

## The multifaceted implications of mental fatigue on women's football players' performance in small-sided games

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### ABSTRACT

Research shows that mental fatigue (MF) can negatively impact physical performance. However, the effects of MF during football match-play are not well understood, particularly in women, and its impact on psychological factors is less known (e.g., attentional focus). This study explored the physical and psychological effects of MF in women's football during 7 vs. 7 small-sided games (SSGs). 14 Women's National League players ( $M$  age = 25.9  $\pm$  5.9 years) participated. A counterbalanced cross-over design was implemented involving a MF (30-min social media use), and a control condition (30-min sitting with teammates with no phone access) prior to 3  $\times$  7-min SSGs, interspersed with 2-min rest. GPS was used to monitor work output. Participants had microphones attached and were asked to 'think aloud' (TA) during SSGs; content analysis was used to examine players' attentional focus and communication. MF (visual analogue scale) and fatigue (BRUMS) increased pre-to post-MF (+1.95  $\pm$  1.45,  $p < .001$ ; +2.57  $\pm$  3.33,  $p = .038$ ) but in control ( $p = 1.00$ ), and happiness (BRUMS) was lower in MF vs. control (-1.96  $\pm$  0.68,  $p = .013$ ). No differences were found between conditions for work output or RPE ( $ps > 0.05$ ). Total TA was lower ( $p = .046$ ) and there was less positive performance-related TA ( $p = .022$ ) in MF (22.53  $\pm$  13.11; 0.15  $\pm$  0.38) vs. control (30.00  $\pm$  17.84; 1.54  $\pm$  2.11). There was more negative non-performance related communication ( $p = .031$ ), and less joking with teammates ( $p = .020$ ) with MF (0.85  $\pm$  1.07; 1.69  $\pm$  1.80) vs. control (0.08  $\pm$  0.28; 4.39  $\pm$  3.78). In sum, 30-min social media use was associated with reduced happiness, vigour and heightened perceptions of fatigue, and effected how able participants were to engage in TA, how positive their thoughts were, and how they communicated with teammates. Avoiding phone use prior to training and match-play may be worth considering. Further team-sport research could incorporate TA methods which the present study showed to be feasible, to understand more on players' cognitive processing in match-play.

### 1. Introduction

The popularity of women's football has grown rapidly and so too have the physical and psychological demands to which players of the game are facing (Wheatley et al., 2023). In England, as of September 2025, the top two tiers of women's football in England (Women's Super League [WSL] and WSL2) are now recognised as fully professional leagues. The Women's National League (FA WNL) makes up the third and fourth tier of the women's football pyramid in England and is comprised of six divisions. The Northern and Southern Premier Divisions act as Tier 3 of the pyramid, with Premier Division One teams residing in Tier 4. There are significant differences in the resources and provisions

available to clubs within and between leagues in the women's football pyramid (Department for Culture, Media & Sport, 2023), demonstrated by some players competing within Tiers 3 and 4 remaining unpaid and of amateur status, with others on full time contracts as professional athletes - though most competing within the WNL would be recognised as semi-professional athletes.

Successful performance in football is dependent upon a myriad of factors including the maintenance of optimal physical performance (Martínez-Lagunas et al., 2014) and the simultaneous execution of a range of cognitive skills (e.g., decision making, attention, communication) (Vestberg et al., 2017; McLean et al., 2021; Grund, 2012). The volume of high-intensity running is a good reflection of the demands of

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the game; larger distances in high-intensity thresholds tend to be covered at higher standards of the game (Ramos et al., 2019; Vescovi et al., 2021). Elite women's football players cover distances of between 9 and 11 km during match-play (Bradley & Scott, 2020; Scott et al., 2020), where significant declines are observed between 60–75 min and 75–90 min compared to the first 15 min of match-play as a result of fatigue (Hewitt et al., 2014).

Progressive fatigue experienced within team-sport is traditionally attributed to the depletion of muscle glycogen stores, increased core temperature, loss of body fluids and changes in the synthesis and metabolism of neurotransmitters (Meeusen et al., 2006; Mohr et al., 2012), alongside perceptual responses to exercise (Marcora & Staiano, 2010). However, research has typically focused exclusively on the occurrence and influence of physical fatigue, despite more recent understanding that mental fatigue can also be detrimental for athletic performance (Yuan et al., 2023).

Mental fatigue refers to a psychobiological state that people may experience after or during prolonged cognitive activity, involving tiredness or exhaustion with associated feelings of lethargy and demotivation, decreased level of commitment or aversion to the task and changes in perception and mood (Boksem & Tops, 2008; Dantzer et al., 2014). Mental fatigue has previously been shown to negatively affect athletic performance (e.g., Sun et al., 2021; Marcora et al., 2009; Abbott et al., 2020) and player wellbeing (Sarmiento et al., 2021). It is explained that mental fatigue could affect performance in two ways: 1) it may increase perceptions of fatigue i.e., "I can't do it, I am exhausted", and 2) it may reduce the value of the importance of success on a task i.e., "I do not feel like doing it, it is not worth it" (Dantzer et al., 2014). Coutts (2016) explains that elite football players may experience high levels of mental fatigue due to expectations of coaching staff, supporters, the media, and club sponsors, alongside during matches due to the need for sustained attention and application of tactical information provided by coaching staff. However, research within the women's side of the game remains sparse (Emmonds et al., 2019; Gledhill, Harwood, & Forsdyke, 2017; Kryger et al., 2022). This is important to address, given the difference in physical and psychological stressors women footballers face compared to their male counterparts.

Increased use of technology (e.g., smartphones) has also been associated with fatigue. In 2023, Data Reportal reported that the average screen time globally for people aged 16 to 64 was 6 h 37 min, with smartphones accounting for 3 h 46 min (Kemp, 2023). Research has highlighted potential detrimental effects linked to the emergence of mental fatigue with even acute use of smartphones (Jacquet et al., 2023); just 45-min use has been shown to increase subjective mental fatigue, drowsiness and impair cognitive performance (i.e., vigilance and inhibition) (Jacquet et al., 2023), which may impact athletic performance. Indeed, previous research found that evening tablet-use decreased vigour, increased fatigue, and influenced depression and annoyance in highly trained netball players (Jones et al., 2018). Further 30-min smartphone use (prolonged cognitive tasks) has been shown to inhibit physical and technical performance in young male footballers on the Loughborough Soccer Passing Test and Yo-Yo Intermittent Recovery Test (Smith et al., 2016). However, evidence examining the causes of, occurrence and consequences of mental fatigue in high-performance women's football is limited due to a lack of women's representation in the existing literature (Emmonds et al., 2019; Thompson et al., 2022).

A review by Yuan et al. (2023), found that mental fatigue significantly influenced team sport athletes' physical performance measured as intermittent endurance and total distance, associated with heightened perceptual exertion, where these declines were not observed within more ecologically valid setting (i.e., SSGs). They also found mental fatigue impaired skill execution, such as increased ball loss, reduced passing and shooting accuracy, and impaired interception and tackling performance. They associated these technical decrements with reduced attentional resources, though just one study included explored this experimentally, finding that mental fatigue decreased peripheral

perception (Kunrath et al., 2020). It is also notable that all 12 studies within the review included only male team sport players (total  $n = 321$ ), reinforcing the lack of women's representation in sport psychology research (Gledhill, Harwood, & Forsdyke, 2017).

Yuan et al. (2023) emphasised that a 30-min Stroop task was predominantly used to induce mental fatigue, with just one study included exploring the impact of 30-min social media use (Fortes et al., 2021). While the Stroop task offers control, it may lack ecological validity in reflecting athletes' pre-competition behaviours. Previous research has found that 58.3 % of English academy soccer players reported using social media on their smartphones as part of their pre-competition routine (Thompson et al., 2020). Previous research has shown that social media use can disrupt attention, concentration, memory and executive function (Durand-Bush & DesClouds, 2018), as well as induce stress and anxiety (Cheever et al., 2014). Social media use can induce mental fatigue due to: a) requiring high cognitive inhibition due to scrolling through content that can provoke negative emotions (Durand-Bush & DesClouds, 2018), and b) requiring the use of sustained attention, involving listening, writing and reading which demand cortical activity in the frontal cortex reducing available resources for other tasks (Fortes et al., 2019). Thus, prolonged mobile phone use has been shown to induce physical and mental fatigue through influencing internal training load, heart rate variability and cognitive interference control (Fortes, Lima Junior, et al., 2022). Although social media is not sport-specific, its ubiquity and cognitive demands make it a more ecologically valid stimulus compared to traditional lab-based tasks.

Furthermore, the focus of these effects has also resided predominantly on the impacts of mental fatigue on physical performance and skill execution, with less focus on important psychological implications. Typically, these factors are seen as more challenging to explore (e.g., attentional control, decision-making) than physical indices which can be objectively monitored such as through Global Positioning Systems (GPS), in more ecologically valid scenarios (i.e., match-play). Through incorporating more novel methodologies such as through the use of think aloud (TA) (Whitehead & Jackman, 2021), there is potential to understand the effects of mental fatigue on performance more holistically, namely its impact on relevant cognitive skills such as attentional focus, as well as communication on the field of play (Farina & Cei, 2019; LeCouteur & Feo, 2011; Sullivan & Feltz, 2003). Whilst TA has been used to investigate attentional focus and decision-making in a variety of contexts across a range of activities (e.g., chess, medicine, nursing) there is still limited research which has explored its use in sports tasks (Whitehead et al., 2015), and none to the authors knowledge during football match-play which could be useful to uncover cognitive processes in footballers during competitive scenarios (Ericsson & Simon, 1993).

## 2. Rationale and research aims

Despite mental fatigue being shown to affect athletic performance across a variety of sports, limited research has explored its effects within women's sport. The effects of mental fatigue have typically been explored within more controlled lab-based settings and not within competitive scenarios where motivation and stressors differ. To date, mental fatigue has typically been induced using prolonged cognitive tasks (e.g., Stroop test) which lacks ecological validity in terms of the pre-training/match routines and stimuli that players might typically engage in (e.g., social media use). Further, mental fatigue has typically been explored in terms of its effects on physical performance indicators, where its effects on the psychology of the athlete (e.g., mood) and cognitive functions associated with sporting success (e.g., attentional focus, communication skills) are also important to understand. Therefore, we firstly sought to understand if 30-min social media use affects women's football players' mental fatigue and mood prior to training. This study also sought to explore if mental fatigue impacted attentional focus (via TA) and women's football players' ability to communicate

with one another during SSGs. Finally, we sought to explore if mental fatigue affected physical performance and perceived exertion during SSGs.

### 3. Methods

#### 3.1. Participants

Fourteen British National League (Tier 3) women's football players ( $M$  age =  $25.9 \pm 5.9$  years;  $M$  height  $170.8 \pm 4.5$  cm;  $M$  weight  $62.7 \pm 6.7$  kg;  $M$  open age experience  $11.4 \pm 7.1$  years) volunteered for this study. All participants were members of the same football club. Participants were required to be well-trained football players, with experience playing at semi-professional level (or above) (i.e., National League). Participants were also non-smokers with no history of cardiovascular or respiratory problems. Participants consisted of defenders ( $n = 6$ ), midfielders ( $n = 4$ ), forwards ( $n = 2$ ) and goalkeepers ( $n = 2$ ) who were subsequently divided into two balanced teams (7 vs. 7) according to their playing positions. The division of the teams remained the same in all experimental conditions. Using a repeated-measures ANOVA calculation in G\*Power, with a medium effect size ( $d = 0.50$ )<sup>1</sup> informed by the size of effects found from 30-min mental fatigue manipulation (via 30-min Stroop) on distance covered during intermittent endurance exercise (i.e., SSGs and beep test, respectively) and for RPE (internal training load) during exercise following 30-min social media use in previously conducted within-subjects repeated-measures experiments (Fortes et al., 2019; Kunrath et al., 2020; MacMahon et al., 2019), a sample size of 14 was estimated to have 80% power. Further, this sample size was deemed suitable given the qualitative nature of some of the primary outcome measures involved (i.e., think-aloud) given sample sizes used in think-aloud research during exercise to date (e.g., Samson & Jensen, 2021; McGreary, Birch, Eubank, & Whitehead, 2020). Following approval from the University of Hull Research Ethics Committee, all participants were provided with a participant information sheet, pre-exercise medical questionnaire, demographic questionnaire and gave their written informed consent prior to commencing the study.

