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Effect of mental fatigue on mean propulsive velocity, countermovement jump, and 100-m and 200-m dash performance in male college sprinters

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Abstract

The objective of this study was to analyze the effect of mental fatigue on mean propulsive velocity (MPV), countermovement jump (CMJ), 100, and 200-m dash performance in college sprinters. Sixteen male athletes of sprint events (100 and 200-m dash) participated in this study. Each participant underwent two baseline visits and then running under the three experimental conditions. Assessments (MPV and CMJ) occurred both before and after either smartphone use (SMA) or Stroop task (ST) or watching a documentary TV show about the Olympic Games (CON). Then, the athletes run the simulated race (i.e., the 100 and 200-m dash). There was no condition ($p > 0.05$) or time effect ($p > 0.05$) for MPV, CMJ, 100-m, and 200-m dash performance. In conclusion, the present study results revealed no effect of mental fatigue induced by SMA or ST on neuromuscular and 100-m and 200-m dash performance in male college sprinters.

Keywords: cognitive fatigue, brain, athletic performance, sport psychology.

Highlights

- 60-min of social media use on smartphone causes mental fatigue.
- No effect of mental fatigue induced by social media on 100 and 200-m dash performance.
- High cognitive demanding does not change athletes' high-intensity performance.
- High cognitive demanding does not affect college sprinters' neuromuscular performance.

Effect of mental fatigue on mean propulsive velocity, countermovement jump, and 100-m and 200-m dash performance in male college sprinters

The 100-m and 200-m dash are the events in track and field competitions that define the fastest athlete for a given period. Sprint performance is a critical factor in 100-m and 200-m dash, not only to reach the highest top velocity but also and most importantly, to cover the distance in the shortest time possible (Slawinski et al., 2017). This ability implies massive forward acceleration, which has been related to producing and applying high amounts of power output in the horizontal direction onto the ground, i.e., high amounts of horizontal external force at various velocities over sprint acceleration (Loturco et al., 2015).

According to previous studies (Loturco et al., 2015), the initial sprint performance phase suffers more significant influence in producing power output (i.e., the product between strength and velocity) on the horizontal plane, while, in the final phase of the sprint, greater vertical power output on the ground. Because sprint running is a dynamic movement, mainly requiring power output production in two dimensions (horizontal and vertical), lower limbs neuromuscular performance in vertical [countermovement jump (CMJ) and mean propulsive velocity (MPV) on half-back squat] and horizontal (e.g., sprints) planes play the central role in the race (Samozino et al., 2016). For example, it has been reported that the height of the vertical jump is strongly correlated with competitive performance in elite sprinters (Loturco et al., 2015).

Previous studies also showed that potential post-activation (Seitz & Haff, 2016; Wilson et al., 2013) or ischemic preconditioning (Caru et al., 2019; Surkar et al., 2020) are strategies that might improve neuromuscular performance. However, several factors might impair the neuromuscular performance, for example, muscle damage-induced exercise (Greenham et al., 2018) and mental fatigue (Filipas et al., 2019).

Mental fatigue is a psychobiological state characterized by increased feelings of tiredness and lack of energy (Marcora et al., 2009) caused by prolonged and highly demanding cognitive activities (Martin et al., 2018; Thompson et al., 2020). Previous scientific investigations showed no changes in maximum voluntary contraction (Pageaux et al., 2013; Rozand et al., 2014; Silva-Cavalcante et al., 2018) or CMJ (Queiros et al., 2020) in trained subjects mentally fatigued. Also, studies demonstrated no changes in sports performance during the physical task with high intensity and short duration (Duncan et al., 2015; Fortes, Nakamura, et al., 2020). The neuromuscular tasks assessed in these studies were all-out with lower duration than five seconds. Specifically, in track and field, Englert and Bertrams (2014) found that participants in a state of mental fatigue showed slower sprint start reaction time than control group but no evaluated the effect of mental fatigue on 100 or 200-m dash performance. Perhaps high-intensity neuromuscular tasks with higher duration than ten seconds can be affected by mental fatigue, for example the 100 and 200-m dash performance.

It was reported that playing videogames (Fortes, Lima-Junior, et al., 2020) or using social media on smartphones (Fortes et al., 2019) for a prolonged period might cause mental fatigue. Evidence points out that ~ 60% of athletes reported using social media in pre-championship activities (Thompson et al., 2020). The use of social media on a smartphone for a prolonged period seems to be increasing among athletes of individual sports (Thompson et al., 2020). Neuroimaging studies of social behaviors have demonstrated that social media use recruits brain network regions, including the prefrontal cortex (PFC), dorsomedial PFC (DMPFC), ventromedial PFC (VMPFC), bilateral temporoparietal junction (TPJ), anterior temporal lobes (ATL), inferior frontal gyri (IFG), and posterior cingulate cortex/precuneus (PCC) (Schurz et al., 2014; Wolf et al., 2010). It is essential to highlight that the PFC and VMPFC are responsible for attention, processing information, and decision-making during physical effort, respectively. Once fatigued by prolonged use of social media on a smartphone, it might impair the 100-m and 200-m dash performance.

