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International Orienteering Experts' Consensus on the Definition, Development, Cause, Impact and Methods to Reduce Mental Fatigue in Orienteering: A Delphi study

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Abstract

Orienteering is an outdoor activity wherein participants use a map and compass to locate control points and choose the quickest path to the next control point in a natural environment. Attentional focus, rapid decision-making, and high aerobic fitness may influence orienteering performance. Therefore, this research aimed to seek international orienteering expert consensus regarding the definition, development, causes, influences and methods to reduce mental fatigue (MF) in orienteering based on practical experience. Following ethical approval, a three-round Delphi survey was conducted online with twenty-four orienteering coaches and athletes (or former athletes) from 10 different countries with international orienteering competition experience. The threshold of consensus was ≥ 70% agreement among respondents. The experts agreed that MF exists in daily life and orienteering with a substantial negative effect on their conscious decision-making performance and psychological responses. The experts disagreed that the form of MF that athletes experienced in orienteering training are similar to the competition. However, there was no agreement that MF would impact endurance and high-speed running performance during orienteering. This research refines the definition of MF and summarises the distinctions in what causes MF in orienteering training and competition, implying that MF should be addressed separately.

Keywords: cognitive fatigue, decision-making, map reading, mental exertion, navigation

Introduction

Orienteering is a running sport that constantly challenges individuals to formulate a route as quickly as possible to the next checkpoints through unfamiliar terrain using a map and compass (Batista et al., 2020; Eccles, Walsh, & Ingledew, 2002). A recent systematic review summarised that the heart rate (HR) of the trained and national orienteers ranges from 150 to 200 beat.min^{-1} during a simulated or an orienteering race (Batista et al., 2020; Creagh and Reilly, 1997). Orienteers from the national team show a mean HR of 167 beat.min^{-1} while running on a combination of horizontal, decline and incline terrain (Creagh and Reilly, 1997). The duration of an orienteering race ranges from 25 to 90 min depending on the type of the competition (Creagh and Reilly, 1997). There are four types of orienteering events: sprint, middle distance, long distance and relay, the estimated distance ranges from 3km to 16km (https://eventor.orienteering.org/Events). The overall running distance is estimated because orienteers need to identify the most effective route choice to each checkpoint with the consideration of their physical capabilities using the map and compass. This reveals the ongoing conscious decision-making whilst interpreting the complexity of a map and recognizing the surrounding features in orienteering (Batista, et al., 2020; Creagh and Reilly, 1997). However, it is unclear whether a dual-task effect would induce mental fatigue (MF) as trained endurance athletes seem to have a higher resistance to MF during exercises (Holgado, Zabala, & Sanabria, 2019; Martin et al., 2016). Furthermore, it would be interesting to investigate MF in orienteers since they are used to coping with a high volume of physical and cognitive load in orienteering. Importantly, missing a checkpoint during the competition will lead to disqualification where orienteers have to maintain a high level of concentration and precise decision-making throughout the race. The long duration of the race together with the high cognitive demand of the sport makes orienteering a favourable sporting model for the study of MF. To the best of the author's knowledge, there is only one study that has investigated MF in orienteering and reported slower completion time in a simulated race when mentally fatigued (Batista et al., 2021). This support the impairment on cognition could directly impair the sport performance of orienteers because the accuracy of cognitive skills plays an important role in orienteering (Mann et al., 2007).

MF is a negative change in psychobiological state caused by performing a prolonged period of cognitively demanding activity (Lam et al., 2021). As summarised in recent meta-analysis and systematic review (Giboin and Wolff, 2019; Habay et al., 2021; Van Cutsem et al., 2017), the majority of the investigations manipulate a static and long duration computerized cognitively demanding task to induce and examine MF where it reports a substantial degree of impairment on subsequent endurance and decision-making performance. Although the subjective ratings of MF remain the most appropriate measurement tool for MF (Smith et al., 2019), the explanation of MF based on these experimental models may lack ecological validity in understanding the development and effects of MF on sports performance as it is unclear whether MF exists in sporting contexts. While most of the literature has focused on the acute effects of MF, recent studies have found that MF could also be elicited chronically during a 4-5 days intense training camp or after an 8-15 days intense competition schedule (Russell et al., 2021). To support the argument of chronic MF in sport, a recent investigation across 16 weeks with elite female netballers during the pre-season training phase found that subjective ratings of MF increased significantly from week 12 onwards (Russell et al., 2022). To elaborate, these authors support that MF can be accumulated over time rather than appearing only after one cognitively demanding session. A comprehensive investigation on MF should not only focus on the acute aspect but also the chronic aspect of MF too. There is growing evidence demonstrating that increased subjective ratings of MF constrain endurance running and laboratory-based decision-making performance insidiously without altering physiological output i.e. heart rate and blood lactate significantly (Giboin and Wolff, 2019; Habay et al., 2021; Van Cutsem et al., 2017). Attention has been drawn to the ecological validity of some findings because the MF protocol largely relied on computerized cognitively demanding tasks which might fail to replicate a realistic MF (Brown et al., 2020; Giboin and Wolff, 2019; Habay et al., 2021; Van Cutsem et al., 2017). Thus, such approaches might oversimplify the impact of MF on sports performance. Coutinho et al. (2017) is the only study that has utilized a soccer-specific MF protocol to overcome the limitation of laboratory-based experiments in examining MF in soccer. Another research has investigated the perspective of MF from elite athletes and practitioners, it also highlighted the importance of developing a population-specific explanation of MF because the nature of the sport and environment may elicit different perceived causes and impacts of MF (Russell et al., 2019). Taken together, it is essential to investigate the contribution of sport-specific cognitive elements that cause MF before further evaluating the impact of MF on sports performance. Meanwhile, the development of MF remains controversial due to the absence of a consensus on the definition and influence of MF in sports (Martin et al., 2018; Smith et al., 2018). Perhaps research is required to take steps to resolve the ambiguity surrounding MF through analysing expert consensus because this study design can overcome practical knowledge gaps when empirical evidence is lacking due to technical limitations or a high degree of uncertainty on specific issues (Hsu and Sandford, 2007; Verhagen et al., 1998).