#### 3.2. Experimental design

This study implemented a counterbalanced, partially<sup>2</sup> randomised cross-over design involving two experimental conditions (mental fatigued [MF] vs. control [CON]). Participants completed a familiarisation, followed by two main experimental trials in a counterbalanced order. Sessions were completed with 1-week intervals and conducted at the same time of day during their usual training time.

#### 3.3. Procedures protocol

##### 3.3.1. Familiarisation

On arrival, participants were familiarised with and practiced the Brunel Mood Scale (Terry et al., 2003) and Visual Analogue Scale as previously adopted by Fortes et al. (2019) and Smith et al. (2019). In alignment with Ericsson and Simon (1993), participants then received instructions for Level 2 TA outlining what they were being asked to do during the study. Level 2 TA was employed rather than Level 3, as

<sup>1</sup> A sensitivity analysis identified that with this sample size, the minimum effect size that our study could reliably detect for the GPS and RPE outcome measures was  $d = 0.36$ .

<sup>2</sup> Only partial randomisation was possible whereby participants were allocated to teams informed by positions to maintain realistic team dynamics during the small-sided games. To counterbalance conditions, 7 participants had to take part in the control first, followed by mental fatigue condition, and vice versa. Therefore, within teams it was randomised as to who would be assigned each condition first, see further details in *Experimental Trials*.

previous research has established that instructing participant to verbalise their thoughts using Level 2 does not alter performance, whereas directing participants to provide explanations for their thoughts (Level 3) may alter performance (Fox, Ericsson, & Best, 2011). The instructions given to participants were written with the football context in mind specifically designed for this study, for example where they directed their attention to prior to receiving the ball (Oliver, McCarthy, & Burns, 2021; Whitehead et al., 2015). Participants were then given the opportunity to ask questions they had on TA. Following instruction, participants were then taken through a series of non-task specific TA practice tasks (Eccles, 2012) to familiarise themselves with verbalising aloud. Participants were subsequently fitted with a Dictaphone (Fikyra Digital Voice Recorder, China) situated between the scapulae in the pouch of a custom designed undergarment (Catapult Sport, Australia), in addition to a clip microphone (Movo Universal Lavalier, Canada) clipped onto the front of their torso clothing to capture TA verbalisations. Participants then practiced with the TA aspect of the protocol during a 20-min SSG on 4G, during which, participants were intermittently prompted by the research team to continue to engage with TA.

##### 3.3.2. Experimental Trials

Prior to the experimental trials, participants were allocated to conditions (MF and CON) in a counterbalanced order, ensuring that there was a mix of experimental conditions within each team so that not all within one team were mentally fatigued during one experimental trial (i.e., Trial 1 = Team 1: 4 × MF, 3 × CON, Team 2: 3 × MF, 4 × CON, Trial 2 = Team 1: 3 × MF, 4 × CON, Team 2: 4 × MF, 3 × CON). Testing took place at their usual training facility between the hours of 7–9pm. Upon arrival, participants completed the Brunel Mood Scale and Visual Analogue Scale and were subsequently fitted with the custom designed undergarment housing a 10 Hz Global Positioning System (GPS) device (Catapult Sport, OptimEye X4, Australia) and Dictaphone with the associated clip microphone. Participants then sat for 30-min in separate rooms for their allocated conditions. The CON condition consisted of sitting in a changing room with no smartphone or technology use. Participants were permitted to talk, to replicate usual pre-match settings. The MF condition consisted of sitting quietly whilst continuously using social media applications (e.g., X®, Facebook®, Instagram®) for 30-min on smartphones. The smartphone use was supervised by a researcher to ensure that the participants remained using the allocated applications at all times (Fortes et al., 2021). Following 30-min, all participants completed the post BRUMS and VAS questionnaires, whilst GPS devices and Dictaphones were then switched on ready for data collection. Participants then conducted a 15-min standardised warm-up led by their S&C coach and played a 3 × 7min SSG interspersed with 2-min rest on a 72 × 47 m pitch representing 75% match-derived relative pitch area (~245 m<sup>2</sup> per player), allowing players sufficient space for high-speed actions and match representation (Olthof et al., 2019; Riboli et al., 2022). During the 2-min rest period, rate of perceived exertion (RPE) was obtained (Borg, 1982), with no further contact made by the research team during game play.

#### 3.4. Variable measurements

##### 3.4.1. Qualitative measures

*Attentional Focus/Communication.* Prior to commencing the SSG, participants were instructed to TA as frequently as possible during the game. Instructions were given to verbalise both immediate and retrospectively thoughts both on and off the ball. Following this, participants were prompted to continue with TA during the 2-min rest period, with no further contact made by the research team during game play. Verbalisation was recorded via a Dictaphone and clip microphone, which remained recording from prior to the warm-up to the cessation of the SSG.

### 3.4.2. Perceptual measures

**Visual Analogy Scale (VAS).** To determine the perception of mental fatigue, the VAS was employed before and after each (CON & MF) condition. The scale consisted of a 10 cm line with two extremities anchored at “none at all” (0 cm) and “maximal” (10 cm), respectively. Participants were instructed to respond to the question: “How mentally fatigued do you feel?” by drawing a vertical line along the 10 cm horizontal line from 0 ‘not at all’ to 10 ‘completely exhausted’ (Van Cutsem et al., 2022). Scores were calculated by measuring the distance (in cm) from the vertical line from 0 cm. VAS has previously been found to be a sensitive and practical tool to assess mental fatigue (Fortes et al., 2021; Smith et al., 2019).

**Brunel Moods Questionnaire (BRUMS).** To determine mood states the 32-item BRUMS (Lane et al., 2007, pp. 115–127) was employed before and after each (MF and CON) conditions. This measures eight identifiable mood states (Anger, Tension, Depression, Vigour, Fatigue, Confusion, Happiness, Calmness) via a self-reported inventory. Participants were instructed to respond to the question “how do you feel right now?” by rating a list of adjectives, on a 5-point Likert scale from “not at all” to “extremely”. Mood state scores range from 0 to 16. The BRUMS has demonstrated acceptable to excellent internal consistency ( $\alpha = .74\text{--}0.90$ ) and was developed as a sport-specific alternative to the Profile of Mood States (POMS), with which it shares strong conceptual alignment (Lane et al., 2007, pp. 115–127).

**Rating of perceived exertion (RPE).** RPE was taken during the 2-min rest periods within the SSGs, using the 6–20 Borg scale (Borg, 1982). Previous research assessing the reliability of the Borg Scale has found excellent agreement during exercise (ICC = 0.77) within individuals across three sessions (Unick et al., 2015).

### 3.4.3. Physical performance measures

**GPS.** During the SSG, locomotor profiles were assessed using the GPS devices previously mentioned. Participants wore the same equipment throughout the duration of the study to minimise interunit error between devices (Malone et al., 2017). GPS data were subsequently downloaded and trimmed using the accompanying proprietary software (Openfield 3.10.5, Catapult Innovations). The following physical variables were quantified; total distance [m], relative distance [ $\text{m}\cdot\text{min}^{-1}$ ] and velocity threshold [ $\text{m}\cdot\text{s}^{-1}$ ]. Velocity thresholds were set in accordance with previous research in women’s football players (Bradley & Vescovi, 2015): standing and walking ( $0.0\text{--}1.6\text{ m s}^{-1}$ ), jogging ( $1.7\text{--}2.2\text{ m s}^{-1}$ ), low-intensity running ( $2.3\text{--}3.3\text{ m s}^{-1}$ ), moderate-intensity running ( $3.4\text{--}4.3\text{ m s}^{-1}$ ), high-intensity running ( $4.4\text{--}5.6\text{ m s}^{-1}$ ) and sprinting ( $>5.6\text{ m s}^{-1}$ ). Raw data were further divided into quarters for each experimental trial ( $3 \times 7\text{ min}$ ) to assess impact of time. Due to technical failure in one device during both experimental trials, activity profiles of 13/14 participants were obtained.

## 3.5. Data analysis

### 3.5.1. TA data

In line with previous post-positivist research using TA (e.g. Whitehead et al., 2018), all TA audio files were transcribed verbatim before being subject to line-by-line content analysis (Maykut et al., 1994). Units of information were coded and put into categories to allow comparisons between the control condition and the mental fatigue condition (See Tables 1 and 2). Importantly, the audio files contained TA verbalisations and verbal communication, both of which were coded during the content analysis. Author 3 analysed the transcripts using NVivo qualitative analysis software, with author 5 acting as a critical friend. Both author 3 and 5 have expertise in TA and coding TA audio using content analysis. Hence, they were able to differentiate between instances of TA and communication.

The analysis of the communication data was inductive and deductive. To begin, author 3 and 5 identified verbal communication deductively based on coding schemes from previous research in football

**Table 1**

Final Coding Scheme for Think Aloud use in Analysis.

Primary Theme	Secondary Theme	Description
Performance Related <i>TA Verbalisations with bearing on performance</i>	Positive	Verbalisations about good performances e.g., ‘good block by [player name]’, ‘this is a good high press’, ‘it’s a great run’
	Negative	Verbalisations about bad performances e.g., ‘fuck me, easy tap in’, ‘that depresses me straight away’, ‘fucked up cos no one was fucking moving’
	Neutral	Verbalisations that are descriptive in nature e.g., ‘cutting the middle off’, ‘watching the run’, ‘waiting for [player] to run back’, ‘[player] fell over again’
Non-performance related <i>TA Verbalisations with no bearing on performance</i>	Internal	Verbalisations about what is happening inside the player and unrelated to performance e.g., ‘I’ve got an itchy eye’, ‘I’m hungry’, ‘too warm’
	External	Verbalisation about what is occurring outside of the player and unrelated to performance e.g., ‘oh that’s gonna hurt’, ‘I like it when you can see steam’, ‘this thing is really pissing me off’
Miscellaneous	–	Verbalisations that lack context and tone for categorisation e.g., ‘oh’, ‘ow’, ‘hmm’

(Blaser & Seiler, 2019) and netball (LeCouteur & Feo, 2011). The initial coding scheme included categories of orientation, stimulation, evaluation, and task irrelevant, describing four types of in game communication (Hanin, 1992). With subcategories such as one-word directives and positive evaluation. Author 3 coded four transcripts from different conditions to trial the coding scheme before identifying further subcategories inductively. For example, asking a teammate a question, communicating position of self-or others, and apologising. The coding scheme for TA verbalisations was inductive and included categories named performance related and non-performance related. Given that the embryonic nature of this research and that the authors were interested in how thoughts were impacted by the conditions, the authors developed an inductive coding framework. During coding, clear verbalisations relating to performance and non-performance factors could be seen. Further, valence of verbalisations was also evident (i.e., positive [saying something pleasant or affirming to one self], neutral [stating something that is neither positive or negative]), or negative [saying something unpleasant or derogative about performance or the self]), which has also been seen within the self-talk literature (Thibodeaux & Winsler, 2020).

