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The influence of the perceived requirements of the next match and motivation on the mental fatigue of soccer players

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Abstract

The high cognitive and/or emotional demands of competition can lead to a state of mental fatigue which has shown to be detrimental to soccer performance. However, there is a need to further understand the true mental demands of soccer players. The aim of the present study was to analyze the influence of motivation and the perceived requirements of the next match on mental fatigue perceived by soccer players over the passing of a season. The combined effect of both variables on the perception of mental fatigue, as well as the influence of the time of the season on perceived mental fatigue, were also analyzed. Twenty-six semi-professional Spanish male players ($M = 26.31 \pm 5.18$ years) participated in the present study, conducted during the 2020–2021 season. Perceived mental fatigue and motivation were measured at each training session. The perceived requirements of the next match were also measured in each of the competitive weeks. Linear mixed models were run with R Studio to examine the influence of motivation and the perceived difficulty of the next match on perceived mental fatigue, the combined effect of both variables on perceived mental fatigue, and the influence of the passing of the season on perceived mental fatigue. The results showed a negative and significant influence of motivation on perceived mental fatigue ($p < 0.001$) and a positive and significant influence of the perceived requirements of the next match on perceived mental fatigue ($p < 0.001$). Regarding the combined effect, there was a positive and significant effect ($p < 0.01$) of the perceived difficulty of the next match on the relation between motivation and perceived mental fatigue. A negative influence of season passage on perceived mental fatigue levels was found ($p < 0.001$). We recommended coaches to consider using the most motivating training tasks when higher next-match requirements are perceived and to be careful with avoidance strategies for mental fatigue, especially at the beginning of the season.

KEYWORDS

factors influencing, football, longitudinal study, mental exertion, mental load

1 | INTRODUCTION

In the sport context, fatigue has been traditionally and extensively studied from a physical point of view (i.e., cardiorespiratory and metabolic systems).[1] However, fatigue also has a cognitive domain, and the combination of physical and cognitive domains plays an important role in human and sport performance.[2] This phenomenon has also occurred in soccer, where most of the publications has been focused on the physical demands of the sport[3] despite soccer being mentally as well as physically fatiguing.[4]

High cognitive and emotional demands caused by sporting contexts can lead to mental fatigue,[5] which has been studied increasingly over the last decade.[2] However, mental fatigue seems to be multifactorial since other types of demands, such as even the physical ones, also cause mental fatigue.[6–8] Mental fatigue has been defined as a psychobiological state caused by situations of high mental demands (i.e., cognitive and emotional demands).[5] However, as previously mentioned, mental fatigue appears to be a multifactorial construct, so that physical demands can also cause mental fatigue.[6] Mental fatigue can manifest itself subjectively, behaviorally (i.e., decreased reaction time and accuracy) and/or physiologically (i.e., alterations in brain activity).[9] However, susceptibility to mental fatigue may vary depending on some individual factors (e.g., experience or personality).[10–12] One of the most significant advances in mental fatigue has been the evidence of the detrimental effects of mental fatigue on sporting performance. For example, mental fatigue has a negative impact on some of the outcomes of sport-specific psychomotor performance (i.e., decision-making, reaction time and accuracy).[13] Endurance performance also worsens in mental fatigue conditions, through increased perceived exertion and, consequently, decreasing time to exhaustion and self-selected power output/velocity.[5]

Focusing on soccer, mental fatigue has been shown to cause decreases in soccer-specific performance at several levels. At the physical level, mental fatigue limits exercise tolerance through increased perception of exertion.[14,15] At the technical level, mental fatigue decreases shooting speed and accuracy, leads to more missed passes, shorter possession times and a reduction in ball control and successful tackles.[16–18] In terms of match tactics, lateral synchronization and distances between team lines decrease, resulting in poorer spacing.[14,15] In addition, mental fatigue worsens the accuracy and speed of decision-making.[17,19,20] Despite evidence of the detrimental effects of mental fatigue on soccer performance, there are some shortcomings regarding the approach to the particular context of soccer and its specific cognitive and behavioral principles in the methodological designs on mental fatigue.[21] This need arises as a consequence of the use of mentally fatiguing tasks far removed from the real-life context of soccer in previous studies. Similarly, other studies have investigated the effects of induced mental fatigue in soccer, but through isolated performance tests.[3] Therefore, Thompson et al.[3] suggested that further knowledge is needed to understand the true mental demands of soccer players. In addition, there is a need for further research into the variables that may affect the perception of mental fatigue, such as motivation and other psychosocial or contextual variables. For example, it has been shown that the perception of mental fatigue of soccer players varies in different phases of the season[22] and may be influenced by some contextual factors, such as playing at home or away, the result of the previous match, or the quality of the opponent.[23]

