.

Moderation Analysis for the Third Study

The role of emotional stability as a moderator of intervention effectiveness was tested. As in the previous study, since the data were collected from a single sample at two time points and dependent 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 created by calculating the difference between the second measurement scores and the first measurement scores for each variable. These new variables, representing the differences between posttest and pretest, were then correlated with emotional stability. If emotional stability indeed acts as a moderator, we would expect to find a positive correlation between it and the newly created variables, as higher emotional stability should be associated with a greater difference between pretest and posttest measurements (i.e., intervention effectiveness). Given the small sample size, Spearman correlations were used. Significant positive correlations were found between emotional stability and the difference between posttest and pretest for general physical condition ($r = .41, p < .05$) and the difference between posttest and pretest for general self-esteem ($r = .39, p < .05$). The data support the idea that athletes with higher emotional stability benefit more from interventions concerning these two variables.

Psychometric Properties of the Physical Self-Efficacy Scale

A statistically significant positive correlation was found between item 1 ("I have excellent reflexes.") and item 2 ("I have agile and precise movements.") of $r = .61, p < .001$. There was a significant positive correlation between item 1 ("I have excellent reflexes.") and item 3 ("My body is rather strong.") of $r = .50, p < .001$. A significant positive correlation was also found between item 1 ("I have excellent reflexes.") and item 4 ("I can run fast.") of $r = .64, p < .001$. Furthermore, item 1 ("I have excellent reflexes.") showed a significant positive correlation with item 5 ("I feel in control when I take dexterity tests.") of $r = .64, p < .001$. A significant positive correlation was found between item 1 ("I have excellent reflexes.") and item 6 ("I have weak muscle tone.") of $r = .55, p < .001$. There was also a significant positive correlation between item 1 ("I have excellent reflexes.") and item 7 ("I am not proud of my sports skills.") of $r = .55$, $p < .001$. Item 1 ("I have excellent reflexes.") was significantly positively correlated with item 8 ("My speed has helped me out of difficult situations.") of $r = .54$, $p < .001$. Additionally, item 1 ("I have excellent reflexes.") showed a significant positive correlation with item 9 ("I have a strong grip.") of $r = .57$, $p < .001$, and item 10 ("Due to my agility, I have been able to do things that others cannot.") of $r = .57$, $p < .001$.

A significant positive correlation was found between item 2 ("I have agile and precise movements.") and item 3 ("My body is rather strong.") of $r = .38$, $p < .001$. There was also a significant positive correlation between item 2 ("I have agile and precise movements.") and item 4 ("I can run fast.") of $r = .71$, $p < .001$. Item 2 ("I have agile and precise movements.") was significantly positively correlated with item 5 ("I feel in control when I take dexterity tests.") of $r = .65$, $p < .001$. Additionally, item 2 ("I have agile and precise movements.") showed a significant positive correlation with item 6 ("I have weak muscle tone.") of $r = .71$, $p < .001$. A significant positive correlation was also found between item 2 ("I have agile and precise movements.") and item 7 ("I am not proud of my sports skills.") of $r = .69$, $p < .001$. Finally, item 2 ("I have agile and precise movements.") was positively correlated with item 8 ("My speed has helped me out of difficult situations.") of $r = .57$, $p < .001$. The remaining correlations are presented in Table 7.

There were no differences between males and females regarding responses to item 9 ("I have a strong grip."; $p = .42$) or item 10 ("Due to my agility, I have been able to do things that others cannot."; $p = .61$).

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

Table 11 presents the loadings of each item on the general factor. As observed, all loadings are above .60. Therefore, we can consider that the items load on a common factor and are latent variables of a common observed construct.

Confirmatory Factor Analysis (CFA) was conducted to test the extent to which the data fit the theoretical model. The model is presented in Figure 11. According to the results, the data did not fit the theoretical model (Table 12). Therefore, modification indices were analyzed to test for correlated errors between items. Correlated errors are presented in Table 13. Item 6 had a high correlated error with item 7, most likely due to the reverse wording of the items.

Table 14 shows the loadings of items on the general factor after accounting for the correlated error between item 6 and item 7. The final model, with the correlated error between item 6 and item 7 included, presents good fit indices. The model is shown in Figure 12. Table 15 presents the fit indices. According to the results, the instrument has a good, unifactorial factorial structure.