After coding the initial four transcripts with the coding scheme for communication and TA, authors 3 and 5 met to discuss issues with the coding scheme and any verbalisations that were ambiguous (i.e., TA or communication). It was decided that listening back to the audio files for ambiguous verbalisations would aid the differentiation between TA and communication. Further, subcategories were added to the coding scheme such as miscellaneous in TA, miscellaneous in communication, cursing in TA, and joking in communication.

After all transcripts had been analysed, authors 3 and 5 met again to make minor changes to the coding scheme. For example, it was noted that zero codes were present for TA cursing as these were categorised into miscellaneous or performance related. Therefore, cursing was removed. Additionally, zero codes were categorised for non-performance related positive in either condition, and so this category was removed.

Frequencies of each category and subcategory were then exported into an excel file for statistical analysis. Square root transformation was

**Table 2**  
Final Coding Scheme for Verbal Communication use in Analysis.

Primary Theme	Secondary Theme	Description
Orientation refers to those communications by teammates regarding planning and coordinating interactions (e.g., what do to, how, when, and where).	Communicating position of self or others	Informing a teammate(s) of their current position or the position of others on the pitch e.g., ‘man on now’, ‘here if you need’, ‘I’ll go I’ll engage’
	One word directives	Directing team-mates’ behaviour on the pitch using one word e.g., drive, feet, recover
	Two word directives	Directing team-mates’ behaviour on the pitch using two words e.g., ‘open up’, ‘play it’, ‘travel forward’
	Two plus word directives	Directing team-mates’ behaviour on the pitch using more than two words e.g., ‘keep our shape’, ‘talk to each other’, ‘look in the middle’
	Asking a clarifying question	Stating a question to teammates to gain understanding of the situation. Questions may be rhetorical. e.g., ‘where are we?’, ‘who is moving?’, ‘who’s following her?’
Stimulating is defined as messages motivating partners to maintain or increase/decrease activity levels with no reference to what to do and how to do it.	Motivating teammates to upregulate	Communication to teammates to increase their activity levels e.g., ‘come on’, ‘go on then’, ‘give it everything’
	Motivating teammates to downregulate	Communication to teammates to decrease their activity levels e.g., ‘nice and easy’, ‘relax it’, ‘go easy’
	Supporting teammates	Communication to aid teammates’ emotional regulation e.g., ‘it’s alright mate’, ‘unlucky’, ‘don’t worry’
Evaluation Performance is briefly assessed and communicated in statements about own or teammates’ actions or behaviour.	Constructive feedback	Communication of solutions to poor performance e.g., ‘make a call if you want it back there’, ‘we need to pick up, it’s getting a bit messy’, ‘we’re outnumbered here we need to get behind the ball’, ‘make sure to trust yourself [player name] and get right at ‘em’
	Negative feedback	Communication of poor performance without providing a solution e.g., ‘For fuck’s sake, it’s a bloody easy pass’, ‘we should have been in there’, ‘what a bag of shit’,
	Positive feedback	Communication of good performance or effort e.g., ‘well done’, ‘good girl’, ‘brilliant from you’, ‘love that’
	Neutral feedback	Communication of objective observations during performance e.g., ‘offside’, ‘foul’, ‘throw in’
	Apologising	A player communicating they acknowledge their mistakes e.g., ‘oh no, sorry again’, sorry, I should have been there’, ‘sorry, that was an awful pass’

**Table 2 (continued)**

Primary Theme	Secondary Theme	Description
Non-performance related communications between players with no bearing on performance.	Negative	Communicating dissatisfaction or a complaint unrelated to performance in the game e.g., ‘help, I can’t feel my foot’, ‘ow, that actually hurt’, ‘I’m never wearing joggers again’
	Neutral	Communicating objective information that is not related to the current match e.g., ‘just talking’, ‘it’s warm int’ it’, ‘hang on, my hair’
	Joking	Humorous remarks to teammates that are unrelated to performance e.g., ‘you’re like a 6 ft giant’, ‘[squeaking noises] it’s gonna sound fucking stupid on this’, ‘ha fuck ha’

performed in excel to allow difference testing for TA and communication data across conditions for such count data in JASP (Festini & Altman, 2002). Data was tested for normal distribution via the Shapiro-Wilk test, where data was not normally distributed, a Wilcoxon signed-rank test was used for analysis, accompanied by biserial correlation effect size. For normally distributed data, a paired-samples T-test was employed, using Cohen’s *d* measure of effect size. In accordance with Cohen (1992), *d* values of 0.2, 0.5 and 0.8 indicated small, moderate, and large effects for pairwise comparisons, respectively. Statistical significance was accepted at  $p \leq .05$  Inferential statistics in-text and within figures presented are reported from the transformed data.

3.5.2. Perceptual and performance data

Statistical analysis was completed using JASP (0.17.2.1) for all perceptual and performance data. After data screening and checking for normality of the data, a series of two-way (experimental condition by time) repeated measures ANOVAs were performed and Bonferroni pairwise corrections applied. Firstly, to check whether 30-min social media use had affected perceived levels of mental fatigue (MF VAS) and mood (BRUMS) compared to the control condition, a 2 (control; mental fatigue) × 2 (pre; post) repeated measures ANOVA was conducted. To explore the effects of mental fatigue on rate of perceived exertion and GPS performance data during SSGs, a series of 2 (control; mental fatigue) × 3 (SSG thirds) repeated measures ANOVAs were conducted. Homogeneity of variance was assessed using Mauchly’s test of Sphericity. Where homogeneity of variance was unable to be assumed, Greenhouse-Geisser corrections were applied. Where significant results were identified, Bonferroni pairwise comparisons post-hoc tests were performed. Two-tailed statistical significance was accepted at  $p \leq .05$ . All data were reported as means and standard deviation (*SD*). Partial eta-squared ( $\eta_p^2$ ) are reported as the effect size for ANOVAs. Cohen’s *d* was again reported as the effect size for pairwise comparisons.

4. Results

**Mental Fatigue [Manipulation Check].** A 2 × 2 repeated measures ANOVA was conducted to establish if the social media intervention induced mental fatigue. No main effect for condition ( $F_{1,11} = 0.430, p = .526, \eta_p^2 = 0.038$ ) for the mental fatigue VAS scale were found. However, there was a main effect for time ( $F_{1,11} = 9.185, p = .011, \eta_p^2 = 0.455$ ) and a significant condition × time interaction effect ( $F_{1,11} = 12.645, p = .005, \eta_p^2 = 0.535$ ) whereby mental fatigue significantly increased following 30-min social media use compared to pre- (+1.95 ± 1.45,  $p < .001, d = 1.004$ ) but did not increase following 30-min sat in the changing room with teammates (control) (−0.23 ± 1.45,  $p = 1.00, d =$

0.116) (Fig. 1).

4.1. Mood (BRUMS)

**Anger.** There was no main effect for condition ( $F_{1,13} = 1.181, p = .297, \eta_p^2 = 0.083$ ), time ( $F_{1,13} = 0.044, p = .836, \eta_p^2 = 0.003$ ) nor condition  $\times$  time interaction effects ( $F_{1,13} = 2.248, p = .158, \eta_p^2 = 0.147$ ) for anger, where it was not different pre-to post-in control ( $-0.50 \pm 1.34, p = .187, d = 0.19$ ) nor with mental fatigue ( $+0.57 \pm 1.61, p = .205, d = 0.29$ ) (Fig. 2).

**Tension.** There was no main effect for condition ( $F_{1,13} = 0.497, p = .493, \eta_p^2 = 0.037$ ), time ( $F_{1,13} = 0.356, p = .561, \eta_p^2 = 0.027$ ) nor condition  $\times$  time interaction effects ( $F_{1,13} = 0.545, p = .474, \eta_p^2 = 0.040$ ) for tension, where it was not different pre-to post-in control ( $-0.07 \pm 0.2.17, p = .904, d = 0.02$ ) nor with mental fatigue ( $+0.43 \pm 1.01, p = .139, d = 0.14$ ) (Fig. 3).

**Depression.** There was no main effect for condition ( $F_{1,13} = 2.957, p = .109, \eta_p^2 = 0.185$ ), time ( $F_{1,13} = 0.659, p = .431, \eta_p^2 = 0.048$ ) nor condition  $\times$  time interaction effects ( $F_{1,13} = 2.533, p = .136, \eta_p^2 = 0.163$ ) for depression, where it was not different pre-to post-in control ( $+0.57 \pm 1.34, p = .135, d = 0.18$ ) nor with mental fatigue ( $+0.21 \pm 1.12, p = .487, d = 0.07$ ) (Fig. 4).

**Fatigue.** There was a main effect for condition ( $F_{1,13} = 5.879, p = .031, \eta_p^2 = 0.311$ ) and a condition  $\times$  time interaction effect ( $F_{1,13} = 12.874, p = .003, \eta_p^2 = 0.498$ ), whereby feelings of fatigue were higher following 30-min social media use compared to pre- ( $+2.57 \pm 3.33, p = .038, d = 0.75$ ) but was not different following the control compared to pre- ( $-2.00 \pm 3.33, p = .122, d = 0.583$ ). Fatigue was also significantly higher following the mental fatigue condition compared to post-control ( $+4.79 \pm 4.53, p = .004, d = 1.395$ ) (Fig. 5).

**Confusion.** There were no main effects for condition ( $F_{1,13} = 0.498, p = .493, \eta_p^2 = 0.037$ ) or time ( $F_{1,13} = 0.582, p = .459, \eta_p^2 = 0.043$ ), nor condition  $\times$  time interaction effects ( $F_{1,13} = 0.271, p = .612, \eta_p^2 = 0.020$ ) for confusion, where it was not different pre-to post-in control ( $-0.36 \pm 1.16, p = .266, d = 0.11$ ) nor with mental fatigue ( $+0.07 \pm 1.73, p = .880, d = 0.02$ ) (Fig. 6).

**Happy.** There was a main effect for condition ( $F_{1,13} = 8.288, p = .013, \eta_p^2 = 0.389$ ) whereby happiness was lower in the mental fatigue condition compared to control ( $-1.96 \pm 0.68, d = 0.58$ ). There was also a main effect for time ( $F_{1,13} = 5.259, p = .039, \eta_p^2 = 0.288$ ) and a strong trend toward a condition  $\times$  time interaction was also found for happiness ( $F_{1,13} = 4.596, p = .052, \eta_p^2 = 0.261$ ) where happiness appeared to reduce following social media use ( $-2.14 \pm 2.66, p = .010, d = 0.60$ ), but did not change pre-to post-in the control ( $+0.36 \pm 2.59, p = .615, d = 0.11$ ) (Fig. 7).

**Calmness.** There were no main effects for condition ( $F_{1,13} = 4.452, p = .055, \eta_p^2 = 0.255$ ), time ( $F_{1,13} = 0.184, p = .675, \eta_p^2 = 0.014$ ) nor condition  $\times$  time interaction effects ( $F_{1,13} = 1.434, p = .252, \eta_p^2 = 0.099$ ) where calmness did not differ pre-to post-with mental fatigue ( $+0.36 \pm 2.66, p = .622, d = 0.24$ ), or in the control ( $-0.79 \pm 2.51, p = .264, d =$

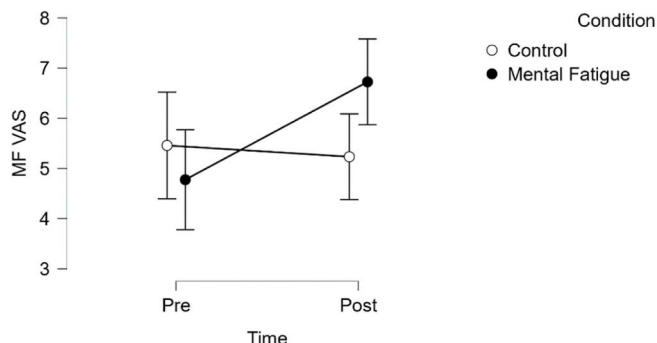


Fig. 1. Mental fatigue (VAS) pre- and post- 30-mins social media use or control.