1.1 | The present study

The role of motivation in mental fatigue comes from different research evidence. Herlambang et al.[24] analyzed the effects of extrinsic motivation on mental fatigue, through a study where participants performed a mentally demanding task for 2.5 h. Two conditions were alternated: reward (i.e., with presence of extrinsic motivation) and non-reward. Participants reported high levels of mental fatigue in both conditions, but performance remained stable over time in the reward condition when compared with non-reward condition. Similarly, it has been shown that with high levels of intrinsic motivation, people seem to maintain their performance over time and to invest more effort when compared with low intrinsic motivation, despite increases in mental fatigue.[25] However, motivation can take on many forms (intrinsic, extrinsic, before a task, after a task, exercise motivation, ...), which makes it difficult to assess in practice and link with mental fatigue. Although the mechanisms that explain how motivation affects performance while mentally fatigued remain unclear, several possible causes have been suggested. For example, Hockey[26,27] advocated constant cost/benefit analysis when performing a task. Benefits of tasks may come in the form of rewards (i.e., extrinsic motivation) or the enjoyment of the task itself (i.e., intrinsic motivation), whereas the costs of maintaining performance and remaining engaged with the task is perceived as effort, including mental effort. Furthermore, previous researchers have frequently included decreased motivation as a subjective feeling of mental fatigue.[5,11]

In this sense, several authors have alluded to the hypothetical accumulation of extracellular cerebral adenosine in situations of high mental demands. Increased adenosine levels would act in two ways: by increasing perceived exertion during subsequent endurance exercise, and by impairing motivation (due to a decrease in dopamine) to perform the effort.[1,28]

Abbott et al.[23] observed a strong negative correlation between subjective perceptions of mental fatigue and motivation to train over a season in professional under-23 English Premier League soccer players. However, less is known about the influence of how motivating weekly-training sessions (i.e., microcycles) influence the perception of mental fatigue in soccer players.

Regarding the relationship between the perceived requirements of the next match and perceived mental fatigue, several authors support the hypothesis of the effect of mental fatigue on the increase in perceived exertion (i.e., RPE) in endurance performance, as a consequence of the accumulation of extracellular brain adenosine.[1,28] However, this relationship has not been studied inversely (i.e., the possibility that the perceived demand of the upcoming match, in an analogy with RPE, could have an effect on perceived mental fatigue). Abbott et al.[23] showed higher values of mental fatigue in professional soccer players after facing mid-table opponents. The variable used by these authors for the classification of the opponent's demand was an objective variable (i.e., according to their position in the league table). However, there could be other subjective aspects that influence the perceived demands of the opponent. In this sense, the variable perceived requirements of the next match was chosen because of the possible influence that some subjective aspects (i.e. perceived difficulty of the next match, considering the relationship between the opponent's objectives and the objectives of one's own team, as well as the situation of one's own team) can have on perceived mental fatigue, regardless of the position in the opponent's ranking.

Studies in contexts other than sport might suggest a positive influence of difficulty on mental fatigue (i.e., the greater the perceived difficulty of the task, the greater the perception of mental fatigue). For instance, Bafna et al.[29] concluded that task difficulty plays an important role in modeling mental fatigue, in the case of eye-typing tasks. They showed increases in mental fatigue in tasks of greater difficulty compared to tasks of lesser difficulty, meaning that increased difficulty increases mental fatigue. Despite research interest in task difficulty and mental fatigue, there is a knowledge gap regarding the influence of other subjective aspects associated with the specific context of the sport in question,[30] as well as factors related to the perception and personality of each individual and influencing perceived mental fatigue.[11] In this sense, the next-match perceived requirements include other aspects of an individual and subjective nature that go beyond the objective difficulty of the task.

The aims of the present study were:

- To analyze the influence of the motivation of trainings microcycles on perceived mental fatigue in semi-professional soccer players.

  Hypothesis 1. Motivation of trainings has a negative effect on perceived mental fatigue.

- To analyze the influence of the perceived requirements of the next match on their perceived mental fatigue.

  Hypothesis 2. Perceived requirements of the next match have a positive effect on perceived mental fatigue.