To enhance the experimental design of the MF research, we need a better understanding of the existence of MF in sports especially the perspectives of MF from athletes and practitioners. Considering the established cognitive and physical demand of orienteering, it provides an ideal model for investigation. Therefore, the aim of this research was to gather the perception of international orienteering expert opinion consensus on the definition, prevalence, causes, influence factors and methods to attenuate MF.

Methodology

Steering Committee

The Delphi survey was created by the authors and reviewed by a steering committee (n = 3) to ensure the terminology was appropriately used. The steering committee consisted of one national-level orienteering coach and one national-level former orienteering athlete, and one sports psychologist with experience in cognition-related research. All steering committee members hold sports science-related undergraduate and/or postgraduate degrees.

Expert panel

To qualify as an orienteering expert in this study, an individual had to have: (1) at least 10 years experience in coaching or competing in orienteering, (2) represented at least once as a national team coach or athlete in an international orienteering competition, (3) the ability to read and write in English fluently, (4) an aged 18 years or above. Twenty-four orienteering experts provided informed consent and agreed to participate in this study. However, a total of six experts were withdrawn as they did not respond to the survey invitations and reminders within two weeks: five in round 2 and one in round 3. The details of the expert panel are shown in table 1. The initial recruitment of the expert panel was based on the orienteering world ranking list 2019-2020 (http://ranking.orienteering.org). Following this purposive sampling technique, a snowball sampling method was implemented. The eligible expert panel members were asked to recommend other orienteering experts using the same criteria outlined above. An identical screening process was completed by the lead researcher for the recommended orienteering experts.

INSERT TABLE 1 HERE

Procedure

Three survey rounds were completed, using an online-based survey system (Online surveys, Jisc, UK). For each survey round, the opening page provided the participant information outlining the aim of the survey round, followed by the instructions for completing the survey. Each survey consisted of the same sections in the following order: (1) the definition of mental fatigue, (2) the development of mental fatigue, (3) the causes of mental fatigue, (4) the impacts of mental fatigue in orienteering, and (5) the methods to reduce mental fatigue in orienteering. Participants were allowed to answer the survey at their own pace and there was no restriction on the order of their responses. However, participants were encouraged to complete the survey in one single session to ensure consistency.

To promote relevant discussion as indicated in Russell et al. (2019), the questions in round 1 were developed based on a review of the literature including previous systematic reviews on mental fatigue (Brown et al., 2020; Giboin and Wolff, 2019; Habay et al., 2021; Van Cutsem et al., 2017) and orienteering (Batista et al., 2020). Round 1 focused on examining whether existing evidence is aligned with the practitioner's experience and identifying the elements that orienteering practitioners believed to be relevant to the identified themes. Given that the Delphi study aims to obtain consensus through a structured method (Hsu and Sandford, 2007), the items in each subsequent round were based on the findings and summative feedback from the previous round. The expert panel were asked to justify their ratings and provide suggestions for further discussion related to the questions, and this was used to facilitate the design of the subsequent survey round. In rounds 2 and 3, the lead author summarised and converted the collected open-ended responses to form the questions for subsequent rounds, and amended the questions as suggested by the fellow authors and steering group committee to ensure the specificity for orienteering population before launching each survey round. The questions and items in survey round 2 and 3 were based on the results and analyses from the previous round, the survey also included part of the findings from the previous round. Survey round 2 and 3 provided an opportunity for the expert panel to further refine their judgement of the items.

