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Article

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TIME INTERVAL MODERATES THE RELATIONSHIP BETWEEN PSYCHING-UP AND ACTUAL SPRINT PERFORMANCE AU2

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ABSTRACT

Hammoudi-Nassib, S, Chtara, M, Nassib, S, Briki, W, Hammoudi-Riahi, S, Tod, D, and Chamari, K. Time interval moderates the relationship between psyching-up and actual sprint performance. *J Strength Cond Res* XX(X): 000–000, 2014—This study attempted to test whether the strongest effect of psyching-up (PU) strategy on actual sprint performance can be observed when the strategy is used immediately (or almost) before performance compared with when there is a delay between PU and performance. To do so, 16 male sprinters (age, 20.6 ± 1.3 years; body mass, 77.5 ± 7.1 kg; height, 180.8 ± 5.6 cm) were enrolled in a counterbalanced experimental design in which participants were randomly assigned to 10 sessions (2 [Experimental Condition: imagery vs. distraction] × 5 [Time Intervals: no interval, 1 minute, 2 minutes, 3 minutes, and 5 minutes]). Before performing the experimental tasks, participants rated: (a) the Hooper index, (b) their degree of self-confidence, and (c) after the completion of the experimental test; they rated their perceived effort. Findings showed that the imagery significantly improved sprint performance. Specifically, the imagery enhanced performance on the phase of acceleration (0–10 m) and on the overall sprint (0–30 m) when used immediately before performance and at 1- and 2-minute intervals but not for 3- and 5-minute intervals. These findings support the hypothesis that the potential effect of the PU strategy on performance vanishes over time. The pre-experimental task Hooper and self-efficacy indexes did not change across the 10 experimental sessions, reinforcing the view that the observed performance changes were directly caused by the experimental manipulation and not through any altered status of the athletes (self-efficacy, fatigue/recovery, and stress). The potential mechanisms underlying such a process and practical applications are discussed.

KEY WORDS PU, imagery, dynamic AU8

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INTRODUCTION

Athletic performance can be boosted by the use of certain psychological strategies (8,12,38,43). Some authors revealed that successful athletes use patterns of thoughts or specific cognitive strategies such as psyching-up (PU). Psyching-up has been used as a technical term in scientific literature to describe self-or athlete-directed cognitive strategies used before or during motor skill execution design to enhance force production (8,12,16,31,37,40,42,43). Reviews of experimental research that meet the definition of PU, and examined its AU9 effects on muscular force production, have found that such cognitive strategies enhanced motor skill execution (33,35). Typical strategies that were subsumed under the label of PU included preparatory arousal, imagery, self-talk, attentional focus, and setting a goal.

In fact, changes in psychological states have been postulated as the major reason why psych-up strategies may enhance force production (4,20). Specifically, increased force production may result from increased arousal, enhanced self-efficacy, and focused attention (4,7,20). Moreover, Weinberg et al. (40) suggested that arousal may be the major mediating variable between PU strategies and motor performance. It has been also suggested also that "PU" may act as a cognitive stimuli which increases arousal (40). In the same context, it has been predicted that higher levels of arousal are needed to produce maximum performance on simple strength and endurance tasks (27,30). Additionally, in the study conducted by Brody et al. (7), participants perceived that they had higher levels of arousal and attention when they psyched up.

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From a neurophysiological perspective, Brody et al. (7) suggested that PU might lead to changes in motor unit recruitment within the muscle. Specifically, it was hypothesized that there could be an increase in motor unit activation in the agonists and a decrease in motor unit activation in the antagonists' muscle. In that regard, it is of interest to remember that the force produced during a voluntary contraction of skeletal muscle is determined by a series of factors beginning with input from the higher motor centers and terminating with the energy-dependent interaction of actin and myosin (21).

These factors may be classified as central, peripheral, and influences (21). Central components include motor unit recruitment, synchronization, and firing rate (13,15). The increase in force production resulting from PU may be determined by changes in the factors mentioned above.

Research revealed that these strategies increased force produced during the tasks such as bench press, hand grip, weightlifting, leg extension (4,11,31,34,37,40,43), muscular endurance (8), power (42), and sprint (8,10,11,16,19)]. The common belief among many athletes is that the use of these strategies will enable them to lift heavier loads (33). In that regard, Tod et al. (33) estimated that PU leads to a 12% increase in strength compared with control conditions.