- To analyze the influence of the combined effect of the perceived requirements of the next match and motivation on their perceived mental fatigue.
- To analyze the influence of the passing of the season on the relationships between motivation and perceived mental fatigue, and between next-match perceived requirements and perceived mental fatigue.
- To analyze the influence of the passing of the season on perceived mental fatigue.

The authors refrain from formulating hypotheses in relation to the other aims of the study, due to the lack of research evidence.

2 | METHODS

2.1 | Participants

Twenty-six semi-professional (i.e., *Tier 3: Highly Trained/National Level*), according to the New Paradigm for Participant Training and Performance Classification proposed by McKay et al.[31]) male players from a Spanish Third Division club ($M = 26.31 \pm 5.18$ years) participated in the present study, which was conducted during the 2020–2021 season (n of training sessions = 152 sessions; n of competitive weeks = 38 weeks). Before the start the study, participants were informed of the study procedures and they provided written informed consent. The university ethics committee approved all the procedures and data were treated in accordance with the ethical codes of privacy outlined by the American Psychological Association (2019). This research fulfilled the Helsinki Declarations (revised in Brazil, 2013) on human research.

2.2 | Outcomes and instruments

2.2.1 | Mental fatigue

A Visual Analogue Scale (VAS-100 mm) was used to measure the mental fatigue reported by players.[18] Participants marked their degree of perceived mental fatigue along a line from 0 (minimum; on the left) to 100 (maximum; on the right) in a period of 0–10 min after each field-training session of the microcycle previous to the next match. The specific question given to the players was: "how mentally fatigued do you feel on a line from 0–100?". The use of the VAS-100 mm to quantify mental fatigue in soccer has been used in previous work.[14,17,32] During analysis, the original units of the VAS-100 mm were transformed to their equivalent on a scale of 0–10 cm (e.g., 57 mm was transformed to 5.7 cm). This transformation allowed researchers to display all responses on a range of 0–10, being consistent with the format of the other scales obtained (see below). Furthermore, and based on Brown et al.,[33] and Van Cutsem et al.[5] players were provided with the following definition of mental fatigue: a psychobiological state caused by high cognitive efforts and characterized by subjective feelings of tiredness and lack of energy. This was provided to avoid self-assessment bias and possible lack of metacognition among players.[3]

2.2.2 | Motivation

A Visual Analogue Scale (VAS-100 mm) was also used to measure motivation. This scale has already been used in previous soccer studies to measure motivation.[16,18,34] Participants marked their degree of motivation along a line from 0 (minimum; on the left) to 100 (maximum; on the right) in a period of 0–10 min after each field-training session of the microcycle previous to the next match. The specific question given to the players was: "how motivating do you quantify the session on a line from 0–100?". Original units of the VAS-100 mm for motivation were also transformed to their equivalent on a scale of 0–10 to be consistent with the format of the other scales obtained, as previously explained.

2.2.3 | Perceived requirements of the next match

A Likert-type scale 0–10, where 0 was the minimum and 10 the maximum, was used to measure the players perception of the requirements of the next match, with the question, "How demanding do you perceive the next match?". This scale was completed by the players after the first weekly field-training session. To improve metacognition, this variable was defined for the players as the perceived difficulty of the match considering the relationship between the opponent's objectives and their own team's objectives, as well as the current state of the team (i.e. injuries, winning/losing streak, ...).

2.3 | Experimental design

A longitudinal, observational, and retrospective study was conducted following the reporting guidelines of Strengthening the Reporting of Observational studies in Epidemiology (STROBE). A familiarization session was performed before the start of the season to ensure the correct use and understanding of the scales. To facilitate data collection of all the players at the end of the session, the previous questionnaires described were digitalized by researchers. This allowed players to easily respond to all the questions using their phone. In total, four field-training sessions per week were recorded and Match Day (MD) was always on a Sunday. Training was: MD + 1, which corresponds to the first training day of the microcycle, located the day after the competition match (i.e., Monday), MD-4 and MD-3, which correspond to the second and third training sessions of the microcycle (i.e., Wednesday and Thursday, respectively), and MD-1, which corresponds to the day before the MD (i.e. Saturday). Data were collected from all these sessions during the full competitive season ($n = 38$ competitive weeks).