From a practical standpoint, the effect of mental fatigue on neuromuscular (i.e., MPV and CMJ), 100, and 200-m dash performance might indicate new protocols, including avoiding high cognitive demanding before events. Thus, this study's objective was to analyze mental fatigue (i.e., social media network on smartphone and Stroop task) on neuromuscular (i.e., MPV and CMJ), 100, and 200-m dash performance in college sprinters. It was developed the following hypothesis: high cognitive demanding for period prolonged (e.g., 60-min) change no neuromuscular (i.e., MPV and CMJ) performance, but impair 100-m and 200-m dash in male college sprinters.

MATERIALS AND METHODS

Experimental Approach of the Problem

This study was a randomized, crossover investigation and within-subject in which all participants performed the sprint events under three experimental conditions, each separated by a 96-h washout interval. The participants underwent two baseline visits and then running under the three experimental conditions.

Participants

A sample size calculation was conducted by G*Power 3.1, with a set power of 0.80, $\alpha = 0.05$, and effect size of 0.20 (i.e., Cohen's d) for neuromuscular performance in trained healthy human mentally fatigued (Silva-Cavalcante et al., 2018) and a two-way ANOVA of repeated measures with a mixed design 3x2 (i.e., three experimental conditions and repeated measures). Results indicated that fifteen subjects would be necessary for the study. Sixteen male college athletes (age, 21.0±0.9 years; height, 172.4±5.2 cm; weight, 70.9±9.5 kg; mean±SD) of sprints events [100-m (12.17 ± 0.69 s) and 200-m dash (26.81 ± 1.22 s); mean±SD], who had more than three years of track and field experience and had undergone 14±1 h per week sprinter training, participated in this study. All of them had participated in a national university championship competition in Brazil. Before the experiment, the subjects were informed of the study's purpose, methods, and risks. Written informed consent was obtained from all of them.

Baseline visits

During the two baseline visits, we collected data for MPV in half-back squat exercise (40 Kg), CMJ, a Stroop task, and a participant self-report on the mental fatigue and motivation Visual Analogue Scale (VAS) following 100, and 200-m dash performance. Next, we randomized the order of the three experimental conditions or each participant using a random number table generator (www.randomizer.org). The three conditions comprise running distances (100 and 200-m) with and without mental fatigue inducement (i.e., social media on a smartphone, Stroop task, or CON). A 96-h washout period separated each of these conditions (see Figure 1). As noted above, the participants maintained their training routines during the washout period. The participants refrained from any physical exercise and alcohol ingestion 48-h before experimental sessions and abstained from caffeine for at least three hours before beginning the sessions.

Experimental conditions

At each experimental session, we used the Stroop task to assess mental fatigue rather than induce it. Assessments occurred both before and after either smartphone use (SMA), Stroop task (ST), or watching a documentary TV show about the Olympic Games (CON). We recommended that the athletes ingest fluid ad libidum up to two hours before each experimental session. Smartphone use two hours before each experimental session was forbidden. Next, the participants warmed-up for five minutes. During the simulated race, a researcher who was blind to the participant's experimental treatment condition provided continuous verbal encouragement. We measured CMJ and MPV before and after each cognitive manipulation (SMA, ST, and CON) in the three experimental sessions.

*****Figure 1 here*****

Mental fatigue protocols

Participants watched 60 minutes of coaching videos about the Olympic Games on an 84-inch screen (smartphone free room) in the control condition. Studies related to mental fatigue and human performance have long used these emotionally neutral documentaries in control conditions because neither behavioral performance (Lopes et al., 2020) nor underlying brain mechanisms of mental fatigue were found to be altered (Franco-Alvarenga et al., 2019).

We used social media apps on smartphones or Stroop task to induce mental fatigue in the experimental conditions (i.e., the SMA and ST conditions). Participants used social media apps (e.g., WhatsApp, Facebook, and Instagram) on smartphones or performed a Stroop task 60 minutes before these races.

Measures

100 and 200-m dash performance

Before the tests' execution, two pairs of photocells (Smart Speed, Fusion Equipment, AUS) were positioned along the running course (i.e., at distances of 0 and 100 m for 100-m dash; 0 and 200 m for 200-m dash). The athletes sprinted, starting on their own, from a semi-crouched position 0.3 m behind the start line. A 10-min rest interval was allowed between the 100 and 200-m dash attempts. In the present study, the intraclass correlation coefficient was 0.99 ($IC_{95\%}$ = 0.98 to 0.99) for 100-m dash and 0.98 ($IC_{95\%}$ = 0.97 to 0.99) for 200-m dash.

