ORIGINAL ARTICLE

The placebo effect does not enhance sprinting or jumping performance in trained athletes

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ABSTRACT

This study aimed to analyse the placebo effect associated with caffeine on the performance of sprinters in a 60-meter sprint test and a standing triple jump. Methods: Thirteen trained sprinters (7 men, 6 women) volunteered to complete the experimental procedures (22.8 ± 4.7 years, 64.7 ± 6.5 kg and 173.9 ± 6.5 cm). A repeated, randomized, and counterbalanced experimental design was used to compare the effects of the ingestion of a placebo reported as caffeine (placebo) and a control situation where no substance was ingested (control). In both conditions, they completed a standing triple jump, and a 60-meter sprint test and filled out a questionnaire about potential side effects. Results: Performance was similar in placebo and control conditions in the 60-meter sprint test (7.52 ± 0.46 vs. 7.55 ± 0.43 s; p = .49; small d = 0.20) and the standing triple jump (7.28 ± 0.84 vs. 7.28 ± 0.87 m; p = .95; trivial d = 0.02). The most frequent side effects derived from deceptive caffeine ingestion were increased activeness (53.8%), nervousness (23.1%) and insomnia (15.4%). Conclusion: Deceptive caffeine ingestion did not alter performance in sprint and triple jump performance in trained athletes, while some minor side effects appeared. Individual responses to placebo ingestion should be carefully considered before making recommendations for sprint athletes.

Keywords: Performance analysis, Expectancy, Deceptive administration, Ergogenic aids, Sports performance.

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INTRODUCTION

Placebo effects involve a variety of psychological and physiological mechanisms and could be influenced by situational and learning conditions (Colloca & Barsky, 2020; Frisaldi et al., 2020; Frisaldi et al., 2023; Murray, 2021). Placebo and placebo effect/s definitions have shown discrepancies but have been used for decades (Macedo et al., 2003). These concepts typically suggest that individuals receiving a placebo treatment show improved health outcomes compared to what would have been anticipated if they had not received the placebo (Murray, 2021). The findings of medical placebo research have shown small to large effects on several health conditions (Frisaldi et al., 2023; Tavel, 2014). However, the discussion about placebo and placebo effects remains open (Murray, 2021), and logically, placebo effects could be effective also outside the medical domain (Pollo et al., 2011).

In sports, the placebo effect refers to the improved exercise performance resulting from the belief that one has received a beneficial treatment (Clark et al., 2000; Szabo, 2023). This placebo effect is likely a key factor in all sport and exercise research studies involving human participants (Beedie et al., 2018). In recent decades, there has been a growing interest in this topic, where previous reviews have found a small to moderate improvement in exercise performance (Beedie & Foad, 2009; Chhabra & Szabo, 2024; Hurst et al., 2020), and the findings of sport placebo research are similar to those found in the medical context (Beedie et al., 2018). The placebo effect can potentially enhance athletic performance or performance-related variables and, in some cases, these improvements are comparable in magnitude to those observed using ergogenic aids (Beedie et al., 2018). The potential to achieve this placebo effect in athletic performance has prompted research across various sports, investigating different placebo interventions, such as nutritional, mechanical, or other characteristics, including verbal manipulation (Chhabra & Szabo, 2024; Hurst et al., 2020). However, most of the studies conducted on the placebo effect have been studied from the perspective of ergogenic aids such as carbohydrates (Clark et al., 2000), amino acids (Kalasountas et al., 2007), sodium bicarbonate (McClung & Collins, 2007), or caffeine (Hurst et al., 2019; Valero et al., 2024).