For the questions seeking consensus, the expert panels were asked to rate their responses to the given statements or questions using a 'Yes or No' option or a 5-point Likert scale (0-4) using the following description: 0 indicating "Totally disagree", 1 indicating "Disagree", 2 indicating "Neutral", 3 indicating "Agree" and 4 indicating "Totally agree". The expert panel was also encouraged to justify their answer in the open-ended question following the ratings. This study adopted ≥ 70% agreement as the consensus threshold among the expert panels, in line with previous Delphi studies with similar participant numbers (Hsu and Sandford, 2007; Kleynen et al., 2014; McCall et al., 2020). No further questions were asked if the expert panels reached a consensus with ≥ 70% agreement, unless the expert panel addressed any further issues in their open-ended responses. The items with < 70% agreement were rephrased or changed as guided by the open-ended responses of the expert panel through two-step qualitative analysis (Cote et al., 1993; Hsieh and Shannon, 2005). However, to ensure a valid consensus-building in the Delphi study (Diamond et al., 2014; Hsu and Sandford, 2007), if the rating for a question or statement remained < 70% after two survey rounds it was considered as 'no consensus' and excluded from any further rounds (McCall et al., 2020). The expert panels were given two weeks to complete each round of the survey followed by approximately 4-6 weeks for the analysis of data and the preparation of each subsequent survey round as recommended (Hsu and Sandford, 2007).

Data Analysis

The expert panel responses were exported to Microsoft Excel for descriptive and content analysis. The response rate of the surveys and the level of consensus were described as a percentage. For the 5-point Likert scale responses, the frequency of the responses was converted into a percentage to identify the level of consensus. For the open-ended responses, summative content analysis was performed by identifying the keywords to generate a relevant concept and creating a theme to form a cluster. This two-step analysis and interpretation are recommended for facilitating and analysing qualitative data (Cote et al., 1993; Hsieh and Shannon, 2005).

Results

The first round of the Delphi survey was disseminated on the 8th March 2021, and the final round of the survey closed on the 20th June 2021.

Round 1

All expert panel members (n = 24) completed the first round of the survey (100% response rate). The key findings of round one of the survey are shown in Table 2, with 11 out of 19 items using the 5-point Likert scale and two yes/no questions achieving consensus. The expert panel agreed that they experience MF in daily life (91.7% "Yes", 8.3% "No") and also reached an absolute agreement that MF exist in orienteering (100% "Yes", 0% "No"). The definition of MF that did not reach consensus in this round was eliminated, and the comments on the definition were utilised to revise the definition that did in the subsequent round.

INSERT TABLE 2 HERE

Round 2

In round two, 19 expert panel members completed the survey (79% response rate). Following the content analysis of the qualitative data from open-ended responses from round one, 20 questions with 65 items were used in round two. In round two, 44 out of the 65 items reached consensus (i.e. 70% agreement) in round two as detailed in Table 3.

INSERT TABLE 3 HERE

Round 3

The expert panel were asked to provide comments from round two of the survey that related to their ratings, and this was incorporated into the revision of the survey questions for the final round of the survey. Four items were excluded from the further investigation because they failed to reach a consensus in round 1 and round 2 as presented in table 3: one item in the development of MF in orienteering, two items in the impacts of MF and one item in the methods to reduce MF in orienteering. Seven items were excluded from the further investigation because the expert panel did not provide any specific comments that can be used to revise the items as in indicated table 3: Lower level of fitness, Time of the competition, Environmental conditions, Distraction (e.g. commentator/ other athletes), Stressed (e.g. pressure from action and/ or environment), Tension (e.g. worried, nervous), and Anger (e.g. annoyed, bad-tempered). Furthermore, a consensus was reached in round 2 on the complexity/difficulty of the task being the main cause of MF in orienteering competition. Therefore, three items regarding the complexity of the orienteering situation were excluded in round 3 to avoid repetition and redundancy.

No further questions were asked regarding the development, causes and impact of MF in orienteering in round 3 as consensus has been reached in either round 1 or 2. The remaining 6 items from 5 questions were revised based on the comments from the orienteering experts in round 2. Although consensus on the definition of MF was reached in round 1 and 2, the expert panel provided comments to further revise the statement. Therefore, the definition of MF was asked for three consecutive rounds to ensure the accuracy of the statement. The third round of the survey achieved a 94% response rate. Table 4 shows that 4 out of 6 items reached ≥ 70% consensus level in this round.

INSERT TABLE 4 HERE

Discussion

The Definition of Mental Fatigue

This study initially questioned the expert panel to identify the situations where they think MF could occur in daily life. In accordance with the existing definition of MF (Habay et al., 2021; Pageaux et al., 2014; Van Cutsem et al., 2017), the expert panel agreed that MF occurs after performing a prolonged period of a cognitive task. The expert panel also reached a consensus that MF will occur after a prolonged period of a physical task and/ or a task requiring a high level of concentration. To explain further, this implies if the task involves precise decision-making which required a high level of concentration, would also elicit MF regardless of the duration of the task. In support of this, functional magnetic resonance imaging studies have demonstrated negative changes in the fronto-parietal brain network along with higher subjective ratings of MF and increased reaction time after a prolonged sustained attention task (Taya et al., 2018). However, the expert panel in round 2 of the current study did not show a consensus that MF occurs after performing a repetitive task or engaging in a task that they do not enjoy. This aligns with the suggestion that the occurrence of MF might be related to the amount of effort invested instead of the duration and repetition of the activity (Giboin and Wolff, 2019). Similar findings were observed in two recent meta-analyses (Brown et al., 2020; Giboin and Wolff, 2019), which reported that the extent of MF is related to the amount of effort invested rather than the time spent on the task. Interestingly, our round 2 expert panel also reached a consensus that MF will occur when adapting to a new or unfamiliar environment and lacking recovery. Recent investigations with well-trained netballers and soccer players show that the subjective rating of MF remains higher than pre-training/competition during a netball training camp and after a soccer match (Abbott et al., 2020; Russell et al., 2021; Thompson et al., 2020). This might reinforce the consensus made by the expert panel that insufficient recovery, the physical and cognitive demands of the task together with the unpredictability of the environment, may be related to the development of MF.