Countermovement jump (CMJ)

An electronic contact jump mat (Hidrofit®, Jump System, Belo Horizonte, Brazil) was used to analyze the CMJ height. Each participant performed three attempts with a 30-s interval among trials, and the mean of three jumps was analyzed. The participants performed the CMJ with hands on the waist and no restrictions on the knee angle during the jump's eccentric phase. The participants were also instructed to maintain the legs in a straight position during the flight and land at the take-off point. The participants were familiar with the test before the beginning of the investigation. In the present study, the intraclass correlation coefficient was 0.98 ($IC_{95\%}$ = 0.96 to 0.99) for CMJ.

Mean propulsive velocity (MPV)

The MPV was assessed in the half back-squat exercise, performed on a Smith machine. The participants were instructed to execute three repetitions at a maximal velocity in the concentric phase using a 40-kg. Participants executed a knee flexion until the thigh was parallel to the ground and, after an initial command, extending the knee (concentric phase of movement) as fast as possible. Before each assessment, an experienced test administrator instructed the participant to maintain constant downward pressure on the barbell throughout the extending the knee to prevent the bar from moving independently of the body. A 30-seconds interval was provided between repetitions. Regarding MPV, a linear transducer (T-Force, Dynamic Measurement System; Ergotech Consulting S.L., Murcia, Spain) was attached to the bar on the Smith machine. Instantaneous bar velocity was sampled at a frequency of 1000 Hz. In the present study, the intraclass correlation coefficient was 0.96 ($IC_{95\%}$ = 0.95 to 0.99) for MPV.

Visual analog scale (VAS)

The subjective rating of mental fatigue was assessed using the 100 mm VAS as previously adopted (Smith et al., 2019). This scale has two extremities anchored from 0 (none at all) to 100 (maximal). No other descriptor was presented in the VAS. The participants were required to answer, "How mentally fatigued you feel now?". The definition of MF (e.g., a psychobiological state caused by prolonged periods of demanding cognitive activity) was provided to participants and examples of "none at all" (no feelings of tiredness and lack of energy) and "maximal" (maximum feelings of tiredness and lack of energy) mental fatigue were explained based on tasks of prolonged periods of demanding cognitive activity. Participants were oriented to drawing a single vertical line to reflect mental fatigue throughout the 100 mm scale according to their perceived status. To quantify values, we measured distance in millimeters from 0 to 100, indicated by the participant. The intraclass correlation coefficient was 0.96 ($IC_{95\%}$ = 0.93 to 0.99) for VAS mental fatigue.

As a manipulation check, a subjective rating of motivation was recorded using a 100-mm VAS anchored by the words "not at all" and "maximal." This scale has been previously used in mental fatigue studies (Fortes, Nakamura, et al., 2020; Smith et al., 2019). Rating of motivation was measured at pre-treatment and post-treatment (i.e., cognitive manipulation). The intraclass correlation coefficient was 0.95 ($IC_{95\%}$ = 0.91 to 0.98) for VAS motivation.

Stroop task

The computerized version of the Stroop task (Graf et al., 1995) assessed inhibitory control and selective attention before and after cognitive manipulation (i.e., Stroop, social media on a smartphone, and documentary). Since a decrement in the response time to the Stroop task is indicative of mental fatigue (Queiros et al., 2020; Van Cutsem et al., 2017), there was used a stimulus (pre- and post-cognitive manipulation) of 45 words with 500 ms of the interval between response and a new stimulus. Moreover, the stimulus did not fade from the screen until any response was given. The total Stroop task duration to evaluate mental fatigue was approximately 2 min. The mean values of accuracy and response time were recorded for analysis. The tests were carried out on a full-HD screen (1800×1260 pixels) laptop (MacBook Pro, A1502 model, USA).

The computerized version of the Stroop task consisting of 60-min (Stroop condition) was performed to induce mental fatigue. The participants answered the word color or according to its name, since the color of the words might be different from what is typed (e.g., the word "blue" might show up in "red" color, the word "green" in "blue," and so on). A stimulus of 50 words with 250 ms of the interval was provided between the response and a new stimulus. The same stimuli (50 words) were randomly shown every time, repeated during 60-min to avoid the learning effect. Moreover, the stimulus did not fade from the screen until a response was given. When the answer was correct, the stimulus disappeared, and a new one was set. In incorrect answers, an X showed up on the screen, and a new stimulus subsequently appeared.