Although a wide range of supplements are promoted for enhancing sports performance, many lack strong evidence supporting their ergogenic effectiveness (Peeling et al., 2018). Only a few (caffeine, creatine, specific buffering agents and nitrate) have good evidence of their benefits (Maughan et al., 2018). In addition, the effectiveness of these ergogenic aids depends on several factors, including the type of athletic event, the specific context in which they are used, the protocol (e.g. timing, dosage) employed and the individual athlete's goals and physiological responsiveness (Burke et al., 2019; Maughan et al., 2018; Peeling et al., 2018). One of the most commonly used ergogenic aids in sports is caffeine (Aguilar-Navarro et al., 2019), due to its well-known beneficial effects on athletic performance (Baltazar-Martins et al., 2020; Grgic et al., 2018; Guest et al., 2021; Salinero et al., 2019). Although caffeine improves several aspects of physical performance, including aerobic and anaerobic activities (Guest et al., 2021), and strength and power exercises (Grgic et al., 2018; Grgic & Varovic, 2022), its use has been more widespread in aerobic sports, perhaps because its benefits in strength/power disciplines were controversial for several years (Giraldez-Costas et al., 2023). However, nowadays there is solid evidence that caffeine is an ergogenic aid for these types of sports (Grgic & Mikulic, 2021; Grgic & Varovic, 2022; Guest et al., 2021). Maybe for this reason, caffeine's use in strength/power-based sports has increased substantially from 2008 to 2015 (Aguilar-Navarro et al., 2019). Thus, caffeine is an ideal substance for studying the placebo effect to maximize the expectations of increased performance, as certain expectations elicit greater placebo responses compared to doubtful expectations (Frisaldi et al., 2023). So, caffeine has become the most commonly used substance to induce a placebo effect in participants (Chhabra & Szabo, 2024; Hurst et al., 2020).

Deceptive caffeine ingestion has been studied in running (Beedie et al., 2007; De La Vega et al., 2017; Hurst et al., 2019; Rohloff et al., 2022; Valero et al., 2024), cycling (Beedie et al., 2006; Duncan, 2010), and resistance performance (Filip-Stachnik et al., 2020; Ortiz-Sánchez et al., 2024) with contradictory results. On cycling performance, Duncan (Duncan, 2010) found a significant placebo effect with deceptive caffeine ingestion on short-term, high-intensity exercise (e.g. Wingate test). In a 10-km time trial, Beedie et al. (Beedie et al., 2006) also found a placebo effect after deceptive caffeine ingestion, and a dose-response relationship emerged, with reduced performance when they believed they had ingested a placebo, 1.3% more power when they believed they had ingested 4.5 $mg \cdot kg^{-1}$ caffeine, and 3.1% more power when they believed they had ingested 9.0 $mg \cdot kg^{-1}$ caffeine. Studies on running endurance performance found improvements with deceptive caffeine ingestion on several times/distances, such as 1000-m running performance (Hurst et al., 2019), 4-km test (Rohloff et al., 2022), and 6-min time trial (Valero et al., 2024). So, belief in caffeine ingestion could propitiate enhanced endurance capacity.

However, controversial results emerged in strength or power performance in resistance exercises. Deceptive caffeine ingestion failed to improve maximal voluntary concentric force (Tallis et al., 2016), or strength variables on bench press or squat exercises (Filip-Stachnik et al., 2020; Ortiz-Sánchez et al., 2024). However, other studies found that placebo intake when the athletes were informed they were taking caffeine, improved the performance of explosive movements (Costa et al., 2019) or repetitions in one set to failure at 60% (Duncan et al., 2009) or 80% repetition maximum (Campelo et al., 2023). Duncan et al. (Duncan et al., 2009) and Campelo et al. (Campelo et al., 2023) found that participants completed more reps (single leg extension and bench press, respectively) when participants perceived they had ingested caffeine, and the RPE was lower in the deceptive caffeine ingestion condition. In contrast, Filip-Stachnik et al. (Filip-Stachnik et al., 2020) found no significant differences in either the number of repetitions completed or one-repetition maximum in the bench press exercise following deceptive caffeine ingestion. Ortiz et al. (Ortiz-Sánchez et al., 2024) observed a significant increase only in two variables of the strength tests (mean velocity bench press at 50% of 1 RM, and rate of force development in squat at 75% of 1RM) but no significant differences were found in the other strength variables studied, where 50%, 75% and 90% 1RM loads were measured both in bench press and squat. So, it is not clear that just the belief of taking caffeine (or other ergogenic aid) would improve sport performance on strength or power performance.

Sprint performance is a key factor for performance in many sports, such as team sports, or sprint events in athletics. Curiously, while some studies have analysed the potential ergogenic effects of caffeine on team sports (Salinero et al., 2019), research about caffeine's effects on sprint events has received minor attention. Specifically in sprint events, Lara et al. (2015) in swimmers and Matsumura et al. (2023) in athletics have demonstrated improvements in sprint performance with acute caffeine ingestion. In the context of the placebo effect, there are controversial results. Beedie et al. (2007) found improved repeated sprint performance, while Hurst et al. (2017) did not find a placebo effect on 5x20 m repeated sprint performance. In athletics, De La Vega et al. (2017) found that drinking an inert liquid, primed with positive information, reduced the time in the 200-m sprint test on recreational runners (≈40 sec for 200-m).