Although in round 1 the expert panel reached a consensus that the definition of MF in previous research appropriately reflects the influence of MF on physical performance (Pageaux et al., 2014; Van Cutsem et al., 2017), the expert panel were concerned that the existing definition of MF does not match the MF they encountered during orienteering. Taking into consideration the ambiguity around a definition of MF (Brown et al., 2020; Martin et al., 2018; Tran et al., 2020), we modified the definition using the most recurrent comments from the expert panel from round 1 and 2, such as: "*leading to inefficient processing of thoughts and poor decision-making ability*" and "*mental fatigue in orienteering more as influencing the ability to concentrate and ability to make good decisions or effectively plan for the route or notice problems in time and act appropriately*". In round 3, the expert panel reached a consensus that the MF experienced in orienteering was well captured by the modified definition: *"Mental fatigue is characterized by the inability to maintain concentration and process information for decision-making efficiently and effectively after a prolonged period of cognitively loaded activity"*.

Summary: The expert panel in our study agreed with the existing definition of MF but added the concentration and decision-making elements might accurately reflect the MF that they experienced during orienteering. It implies that the frequently used definition of MF in the laboratory-based experiment may be insufficient to describe MF in the athletic population. Our finding shows that in order to properly explain MF in sports, it may be necessary to operationalise a specific definition of MF to explain the phenomenon after a cognitively loaded task. Additionally, future research must investigate other influencing variables (i.e. recovery) that might be associated with MF to further sharpen the definition of MF in sports.

The Development of Mental Fatigue

In round 1, the expert panel reached a consensus that MF exists in orienteering. However, the expert panel did not reach a consensus that the MF they experienced in the orienteering competition can be replicated in training. The responses from the experts revealed that the context of MF in orienteering competition might be different to training. Further, emerging from rounds 2 and 3, the expert panel reached a consensus that the mental stress and pressure from competitors are the essential MF stimuli in an orienteering competition, which cannot be replicated in training. Therefore, we recommend MF in orienteering training and competition should be discussed, and investigated in future research separately.

In round 2, a consensus was reached that the demands of technical training and the complexity of the task contributed to the development of MF during orienteering training. Consistent with previous research (Giboin and Wolff, 2019; O'Keeffe, Hodder, & Lloyd, 2019; Van Cutsem et al., 2017), exploring the intensity of cognitive activity is essential in understanding the development of MF. This establishes the importance of an individualized approach to investigate MF as suggested by O'Keeffe et al. (2019), which may affect whether MF is induced effectively i.e. replicate MF during orienteering training. In round 2, the expert panel reached a consensus that insufficient recovery and non-orienteering challenges from daily activities can influence the MF experienced in orienteering training. Their consensus supports the explanation that MF could be accumulated over time or during intense training due to insufficient recovery (Russell et al., 2019; Russell et al., 2021). It is beyond the scope of this study to investigate the specific types of non-orienteering challenges that could potentially accelerate the development of MF during both competition and training. However, it has been previously reported that prolonged use of a smartphone could induce MF and impair subsequent sports performance (Fortes et al., 202; Fortes et al., 2020; Trecroci et al., 2020). Furthermore, Martin et al. (2019) found that one could have better resistance to MF if one is regularly exposed to a high cognitive demand environment, which seems to support Eccles et al's explanation (2006a) that regularly competing orienteers could be less susceptible to MF. However, in our study, no consensus was reached on whether fitness level could affect the extent of MF experienced during orienteering training. This supports the suggestion that cognitive training adaptation is relatively more important than physical fitness status in terms of tolerance to, or reduced accumulation of MF (Eccles and Arsal, 2015).