4. Discussions

The purpose of the current study was to test a psychological intervention for alleviating the psychomotor consequences of doping. Additionally, the moderating role of conscientiousness and emotional stability in the effectiveness of the intervention was examined. The intervention included two types of activities: biofeedback and mental imagery/repetition. Athletes reported higher scores after the intervention for coordination, sports skills, general physical condition, strength, flexibility, endurance, and general self-esteem. These data are consistent with existing research on biofeedback (Gevirtz, 2013; Paul et al., 2012) and mental imagery (Dosil, 2006). The data support the idea that athletes who are more conscientious benefit more from interventions concerning coordination, flexibility, and endurance. These results can be explained by the fact that conscientious athletes are much more organized and self-disciplined (i.e., they are more likely to practice biofeedback or mental imagery techniques at certain times of the day), making them more likely to achieve greater psychomotor performance. The data also support the notion that athletes with higher emotional stability benefit more from interventions regarding general physical condition and general self-esteem. These relationships can be explained by the fact that emotionally unstable athletes tend to ruminate (Costa & McCrae, 1992) and exhibit more pronounced avoidance behavior than emotionally stable athletes (Lommen et al., 2010), making them more prone to a negative state that blocks the positive effect of biofeedback techniques in achieving a state of relaxation conducive to practicing mental imagery in a beneficial context.

Theoretically, this research makes two important contributions. First, it highlights the importance of psychological interventions in improving athletes' psychomotor performance. The study emphasizes that biofeedback and mental imagery are useful psychological techniques for recovery following doping. Second, the study contributes to the field by capturing the interaction between psychological interventions and participants' individual differences. The results show that not all athletes respond equally to psychological interventions, as this is determined by the behavioral predispositions of those receiving interventions. As previously noted, these differences are related to athletes' discipline in practicing psychological exercises even on days when they do not work directly with the psychologist and their ability to relax easily when practicing biofeedback or mental imagery. Practically, the results are relevant for sports psychology practitioners as they provide additional evidence for the use of biofeedback or mental imagery with athletes suspected or confirmed to have used doping. These interventions can also be used with other athletes as methods to enhance performance beyond traditional physical training. The second practical implication concerns the role of individual differences. Practitioners can identify athletes with lower levels of conscientiousness and ensure they perform psychological exercises at the club, where they are more likely to engage in the interventions, given that they lack the discipline to follow the psychologist's instructions in the psychologist's absence. Simultaneously, the sports psychologist will work longer with athletes with low emotional stability, considering the difficulties they face when trying to relax.

Like any other research, this study has several limitations. First, the sample was a convenience sample. Given the nature of the study and research ethics principles, personal data (age, gender, sport practiced by each participant) were not collected. These sample characteristics do not allow conclusions about the generalization of results. It is possible that the results obtained from this sample may not be replicated in other samples, depending on factors such as age, gender, or sport practiced by the study participants. Future research could consider different samples to verify whether the intervention effects can be replicated. Second, two psychological intervention techniques were used simultaneously. As a result, the effect of each individual intervention cannot be isolated to identify the source of the intervention's effectiveness. It is possible that one of the two methods used (biofeedback or mental imagery) is the main reason for the intervention's 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. In such a research model, the three groups should be as equivalent as possible to avoid results being affected by individual differences among study participants.

Another limitation of the study concerns the use of subjective measures. Since the results are based on self-report instruments, the measurements may be distorted. Even though the data were collected under anonymity protection, it is possible that the athletes involved tried to present doping as having affected them less than it actually did. Additionally, involuntary self-deception might lead participants to report distorted scores on the measured variables due to ignoring the negative effects of doping because accepting them is difficult. Future studies could consider more objective measurements 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. Thus, conclusions regarding the effectiveness of the intervention can be based on data with a lower chance of distortion. However, it is important to note that the results of the current study provide a robust starting point for future research. A major limitation of the current study is the lack of a control group. The results observed in the experimental group cannot be compared to those of athletes who did not receive any intervention. Given the absence of a control group, alternative explanations for the results, such as the passage of time, natural evolution of participants, or other events unrelated to the tested psychological intervention, cannot be excluded. It is possible that the observed effects are due to the passage of time reducing the negative effects of doping or that participants have overcome certain negative consequences of doping on their own initiative. Furthermore, the effect may be due to the support received from family, friends, teammates, or the sports club rather than the psychological intervention itself. Future studies could include a control group to test these alternative explanations and to increase the validity of the research. Finally, the study did not include a placebo group. Therefore, we cannot exclude the impact that expectations regarding the effectiveness of the intervention might have had on the results. It is possible that participants reported improvements following the intervention simply because they perceived it to be effective based on the placebo effect, without actual changes occurring. Therefore, to control for the placebo effect, future studies could include a group participating in an intervention that mimics a psychological program but has no actual effect. If there are differences between the experimental group and the placebo group, then we can conclude that the results are due to the intervention and not to this phenomenon.

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