Statistical analysis

The Shapiro-Wilk test evaluated data distribution. The Levene test verified homoscedasticity. Measures of central tendency (mean) and dispersion (standard deviation) described the research variables. The two-way Anova was used to analyze condition (CON versus SMA versus ST) x time (baseline versus post-experiment) interaction for neuromuscular (MPV and CMJ), 100, and 200-dash performance. The same test was used to analyze condition (CON versus SMA versus ST) x time (pre-treatment versus post-treatment) interaction for VAS (mental fatigue and motivation) and Stroop task (accuracy and response time). A Bonferroni post-hoc test was used to identify possible statistical differences. Partial eta squared (ηp^2) effect size (ES) were determined and interpreted using the following cutoffs (Cohen, 1992): small effect, $\eta p^2 < 0.03$; moderate effect, $0.03 \leq \eta p^2 < 0.10$; large effect, $0.10 \leq \eta p^2 < 0.20$; very large effect, $\eta p^2 \geq 0.20$. Data were processed in the Statistical Package for Social Sciences Version 21.0 (IBM Corp., Armonk, NY, USA) and GraphPad Prism 8 (San Diego, CA, USA) with a significance level of 5%.

RESULTS

Mental Fatigue

Stroop task

There was no condition x time interaction for accuracy [Figure 2A; ($F_{(2, 48)}$ = 0.34; p = 0.70 [$IC_{95\%}$ = 0.61 to 0.77]; η^2 = 0.003 [$IC_{95\%}$ = 0.001 to 0.01]; ES small). Also, no condition ($F_{(2, 48)}$ = 1.30; p = 0.28 [$IC_{95\%}$ = 0.23 to 0.36; η^2 = 0.01 [$IC_{95\%}$ = 0.004 to 0.02]; ES small) or time effect ($F_{(1, 24)}$ = 0.45; p = 0.50 [$IC_{95\%}$ = 0.39 to 0.54]; η^2 = 0.003 [$IC_{95\%}$ = 0.002 to 0.01]; ES small) were found.

A condition x time interaction for response time [Figure 2B; ($F_{(2, 48)}$ = 5.48; p = 0.007 [$IC_{95\%}$ = 0.01 to 0.02]; η^2 = 0.17 [$IC_{95\%}$ = 0.14 to 0.20]; ES large) occurred. A main effect of condition ($F_{(2, 48)}$ = 3.72; p = 0.03 [$IC_{95\%}$ = 0.02 to 0.05; η^2 = 0.23 [$IC_{95\%}$ = 0.18 to 0.26]; ES very large) and time effect ($F_{(1, 24)}$ = 3.21; p = 0.04 [$IC_{95\%}$ = 0.02 to 0.06]; η^2 = 0.09 [$IC_{95\%}$ = 0.07 to 0.13]; ES moderate) were found. Response time only increased for the SMA and ST conditions ($p < 0.05$), with statistical difference to CON condition ($p < 0.05$).

VAS

A condition x time interaction for subjective rating of mental fatigue [Figure 2C; ($F_{(2, 48)}$ = 18.95; p = 0.001 [$IC_{95\%}$ = 0.001 to 0.01]; η^2 = 0.32 [$IC_{95\%}$ = 0.25 to 0.38]; ES very large) was found. Condition ($F_{(2, 48)}$ = 16.48; p = 0.001 [$IC_{95\%}$ = 0.001 to 0.003; η^2 = 0.27 [$IC_{95\%}$ = 0.24 to 0.32]; ES very large) and time effect ($F_{(1, 24)}$ = 13.00; p = 0.001 [$IC_{95\%}$ = 0.001 to 0.004]; η^2 = 0.22 [$IC_{95\%}$ = 0.19 to 0.27]; ES very large) were found. Subjective rating of mental fatigue only increased for the SMA and ST conditions (p <

0.05), with greater increase for ST than SMA condition ($p < 0.05$). SMA and ST conditions showed higher subjective rating of mental fatigue in post-cognitive manipulation than CON condition ($p < 0.05$).

No condition x time interaction for subjective rating of motivation [Figure 2D; ($F_{(2, 48)} = 0.04$; $p = 0.96$ [$IC_{95\%} = 0.90$ to 0.99]; $\eta^2 = 0.002$ [$IC_{95\%} = 0.001$ to 0.004]; ES small) was found. Also, condition ($F_{(2, 48)} = 0.29$; $p = 0.74$ [$IC_{95\%} = 0.63$ to 0.80; $\eta^2 = 0.002$ [$IC_{95\%} = 0.001$ to 0.01]; ES small) or time effect ($F_{(1, 24)} = 0.01$; $p = 0.99$ [$IC_{95\%} = 0.89$ to 0.99]; $\eta^2 = 0.003$ [$IC_{95\%} = 0.002$ to 0.01]; ES small) were not significant.