2.4 | Statistical analysis

All data were analyzed using R-Studio Team® (MA, Boston, EEUU). Linear mixed models (LMM) were used to examine the influence of motivation and perceived difficulty of the next match on mental fatigue. LMM was used to overcome the assumption of independence and also because of the flexibility shown in working with altered sample sizes across groups with repeated measures.[23] First, the variables mental fatigue, motivation, perceived requirements of the next match, and passing of the season were group-mean centered, being centered to the team's mean in the season for a suitable interpretation of the results. Prior to running the LMM, a basic component analysis of variance was performed on the dependent variable (i.e., mental fatigue) to assess whether player random factors contributed significant variance. The Wald Z statistic was used to test the null hypothesis that the population variance is zero. As the ICC was >10%, the need to perform this type of analysis (i.e., LMM) was corroborated. A comparison between different LMM models were performed:

(i) motivation as independent variable, (ii) perceived requirements of the next match as independent variable, (iii) the passing of the season as independent variable, and (iv) motivation, perceived requirements of the next match and the passing of the season as independent variables. A comparison between different models were performed, being the model with the three variable (i.e., motivation, perceived requirements of the next match and the passing of the season) which best fitted. Then, LMM were run with motivation, perceived requirements of the next match and the passing of the season as independent variables. Model fit was assessed using Akaike's information criterion (AIC). Significance was set at $p < 0.05$.

3 | RESULTS

Table 1 shows the results of the LMM with mental fatigue, including motivation, perceived requirements of the next match and weeks of training as covariables.

The results showed that motivation ($M = 7.30 \pm 1.94$) has a negative and significant effect on perceived mental fatigue ($M = 27.9 \pm 21.2$; *Estimate* $= -1.56$; $p < 0.001$), meaning that as motivation increases 1 point, mental fatigue decreases 1.56 points (i.e., analogous to an inverse relation). Contrary, the next-match perceived requirements ($M = 9.41 \pm 0.831$) has a positive and significant effect on perceived mental fatigue (*Estimate* $= 3.32$; $p < 0.001$) (i.e., analogous to a direct relation). Regarding the passing of the season, a negative and significant effect of this variable on perceived mental fatigue (*Estimate* $= -0.259$; $p < 0.001$) was found, so mental fatigue decreases as the weeks of training (i.e., the season) progress. When motivation and next-match perceived requirements were combined, the results showed a positive and significant effect (*Estimate* $= 0.851$; $p < 0.01$) of the perceived requirements of the next match on the relation between motivation and mental fatigue. This finding means that as the perceived requirements of the next match increase, the intercept of the relation between motivation and mental fatigue increases (*Estimate* $= -1.56 + 0.851$), whereby the decline in mental fatigue is less pronounced when motivation increases (see Figure 1).

The combination of motivation and the passing of the season has a negative and significant effect (*Estimate* $= -0.097$; $p < 0.01$) of the passing of the season on the relation between motivation and mental fatigue, so as the season progress, the intercept of the relation between motivation and perceived mental fatigue decreases (*Estimate* $= -1.56 + (-0.097)$), whereby the decline in mental fatigue was more pronounced when motivation increased. When combined the perceived requirements of the next match and passing of the season, a positive and significant effect (*Estimate* $= 0.290$; $p < 0.001$) of the passing of the season on the relation between the perceived requirements of the next match and mental fatigue was found. This means that as the season progresses, the intercept of the relation between the next match perceived difficulty and perceived mental fatigue increases (*Estimate* $= 3.32 + 0.290$), being the increment in mental fatigue is more pronounced when the perceived requirements of the next match increases.

4 | DISCUSSION

The aims of this study were (i) to analyze the influence of motivation on perceived mental fatigue, (ii) to analyze the influence of the perceived requirements of the next match on perceived mental fatigue, (iii) to analyze the influence of the combined effect of the next-match perceived requirements and motivation on perceived mental fatigue, and (iv) to analyze the influence of the passing of the season on the relationships between motivation and perceived mental fatigue, and between the next-match perceived requirements and perceived mental fatigue in semi-professional soccer players.

This study showed a negative and significant effect of motivation on perceived mental fatigue. In this sense, the first hypothesis has been verified. This finding is in line with the findings of the longitudinal study carried out by Abbott et al.[23] in which a significant negative correlation

TABLE 1 Results of the performed LMM with mental fatigue, motivation, next-match perceived requirements and weeks of training.