Many athletes in strength-based sports, such as powerlifting and weightlifting, "psych-up" immediately before performance, both in training and competition. Previous research with trained individuals (31,37), including a recent study that has measured the force produced during the bench press exercise, found that PU resulted in greater peak force than cognitive distraction and an "attention-placebo condition" in participants with a minimum of 1 year of weight training experience (34).

However, it is quite surprising in this context, that the mental preparation-force production relationship has received limited empirical attention given the value that athletes place on their mental preparation immediately before competition. In fact, the majority of the research studies have examined the effectiveness of PU strategies using different interval rests between the end of the PU and the start of the task. Some researchers have asked participants to use the PU strategy immediately before performance in tasks such as sprinting (19), hand-grip test (12), strength performance (7,16,29,32,34), and muscular endurance (24). Although the majority of the research (8,12,16,31,37,40,42,43) generally support the hypothesis that PU enhances strength before performance, the question of whether the time period between PU and performing influences performance outcomes or not has not been examined yet. Another question that was neglected and that should be dealt with is: does the effectiveness of a PU strategy decrease as the time period between its use and performance increases? Therefore, firm conclusions are not possible because various interval rests were used and no explanation, for why the length interval between PU and actual performance may influence force production, has any substantive support. This may be a particularly important area of research because athletes need to produce strength in a short time period (1), and the fact that the rest interval time taken after PU may influence the relationship between effectiveness of PU and force production. Therefore, further research studies are required to determine which interval rest leads to optimized gains in strength performance.

Hence, the importance of this study lies in further understanding the duration's effects of the length interval between PU and actual performance. Evenly, it will help to further understand which intervals of rest period produced a better performance and which ones may be misleading in terms of PU effects. In this respect, we argue that immediacy is a characteristic of the PU strategy, so that its strongest effect on actual performance, such as sprint performance, should be observed when the PU strategy is directly followed by performance.

Outside the domain of PU strategies per se, Briki et al. (5) showed that when an experience of momentum was interrupted during a game, the feeling that everything goes smoothly was lowered. This suggests that a psychological impulse can dispel over time if not sustained, therefore, its potential impact on the actual performance could also decrease over time. In this context, we hypothesized that the strongest effect of a PU strategy on actual performance, such as sprint performance, should be observed when the PU strategy is directly followed by performance. In other words, the higher the time spent between the PU strategy and the task, the lesser its impact on performance should be observed. Specifically, the purpose of the study was to assess the efficacy of PU on sprint performance across a range of time delays between being able to psych-up and sprinting (i.e., 0, 1, 2, 3, 4, and 5 minutes), and it was expected that that PU would be associated with enhanced sprint performance only in the short-term delay conditions.

Experimental Approach to the Problem

Based on the view that psychological impulses vanish over time (6), it was expected that the strongest effect of the PU strategy on actual sprint performance should be observed when the PU strategy is used immediately before the actual sprint. In addition, it was expected that the effects of PU strategies on the actual performance decrease over time. Because of imagery strategy, was found to increase physical performance in many studies (8,12,16,19,24,37,39,43), a within-participant design protocol was used to examine the moderating effect of time interval on the relationship between imagery psych-up and sprint performance. AU10 AU11

Methods

Subjects

Sixteen male sprinters (age, 20.6 ± 1.3 years; body mass, 77.5 ± 7.1 kg; height, 180.8 ± 5.6 cm) were recruited for this study. They had at least 7 years of sprint training experience. They were sports science students pursuing degrees in Exercise Science and Physical Education at the University AU12 AU13