*****Figure 2 here*****

100 and 200-m dash performance

100-m dash

No condition x time interaction for 100-m dash [Figure 3A; ($F_{(2, 48)} = 0.21$; $p = 0.81$ [$IC_{95\%} = 0.76$ to 0.89]; $\eta^2 = 0.003$ [$IC_{95\%} = 0.002$ to 0.004]; ES small) was found. Condition ($F_{(2, 48)} = 0.20$; $p = 0.83$ [$IC_{95\%} = 0.75$ to 0.90; $\eta^2 = 0.005$ [$IC_{95\%} = 0.001$ to 0.005]; ES small) or time effect ($F_{(1, 24)} = 0.01$; $p = 0.90$ [$IC_{95\%} = 0.87$ to 0.98]; $\eta^2 = 0.003$ [$IC_{95\%} = 0.002$ to 0.01]; ES small) were not found as well.

200-m dash

No condition x time interaction for 200-m dash [Figure 3B; ($F_{(2, 48)} = 1.63$; $p = 0.21$ [$IC_{95\%} = 0.16$ to 0.29]; $\eta^2 = 0.01$ [$IC_{95\%} = 0.004$ to 0.02]; ES small) was found. Condition ($F_{(2, 48)} = 1.25$; $p = 0.24$ [$IC_{95\%} = 0.15$ to 0.27; $\eta^2 = 0.01$ [$IC_{95\%} = 0.003$ to 0.02];

ES small) and time effect ($F_{(1, 24)}$ = 0.96; p = 0.47 [$IC_{95\%}$ = 0.39 to 0.58]; $\eta^{2} =$ 0.005 [$IC_{95\%}$ = 0.002 to 0.01]; ES small) were not significant.

MPV

No condition x time interaction for MPV in the half-back squat exercise [Figure 3C; ($F_{(2, 48)}$ = 0.07; p = 0.92 [$IC_{95\%}$ = 0.86 to 0.95]; $\eta^{2} =$ 0.01 [$IC_{95\%}$ = 0.004 to 0.02]; ES small) was found. Similar results happened to condition ($F_{(2, 48)}$ = 0.09; p = 0.84 [$IC_{95\%}$ = 0.82 to 0.89; $\eta^{2} =$ 0.004 [$IC_{95\%}$ = 0.003 to 0.01]; ES small) and time effect ($F_{(1, 24)}$ = 0.05; p = 0.87 [$IC_{95\%}$ = 0.82 to 0.91]; $\eta^{2} =$ 0.005 [$IC_{95\%}$ = 0.003 to 0.01]; ES small).

CMJ

No condition x time interaction for CMJ [Figure 3D; ($F_{(2, 48)}$ = 0.59; p = 0.55 [$IC_{95\%}$ = 0.46 to 0.59]; $\eta^{2} =$ 0.004 [$IC_{95\%}$ = 0.003 to 0.01]; ES small) was found. Was Also, no condition ($F_{(2, 48)}$ = 0.53; p = 0.64 [$IC_{95\%}$ = 0.59 to 0.69; $\eta^{2} =$ 0.003 [$IC_{95\%}$ = 0.001 to 0.004]; ES small) or time effect ($F_{(1, 24)}$ = 0.03; p = 0.85 [$IC_{95\%}$ = 0.80 to 0.92]; $\eta^{2} =$ 0.003 [$IC_{95\%}$ = 0.001 to 0.004]; ES small) were found.

*****Figure 3 here*****

DISCUSSION

This study compared the effect of different cognitive manipulations (i.e., social media on a smartphone, Stroop task, and documentary) on all-out neuromuscular (i.e., MPV and CMJ) and simulated sprints (i.e., 100 and 200-m dash) performance in male college sprinters. The main findings showed no difference for all-out neuromuscular or simulated competitive performance between experimental conditions (CON versus SMA versus ST), corroborating the study's hypotheses partially.

It is critical to understand how to assess the psychobiological state of mental fatigue. Typically, mental fatigue assessment methods can be categorized as performance/behavioral, psychological/subjective, or physiological/cognitive indicators (Smith et al., 2019). The present investigation findings showed changes in response time of the inhibitory task and subjective rating of mental fatigue after 60-min of social media on smartphone use or Stroop task compared to documentary, with a higher increase of both indicators (behavioral and subjective) ST than SMA. Previous studies revealed impaired response time on inhibitory tasks and increased subjective rating of mental fatigue following a cognitive task per prolonged period (Filipas et al., 2019; Smith et al., 2019). More recently, scientific investigations also showed impaired response time on inhibitory tasks and increased subjective rating of mental fatigue after social media use on smartphones (Fortes et al., 2019; Fortes, Lima-Junior, et al., 2020).

This study is the first to compare a controlled mental fatigue induction (i.e., ST) with an uncontrolled and real-world induction of mental fatigue (i.e., SMA). Although the lower magnitude of mental fatigue compared to ST, the present study adds to scientific literature that social media on smartphones after a prolonged period causes mental fatigue in athletes. It is a remarkable finding once previous studies have reported the high incidence of smartphone use before training and matches (Thompson et al., 2020). Regarding the accuracy of inhibitory task and motivation, no changes following 60-min of cognitive manipulation (i.e., CON, SMA, and ST) were found. These results corroborate previous studies (Queiros et al., 2020; Smith et al., 2019). More investigations are recommended to confirm these findings.