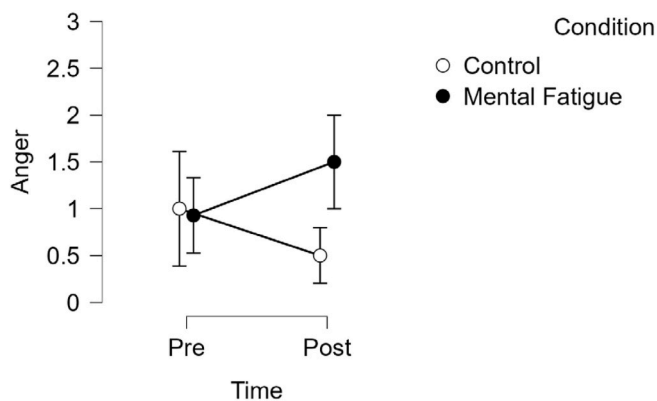


Fig. 2. Anger (BRUMS subscale) pre- and post- 30-min social media use and control.

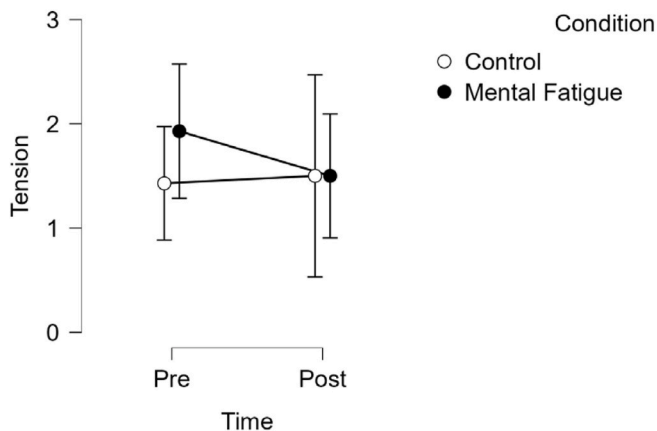


Fig. 3. Tension (BRUMS subscale) pre- and post- 30-min social media use and control.

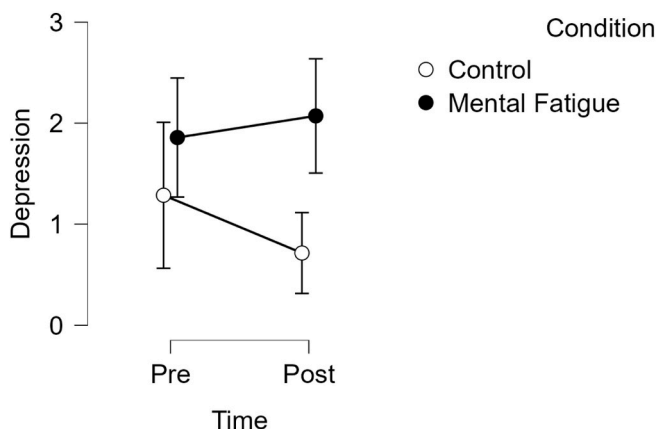


Fig. 4. Depression (BRUMS subscale) pre- and post- 30-min social media use and control.

0.16) (Fig. 8).

**Vigour.** There was a significant main effect for condition ( $F_{1,13} = 23.192, p < .001, \eta_p^2 = 0.641$ ), time ( $F_{1,13} = 14.091, p = .002, \eta_p^2 = 0.520$ ) and condition  $\times$  time interaction ( $F_{1,13} = 10.217, p = .007, \eta_p^2 = 0.440$ ). Vigour was significantly lowered post-social media use in the mental fatigue condition ( $-4.14 \pm 2.84, p < .001, d = 1.45$ ) but was not different between time-points (pre-to post-) in the control condition ( $-0.21 \pm 3.48, p = .821, d = 0.07$ ) (Fig. 9).

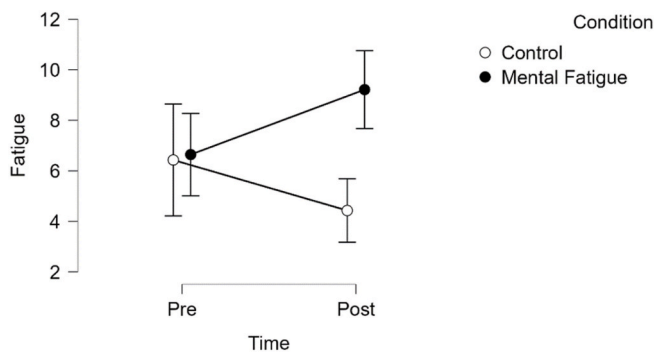


Fig. 5. Fatigue (BRUMS subscale) pre- and post- 30-min social media use and control.

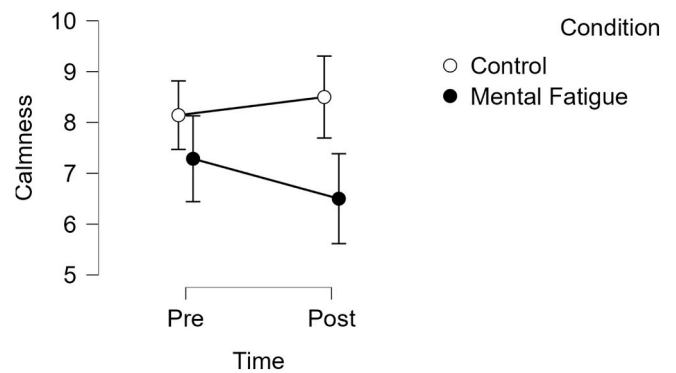


Fig. 8. Calmness (BRUMS subscale) pre- and post- 30-min social media use and control.

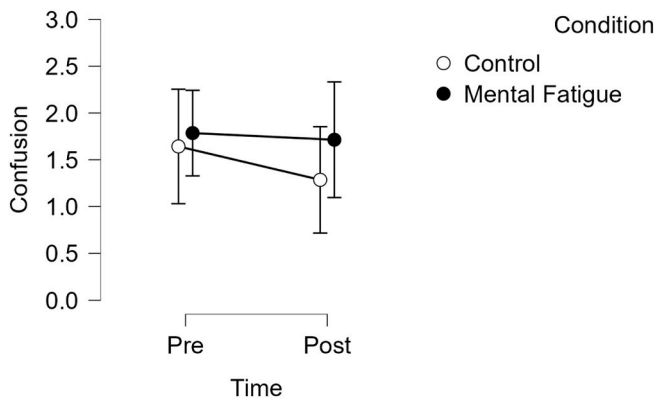


Fig. 6. Confusion (BRUMS subscale) pre- and post- 30-min social media use and control.

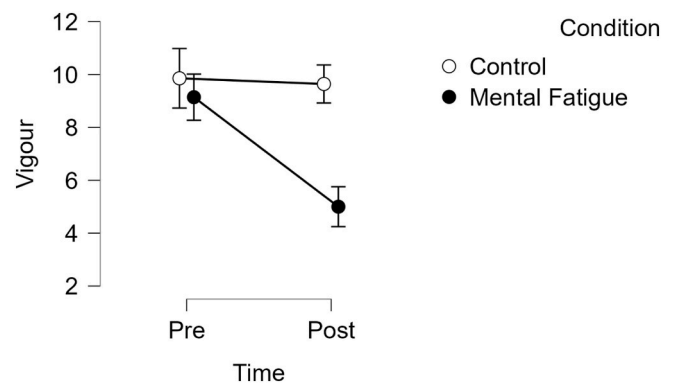


Fig. 9. Vigour (BRUMS subscale) pre- and post- 30-min social media use and control.

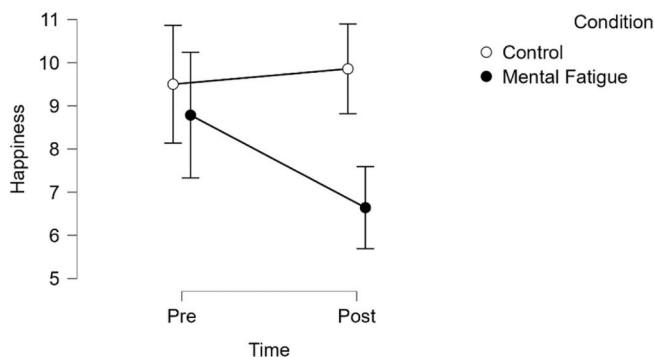


Fig. 7. Happiness (BRUMS subscale) pre- and post- 30-min social media use and control.

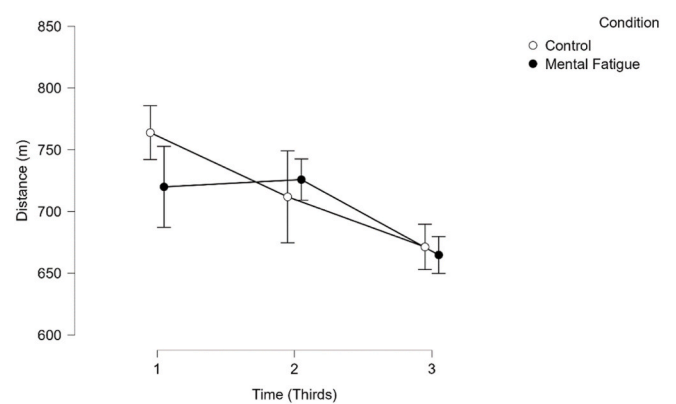


Fig. 10. Total distance (m) during SSGs across thirds and between conditions.

**GPS<sup>3</sup> Total Distance.** There was no main effect for condition ( $F_{1,11} = 0.254, p = .624, \eta_p^2 = 0.023$ ) nor condition  $\times$  time interaction effects ( $F_{2,22} = 0.838, p = .446, \eta_p^2 = 0.021$ ) for total distance (m). However, there was a main effect for time ( $F_{2,22} = 4.558, p = .022, \eta_p^2 = 0.293$ ), whereby total distance was significantly lower in the final third, compared to the first third of the SSG ( $p = .022, d = 0.387$ ), but not between the first and second third ( $p = 1.000, d = 0.121$ ) nor the second and final third ( $p = .164, d = 0.266$ ) (Fig. 10).

<sup>3</sup> GPS data was analysed with and without goalkeepers included. There were no differences in the changes or direction of changes observed, therefore data is reported including both outfielders and goalkeepers.

#### 4.2. Velocity thresholds

**V1 and V2** (see Table 3). There was no main effect for condition ( $F_{1,11} = 0.107, p = .749, \eta_p^2 = 0.010$ ), time ( $F_{2,22} = 0.901, p = .420, \eta_p^2 = 0.076$ ) nor condition  $\times$  time interaction effects ( $F_{2,22} = 2.384, p = .116, \eta_p^2 = 0.178$ ) for V1 distance. There was no main effect for condition ( $F_{1,11} = 0.173, p = .686, \eta_p^2 = 0.015$ ) nor condition  $\times$  time interaction effects ( $F_{2,22} = 0.507, p = .609, \eta_p^2 = 0.044$ ) for V2 distance (m). However, there was a main effect for time ( $F_{2,22} = 3.488, p = .048, \eta_p^2 = 0.241$ ), though Bonferroni post-hoc comparisons identified no significant differences between thirds (See Table 3 for descriptives).