Therefore, it seems that the placebo effect could be incorporated as a simple strategy to improve performance since it does not present any risk to the health of athletes, diminishing the possible side effects of other ergogenic aids used by athletes, such as caffeine, where it has been shown that it can cause nervousness, gastrointestinal discomfort, or insomnia (Pallarés et al., 2013; Salinero et al., 2014). In addition, higher doses of caffeine (i.e., 9 mg/kg of body mass) drastically increased the frequency of the adverse side effects compared with moderate doses (i.e., 3 to 6 mg/kg). For example, with that higher dose, 38% of participants reported gastrointestinal problems, and 54% of subjects reported insomnia or sleep disturbances (Pallarés

et al., 2013). However, similar to the placebo effect, it is also possible that the negative effects associated with caffeine consumption may be reproduced in participants who believe they have ingested caffeine. This is the nocebo effect, an undesirable effect resulting from anticipated or conditioned negative outcomes (Beedie et al., 2018). Curiously, the belief in caffeine ingestion was also associated with some minor side effects, such as greater activeness or nervousness (Ortiz-Sánchez et al., 2024; Valero et al., 2024).

Therefore, this study aimed to analyse the placebo effect associated with caffeine on the performance of sprinters in a 60-meter sprint test and a standing triple jump and potential side effects.

MATERIAL AND METHODS

Participants

An a priori sample size estimation revealed that at least 11 participants were required to investigate the potential placebo effect of caffeine with an effect size of 1.15 tested with a two-tailed paired sample t-test ($1 - \beta = 0.9$; $\alpha = .05$). This calculation was based on the effect size obtained with placebo vs. control conditions of the Hurst et al. investigation (2019), and it was performed with G*Power (v3.1.9.7) software. Thirteen trained sprinters (7 men and 6 women) volunteered to complete the experimental procedures (22.77 ± 4.66 years, 64.65 ± 6.52 kg and 173.92 ± 6.47 cm). The participants were classified as Tier 2 (Trained/Developmental) and 3 (Highly trained) (McKay et al., 2022) and presented a punctuation of 884.27 ± 122.29 World Athletics points. They were all sprinters competing in 100, 200 or 400 meters.

Procedures

A repeated, randomized, and counterbalanced experimental design was used to compare the effects of the ingestion of a placebo reported as caffeine (placebo) and a control situation where no substance was ingested (control). Seven participants started with the control condition, and 6 participants started with the placebo condition. Participants were thoroughly informed of potential risks associated with the experimental procedures before providing written informed consent. The study was performed following the principles of the Declaration of Helsinki, and the experimental protocols were approved by the local ethics committee (ref. 28.1.2021CEI-UCJC).

A familiarization session was carried out the week before, even though the athletes were used to this type of testing in their training routines. Secondly, participants were informed about their participation in a "*caffeine effect*" study reinforcing their belief that the intake would be caffeine and not another different substance, as in the case of this study, a placebo substance.

Participants performed the tests twice at the same time of day to avoid circadian influences (Chtourou & Souissi, 2012). In a counterbalanced manner, one group ingested the placebo (100mg of wheat flour in an opaque capsule) on the first day and had no intake on the second day, while the other group did vice versa. To ensure that performance variations could not be attributed to differences in training load between data collections, both measurements were taken one week apart. The evaluation sessions were included within a similar microcycle, specifically scheduled on the day after an easy training session.

Placebo intake was just before starting warm-up, 50 minutes before the tests. Participants were instructed to avoid any ergogenic substance 24 hours before the data collection. In addition, the athletes used the same track spikes on both days (their own competition spikes).

The tests were performed on an athletics track. The warm-up consisted of 15 minutes of jogging followed by mobility and drill exercises. Then, five 50-meter repetitions were carried out increasing speed throughout each repetition. Recovery time was 1 minute.