Concerning 100-m and 200-m dash performance, the results showed no changes after cognitive manipulation (i.e., CON, SMA, and ST). It is essential to highlight that the 100- and 200-m dash was performed in maximum effort, and the duration stimulus was lower than 30-s. Previous scientific investigations also indicated unchanged short-term anaerobic performance in mentally fatigued participants (Pageaux et al., 2013; Rozand et al., 2014). Fortes et al.(2020) demonstrated no effect of mental fatigue on 50-m freestyle performance in professional swimmers after 30-min of social media on smartphone use. Duncan et al.(2015) also showed no difference in mean power output during four Wingate's stimuli (i.e., 30-s all-out) in team sport mentally fatigued amateur athletes. It turns out that the brain areas activated in high-intensity efforts with short duration are different from the areas affected by mental fatigue. Previous studies using functional magnetic resonance imaging (fMRI) indicated high activation on posterior cingulate cortex during high-intensity exercise (Fontes et al., 2015; Guimaraes et al., 2015), while mental fatigue generates changes in the prefrontal cortex (PFC) and dorsolateral PFC (DLPFC) (Pires et al., 2018; Wascher et al., 2014). It could explain why mental fatigue did not affect 100-m and 200-m dash performance in the present study. Also, its important highlight is that in the present investigation the athletes sprinted starting on their own in 100 and 200-m dash, which removed motor-cognitive reaction time. Previous findings showed impaired motor-cognitive reaction time in athletes mentally fatigued (Van Cutsem et al., 2019). The absence of the mental fatigue effect on 100 and 200-m dash performance can be explained by how the sprint was measured in the present study. It is suggested to perform more experimental investigations to confirm these findings.

Concerning all-out neuromuscular performance (i.e., MPV and CMJ), the results indicated no cognitive manipulation effect in experimental conditions (i.e., CON, SMA, and ST). These results agree with findings from studies using maximum muscular voluntary contraction (Pageaux et al., 2013; Silva-Cavalcante et al., 2018) or peak power output (Fortes, Nakamura, et al., 2020; Queiros et al., 2020) in subjects trained mentally fatigued. A systematic review with meta-analysis also showed no high cognitive demanding effect on all-out neuromuscular performance (Brown et al., 2020). As previously suggested (Pageaux et al., 2013; Rozand et al., 2014), mental fatigue and central fatigue appear to be distinct phenomena, probably induced by modifications in different brain areas. More specifically, the all-out neuromuscular performance (i.e., MPV and CMJ) or fatigue can be regulated by peripheral mechanisms. For example, the increase in Na+/K+ pump activity by epinephrine during the high-intensity exercises would increase the membrane potential (Clausen, 2003) or a greater synchronization of muscle fiber action potentials. It could explain why mental fatigue does not change MPV and CMJ performance in male college sprinters.

Several limitations and directions for future research should be considered. Although behavioral and subjective measures effectively measure mental fatigue (Smith et al., 2019), no physiology/cognitive measurements (e.g., EEG or fNIRS) were utilized in the present study. Therefore, future studies should test whether social media on smartphones could change brain activation utilizing EEG or fNIRS. Finally, not including an MVC measurement could also be considered as a limitation of the present study, so it is recommended that future studies also perform these type of measurements (e.g., twitch interpolation) to obtain a more in-depth insight into the mechanisms responsible for all-out neuromuscular performance in athletes mentally fatigued.

CONCLUSIONS

In conclusion, the present study results revealed no effect of mental fatigue induced by social media or ST on all-out neuromuscular (i.e., MPV and CMJ), 100-m, and 200-m dash performance in male college sprinters. Specifically, high cognitive demanding during prolonged periods immediately before the official championship for sprinters (i.e., 100-m and 200-m dash) does not change athletes' performance. These findings suggest that the high cognitive demanding (e.g., social media) during a prolonged period before a race does not affect college sprinters' physical performance. However, a cognitive component as motor-cognitive reaction time, which is highly required at the beginning of races, might influence the athlete’s performance.