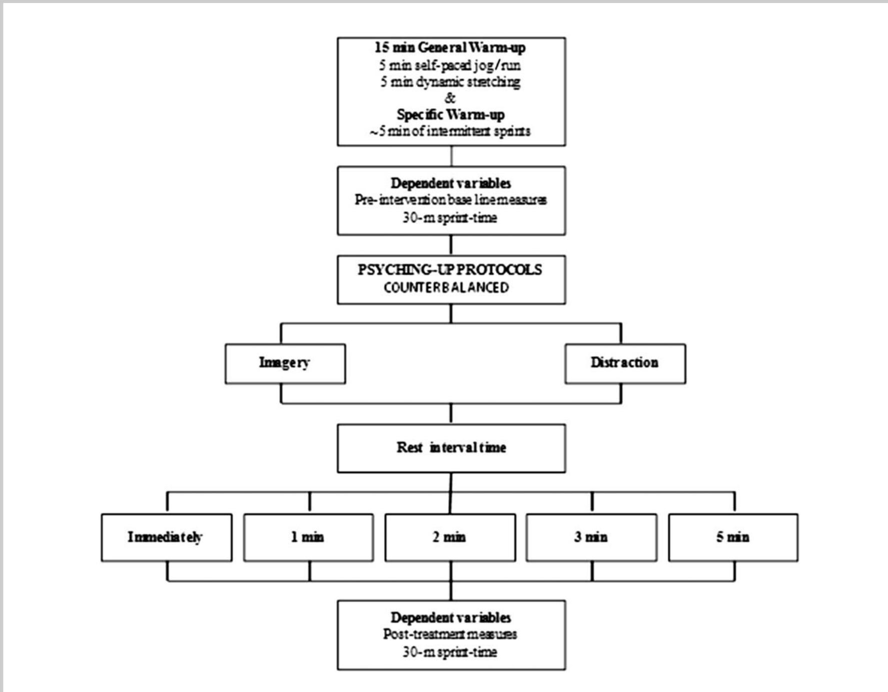

Figure 1. Summary of the protocol design.

of Manouba, Tunis (Tunisia). They were randomly assigned to the counterbalanced experimental design, 2 (Experimental Condition) × 5 (Time Intervals). Thus, each participant completed the 10 test sessions of the study by being tested in 10 different days.

Experimental Design

Before starting it, this experiment received the approval from the Scientific Research Committee and the Ethic Committee of the National Center of Medicine and Science of Sports of Tunisia. The aim of the study was to test whether the moderating effect of time interval impacts the relationship between PU (imagery) and control condition (distraction) on actual sprint performance. Accordingly, a randomized within-participants experimental design was used. So, athletes were instructed to perform imagery or distraction before sprint according to the different interval rest during every session. To do so, a counterbalanced experimental design was used: 2 (Experimental Conditions: imagery vs. control) × 5 (Time Intervals: No Interval [immediately], 1 minute, 2 minutes, 3 minutes, and 5 minutes) to which
F1 participants were randomly assigned (Figure 1).

Experimental Conditions. Two kinds of experimental conditions were used: PU (imagery) condition and control (distraction) condition. In imagery condition, participants had to imagine that they were performing sprints as best they could, for example in some studies (19), participants were given the following instructions:

You have 30 seconds during which I would like you to visualize yourself performing sprints as best you can. Please, close your eyes and imagine yourself doing sprint as fast as possible. Visualize yourself setting a new personal best on each sprint.

In control condition, participants were asked to engage in a mental task that prevented them from PU (19). Specifically, participants were asked to count backward:

You have 30 seconds during which I would like you to count backward out loud from 1,000 in groups of 7; for example, 1,000; 993; 986; 979… and so on.

Time Intervals. The time intervals represent the amount of time that separates a PU strategy from the moment of performing the sprint. Five time-interval conditions were included in the protocol: (a) no interval (the participant spent few seconds to get ready on the starting line and immediately sprinting), (b) 1-minute, (c) 2-minute, (d) 3-minute, and (e) 5-minute intervals. For all conditions, except for the no-interval condition, participants were asked to gather, drink water if they wished, and freely talk to each other to prevent them from PU.

To increase the methodological control of the protocol, some precautions had been taken. First, the experimental sessions were spaced out by 48 hours to avoid any order effect to avoid participants experiencing fatigue. Second, no participants had ever consciously performed imagery to improve performance before engaging in the protocol. This has been checked by individual interview. Third, participants had to wear the same shoes during each session, to abstain from having hard training sessions on the day before each testing session, and to maintain a consistent dietary intake on each testing day. Fourth, no information about the purposes of the study was provided to participants until after they fully completed the experiment.

Procedure

Contact Session. Before the experiment per se, participants were invited to a session in which they were informed about: the protocol design that was composed of 10 testing sessions, the necessity to conform to specific constraints, and the way their sprint performance was going to be measured (photocell beams). Then, the psychological measures used in the study were presented and explained to them.