**V3.** There was no main effect for condition ( $F_{1,11} = 0.003, p = .986, \eta_p^2 = 0.0003$ ) nor condition  $\times$  time interaction effects ( $F_{2,22} = 0.239, p =$

**Table 3**

Descriptive statistics (M & SD) for GPS distance (m) across velocity thresholds between control and mental fatigue conditions over each third of the SSGs.

GPS Variable	Control			Mental Fatigue		
	1/3	2/3	3/3	1/3	2/3	3/3
V1 Distance (m)	291.10 ± 45.18	276.26 ± 62.92	273.52 ± 47.56	264.09 ± 53.61	291.00 ± 40.35	270.00 ± 49.71
V2 Distance (m)	116.38 ± 46.56	95.09 ± 34.92	99.79 ± 38.66	111.95 ± 41.31	101.55 ± 40.39	96.87 ± 36.44
V3 Distance (m)	211.00 ± 94.84	175.23 ± 76.84	166.89 ± 82.25	211.49 ± 92.70	187.94 ± 84.54	168.88 ± 76.43
V4 Distance (m)	105 ± 62.78	93.11 ± 48.99	87.07 ± 49.18	97.74 ± 54.23	90.61 ± 47.85	89.49 ± 47.93
V5 Distance (m)	43.68 ± 33.95	50.06 ± 29.37	43.92 ± 26.93	43.48 ± 28.68	47.02 ± 24.88	42.31 ± 28.29
V6 Distance (m)	11.53 ± 22.22	14.19 ± 13.71	3.64 ± 5.16	4.66 ± 4.10	13.36 ± 13.98	2.42 ± 4.60

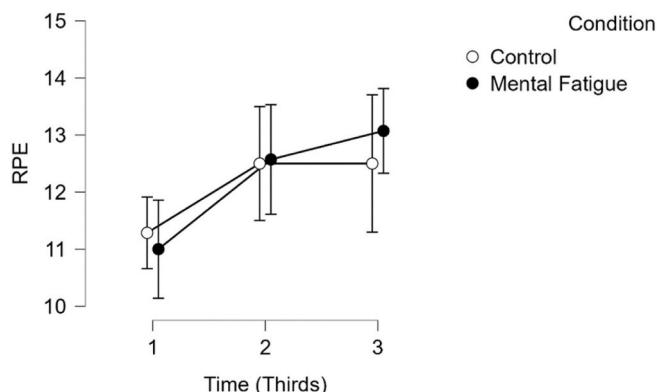
.790,  $\eta_p^2 = 0.021$ ) for total distance (m). However, there was a main effect for time ( $F_{2,22} = 6.612, p = .006, \eta_p^2 = 0.375$ ), where Bonferroni post-hoc comparisons identified a significant reduction in V3 distance between the final third ( $169.44 \pm 78.25$  m) and first third ( $207.92 \pm 89.79$  m) ( $p = .005, d = 0.443$ ), but not between the first and second third ( $183.21 \pm 77.70$  m) ( $p = .093, d = 0.285$ ) nor the second and final third ( $p = .637, d = 0.159$ ).

**V4 and V5.** There was no main effect for condition ( $F_{1,11} = 0.352, p = .565, \eta_p^2 = 0.031$ ), time ( $F_{1,199,13,187} = 1.104, p = .326, \eta_p^2 = 0.091$ ), nor condition  $\times$  time interaction effects ( $F_{2,22} = 0.187, p = .831, \eta_p^2 = 0.002$ ) for V4 distance. There was no main effect for condition ( $F_{1,11} = 0.084, p = .778, \eta_p^2 = 0.008$ ), time ( $F_{2,22} = 0.882, p = .428, \eta_p^2 = 0.074$ ), nor condition  $\times$  time interaction effects ( $F_{2,22} = 0.220, p = .804, \eta_p^2 = 0.020$ ) for V5 distance.

**V6.** There was no main effect for condition ( $F_{1,11} = 0.338, p = .572, \eta_p^2 = 0.003$ ), nor condition  $\times$  time interaction effects ( $F_{1,296,14,258} = 0.074, p = .850, \eta_p^2 = 0.007$ ) for V6 distance. However, there was a main effect for time ( $F_{1,083,11,918} = 8.197, p = .013, \eta_p^2 = 0.427$ ), whereby V6 distance was significantly higher in the second third ( $13.77 \pm 9.77$  m) compared to the first third ( $8.09 \pm 9.77$  m,  $p = .023, d = 0.894$ ), and significantly lower in the final third ( $3.03 \pm 9.77$  m) compared to the second third ( $p = .002, d = 1.187$ ).

**4.3. RPE**

A  $2 \times 3$  repeated measures ANOVA identified no main effect for condition ( $F_{1,13} = 0.073, p = .792, \eta_p^2 = 0.006$ ), nor condition  $\times$  time interaction effects ( $F_{2,26} = 0.516, p = .603, \eta_p^2 = 0.038$ ). However, there was a main effect for time ( $F_{2,26} = 12.551, p < .001, \eta_p^2 = 0.491$ ), whereby RPE was significantly higher in the second third compared to the first third ( $+1.39 \pm 0.35, p = .001, d = 0.57$ ), and the final third compared to the first third ( $+1.64 \pm 0.035, p < .001, d = 0.67$ ), but was not different between the second and final third ( $+0.25 \pm 0.35, p = .486, d = 0.10$ ) (Fig. 11).



**Fig. 11.** RPE during SSGs across thirds and between conditions.

**4.4. Verbal reports**

**4.4.1. Think aloud**

**Positive Performance TA.** There was a significant difference in the number of positive performance-related think aloud verbalisations ( $W = 28.000, z = 2.366, p = .020, ES = 1.000$ ), whereby these were lower in the mental fatigue condition compared with control (Fig. 12).

**Neutral Performance TA.** There was a significant difference in the number of neutral performance-related think aloud verbalisations ( $t(12) = 4.612, p < .001, d = 1.279$ ) whereby these were lower in the mental fatigue condition compared to control (Fig. 13).

**Negative Performance TA.** There was no difference in the number of negative performance-related think aloud verbalisations ( $t(12) = 1.381, p = .192, d = 0.383$ ).

**Non-Performance TA.** There was no difference in the number of non-performance internal think aloud verbalisations ( $t(12) = 0.510, p = .619, d = 0.141$ ), nor non-performance external think aloud verbalisations ( $W = 13.000, z = 1.483, p = .170, ES = 0.733$ ).

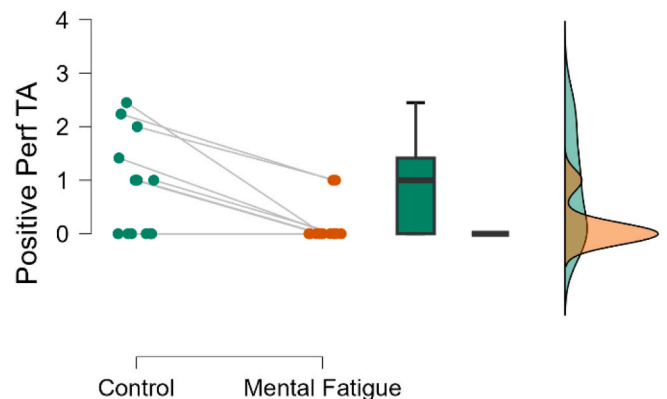
**Miscellaneous TA.** There was no difference in the number of negative performance-related think aloud verbalisations ( $t(12) = -0.974, p = .349, d = 0.270$ ).

**TA Total.** There was a significant difference in the total number of TA verbalisations ( $t(12) = 2.326, p = .038, d = 0.645$ ), whereby players verbalised less TA in the mental fatigue condition compared to control (Fig. 14).

**4.5. Performance communication**

**4.5.1. Stimulating communication**

There was no difference in the number of *supportive* communication verbalisations between conditions ( $t(12) = 1.408, p = .185, d = 0.390$ ). There was also no difference in the number of *motivate to upregulate* communication verbalisations between conditions ( $t(12) = 0.407, p = .691, d = 0.113$ ). Further, there were no difference in *motivate to downregulate* communication verbalisations between conditions ( $W = 0.000, z = -1.342, p = .371, ES = -1.000$ ). Overall, there was no



**Fig. 12.** Positive performance-related TA between conditions (SQRT transformed count data).

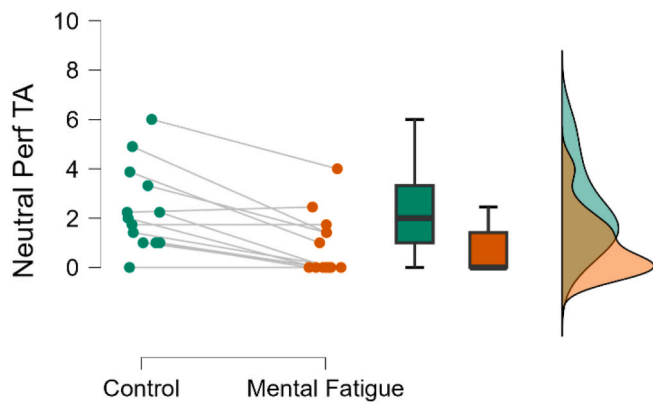


Fig. 13. Neutral (descriptive) performance-related TA between conditions (SQRT transformed count data).

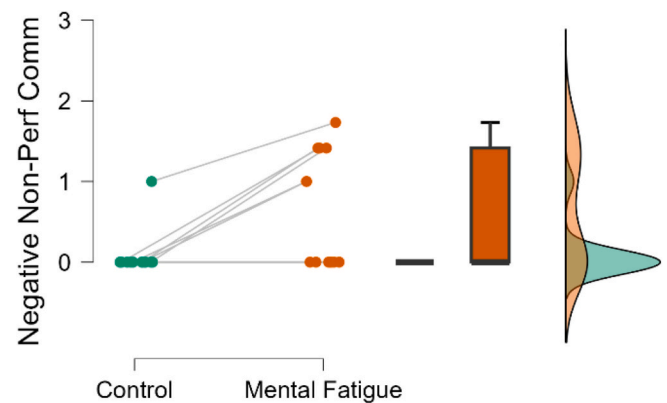


Fig. 15. Negative non-performance related communication between conditions (SQRT transformed count data).

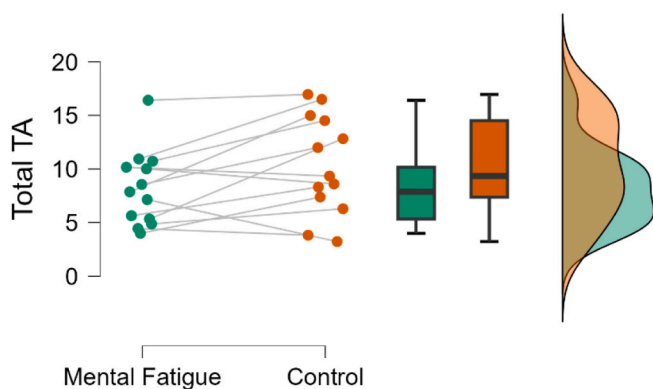


Fig. 14. Total TA between conditions (SQRT transformed count data).