Our expert panel reached a consensus the mental readiness for competition and/or a prolonged racing schedule or season can influence the development of MF in orienteering competition. In agreement with the previous investigation with elite athletes (Russell et al., 2019; Russell, et al., 2021; Russell et al., 2022), our findings also support the argument that MF can be the result of the accumulation of fatigue throughout the season. More specifically, our expert panel agreed that the physical condition and lack of sufficient opportunity for mental recovery during a single competition would affect the development of MF. This consensus indicates that MF may develop acutely and chronically in orienteering too. However, the overall physical and concentration intensity required during competition is influenced by how orienteers execute their plan during the race (Batista et al., 2020; Eccles et al., 2002). Therefore, to a certain extent, and based on the experience of the orienteers, they can self-regulate to a greater or lesser degree their management of physical output and allocation of mental rest during competition. If the orienteers become overloaded either physically or cognitively (or both) this can lead to mistakes such as an error in map reading/ incorrect route choice, indicating that decision-making during orienteering competition can directly influence the development of MF in competition. As discussed earlier, the similarity of MF between orienteering competition and training is low because of the failure to replicate the mental stress and pressure from other competitors. Previous research has highlighted the quality of decision-making is impaired when different stressors are presented (Phillips-Wren and Adya, 2020). In agreement, our expert panel reported that psychological stressors can lead to increased errors and unintentionally increase the physical and cognitive demand of the task, accelerating the development of MF. At present, no consensus was reached on how the environmental conditions and the time of the competition will influence the extent of MF during orienteering competition. Previous research emphasized that experienced orienteers appear to prepare themselves by visualizing the map and terrain prior to and during the competition (Eccles, 2006b; Eccles, 2008), which again means environmental conditions might be less important to the contribution to MF. As such, the development of MF in orienteering competition may be largely based on internal factors such as conscious decision-making and emotional state together with some uncontrolled variables such as a prolonged or condensed racing schedule. Hence, based on our findings, it appears that MF during orienteering competition can negatively impact the performance of orienteers. Therefore, further study is warranted on the effects of a prolonged racing schedule as well as insufficient mental breaks during competition, to inform orienteers and coaches how these issues can be appropriately addressed.

Taken together, our expert panel believed that the cognitive demand of the activity and emotional state are the key components that influence the development of MF in orienteering training and competition, and future studies must consider these when analyzing how MF is elicited in orienteering. Despite the potential differences of MF between orienteering training and competition, the future investigation should consider implementing MF measurement into daily practice as previous research (Russell et al., 2021; Russell et al., 2022) and our expert panel also agreed that MF could be developed chronically. To enhance the validity of the argument, future research should measure other well-being variables such as sleep quality, perceived stress and physical fatigue as conducted by Russell et al. (2022) to observe whether MF could be elicited without influencing other well-being variables. However, to date, there is no objective valid method to measure MF to confirm the development of MF due to technological limitations and methodological weaknesses as specified in previous investigations (Holgado et al., 2020; Martin et al., 2018; Smith, et al., 2018; Van Cutsem et al., 2017), and any future research should also accommodate sport-specific considerations that could elicit MF. Furthermore, instead of speculating about the effectiveness of the existing computerized laboratory-based MF protocols, the emotional state of the individuals should be taken into account when investigating the development of MF either in orienteering training or competition.

Summary: The expert panel reached a consensus that the MF experienced during the orienteering competition cannot be replicated in training due to the difference in cognitive demands between competition and training, mental condition, and environmental condition. To ensure the accuracy of the investigation, our expert panel felt that future research on MF in orienteering training and competition should be investigated separately.

The Causes of Mental Fatigue

It was agreed that multi-tasking in orienteering is cognitively demanding with consensus indicating the following orienteering technical tasks would cause MF: map reading, navigation, and route choice selection. Interestingly, experts also agreed that intentionally increasing the volume of work of the above components would induce MF in orienteering. Our consensus showed that cognitive exertion is greater when the activity is combined with different cognitive stressors, whereas an isolated stressor might not be sufficient to elicit MF. Regarding the MF protocol used to induce MF, such as incongruent Stroop-colour task, the protocol should require ongoing conscious decision-making together with selective attention to challenge the ability to inhibit cognitive interference (Brown et al., 2020; Hotama et al., 2017; Van Cutsem et al., 2017). Therefore, it appears that a prerequisite to induce MF in orienteering is whether the task sufficiently challenges the orienteers' cognition. Considering there is limited evidence examining the causes of MF, the majority of investigations on MF largely rely on computerized cognitively demanding tasks that suffer from low specificity and ecological validity (Brown et al., 2020; Habay et al., 2021; Smith et al., 2018; Van Cutsem et al., 2017). The present study provides some novel and potentially practical causes of MF for future research to explore whether adjusting the volume of the identified component could elicit realistic MF in orienteering. It also provides an insight that future investigation on MF should consider utilizing multiple cognitive stressors to induce MF effectively.

In relation to orienteering competition, there was consensus that the concentration level, the complexity of the task and external pressures/stress (e.g. from other competitors) are the causes of MF. In terms of external stress, the expert panel reached a consensus that losing attentional focus and a competitive environment are the causes of MF in orienteering competition. While consensus was not reached regarding distraction, fear of losing, and losing concentration. It is understandable that the competitive environment could be external stress that induces MF because orienteers usually have limited information about the terrain and map prior to the competition, highlighting the importance of competition-specific training for orienteers in preparation for optimal competitive performance (Eccles, 2008). The expert panel consensus shows the importance of attentional focus during an orienteering competition because orienteers are expected to compete in an unfamiliar environment while attempting to complete the race as quickly as possible. Our consensus also shows that the perception of MF might trigger by different types of attentional focus which require further investigation. Moreover, the consensus found in our study is supported by previous investigations in orienteering, namely that attentional focus is the key variable when discussing the cognitive demands placed on orienteers during the competition (Celestino et al., 2015; Eccles, 2008; Eccles and Arsal, 2015; Eccles et al., 2002). Although our expert panel agreed that multi-tasking is cognitively demanding, orienteers could naturally circumvent the limitation of information processing through training adaptation because the control of attentional focus is proposed to differentiate the level of orienteers (Eccles, 2006b; Eccles et al., 2002, 2006a). This provides additional support that orienteers aim to maintain a superior level of attentional focus to execute their plan effectively, which might unconsciously cause MF during competition.