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Table 1. Effect of different conditions and time intervals on 30-m sprint performance.*

	Condition	Mean difference	95% confidence limits		Cohen's *d*	Likelihood of exceeding smallest worthwhile change (%)			No. participants whose performances were better than the control session
			Lower	Upper		Higher	Trivial	Detrimental	
30 m, immediately	Imagery	−0.099*	−0.040	−0.157	0.61	98.56	1.43	0.01	14
	Distraction	0.033	0.112	−0.046	0.19	4.31	47.62	48.07	4
30 m, 1′	Imagery	−0.056*	0.002	−0.114	0.40	83.91	15.73	0.36	13
	Distraction	0.012	0.048	−0.025	0.08	1.37	83.19	15.44	6
30 m, 2′	Imagery	−0.051*	−0.014	−0.088	0.30	83.07	16.92	0.01	12
	Distraction	−0.023	0.079	−0.125	0.14	42.19	44.77	13.04	7
30 m, 3′	Imagery	−0.034	0.033	−0.101	0.20	49.54	48.11	2.35	7
	Distraction	0.061	0.112	0.010	0.34	0.05	15.09	84.85	5
30 m, 5′	Imagery	0.027	0.086	−0.032	0.16	2.08	58.71	39.22	5
	Distraction	0.064	0.126	0.001	0.40	0.26	14.54	85.20	4

*The improvements were >75% likely.

During this session, neither the imagery nor the control conditions were mentioned. After receiving all instructions, participants were assured that both of their performance data and their answers to the psychological items would remain confidential, and that they were able to withdraw from the study at any time without any penalty. All participants gave their consent to participate in this study by signing a consent form. Afterward, participants had to warm-up and to perform a maximal intensity 30-m control sprint.

Experimental Sessions. Before each experimental session, the Hooper index was used to monitor the participants' feeling for quality of sleep of the previous night, the perceived quantity of stress, delayed onset muscle soreness, and fatigue (23). During the experimental sessions per se, participants started by completing a specific standardized warm-up, which is characterized by 3 parts (36). First, participants performed a 5-minute self-paced jog/run general warm-up followed by 4 minutes of active rest, which consisted of walking on the track. Second, participants completed the dynamic stretching warm-up during 15 minutes. Third, participants performed incremental intermittent sprints during 5 minutes.

After the warm-up, participants performed 2 baseline (preintervention) test measures of 30-m sprints on an indoor track as baseline measure before the experimental test. After completing the general and specific warm-up and the sprint baseline measures, participants had to rate their degree of self-confidence (explained below). Then, participants received the instructions delivered according to the assigned experimental condition (i.e., imagery or Control Condition), and they were asked to achieve *as best as they could* for the postintervention sprints 30 m. Just after the completion of the sprint test (within 10 seconds of the end of the sprint), the RPE scale (14) was used to rate the participants' perceived effort. AU14 As participants were French speaking, the validated version of the CR-10 Foster RPE scale was used (17).

The same experimenters were present throughout the experimental sessions and did provide consistent encouragements to the participants while they were sprinting, independently of the experimental condition to which the participants were allocated. To account for diurnal variation, participants were assessed at the same time of the day (between 9.30 and 11.00 AM). Temperature and relative humidity were 22° C (±1° C) and 43% (±1%), respectively. No medical problem seemed during the study. After the completion of all the testing sessions of the whole study, participants were debriefed on the interventions and received feedback regarding their individual performances.

Measures

Preliminary Measures. Two kinds of pretest measures were used to control the psychological status of participants before performing the experimental task: the index of Hooper (23) and self-efficacy index (3). First, participants had to record subjective rating of stress, fatigue, delayed onset muscles soreness, and last-night's sleep on a 7-Likert point ranging from : "very very low" (1) to "very very high" (7), with a midpoint "average" (4) for stress, fatigue, and muscles soreness; and from "very very good" (1) to "very very bad" (7), with a midpoint "average" (4) for last-night's sleep. Indeed, despite the randomization of the 4 conditions, one of these could have been biased by a different status of "fatigue" or "stress." Thus, the Hooper index was used to monitor the participants' feeling for quality of sleep of the previous night, and the perceived quantity stress, delayed

TABLE 2. Effect of different conditions and time intervals on 0–10-m sprint performance.*

	Condition	Mean difference	95% confidence limits Lower	Upper	Cohen's *d*	Likelihood of exceeding smallest worthwhile change (%) Higher	Trivial	Detrimental	No. participants whose peak performances were better than the control session
10 m, immediately	Imagery	−0.035*	−0.008	−0.062	0.46	93.08	6.87	0.06	12
	Distraction	0.011	0.043	−0.021	0.14	5.52	55.14	39.3	6
10 m, 1′	Imagery	−0.025*	−0.009	−0.041	0.29	84.35	15.65	0.00	12
	Distraction	−0.010	0.023	−0.043	0.13	36.40	57.49	6.10	9
10 m, 2′	Imagery	−0.023*	−0.006	−0.039	0.39	90.68	9.29	0.03	13
	Distraction	0.011	0.073	−0.052	0.17	21.99	30.59	47.42	7
10 m, 3′	Imagery	−0.021	0.015	−0.057	0.28	63.51	33.82	2.67	9
	Distraction	0.036	0.080	−0.007	0.55	1.38	12.42	88.20	7
10 m, 5′	Imagery	0.011	0.047	−0.026	0.14	7.47	53.43	39.11	6
	Distraction	0.066	0.097	0.035	0.92	0.00	0.15	99.85	3