Variables	Estimate	SE	*p*-value
(Intercept)	28.41	3.37	<0.001
Motivation	−1.56	0.254	<0.001
Next-match perceived requirements	3.32	0.738	<0.001
Passing of the season	−0.259	0.054	<0.001
Motivation: next-match perceived requirements	0.851	0.314	0.0068
Motivation: passing of the season	−0.097	0.030	0.0014
Next-match perceived requirements: passing of the season	0.290	0.072	<0.001

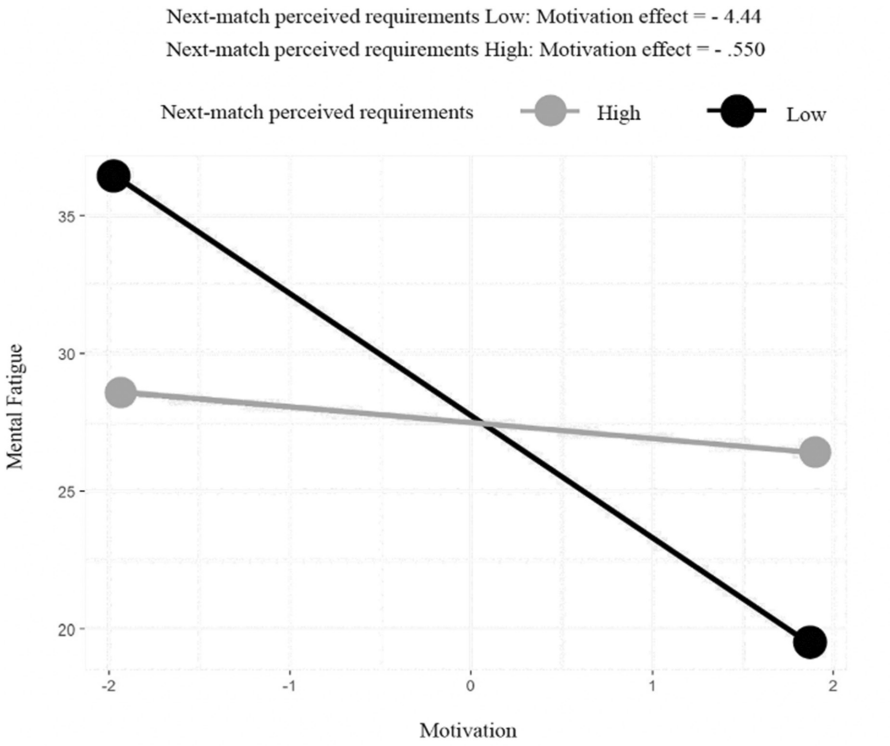

FIGURE 1 Effects of the next-match perceived requirements on the relation between motivation and mental fatigue.

between motivation to train and subjective perceptions of mental fatigue is evident. However, the present study is the first to investigate the influence of post-training motivation on perceived mental fatigue. This information is of great relevance for coaches when selecting motivating tasks depending on their specific objectives regarding the mental fatigue of their players (i.e., increasing mental fatigue levels to induce adaptations, lowering mental fatigue levels to arrive in an optimal state to the competition, ...). Motivation, as mentioned in the introduction, can take many forms (i.e., intrinsic, extrinsic, before a task, after a task, exercise motivation, ...) so it is important to take into account the variability of motivation when studying its relationships with mental fatigue. The link between motivation and mental fatigue has been previously evidenced,[11,24,25] so that performance could be affected by the costs/benefits balance of tasks, training, or competitions.[26,27] Thus, when benefits (coming from extrinsic motivation or intrinsic motivation) are greater than the costs (coming from effort, including mental effort), soccer players will maintain performance and remain engaged.

Another novelty of the present study is the analysis of the influence of the perceived requirements of the next match on mental fatigue. This study showed a positive and significant effect of the perceived requirements of the next match on perceived mental fatigue, verifying the second hypothesis. Bafna et al.[29] concluded that task difficulty is an important factor in modeling mental fatigue. Indeed, when they included the difficulty of a typing task within a model to predict subjective mental fatigue, the variance explained increased. Furthermore, participants reported greater perceptions of mental fatigue as typing task difficulty increased. This was explained by the authors to the extent that more difficult tasks involve a greater cognitive load. Bandura's theory of self-efficacy could provide another possible explanation.[35] According to this theory, self-efficacy is considered a key psychological factor for sport performance. The level of self-efficacy has been defined as the expected achievement of performance at different levels of difficulty.[36] There are findings of a relationship between levels of self-efficacy and mental fatigue, such that low levels of perceived self-efficacy may lead more easily to a state of mental fatigue.[37] Research on the relationships between difficulty expectancies, self-efficacy and mental fatigue could be of interest.