Our expert panel did not reach a consensus that the physical fatigue and MF would increase simultaneously, highlighting that orienteers can experience MF independently from physical fatigue. However, the expert panel reached a consensus that being physically fatigued can exacerbate MF during orienteering. Although Le Mansec et al. (2018) demonstrated that both physical fatigue and MF significantly impaired sport-specific motor skills, future research is needed to determine whether the amount of MF orienteers experienced can be influenced by physical fatigue. This expert panel consensus supports the notion that MF is different from physical fatigue, and further investigation is warranted on the causes of MF in orienteering.

Summary: Our expert panel reached a consensus that increasing the volume of work of the following elements would cause MF in orienteering: map reading, navigation and route choice selection. Regarding acute MF, there was consensus that concentration level, complexity and external pressure or stress would be the causes of MF in orienteering competition. The expert panel also reached a consensus that being physically fatigued would accelerate the development of MF, but MF can occur without being physically fatigued, which highlights why MF should be examined independently.

The Impacts of Mental Fatigue in Orienteering

In accordance with the literature (Fortes et al., 2021; Habay et al., 2021; Trecroci et al., 2020), our expert panel reached a consensus that the ability and accuracy of conscious decision-making in orienteering are affected by MF, with the majority of comments concerning the efficiency of selecting a route and interpreting the map. The expert panel also reached a consensus that reaction time is impaired by MF, which has been classified as one of the impairments in cognitive function when experiencing MF (Taya et al., 2018). Although endurance running performance has previously been shown to be impaired following cognitively demanding activity because individuals experienced higher than the normal perception of effort (Filipas et al., 2020; MacMahon, Hawkins, & Schücker, 2019; Van Cutsem et al., 2017), our expert panel did not reach a consensus that MF would affect endurance capacity or high-speed running performance in orienteering with some conflicting comments: *"...MF can lead to a higher pace if panicking*" and "*...you will tend to slow down to make the navigation easier*". It might be related to the training status of the investigated population because Martin et al. (2016) also found that professional endurance athletes are more resilient to MF, which supports the explanation of orienteering experts. Even though our expert panel reached a consensus that MF affects ratings of perceived exertion and subjective ratings of tiredness, they believed that physiological dominant variables are less affected by MF due to less involvement of cognitive resources. Our expert panel did not agree with the majority of the literature (Van Cutsem et al., 2017), there was no consensus on the impact of MF on endurance performance. However, it is vital to note that athletes and practitioners may have different perceptions of the causes and effects of MF (Russell et al., 2019). MF is a combination of behavioural, subjective and physiological manifestations, it does not have to be present in all three elements to be present (Russell et al., 2019; Van Cutsem et al., 2017). As a result of the compensatory mechanism, one can experience MF without presenting any cognitive impairment. It might also explain why the expert panel reached a consensus on the effects of MF on the ability and accuracy of decision-making but not on high-speed and endurance running performance.

Our expert panel reached a consensus that MF induces negative psychological changes in orienteering including confusion, demotivation, distraction and fatigue, but not stress, anger and tension. Considering previous investigations modified the Brunel Mood Scale and the Profile of Mood State to support the measurement of MF (Brown et al., 2020; Pageaux et al., 2014; Pires et al., 2018), this current consensus supports the measurement of emotional state together with a consideration of measuring confusion as well. However, no consensus was reached for MF having a larger negative effect on the emotional state than physiological capacity in orienteering. It is important to note that recent investigations with elite sports populations display a carryover effect of MF that could last longer than one single occasion, particularly after a training camp and competition (Abbott et al., 2020; Russell et al., 2021; Thompson et al., 2020). Also, performance may remain impaired and fail to return to pre-MF state until fully rested and recovered (Jacquet et al., 2021; Magnuson, Doesburg, & McNeil, 2021). Surprisingly, Abbott et al. (2020) found that MF could be even higher when athletes lost the match, supporting that negative psychological responses and MF appear to be closely related. Therefore, there is a possibility that the impact of MF may affect performance on subsequent days. This may explain the consensus that our expert panel reached that pre-competition mental readiness affects the amount of MF experienced during orienteering.

Our expert panel reached a consensus that the amount of MF will fluctuate depending on the amount of cognitive effort required to complete the event. They were asked to identify when they expected to experience the impacts of MF in orienteering. There was consensus on this for more difficult and complex terrain and routes, but no consensus for simple and easy terrain and route. The expert panel supported the conclusion reached in recent meta-analyses and systematic reviews (Brown et al., 2020; Giboin and Wolff, 2019) that the amount of cognitive effort is closely related to the development and extent of influence of MF. This highlights the impact of MF in orienteering might be less affected by the duration of the task. Thus, although it seems that the effective time range to induce MF is unclear and unstandardized (Habay et al., 2021; Van Cutsem et al., 2017), the current study provides novel evidence from orienteering practitioners to further understand the development and impact of MF. Our findings suggest that the design of a MF protocol to investigate the impact of MF should prioritize the specificity of the cognitive activity based on the sport, with less attention on the duration of the task.