*The improvements were >75% likely.

onset muscle soreness, and fatigue. Second, participants had to rate their degree of self-efficacy on a 9-unit interval scale ranging from "cannot do" (0) to "highly certain can do" (100), with a midpoint "moderately certain can do" (50). This study protocol monitored this psychological status to make sure that the eventual effects on the dependent variable were caused by the intervention itself and not by any status of fatigue or change in the participants' feeling of self-efficacy.

Sprint Performance. Straight running sprint was assessed using photocell beams (Brower Timing Systems, Salt Lake City, UT, USA; accuracy of 0.01 seconds) set at 50 cm height at 0, 10, 20, and 30 m from the starting line. The subjects started when they felt ready after having obtained from the experimenter a period of at maximum 5 seconds to start, whenever they felt free for doing so. Subjects began from a standing-start position 0.5 m behind the first timing gate, thus avoiding triggering the electronic gate prematurely with

TABLE 3. Effect of different conditions and time intervals on 10–30-m sprint performance.*

	Condition	Mean difference	95% confidence limits Lower	Upper	Cohen's *d*	Likelihood of exceeding smallest worthwhile change (%) Higher	Trivial	Detrimental	No. participants whose performances were better than the control session
20 m, immediately	Imagery	−0.064*	−0.007	−0.121	0.51	91.52	8.25	0.23	12
	Distraction	0.022	0.107	−0.062	0.16	44.72	44.22	11.07	6
20 m, 1′	Imagery	−0.031	0.023	−0.086	0.35	69.60	26.70	3.70	8
	Distraction	0.022	0.073	−0.029	0.18	3.47	51.18	45.34	6
20 m, 2′	Imagery	−0.029	0.006	−0.064	0.18	43.14	56.75	0.11	12
	Distraction	−0.034	0.059	−0.126	0.20	49.84	43.19	6.97	10
20 m, 3′	Imagery	−0.013	0.049	−0.076	0.09	28.00	64.16	7.84	8
	Distraction	0.025	0.068	−0.018	0.17	0.88	57.38	41.74	5
20 m, 5′	Imagery	0.016	0.062	−0.029	0.13	3.81	60.50	35.69	6
	Distraction	−0.002	0.063	−0.068	0.02	18.44	66.93	14.64	5

*The improvements were >75% likely.