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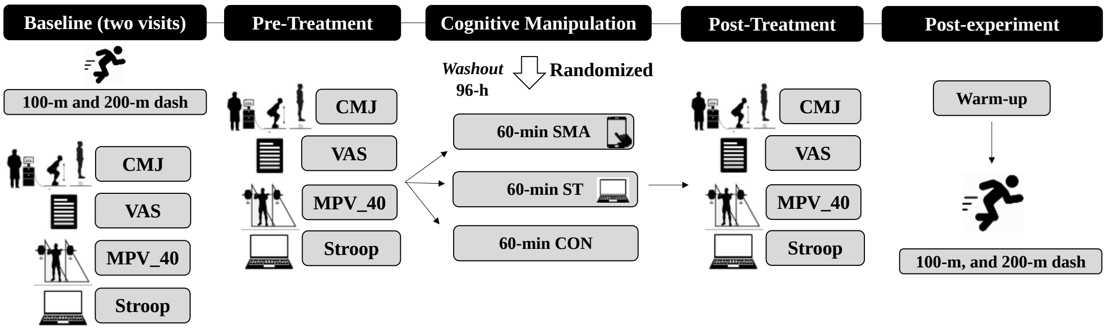

Figure 1

Experimental design of the study

Note. CMJ = countermovement jump; VAS = Visual Analogue Scale (mental fatigue and motivation); MPV_40 = mean propulsive velocity (40 kg); SMA = social media on smartphone; ST = stroop task; CON = control.

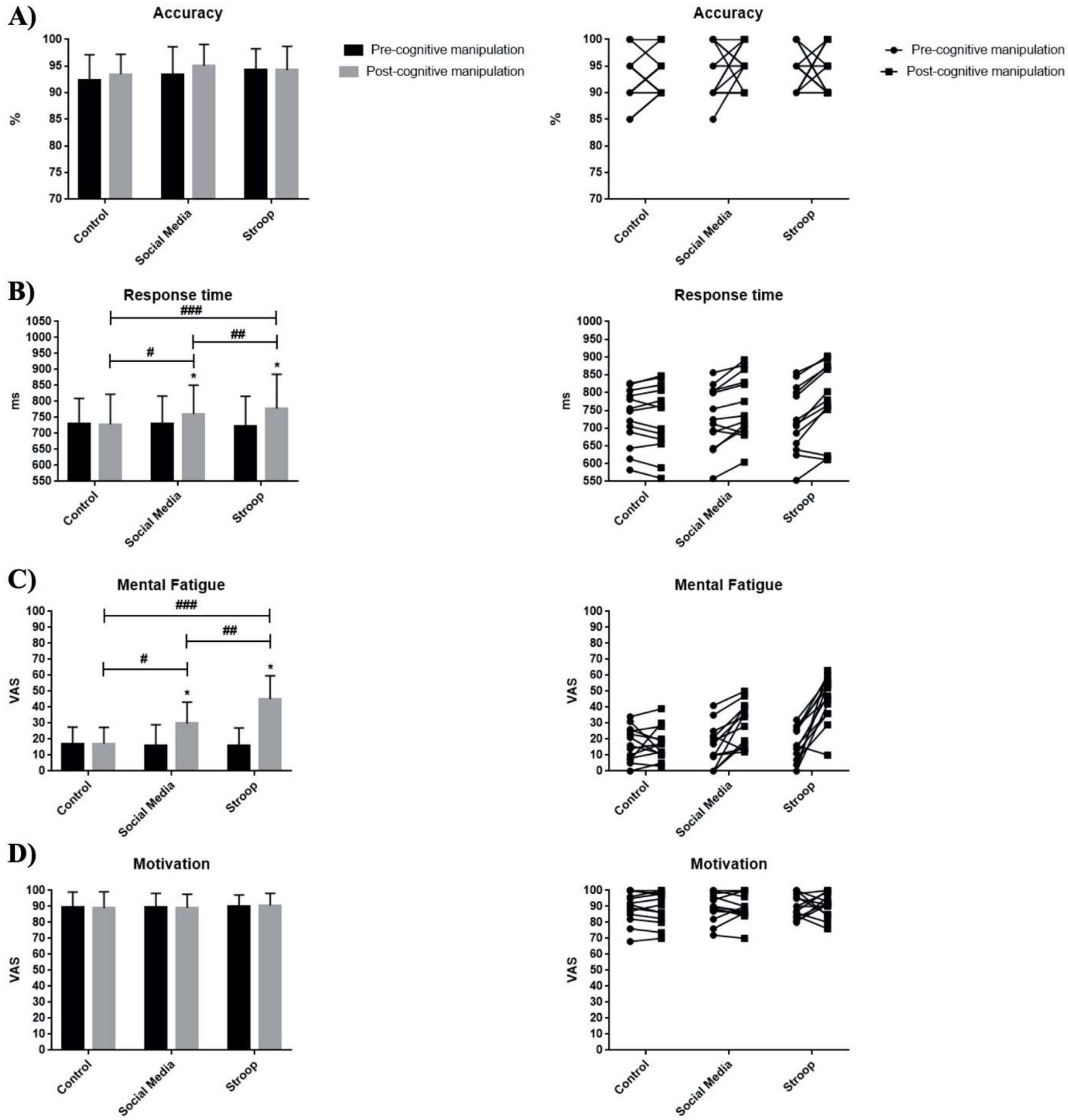

Figure 2

Stroop task [accuracy (A) and response time (B)] and VAS [mental fatigue (C) and motivation (D)] according to the experimental condition (CON versus SMA versus ST) and time (pre versus post-cognitive manipulation) in male sprinters.