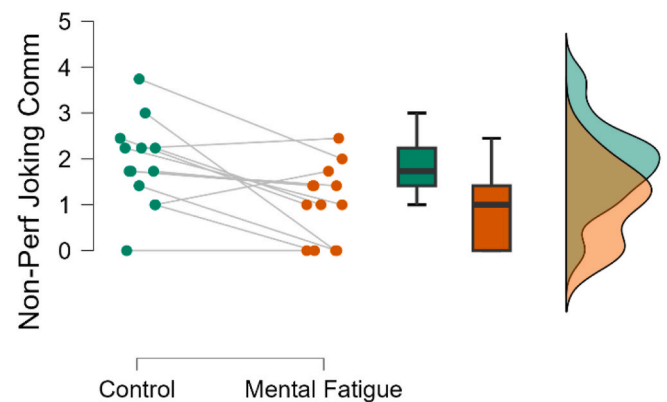


Fig. 16. Non-performance related joking with teammates between conditions (SQRT transformed count data).

difference in *stimulating* communication verbalisations between conditions ( $t(12) = 0.430, p = .675, d = 0.119$ ).

#### 4.5.2. Orientation communication

There was no difference in the number of *two-word orientation* communication verbalisations between conditions ( $t(12) = -0.473, p = .645, d = 0.131$ ). There was no difference in the number of *two-plus word orientation* communication verbalisations between conditions ( $t(12) = -0.803, p = .438, d = 0.223$ ). There was no difference in the number of *one-word orientation* communication verbalisations between conditions ( $t(12) = 0.093, p = .927, d = 0.026$ ). There was no difference in the number of *positional orientation* communication verbalisations between conditions ( $t(12) = 0.979, p = .347, d = 0.272$ ). There was no difference in the number of *clarifying orientation* communication verbalisations between conditions ( $t(12) = -0.499, p = .627, d = 0.138$ ). Overall, there was no difference in the number of *total orientation* communication verbalisations between conditions ( $t(12) = -0.345, p = .736, d = 0.096$ ).

#### 4.5.3. Communication – non-performance

There was a significant difference in negative non-performance communication verbalisations between conditions ( $W = 0.000, z = -2.201, p = .034, ES = 1.000$ ), whereby players made more *negative non-performance verbalisations* in the mental fatigue condition compared to control (Fig. 15).

There was also a significant difference in *non-performance joking communication* between conditions ( $t(12) = 2.686, p = .020, d = 0.745$ ), whereby players joked less in the mental fatigue condition compared to control (Fig. 16).

There was no difference in *positive non-performance communication*

between conditions ( $W = 1.500, z = 0.000, p = 1.000, ES = 0.000$ ). There was also no difference in *neutral non-performance communication* between conditions ( $t(12) = 0.312, p = .761, d = 0.086$ ). Overall, there was no difference in *total non-performance communication* between conditions ( $t(12) = 0.908, p = .382, d = 0.252$ ).

#### 4.5.4. Evaluation communication

There was no difference in total *evaluation communication* between conditions ( $t(12) = 0.263, p = .797, d = 0.073$ ). There was also no difference in *positive evaluation communication* between conditions ( $t(12) = 0.758, p = .463, d = 0.210$ ). There was also no difference in *negative evaluation communication* ( $t(12) = 0.857, p = .408, d = 0.238$ ), or *apologetic evaluation communication* between conditions ( $t(12) = 0.861, p = .406, d = 0.239$ ). However, there was a significant difference for *constructive evaluation communication* between conditions ( $t(12) = -2.716, p = .019, d = 0.753$ ), whereby constructive evaluation TA was significantly higher with mental fatigue ( $1.35 \pm 1.34$ ) compared to control ( $0.58 \pm 0.85$ ) (Fig. 17).

#### 4.5.5. Miscellaneous communication

There was no significant difference in miscellaneous communication between conditions ( $t(12) = 0.719, p = .486, d = 0.200$ ).

#### 4.5.6. Total communication

There was no significant difference in miscellaneous communication between conditions ( $t(12) = 0.029, p = .977, d = 0.008$ ).

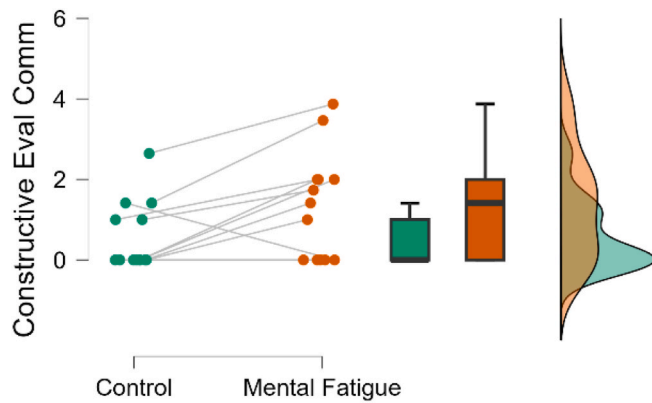


Fig. 17. Constructive evaluation communication (performance related) between conditions (SQRT transformed count data).

## 5. Discussion

In sum, the present study observed that 30-min social media use was associated with increased self-reported mental fatigue (measured by VAS) in women's football players prior to training by  $\sim 41\%$ , when compared to spending 30-min sitting with teammates without mobile phone access ( $\sim 4.1\%$ ). Social media use also appeared to be negatively associated with some mood states of players prior to training, with increased perceptions of fatigue, and reduced happiness and vigour on the BRUMS compared to control. Despite this, there were no notable differences in calmness, confusion, depression, tension and anger between the mental fatigue and control conditions. However, there were no observed differences in physical work output across velocity threshold between conditions, nor in RPE during SSGs. Notably, verbal report data differed between conditions, particularly in the frequency and type of TA and communication recorded. Overall, the total number of TA verbalisations were significantly lower in the mental fatigue condition compared to control, with significantly reduced neutral and positive verbalisations relating to performance were significantly lower during SSGs following 30-min social media use compared to control. Communication data also differed between conditions, with players in the mental fatigue condition expressing more negative verbalisations where they communicated dissatisfaction and joked less with their teammates during SSGs compared to control, potentially aligning with the deterioration in some of the mood states observed (e.g., happiness).

Despite observing changes in mood states, namely heightened fatigue and reduced happiness, alongside increased perceived mental fatigue (VAS) following 30-min social media use, no corresponding differences in physical work output were observed. This contrasts previous research which has found that mental fatigue was linked to impaired physical performance (Marcora et al., 2009). For example, Smith et al. (2016) found that running distance in the Yo-Yo Intermittent Running test reduced by  $16.3\% \pm 5.1\%$  in male footballers; though mental fatigue was induced by a 30-min continuous Stroop task, rather than social media use which may be more reflective of activity players would engage in prior to training or match-play. The present study also included highly competitive women's football players, most of whom were juggling demands of playing competitively within the Women's National League alongside full-time job roles and there are noticeable differences in the starting self-report mental fatigue levels (as per 100-mm VAS) compared to Smith et al. (2016). On arrival, prior to any experimental manipulation across conditions the women's football players in this study, reported elevated baseline levels of mental fatigue (Control:  $5.46 \pm 2.43$  cm; MF:  $4.78 \pm 2.17$  cm) compared to Smith et al. (2016) (Control:  $0.6 \pm 0.8$  cm; MF:  $0.8 \pm 0.9$  cm). Whilst a significant increase in mental fatigue was observed in the mental fatigue condition (and a decrease in the control) in this study, differences between studies

in relation to physical performance inhibition may be due to players reporting moderate to high levels of mental fatigue prior to any manipulation across conditions. These findings may point to the challenges of juggling multiple demands (e.g., dual career) whilst continuing to perform at a competitive standard, and further research should explore the prevalence and implications of mental fatigue, and factors which may influence it (e.g., training times, job role), particularly within women's football where there is a notable lack of existing research.

Similar to Smith et al. (2016), much of the research which have observed detrimental effects of mental fatigue on physical performance have employed laboratory-based exercise protocols less reflective of competition. Recently, Staiano et al. (2024) found that mental fatigue, induced by 30-min Stroop task impaired directional repeated sprint ability and repeated countermovement jump performance compared to control. This impairment was linked to heightened RPE in the absence of physiological changes. However, when exploring the effects during activity more reflective of match-play similar to this study in SSGs, some have found limited effects or a less clear impact of mental fatigue on physical performance (e.g., total distance), despite technical performance changes (Badin et al., 2016; Coutinho et al., 2017; Trecroci et al., 2020). This is perhaps due to testing in laboratory settings limiting motivation compared to competitive match-play more reflective of "real-world" demands which could have reflected in effort invested. Further, more consistent effects of mental fatigue on technical skill execution rather than physical performance (i.e., running metrics) are likely to be resultant of open-skills being more dependent on cognitive resources than closed-skills (Russo et al., 2022), which are depleted as a result of mental fatigue compared to physical work output.

TA was used within the present study to explore the impact of mental fatigue on players' attentional focus during match-play. Overall, the number of TA verbalisations were significantly reduced during the SSGs in the mental fatigue condition compared to control. This may be explained due to TA increasing activity of the left pre-frontal cortex to support the articulation of cognitions (diverting resources away from the right pre-frontal cortex), placing additional cognitive load on the athletes (Whitehead et al., 2022). However, these findings represent associations rather than confirmed mechanisms, and further research is needed to establish the impact of TA during different work-load intensities on blood flow distribution within areas of the brain. Specifically, there were significantly less neutral TA verbalisations that were descriptive, but which related to performance with mental fatigue (e.g., "waiting for [player] to run back"); which offers some support to Coutinho et al. (2017) who suggests that mental fatigue affects players' ability to use environmental information. As noted, using social media can induce mental fatigue due to requiring the use of sustained attention, involving listening writing and reading which demands activity of the pre-frontal cortex (Fortes et al., 2019) which could therefore have reduced available resources for articulating cognitions during the SSGs. Further, there were less positive TA verbalisations relating to performance, which appeared to align with the decline in some of the mood states observed (i.e., where players felt less happy, the number of positive thoughts in relation to performance was lower). Social media is also explained to induce mental fatigue due individuals also requiring high cognitive inhibition due to scrolling through content that can provoke negative emotions (Durand-Bush & DesClouds, 2018), which may help explain why happiness was reduced in the mental fatigue condition but not in control. However, the nature of content reviewed by each participant (i.e., whether it would likely invoke positive or negative emotions) was not monitored in this study and future research should look to consider content analysis.

Similar trends were observed for communication whereby in line with mood changes observed (i.e., lower happiness, greater perceived fatigue and reduced vigour), players were more likely to engage in negative communication in the mental fatigue condition. Players complained or communicated dissatisfaction unrelated to performance more

following the mental fatigue condition than in the control, suggesting a potential association between mental fatigue and distraction, where players communicated to teammates more on factors unrelated to performance following the social media intervention. Indeed, screen time in a variety of forms (e.g., receiving WhatsApp messages, 15-min online shopping) has been shown to fatigue cognitive resources (e.g., attentional capacity and inhibition control), through continuous top-down processing of online content, and these effects have been shown to continue following internet activity (Aharony & Zion, 2018; Peng et al., 2018).

Players also joked less with their teammates during the SSGs within the mental fatigue condition, again potentially aligning with the deterioration in some of the mood states observed (i.e., happiness, vigour) compared to following sitting in the changing rooms with teammates without phones. Previous research exploring relationships between screen time and social connectedness, found that when participants used their smartphones more in the hour prior to the research teams' assessments, perceived social connectedness was lower (Anderl et al., 2023). This may offer some insights as to why negative non-performance related communication increased, and there was less humour seen in the communication with teammates if they felt less connected to them following 30-min social media use; though further research is needed in relation to the immediate social and specifically, communication implications following acute social media use. However, players appeared to communicate more constructive criticism in the mental fatigue condition compared to the control; perhaps due to having fewer positive thoughts in relation to performance as identified with the TA data whereby they felt their performances needed to improve more so than in the control condition.