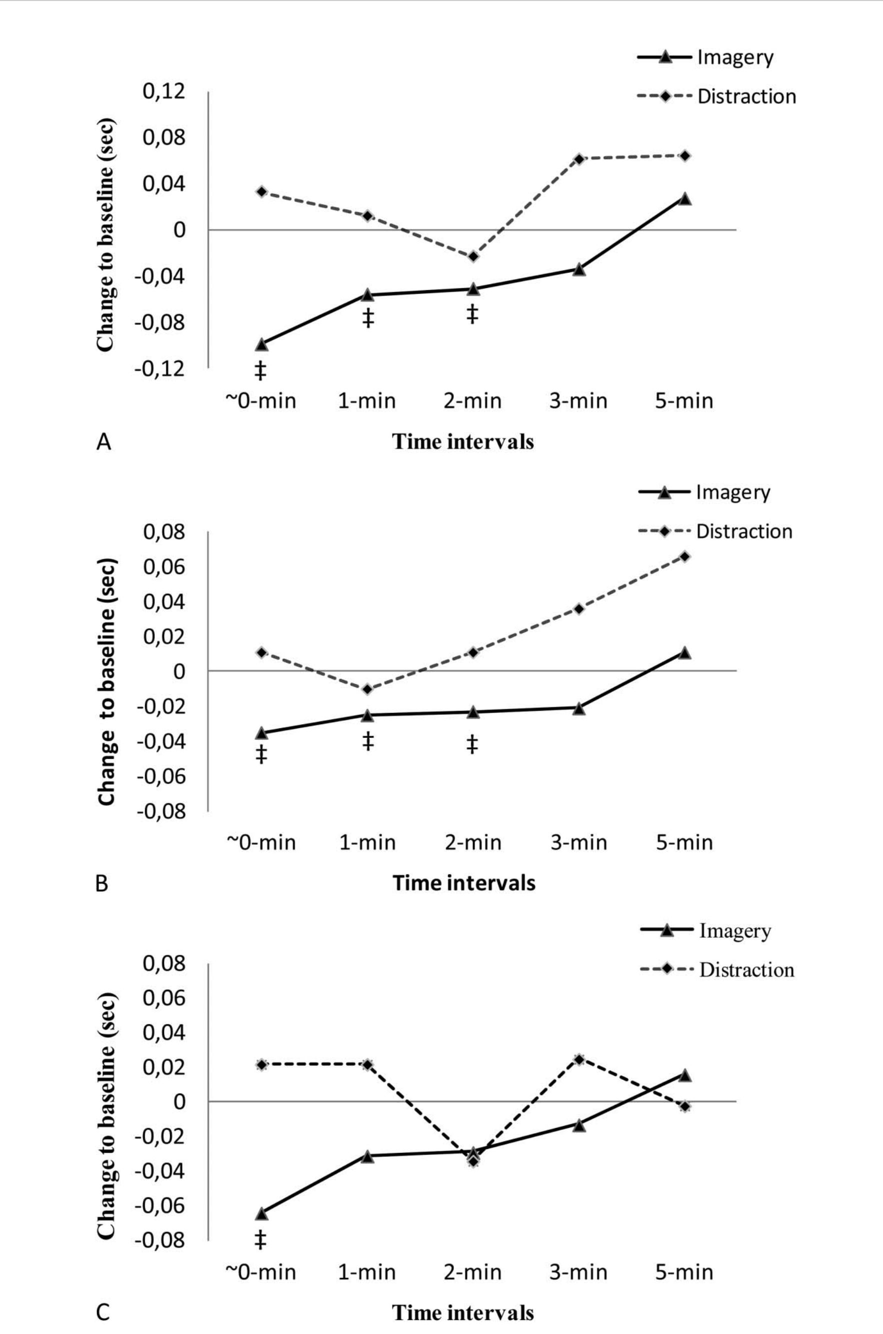

Figure 2. Mean change in performance for each condition and time interval. A) Overall 30-m sprint time. B) Acceleration phase of the sprint (0- to 10-m lap time). C) Maximal velocity phase of the sprint (10- to 30-m lap time). ‡The improvements were >75% likely.

any move of the lower or upper limbs. The start of the sprint was taken in a consistent order and at the sound of the experimenters. Acceleration was assessed for a distance of 10 m, with the players beginning in a stationary position. Maximal velocity was recorded for the last 20 m of the 30-m sprint. Total 30-m performance was also considered.

Rating Perceived Effort. After the completion of the experimental test, the RPE scale (14) was used to rate the participants' perceived effort. A rating of 0 corresponded to "no perceived effort" (i.e., rest), whereas a rating of 10 corresponded to "maximal perceived effort" (i.e., the most stressful exercise ever performed).

Statistical Analyses

Mean ± *SDs* were used to describe variables. Before using parametric tests, the condition of normal variation was verified using the Kolmogorov-Smirnov test. Reliability of the measures (10-, 20-, and 30-m sprint times) was assessed with a Cronbach model interclass correlation coefficient (ICC) through 1-way analysis of variance (ANOVA), with a value of 0.7–0.8 being questionable and 0.9 indicating high reliability (38). A 1-way ANOVA with repeated measures was used to examine the difference between scales' scores before each intervention (fatigue, sleep, stress, muscle soreness, RPE, and SES). The effect size AU15 was calculated for all ANOVAs with the use of a partial η^2 (9). In addition to the comparison analyses, Cohen's *d*, smallest worthwhile change (SWC), and likelihood of clinical meaningfulness were calculated for 10-, 20-, and 30-m sprint distances (25). The Cohen's *d* is calculated from the mean change divided by the *SD* of the data; thresholds for qualitative descriptors of Cohen's *d* were set at <0.20 as "trivial," 0.20 to <0.50 as "small," 0.50 to <0.80 as "moderate," and ≥0.80 as "large" (9). The smallest change to be considered worthwhile (SWC) was thus calculated from 0.20 of the *SD* of the data. The threshold of a clinical meaningful effect was set at 75% (25). The quantitative chances of beneficial effects were assessed qualitatively as follows: <1% almost certainly not, 1 to <5% very unlikely,

Table 4. Precision of the predicted increase from baseline to peak of each psych-up protocol on each of the dependent variables.