First, the standing triple jump test was carried out. Participants were instructed to start from feet together, and then participants performed 3 jumps altering the landing leg and ending in the long jump pit on the last jump. Each participant performed two attempts. The longest jump was used as the test score. Before 5 min of recovery, participants performed a 60-meter sprint test with a standing start (without starting blocks). Double photocells (Witty-Gate, Microgate, Italy) were employed to measure time. This system ensures that the photocells are interrupted by the chest and not by the athlete's leading arm. The lower photocells were mounted around the level of the hips, and the upper photocells were mounted 0.20 m higher, as recommended by previous studies (Yeadon et al., 1999) and throughout the 60 m. Therefore, we obtained split times from start to the 10-meter line; from 10 to the 30-meter line; from start to the 30-meter line; from 30 to 60-meter line, and 60-meter total time.

Finally, the morning after carrying out the test, participants in the placebo condition completed a questionnaire assessing caffeine-related side effects. They were provided with a link to an electronic form (Google Forms) to report any potential side effects. The form utilized a dichotomous (yes/no) scale to indicate the presence or absence of specific symptoms, including nervousness, digestive disturbances, or sleep difficulties. This questionnaire had been previously used to evaluate side effects associated with caffeine consumption (Salinero et al., 2014).

Analysis

Data is presented as mean ± SD. Normality was checked using Shapiro-Wilk test. The variables followed a normal distribution enabling the use of parametric statistics. A paired samples student's t-test was performed to analyse differences between both conditions. In addition, Cohen's *d* was carried out to check the effect size (<0.20 trivial, ≥0.20-0.59 small, ≥0.60-1.19 moderate, ≥1.20-1.99 large, and ≥2.00 very large) (Hopkins, 2016). The significance level was established at $p < .05$. The JASP 0.18.3 software was employed to execute all calculations.

RESULTS

Table 1 illustrates the split times and complete time of the 60-meter sprint test and the distance covered in the standing triple jump in the placebo and control conditions. No significant differences were found in any parameter analysed with trivial (0 – 10 meters, 30 – 60 meters, and triple jump) or small (10 – 30 meters, 0 – 30 meters, and 0 – 60 meters) effect sizes for all parameters.

Table 1. Split and complete time on 60-m sprint test and distance covered in the standing triple jump.

	Placebo	**Control**	***p***	**d**
0 – 10 m	1. 74 ± 0.12	1.74 ± 0.09	.77	0.08
10 – 30 m	2.41 ± 0.14	2.42 ± 0.14	.43	0.23
0 – 30 m	4.15 ± 0.24	4.16 ± 0.22	.46	0.21
30 – 60 m	3.38 ± 0.23	3.39 ± 0.22	.67	0.12
0 – 60 m	7.52 ± 0.46	7.55 ± 0.43	.49	0.20
Triple jump	7.28 ± 0.84	7.28 ± 0.87	.95	0.02

Figure 1 depicts the individual analysis of 60-meter total times and the standing triple jump. Figure 1A shows that only 5 out of 13 improved the 60-meter sprint test, while Figure 1B points out how 7 out of 13 athletes improved the standing triple jump performance.

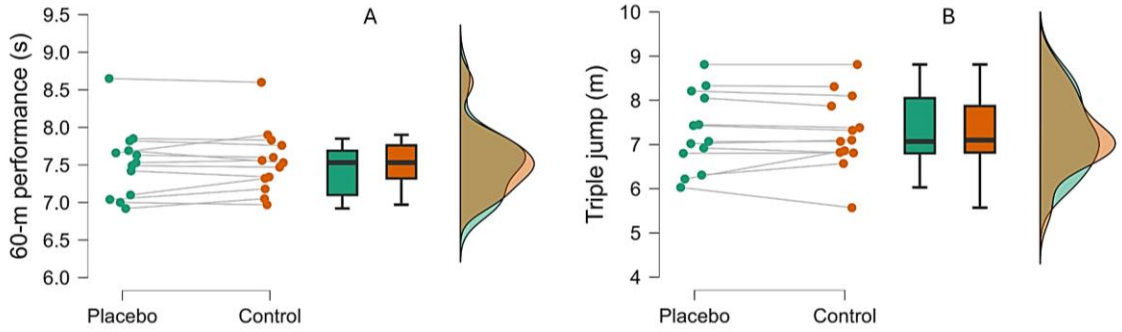

Figure 1. Individual 60 meters total times (Figure 1A) and individual standing triple jump (Figure 1B).

Finally, the self-reported side effects are outlined in Table 2. The main side effects reported the day that athletes ingested the placebo capsule were activeness (53.8%), nervousness (23.1%), and insomnia (15.4%).

Table 2. Self-reported side-effects the day that athletes ingested the placebo.