Results evidenced a negative and significant effect on the perception of mental fatigue when the variables of motivation and perceived requirements of the next match were combined. This finding means that the perceived requirement of the next match modifies the relationship between motivation and perceived mental fatigue, making the effect of motivation on mental fatigue less prominent. To our knowledge, this is the first study to investigate the effect of the combination of these two variables (i.e., motivation and next-match perceived requirements) on subjective mental fatigue. Further studies are needed to investigate the possible causes of these results and the relationship between these three variables (i.e., perceived

demands of the upcoming match, motivation, and mental fatigue).

Finally, there was a negative and significant influence of the passing of the season on perceived mental fatigue, meaning that perceived mental fatigue declines as the season progresses. Previous research in different sports[30,38,39] found that the perceived mental fatigue significantly fluctuated across a season, although it does not necessarily decrease over the course of the season.[30] Some of the reasons for these fluctuations suggested by Russell et al.[40] may be pressure to achieve expected targets, media commitments, changes in training volumes or environmental instability (i.e., play-off phases, long travels, ...). Another reason could be fixture congestion, according to the findings of Díaz-García et al.[41] Furthermore, individual factors (i.e., experience and personality) that may contribute to individual susceptibility to mental fatigue need to be taken into account in further research.[10,11]

4.1 | Limitations and future guidelines

A VAS was used to measure perceived mental fatigue. Future research should use objective measures of mental fatigue (e.g., EEG and HRV) and combine them with subjective measures. Another limitation is the small number of matches. The team that participated in the study played a total of 38 matches, which is a rather small number compared to the number of matches played by professional teams, which can reach up to 60 per competitive season.[42] It should be mentioned that some individual factors which could influence on mental fatigue susceptibility were not considered. Future studies should include factors (i.e., related to experience and personality) in order to shed lighter on the findings about the changes in mental fatigue across a season.[11]

4.2 | Practical applications

The results of this study have important practical applications to consider. Coaches and practitioners should consider the degree of motivation of the training tasks depending on their objectives with respect to the levels of mental fatigue they want to achieve in their players and bearing in mind that the relationship between motivation and mental fatigue becomes stronger as the competitive season progresses. The most motivating training tasks should be especially included in those training weeks close to an opponent of higher perceived requirements, especially in the days before the competition, to avoid soccer players arriving with high levels of mental fatigue to the match. Coaches and technical staff are encouraged to monitor the perceived variables of motivation, requirements of the next match and mental fatigue in order to track their athletes. Finally, attention to mental fatigue avoidance strategies is suggested, especially at the beginning of the competitive season, given the trend of higher levels of perceived FM in the early phase of the soccer season.

5 | CONCLUSIONS

Considering that the results of this study are only representative for this season and for the sample used, the variables of motivation and perceived requirements of the next match significantly influence the perception of mental fatigue. Specifically, motivation has a negative effect on the perception of mental fatigue, which becomes less effective as the season progresses. Perceived requirements of the next match has a positive effect on the perception of mental fatigue, which also becomes less effective as the season progresses. Combining both variables, we found that the perceived requirements of the next match makes the effect of motivation on mental fatigue less impactful. Finally, perceived mental fatigue tends to decrease as the competitive season progresses.

6 | PERSPECTIVE

This study showed that the perceived requirements of the next match and motivation, as well as the interaction between both variables, influence the perceived mental fatigue of soccer players during the pre-match training week. In addition, the present study showed that the passage of the season affects players' perceived mental fatigue during the training weeks. This passage of the season also affects the influence of perceived requirements of the next match and motivation on mental fatigue. Therefore, we recommend that soccer coaches and staff take into account the variables of perceived requirements of the upcoming match and motivation in order to control the mental fatigue levels of their players, as well as to provoke adaptations to mental fatigue (i.e., increase resistance to mental fatigue). Therefore, we recommend that soccer coaches and coaching staff take into account the variables of perceived demands of the requirements match and motivation in order to control the mental fatigue levels of their players, as well as to provoke adaptations to mental fatigue (i.e., increase resistance to mental fatigue). Specifically, we recommend the inclusion of the more motivating tasks on days close to the match and in weeks when the perceived demands of the upcoming match are high, while less motivating tasks might fit better in the middle days of the training week. In addition, we recommend keeping

an eye on the mental fatigue levels of the players, which becomes particularly relevant as the season progresses. Finally, it would be interesting to analyze other variables and contextual factors that may influence this fluctuation of mental fatigue as the season progresses (i.e., win/loss streak, injuries, coaching changes, players' state of well-being, match congestion, ...).

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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