		Mean difference	95% confidence limits		Cohen's d	Likelihood of exceeding smallest worthwhile change (%)			Imagery vs. distraction; no. participants whose performances were better	Time to peak (min); Mean ± *SD*
			Lower	Upper		Higher	Trivial	Detrimental		
Imagery vs. distraction	0–30-m sprint	0.048	−0.017	0.113	0.64	85.24	11.97	2.79	13	1.25 ± 1.24 vs. 2.69 ± 1.49
	0–10-m sprint; acceleration	0.027	−0.006	0.060	1.10	91.29	5.86	2.84	13	1.81 ± 180 vs. 1.38 ± 0.89
	10–30-m sprint; maximal velocity	0.006	−0.040	0.052	0.07	31.08	54.18	54.18	9	1.38 ± 1.45 vs. 2.88 ± 1.71

*Comparison between conditions that elicited changes >75% likelihood of exceeding the smallest worthwhile change.

5 to <25% unlikely, 25 to <75% possible, 75 to <95% likely, 95 to <99 very likely, and ≥99% almost certain. The results are expressed as mean ± *SD* and 95% confidence intervals. A significance level of $p \leq 0.05$ was selected.

Results

Measures

Concerning the psychological and perception variables (fatigue, sleep, stress, muscle soreness, RPE, and self-efficacy), repeated-measure ANOVA's results revealed no significant difference between scales' scores before each intervention ($p > 0.05$).

Performance-Related Results

The ICC and 95% confidence intervals (CIs) values for all baseline measures demonstrated "high reliability" of the measure: for overall sprint (ICC = 0.96; 95% CI, 0.93–0.98), acceleration (ICC = 0.90; 95% CI, 0.83–0.96), and maximal velocity (ICC = 0.93; 95% CI, 0.87–0.97). Furthermore, a repeated-measure ANOVA showed no significant differences between the scores recorded during the presession sprints mean baseline measures for all phases of sprint (overall sprint: $F_{(1,15)} = 1.16$; $p = 0.34$; $\eta^2 = 0.07$, acceleration: $F_{(1,15)} = 0.56$; $p = 0.74$; $\eta^2 = 0.04$, and maximal velocity: $F_{(1,15)} = 1.58$; $p = 0.13$; $\eta^2 = 0.09$).

Magnitude-Based Inferences for Each Time Interval

The imagery condition elicited a substantial likelihood of potentiating overall 30-m sprint time and acceleration, with a substantial amount (i.e., had a >75% of exceeding a small Cohen's d (9)). This substantial likelihood is observed immediately, 1 minute and 2 minutes after the use of the PU strategy (Tables 1–3). For the maximal velocity, imagery also elicited changes that had >75% likelihood of exceeding the SWC, which was only observed immediately after the intervention (zero-minute interval, Table 3).

Magnitude-Based Inferences for Each Peak of Performance

The imagery improved both the peak of performance in the 30-m overall sprint and the acceleration (first 10 m of sprint) as compared with the distraction condition (85.24 and 91.29% likelihood of exceeding the SWC, respectively) (Figure 2). The peak of the maximal velocity (i.e., last 20 m of sprint) was unaffected by the imagery; indeed, the imagery did not elicit a 75% likelihood of exceeding the SWC compared with the distraction condition (Table 4).

Individual Responses

Table 5 presents the number of participants who ran faster and did succeed in making a better performance at each sprint phase in either the imagery or distraction condition compared with the baseline condition. Across the 3 performance measures (30, 20, and 10 m), the number of participants who were quicker in imagery condition was lower as the time between PU and performance increased. There was a great consistency between the results of the different phases of sprint, with patterns emerging on the responders

Table 5. No. participants whose peak performances were better than the baseline condition.

		Immediately	1 min	2 min	3 min	5 min
0–30-m sprint	Imagery	6	4	2	4	0
	Distraction	0	3	7	2	4
0–10-m sprint	Imagery	5	2	1	5	3
	Distraction	3	5	6	1	0
10–30-m sprint	Imagery	6	3	4	2	1
	Distraction	1	0	6	3	5

and nonresponders to the PU protocols. For overall 30-m sprint, most of participants responded positively after the imagery condition vs. distraction condition. Such a finding was observed for the time conditions: "immediately," 1 minute, 2 minutes, and 3 minutes. The number of participants who performed a better sprint performance after *imagery* than after the *distraction* condition across different time intervals comes as follows (6, 4, 2, and 4, for the different time intervals mentioned above, respectively). Whereas, 4 participants responded positively after the distraction condition in 5-minute interval compared with the imagery condition. Additionally, most of the participants performed better after the imagery condition compared with the distraction condition in all phases of the sprint (in the acceleration phase, maximal velocity as well overall sprint).