Note. **p*<0.05 pre-vs post-experiment; #*p*<0.05 control-vs social media in post-experiment; ##*p*<0.05 social media-vs stroop in post-experiment; ###*p*<0.05 control-vs stroop in post-experiment.

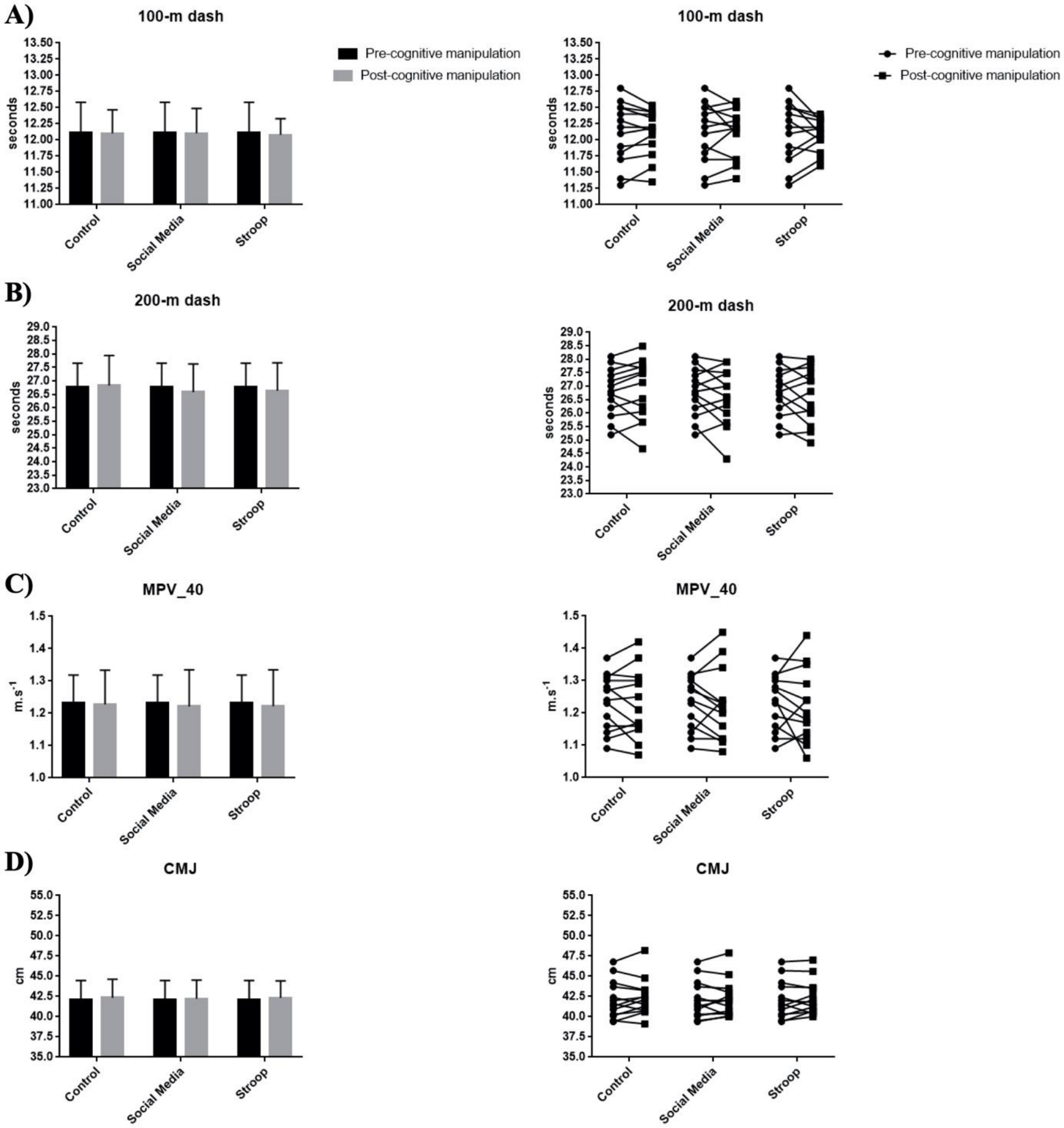

Figure 3

100-m (A), 200-m dash (B), MPV in the half back-squat exercise (C), and CMJ (D) according to the experimental condition (CON versus SMA versus ST) and time (baseline versus post-experiment) in male sprinters.

Note. MPV = mean propulsive velocity; CMJ = countermovement jump.