Summary: Our expert panel reached a consensus that the impact of MF in orienteering is greater for cognitive variables (reaction time, decision-making, rating of perceived exertion and subjective rating of tiredness), with less impact on the running performance of orienteers. They also agreed that MF might trigger negative psychological changes in individuals which affects the amount of MF experienced during orienteering.

Methods to Reduce Mental Fatigue in Orienteering

Our expert panel in round 1 reached a consensus that the development of MF in orienteering can be delayed through training adaptation. They concluded that either combining physical and orienteering technical training or technical training alone could maximise the training adaptation. Thus, repeated high-intensity and high-quality orienteering technical training were considered to be the key element in reducing MF. This expert consensus partially supports Filipas et al. (2020), who found that untrained individuals showed improved MF tolerance in cycling time trial performance following a 90 min cognitively demanding task after 4 weeks of endurance training. Although other variables such as RPE and subjective ratings of mental exertion did not demonstrate a significant change (Filipas et al., 2020), untrained individuals produced higher power output for the same reported RPE even after mental exertion condition. This revealed that the tolerance to MF may be trainable, which lends some support to the consensus reached in the present study.

However, in our study, no consensus was reached on whether the fitness status of the individual or physical training only can effectively reduce MF in orienteering. Further, there was no consensus that the frequency and volume of the training would maximise the training adaptation in counteracting MF in orienteering. To elaborate, improving physiological tolerance might be able to delay the development of MF, but it does not terminate the occurrence of MF, which might explain why our expert panel does not agree that improving physiological tolerance only, will reduce the likelihood of experiencing MF. In support of our expert panel consensus, previous studies highlighted that cognitive skills and performance are superior in trained and elite populations compared to amateur athletes (Batista et al., 2020; Scharfen and Memmert, 2019). Therefore, it cannot completely rule out the possibility that training status or training history is one of the potential underlying factors because Martin et al. (2019) found that individuals who are exposed to a regular cognitively demanding environment are less susceptible to MF. In this regard, orienteering athletes adequately exposed to a high cognitively demanding training environment might adapt to handling the increased cognitive stress, thereby reducing MF in orienteering.

Interestingly, our expert panel reached a consensus that mental breaks is effective in reducing MF during orienteering. They commented on how mental breaks during orienteering should be utilized, such as: *"allow small mental breaks during the competition e.g. during running on a part and then decide when to be on the map again"* and *"while running on a track give a rest to the brain until the next entrance in the forest"*. This consensus is in line with previous investigations evidencing that a mental break could improve perceived MF (Blasche et al., 2018; Loch et al., 2020) and cognitive function (Li et al., 2016; Lim and Kwok, 2016; Lim, Quevenco, & Kwok, 2013; Qi et al., 2020). In some agreement with our expert panel, Blasche et al. (2018) found that a 6-minute break with light aerobic and stretching exercises (i.e. a dynamic mental break) further decreased perceived fatigue with its effect lasting at least 20 minutes while most of the studies focused on a static mental break only (Li, et al., 2016; Lim and Kwok, 2016; Lim, et al., 2013; Loch, et al., 2020; Qi, et al., 2020). Interestingly, some recent observational studies have shown that MF could be accumulated after intense training schedule or competition because MF does not subside immediately after the termination of the task (Abbott et al., 2020; Russell et al., 2019; Russell et al., 2021; Thompson et al., 2020). As previously stated, the acute effect of MF is detrimental to sports performance (Giboin and Wolff, 2019; Habay et al., 2021; Van Cutsem et al., 2017). However, Loch et al. (2020) highlighted that a 20-min mental recovery strategy using a combination of systematic breathing and mental imagery in a lying position successfully regained emotional level and reduced perceived MF after performing a 60 min computerized MF protocol. It supports our expert panel consensus that utilizing a mental break between cognitively demanding activities might reduce the acute and chronic effects of MF that developed during orienteering training or competition. Importantly, our expert panel did not reach a consensus that distraction can reduce MF during orienteering, meaning the mental break intervention should be a relaxation method instead of a distraction from the cognitively demanding activity only. However, the practical application of a mental break to remediate MF is rudimentary and requires further clarification. In terms of reducing MF in orienteering, future research might investigate the effectiveness of a dynamic mental break intervention on perceived MF during orienteering with the duration of the mental break ranging from 1 to 10 minutes as suggested (Li et al., 2016; Lim and Kwok, 2016; Lim et al., 2013). Future research might also evaluate to what extent the implementation of static mental breaks reduces MF throughout the season and intense racing schedule.