Discussion

This study aimed to test whether the interval time duration between a PU strategy and actual sprint performance may reduce the impact of the former on the latter. To do so, the impact of the imagery on the actual sprint performance was examined (19). Globally, the data supported the hypothesis with post-psych-up long durations (3 and 5 minutes) being too long to maintain the positive effects of imagery on short-distance sprint performance.

The imagery condition improved the sprint performance (on the acceleration phase [0–10 m], on the overall sprint [0–30 m], and to a lesser extent the maximal velocity [10–30 m]), supporting the findings of Hammoudi-Nassib et al (19). Possibly, PU strategies might generate psychological impulses that may produce positive dynamics in affects, cognitions, motivation, physiology, and behaviors (4,7,20)]. Potentially, a change in cognitions (e.g., imagining oneself in success), caused by a PU strategy (e.g., imagery), would produce changes in arousal (e.g., related increase of heart rate), cognitions (e.g., anticipation of success, self-efficacy), and affects (e.g., eagerness), thereby leading to positive behavioral changes with a related increase in actual performance.

Additionally, the findings of this study showed that the greater the post-psych-up time interval lasted, the lesser the impact of the imagery on performance was. Specifically, the imagery condition impacted the sprint performance (a) immediately, and at 1- and 2-minute intervals (b) but not at 3- and 5-minute intervals. Similarly, to past research, this confirms that imagery enhances performance (26,28), nevertheless, this extends the previous research's findings by revealing that only imagery which is used *immediately or shortly* before competition improves performance, with any delay of 3-minute or more leading to vanished effects.

Thus, the findings of this study suggest that the potential psychological and physiological dynamic, generated by a PU strategy, is fragile (i.e., sensitive to post-task elapsed time), and then its potential effects on performance do actually vanish over time. This is compatible with the general view that the psychological impulses are inherently dependent on situational events and global context (5,6). The Hooper index–monitoring levels of some determinants of performance (e.g., fatigue, stress, etc.)–and self-efficacy performing the experimental task revealed no change across the 10 experimental sessions, reinforcing the view that changes observed in performance were directly caused by the experimental manipulation and not through some altered status of the athletes (motivation, fatigue/recovery, and stress). Thus, this supports the assumption that the imagery used immediately before competition has the most important impact on performance. Accordingly, the goal of mental imagery is to increase the athletic experience so well that athletes feel as if they are actually performing their own sport (18,22).

Athletes should therefore avoid performing their psych-up routines too early before their sprinting tasks.

This study represents the first attempt consisting to examining the dynamical properties of PU. It demonstrated that short-distance sprint performance (up to 30 m) was positively altered when it was preceded by PU strategy immediately or no more than 2 minutes before it. A limitation of this study is that it did not examine the mechanisms underlying such a process. However, exploring such mechanisms would have generated time intervals (for testing explanatory variables), thus leading to biasing the protocol design and therefore the findings. Because this study showed that 1- and 2-minute post-psych-up intervals could alter performance, further studies should focus on finding a way to examine psychological and physiological explanatory mechanisms during such time intervals.

Practical Applications

From an applied standpoint, the findings of this study suggest that the imagery used before sprinting enhances sprint for initial acceleration (0–10 m) and overall sprint (0–30 m) when it is performed "immediately," 1 minute and 2 minutes before sprinting but not when the post-PU interval is extended to 3 minutes and 5 minutes for which the PU positive effect vanishes. Correspondingly, the last 20 m of the sprint was improved for the "immediate condition" but was unchanged regarding the 1-minute, 2-minute, 3-minute, and 5-minute intervals. Therefore, the current findings have important practical implications for athletes because sprint performance is fundamental to success in several sports (2).

As a result, elite athletes could use imagery to improve strength and probably individual athlete's arousal level by combining imagery with physical training. The results of this investigation do not only provide evidence demonstrating the importance of mental preparation techniques in strength performance but also show the need for coaches and athletes to manage the use of PU strategies in such a way that they can benefit from the psychological impulse for their performance. They, therefore, have to consider reserving the last moments just before sprinting to a moment dedicated to imagery. More generally, regardless of their age or skill level, athletes should consider integrating the imagery strategy as a systematic routine into their sport practice (16,41).

In conclusion, the findings of this study suggest that PU was beneficial to performance predominantly requiring speed.

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