Finally, whilst a growing body of research has begun to implement TA methods, this has typically been in individual endurance activity and within controlled laboratory conditions. A lack of empirical TA research within endurance sport has previously been attributed to the challenges athletes could face in attempting to simultaneously articulate their thoughts during aerobically demanding activity (Nicholls & Polman, 2008). This research demonstrates that TA is feasible in team-sports players during simulated match-play and future research should continue to build on this understanding, particularly in team-sport which is more reliant on the simultaneous execution of physically demanding activity and complex cognitive skills (e.g., decision-making).

## 6. Limitations

While the present study offers valuable insights into the multifaceted implications of mental fatigue on women footballers' performance in SSGs, some limitations should be acknowledged. Firstly, players reported elevated levels of mental fatigue prior to any experimental manipulation (though this did significantly increase following experimentation). Pre-existing mental fatigue may have influenced the extent of differences observed between conditions (particularly for physical performance); however, it does also highlight important practical considerations in terms of the challenges this level of player faces in the women's game such as having to juggle dual-career roles. Future research should further explore the causes and implications of mental fatigue (without experimental manipulation) in women footballers.

Although the study sought to improve on the ecological validity of previous research by replicating competitive match-play demands through SSGs providing players with 75 % of the match-derived area, players would likely be more motivated during true competitive scenarios. Further exploration is warranted on the effects of mental fatigue on true competitive performance and the impacts of this on TA and communication. Additionally, future research should look to provide players with 100 % of the match-derived pitch space in order to more closely reflect the time and space they would have on a match-day, which could influence the frequency and content of the think-aloud data. Furthermore, the 30-min social media exposure was standardised

based on prior research (e.g., Fortes et al., 2021) to isolate cognitive effects. Though this may not fully reflect real-world routines, limiting ecological validity. Additionally, this study did not assess the influence of mental fatigue on more cognitively demanding technical skill acquisition, integration of this could provide further insights into its effects on performance beyond solely physical performance.

Furthermore, while the study aimed to simulate typical pre-training and match-play activities (social media use versus sitting chatting with teammates in the changing rooms), the potential social and environmental benefits of the control condition (such as increased social connectedness) limit the ability to isolate the specific impact of social media use on mental fatigue and performance. Therefore, future research interested in exploring the effects of social media on mental fatigue, social connectedness, attentional focus and communication may seek to implement a control condition which does not facilitate social interaction.

Another potential limitation of the present study is the absence of participant blinding to the experimental condition, which may have introduced expectancy or demand characteristics. Specifically, players may have reported higher levels of perceived fatigue in the mental fatigue condition due to prior assumptions about the effects of social media use. While efforts were made to standardise pre-testing procedures and limit potential priming (e.g., neutral study briefing, consistent testing environment), we acknowledge that subjective measures such as the VAS and BRUMS are susceptible to bias in unblinded designs. Future studies could benefit from incorporating blinding procedures or using deception paradigms where ethically appropriate, to minimise expectancy effects and enhance internal validity.

Additionally, individual differences in players' habitual social media use (e.g., time spent scrolling, emotional investment, content preferences) were not measured or controlled for. Such variability may influence how cognitively or emotionally fatiguing the exposure was for each participant, potentially affecting their responsiveness to the experimental condition. Further, external factors such as sleep quality, and work-related stress may have confounded outcomes by independently affecting mood and fatigue levels, given the dual careers of many participants. Finally, it is important to note that these findings represent associations only, as the observational design of the study does not allow for causal conclusions to be drawn. Rather, the results should be viewed as exploratory and hypothesis-generating, providing a foundation for future research employing experimental designs capable of establishing causal relationships.

## 7. Conclusions

In conclusion, the present study examined associations between 30-min social media use (implemented to induce mental fatigue), and women football players' mood and perceptions of fatigue prior to training. Conversely, it suggests that having time to sit and converse with teammates (away from technology) may be associated with positive mood states. While the mental fatigue condition did not appear to influence physical performance (work output across velocity thresholds), it was linked to changes in players' attentional focus, whereby players verbalised fewer positive-performance related thoughts, which corresponded with the more negative mood states observed (i.e., lower happiness). Further, the mental fatigue condition was associated with a reduction in total think aloud verbalisations recorded compared to control, with fewer neutral 'descriptive' performance-related thoughts, which may indicate a reduced ability to use (or verbalise) environmental information when mentally fatigued. Finally, 30-min social media use was associated with differences in communication on the pitch compared to time spent with teammates (control), whereby there was more negative non-performance related communication and less joking. These may be indicative of reduced social connectedness, and appear to coincide with some of the more negative mood states observed (i.e., reduced happiness, increased perception of fatigue and lower vigour).

This study's findings reinforce many teams' policies on having no phones in the changing rooms; teams' staff and players may wish to consider extending this to avoiding its use when travelling to games or reducing extended use in the hours leading up to a game. This study implemented think aloud methods for the first time during team sport match-play, showing it is feasible to gain insights into players' cognitive processing during match-play; future research should look to integrate these methods, perhaps in different match-formats to understand how this can affect players' thoughts.

### CRedit authorship contribution statement

**K.J. Donnan:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **M.J. Bargh:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Data curation. **L. Swettenham:** Writing – review & editing, Formal analysis, Data curation. **S. Olthof:** Writing – review & editing, Project administration, Methodology. **A. Whitehead:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Formal analysis, Data curation.

### Declaration of competing interest

There are no competing interests to declare.

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### Data availability

Data will be made available on request.

### References

- Abbott, W., Brownlee, T. E., Naughton, R. J., Clifford, T., Page, R., & Harper, L. D. (2020). Changes in perceptions of mental fatigue during a season in professional under-23 English Premier League soccer players. *Research in Sports Medicine*, 28(4), 529–539. <https://doi.org/10.1080/15438627.2020.1784176>
- Aharony, N., & Zion, A. (2018). Effects of whatsapp's use on working memory performance among youth. *Journal of Educational Computing Research*, 57(1). <https://doi.org/10.1177/0735633117749431>
- Anderl, C., Hofer, M. K., & Chen, F. S. (2023). Directly-measured smartphone screen time predicts well-being and feelings of social connectedness. *Journal of Social and Personal Relationships*, 41(5). <https://doi.org/10.1177/02654075231158300>
- Badin, O., Smith, M., Conte, D., & Coutts, A. J. (2016). Mental fatigue: Impairment of technical performance in small-sided soccer games. *International Journal of Sports Physiology and Performance*, 11(8). <https://doi.org/10.1123/ijspp.2015-0710>
- Blaser, M. A., & Seiler, R. (2019). Shared knowledge and verbal communication in football: Changes in team cognition through collective training. *Frontiers in Psychology*, 10, 77. <https://doi.org/10.3389/fpsyg.2019.00077>
- Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise*, 14, 377–381. <https://doi.org/10.1249/00005768-198205000-00012>
- Bradley, P., & Scott, D. (2020). *Physical analysis of the FIFA women's World Cup France 2019TM*. Zurich.
- Bradley, P. S., & Vescovi, J. D. (2015). Velocity thresholds for women's soccer matches: Sex specificity dictates high-speed-running and sprinting thresholds—female athletes in motion (FAiM). *International Journal of Sports Physiology and Performance*, 10(1), 112–116.
- Cheever, N. A., Rosen, L. D., Carrier, L. M., & Chavez, A. (2014). Out of sight is not out of mind: The impact of restricting wireless mobile device use on anxiety levels among low, moderate and high users. *Computers in Human Behavior*, 37, 290–297. [10.1016/j.chb.2014.05.002](https://doi.org/10.1016/j.chb.2014.05.002)
- Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science*, 1(3), 98–101.
- Coutinho, D., Gonçalves, B., Travassos, B., Wong, D. P., Coutts, A. J., & Sampaio, J. E. (2017). Mental fatigue and spatial references impair soccer players' physical and tactical performances. *Frontiers in Psychology*, 21, 8–1645. <https://doi.org/10.3389/fpsyg.2017.01645>
- Coutts, A. (2016). Fatigue in football: it's not a brainless task! *Journal of Sports Sciences*, 34(14), 1296. <https://doi.org/10.1080/02640414.2016.1170475>
- Dantzer, R., Heijnen, C. J., Kavelaars, A., Laye, S., & Capuron, L. (2014). The neuroimmune basis of fatigue. *Trends in Neurosciences*, 37, 39–46. <https://doi.org/10.1016/j.tins.2013.10.003>
- Durand-Bush, N., & DesClouds, P. (2018). Smartphones: How can mental performance consultants help athletes and coaches leverage their use to generate more benefits than drawbacks? *J. Sport Psychol. Action*, 9, 227–238. <https://doi.org/10.1080/21520704.2018.1496211>
- Emmonds, S., Haywood, O., & Jones, B. (2019). The challenge of applying and undertaking research in female sport. *Sports Medicine – Open*, 51(1). <https://doi.org/10.1186/s40798-019-0224-x>
- Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data (Revised edition)*. The MIT Press.
- Farina, M., & Cei, A. (2019). Concentration and self-talk in football. In *Football psychology: From theory to practice, 1st*. Routledge.
- Festin, F. W., & Altman, D. G. (2002). Guidelines for the design and statistical analysis of experiments using laboratory. *Animals*, 43(4), 244–258.
- Fortes, L. S., Lima Junior, D., Costa, Y. P., Albuquerque, M. R., Nakamura, F. Y., & Fonseca, F. S. (2022). Effects of social media on smartphone use before and during velocity-based resistance exercise on cognitive interference control and physiological measures in trained adults. *Appl. Neuropsychol. Adult*, 29, 1188–1197. <https://doi.org/10.1080/23279095.2020.1863796>
- Fortes, L. S., Lima-Junior, D. D., Gantois, P., Nascimento-Junior, J. R., & Fonseca, F. S. (2021). Smartphone use among high level swimmers is associated with mental fatigue and slower 100-and 200-but not 50-meter freestyle racing. *Perceptual and Motor Skills*, 128(1), 390–408.
- Fortes, L. S., Lima-Junior, D., Nascimento-Júnior, J. R., Costa, E. C., Matta, M. O., & Ferreira, M. E. (2019). Effect of exposure time to smartphone apps on passing decision-making in male soccer athletes. *Psychology of Sport and Exercise*, 44, 35–41. <https://doi.org/10.1016/j.psychsport.2019.05.001>
- Gledhill, A., Forsdyke, D., & Harwood, C. (2017). Psychosocial factors associated with talent development in football: A systematic review. *Psychology of Sport and Exercise*, 31, 97–112.
- Grund, T. U. (2012). Network structure and team performance: The case of English Premier League soccer teams. *Social Networks*, 34, 682–690. <https://doi.org/10.1016/j.socnet.2012.08.004>
- Hanin, Y. L. (1992). Social psychology and sport: Communication processes in top performance teams. *Sport Science Review*, 1(2), 13–28.
- Hewitt, A., Norton, K., & Lyons, K. (2014). Movement profiles of elite women soccer players during international matches and the effect of opposition's team ranking. *Journal of Sports Sciences*, 32(2), 1874–1880.
- Jacquet, T., Lepers, R., Pageaux, B., & Poulin-Charronnat, B. (2023). Acute smartphone use impairs vigilance and inhibition capacities. *Scientific Reports*. <https://doi.org/10.1038/s41598-023-50354-3>
- Jones, M. J., Peeling, P., Dawson, B., Halson, S., Miller, J., Dunican, I., Clarke, M., Goodman, C., & Eastwood, P. (2018). Evening electronic device use: The effects on alertness, sleep and next-day physical performance in athletes. *Journal of Sports Sciences*, 36(2), 162–170. <https://doi.org/10.1080/02640414.2017.1287936>
- Kemp, S. (2023). For data reportal. *Digital 2023: Global Overview Report*. Available at: <https://datareportal.com/reports/digital-2023-global-overview-report>. (Accessed 6 June 2024).
- Kryger, K. O., Wang, A., Mehta, R., Impellizzeri, F. M., Massey, A., & McCall, A. (2022). Research on women's football: A scoping review. *Science and Medicine in Football*, 6(5), 549–558. <https://doi.org/10.1080/24733938.2020.1868560>
- Kunrath, C. A., Nakamura, F. Y., Roca, A., Tessitore, A., & Teoldo, I. (2020). How does mental fatigue affect soccer performance during small-sided games? A cognitive, tactical and physical approach. *Journal of Sports Science*, 38, 1818–1828. <https://doi.org/10.1080/02640414.2020.1756671>
- Lane, A., Soos, I., Leibinger, E., Arsal, I., & Harmar, P. (2007). Validity of the Brunel Mood Scale for use with UK, Italian and Hungarian athletes. *Hot topics in sports and athletics*. New York: New Science Publishers Inc. BAKERE, Samueld.
- LeCouteur, A., & Feo, R. (2011). Real-time communication during play: Analysis of teammates' talk and interaction. *Psychology of Sport and Exercise*, 12(2), 124–134. <https://doi.org/10.1016/j.psychsport.2010.07.003>
- MacMahon, C., Hawkins, Z., & Schücker, L. (2019). Beep Test performance is influenced by 30 minutes of cognitive work. *Medicine & Science in Sports & Exercise*, 51(9), 1928–1934. <https://doi.org/10.1249/MSS.0000000000001982>
- Malone, J. J., Lovell, R., Varley, M. C., & Coutts, A. J. (2017). Unpacking the black box: Applications and considerations for using GPS devices in sport. *International Journal of Sports Physiology and Performance*, 12(s2), S2–S18.
- Marcora, S. M., & Staiano, W. (2010). The limit to exercise tolerance in humans: Mind over muscle? *European Journal of Applied Physiology*, 109, 763–770.
- Marcora, S. M., Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans. *Journal of Applied Physiology*. <https://doi.org/10.1152/jappphysiol.91324.2008>
- Martínez-Lagunas, V., Niessen, M., & Hartmann, U. (2014). Women's football: Player characteristics and demands of the game. *Journal of Sport and Health Science*, 3(4), 258–272. <https://doi.org/10.1016/j.jshs.2014.10.001>
- Maykut, P., Maykut, P. S., & Morehouse, R. (1994). *Beginning qualitative research: A philosophic and practical guide* (Vol. 6). Falmer Press.