	% of affirmative responses
Nervousness	23.1
Gastrointestinal problems	0
Activeness	53.8
Irritable	0
Muscular pain	7.7
Headache	7.7
Increased urine production	7.7
Insomnia	15.4

DISCUSSION

The aim of the study was to analyse the potential placebo effect derived from deceptive caffeine ingestion on the performance of sprinters in a 60-meter sprint test and a standing triple jump. To address this objective, 13 trained athletes completed a 60-meter sprint test and a triple jump on two occasions: after ingesting a placebo informed as caffeine and without ingesting any substance (control) in a randomized and counterbalanced design. The results revealed that the belief of having consumed caffeine did not improve sprint performance or increase jumping ability, despite participants reporting feeling more active on the day they took the placebo. Therefore, it seems that the placebo effect does not appear to be an effective strategy for enhancing performance in this type of test.

Previous studies have found performance improvements following the ingestion of supposed caffeine in longer-distance running tests, such as 1000 meters (Hurst et al., 2019) or a 6-minute running test (Valero et al., 2024), while other studies focusing on strength-power tests have not found a significant placebo effect (Filip-Stachnik et al., 2020; Ortiz-Sánchez et al., 2024). Thus, it seems that the placebo effect may be more evident in longer-duration tests where volitional aspects may have a greater impact on performance. In

contrast, the placebo effect did not enhance performance in shorter tests where neuromuscular components predominate. In endurance running tests, what was reported as a placebo effect could be mediated by the result of the participants having adopted a less conservative and more optimal pacing strategy (Beedie et al., 2018). Hurst et al. (2019) observed a faster pace during the first half of their 1000-meter trials, which resulted in improved overall performance. This suggests that deceptive caffeine intake may influence participants' perception of their speed capabilities (Hurst et al., 2019). However, in sprint events like the 60-meter sprint, which are short all-out tests, there is no strategic distribution of energy. This may be one reason why the placebo effect did not influence these athletes. However, further studies are needed to confirm these findings.

The deceptive caffeine ingestion led 7 out of 13 athletes to perceive themselves as more active. However, as we have observed, this did not result in improved performance. Notably, 23% of the athletes reported feeling more nervous, which could negatively impact performance in competition. These findings align with previous research (Ortiz-Sánchez et al., 2024; Valero et al., 2024). Ortiz-Sánchez et al. (2024) reported that 33% of participants experienced nervousness, while Valero et al. (2024) observed this effect in 7.7% of participants. Therefore, individual responses to deceptive caffeine ingestion should be considered before recommending the use of caffeine-related placebos in competition. In future studies, it would be interesting to explore whether the perception of side effects is linked to the typical side effects associated with the reported substance. In such cases, it may be advisable to suggest the use of other substances without known side effects to the participants.

This experimental study presents some limitations that should be discussed. In the 60-meter test, only one repetition was performed, which means day-by-day individual variability may have influenced the outcomes. Due to the nature of the test and the fact that the participants were trained sprinters, it would be impossible to perform a second attempt within a short time frame under the same (non-fatigued) conditions (Tomazin et al., 2012). However, this approach provides a more ecological experimental design, as athletes only have a single attempt during their competitions. Additionally, athletes with positive expectations about a treatment would experience a greater improvement in performance compared to those with no expectations (Beedie et al., 2018). To minimize this limitation, athletes were informed about the ergogenic effects of caffeine and were convinced that the dose administered was optimal for enhancing performance in these tests.

CONCLUSIONS

Deceptive caffeine ingestion did not alter performance in sprint and triple jump performance in trained athletes, while some minor side effects appeared. Individual responses to placebo ingestion should be carefully considered before making recommendations for sprint athletes.

AUTHOR CONTRIBUTIONS

All authors contributed significantly to the final version of this manuscript and to the interpretation of the results. Study design: PM, VM, FGM and JJS. Data collection: AA, VM, FV, PM, and JJS. Statistical analysis: FGM and JJS. Data interpretation: FV, FGM and JJS. Literature search: PM, FV and JJS. Writing-original draft preparation: AA, FV, FGM and JJS. Writing- review and editing: All authors. Supervision: FGM and JJS. Project administration: JJS. All authors have read and agreed to the published version of the manuscript.

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DISCLOSURE STATEMENT

The authors declare no conflict of interest. The experiments comply with the current laws of the country in which they were performed.

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