- McGreary, M., Birch, P., Eubank, M., & Whitehead, A. (2020). Thinking Aloud. A qualitative analysis of stressors and coping responses in cricket bowlers during a competitive match. *Qualitative Research in Sport, Exercise and Health*, 13, 972–989. <https://doi.org/10.1080/2159676X.2020.1829013>
- McLean, S., Salmon, P. M., Gorman, A. D., Dodd, K., & Solomon, C. (2021). The communication and passing contributions of playing positions in a professional soccer team. *Journal of Human Kinetics*, 77, 223–234. <https://doi.org/10.2478/hukin-2020-0052>
- Meeusen, R., Watson, P., Hasegawa, H., Roelands, B., & Piacentini, M. F. (2006). Central fatigue: The serotonin hypothesis and beyond. *Sports Medicine*, 36(10), 881–909.
- Mohr, M., Nybo, L., Grantham, J., & Racinais, S. (2012). Physiological responses and physical performance during football in the heat. *PLoS One*, 7(6).
- Nicholls, A. R., & Polman, R. C. J. (2008). Think aloud: Acute stress and coping strategies during golf performances. *Anxiety, Stress & Coping*, 21(3), 283–294. <https://doi.org/10.1080/10615800701609207>
- Olthof, S., Frencken, W., & Lemmink, K. (2019). A match-derived relative pitch area facilitates the tactical representativeness of small-sided games for the official soccer match. *The Journal of Strength & Conditioning Research*, 33(2), 523–553. <https://doi.org/10.1519/JSC.0000000000002978>
- Peng, M., Chen, X., Zhao, Q., & Zhou, Z. (2018). Attentional scope is reduced by internet use: A behavior and ERP study. *PLoS One*. <https://doi.org/10.1371/journal.pone.0198543>
- Ramos, G. P., Nakamura, F. Y., Penna, E. M., Wilke, C. F., Pereira, L. A., Loturco, I., ... Coimbra, C. C. (2019). Activity Profiles in U17, U20, and Senior Women's Brazilian National Soccer Teams During International Competitions: Are There Meaningful Differences? *Journal of Strength and Conditioning Research*, 33(12), 3414–3422. <https://doi.org/10.1519/JSC.0000000000002170>
- Riboli, A., Olthof, S. B. H., Esposito, F., & Coratella, G. (2022). Training elite youth soccer players: Area per player in small-sided games to replicate the match demands. *Biology of Sport*, 39(3), 579–598. <https://doi.org/10.5114/biolsport.2022.106388>
- Russo, G., Bigliassi, M., Ceciliani, A., & Tessari, A. (2022). Exploring the interplay between sport modality and cognitive function in open- and closed- skill athletes. *Psychology of Sport and Exercise*, 61. <https://doi.org/10.1016/j.psychsport.2022.102186>
- Samson, A., & Jensen, J. C. (2021). "Come on legs, get me there". An Examination of Distance Runners' thoughts utilizing the think – Aloud protocol. *Journal of Sport Behaviour*, 44(2), 256–272.
- Sarmiento, H., Frontini, R., Marques, A., Peralta, M., Ordoñez-Saavedra, N., Duarte, J. P., Figueiredo, A., Campos, M. J., & Clemente, F. M. (2021). Depressive symptoms and burnout in football players: A systematic review. *Brain Sciences*, 11(10), 1351.
- Scott, D., Haigh, J., & Lovell, R. (2020). Physical characteristics and match performances in women's international versus domestic-level football players: A 2-year, league-wide study. *Science and Medicine in Football*, 4(3), 211–215.
- Smith, M. R., Chai, R., Nguyen, H. T., Marcora, S. M., & Coutts, A. J. (2019). Comparing the effects of three cognitive tasks on indicators of mental fatigue. *The Journal of Psychology*, 153(8), 759–783.
- Smith, M. R., Coutts, A. J., Merlini, M., Deprez, D., Lenoir, M., & Marcora, S. M. (2016). Mental fatigue impairs soccer-specific physical and technical performance. *Medicine & Science in Sports & Exercise*, 48(2), 267–276. <https://doi.org/10.1249/MSS.0000000000000762>
- Staiano, W., Bonet, L. R., Romagnoli, M., & Ring, C. (2024). Mental fatigue impairs repeated sprint and jump performance in team sport athletes. *Journal of Science and Medicine in Sport*, 27(2), 105–112. <https://doi.org/10.1016/j.jsams.2023.10.016>
- Sullivan, P., & Feltz, D. L. (2003). The preliminary development of the Scale for effective communication in team sports (SECTS). *Journal of Applied Social Psychology*, 33(8), 1693–1715.
- Terry, P. C., Lane, A. M., & Fogarty, G. J. (2003). Construct validity of the POMS-A for use with adults. *Psychology of Sport and Exercise*, 4(2), 125–139. [https://doi.org/10.1016/S1469-0292\(01\)00035-8](https://doi.org/10.1016/S1469-0292(01)00035-8)
- Thibodeaux, J., & Winsler, A. (2020). Careful what you say to yourself: Exploring self-talk and youth tennis performance via hierarchical linear modelling. *Psychology of Sport and Exercise*, 47, Article 101646. <https://doi.org/10.1016/j.psychsport.2020.101646>
- Thompson, C. J., Smith, A., Coutts, A. J., Skorski, S., Datson, N., Smith, M. R., & Meyer, T. (2022). Understanding the presence of mental fatigue in elite female football. *Research Quarterly for Exercise and Sport*, 93(3), 504–515. <https://doi.org/10.1080/02701367.2021.1873224>
- Trecroci, A., Boccolini, G., Duca, M., Formenti, D., & Alberti, G. (2020). Mental fatigue impairs physical activity, technical and decision-making performance during small-sided games. *PLoS One*, 15(9). <https://doi.org/10.1371/journal.pone.0238461>
- Unick, J. L., Stohacker, K., Papandonatos, G. D., Williams, D., O'Leary, K. C., Dorfman, L., ... Wing, R. R. (2015). Examination of the Consistency in Affective Response to Acute Exercise in Overweight and Obese Women. *Journal of Sport and Exercise Psychology*, 37(5), 534–546. <https://doi.org/10.1123/jsep.2015-0104>
- Van Cutsem, J., Schuerbeek, P. V., Pattyn, N., Raeymaekers, H., De Mey, J., Meeusen, R., & Roelands, B. (2022). A drop in cognitive performance, whodunit? Subjective mental fatigue, brain deactivation or decreased parasympathetic activity? It's complicated. *Cortex*, 155, 30–45. <https://doi.org/10.1016/j.cortex.2022.06.006>
- Vescovi, J. D., Fernandes, E., & Klas, A. (2021). Physical demands of women's soccer matches: A perspective across the developmental spectrum. *Front Sports Act Living*, 3, Article 634696.
- Vestberg, T., Reinebo, G., Maurex, L., Ingvar, M., & Petrovic, P. (2017). Core executive functions are associated with success in young elite soccer players. *PLoS One*, 12, Article e017084. <https://doi.org/10.1371/journal.pone.017084>
- Wheatley, C., Batey, M., Denovan, A., & Dagnall, N. (2023). Mental toughness in the Football Association Women's Super League: Relationships with playing experience, perceptions of club infrastructure, support mechanisms and self-esteem. *PLoS One*, 18(5). <https://doi.org/10.1371/journal.pone.0285594>
- Whitehead, A. E., & Jackman, P. C. (2021). Towards a framework of cognitive processes during competitive golf using the Think Aloud method. *Psychology of Sport and Exercise*. <https://doi.org/10.1016/j.psychsport.2020.101869>
- Whitehead, A. E., Jones, H. S., Williams, E. L., Rowley, C., Quayle, L., Marchant, D., & Polman, R. C. (2018). Investigating the relationship between cognitions, pacing strategies and performance in 16.1 km cycling time trials using a think aloud protocol. *Psychology of Sport and Exercise*, 34, 95–109.
- Whitehead, A., Montgomery, C., Swettenham, L., & Robinson, N. J. (2022). The effect of think aloud on performance and brain oxygenation during cycling – An exploratory study. Executive function and sport/exercise. *Perceptual and Motor Skills*, 0(0), 1–22. <https://doi.org/10.1177/00315125221104769>
- Whitehead, A. E., Taylor, J. A., & Polman, R. C. J. (2015). Examination of the suitability of collecting in event cognitive processes using Think Aloud protocol in gold. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2015.01083>
- Yuan, R., Sun, H., Soh, K. G., Mohammadi, A., Toumi, Z., & Zhang, Z. (2023). The effects of mental fatigue on sport-specific motor performance among team sport athletes: A systematic scoping review. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2023.1143618>