Summary: Our expert panel agreed that manipulating the complexity and intensity of the mental training and orienteering technical training would maximise the training adaptation to delay the development of MF in orienteering. Besides, practitioners could also consider using a mental break intervention to reduce the development of MF in orienteering.

Limitations

Although our study successfully invited both elite orienteering athletes and coaches, the sample size of the respondents is relatively small and most respondents (n = 17) described themselves as competitive or former orienteering athletes. This may affect the accuracy and validity of the findings when discussing the suitable training methods to reduce MF because orienteering training programs are usually designed and delivered by the coaches. Furthermore, there might be a chance the participants who selected their current role as an orienteering coach explain their thoughts from an athlete perspective because some participants were once professional athletes and still competing leisurely. The inability to determine which perspectives the participants were using to provide their responses was a reason why this study did not attempt to analyse the data in a separate population (e.g. coaches vs. athletes). Considering the sub-items in Round 2 and Round 3 of the survey were based on the consensus and comments from the experts, this may have overlooked some specific issues related to MF and orienteering that could have been identified by recruiting a broader range of orienteering experts. Also, it is important to note that work investigating MF in elite sport population is in its infancy. Work such as this Delphi study is important in developing understanding of elite sporting stakeholder perspectives of MF, but future work will need to conduct similar work with an additional focus on considerations of the conceptualization of MF and how this may be related to/different from concepts such as regulation and stress-induced cognitive disruption.

Conclusions and Practical Applications

Our Delphi study is the first study to unify the definition and identify the development of MF in orienteering based on the consensus opinions of elite orienteering experts. Our study further supports that MF could be developed acutely and chronically. Our findings highlighted the potential differences in MF between orienteering training and competition. Establishing an occasion-specific context might increase the accuracy and validity when investigating MF. Although it is widely reported that MF affects endurance running performance, our findings concluded that MF might influence the perceptual responses and emotional state of the orienteers instead of running performance. To delay the development of MF in orienteering, orienteering practitioners should consider manipulating the complexity, intensity and volume of orienteering technical work including map reading, navigation and route choice selection. Further investigation could also examine whether being physically fatigued would exaggerate the amount of MF an individual experienced. Taken together, our study identified the perceived causes and impacts of MF that can be utilized by orienteering practitioners and potentially create ecologically valid research for the orienteering population. This study reinforces future investigation to put individual specificity into consideration to fully explain the causes and impacts of MF in sports.

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Authorship Contribution:

HKNL: conceptualization, manuscript writing (first draft), participant recruitment, survey distribution, data collection, data analysis, development of the survey, manuscript review and editing

JS: conceptualization, act as 2nd reviewer to review, edit and approve the survey, provide guidance on data analysis, manuscript review and editing

AT: conceptualization, act as 2nd reviewer to review, edit and approve the survey, provide guidance on data analysis, manuscript review and editing

PM: participant recruitment, act as 3rd reviewer to review, edit and approve the survey, manuscript review

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Table captions

Table 1. The demographics and characteristics of the orienteering experts.

Table 2. The descriptive summary of the round 1 survey responses from 24 orienteering experts.

Table 3. The descriptive summary of the round 2 survey responses from 19 orienteering experts.

Table 4. The descriptive summary of the round 3 survey responses from 18 orienteering experts.

Table 1.

Categories	Number of experts
Sex	
Male	16
Female	8
Currently based (country)	
Canada	1
Denmark	1
Finland	1
France	2
Italy	2
Norway	2
Russia	1
Sweden	4
Switzerland	3
United Kingdom (England, Scotland, Wales)	7
Country of practice	
Australia	1
Canada	1
Denmark	1
France	3
Italy	2
Norway	2
Sweden	1
Switzerland	3
United Kingdom (England, Scotland, Wales)	8
Multi-location (more than one country)	2
Primary role in Orienteering	
Athlete	13
Former Athlete	4
Orienteering Coach	7
Years of experience in Orienteering	
Athlete & Former athlete	16.2 ± 7.27
Orienteering Coach	16.7 ± 7.16
Involvement in orienteering*	
As a coach	
Sprint Distance	7
Middle Distance	9
Classic/ Long Distance	9
Relay	7
As a competitor	
Sprint Distance	20
Middle Distance	22
Classic/ Long Distance	23
Relay	23

*Experts were allowed to respond more than one answer.

Table 2.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
The Definition of Mental Fatigue						
"*Mental fatigue characterized by feelings of tiredness and a lack of energy and induced by prolonged periods of demanding cognitive activity*" Do you agree this definition reflects its influence on physical performance in orienteering?	0%	0%	4.2%	58.3%	37.5%	Yes
"*Mental fatigue is induced by the prolonged cognitive task that heightened perception of physical effort independent of changes in cardiorespiratory (aerobic capacity), metabolic and/or neuromuscular responses*" Do you agree this definition reflects its influence on physical performance in orienteering?	0%	20.8%	25.0%	37.5%	16.7%	No
The Development of Mental Fatigue						
The mental fatigue you experienced during orienteering training is the same as the one you experienced during in orienteering competition?	4.2%	33.3%	37.5%	20.8%	4.2%	No
The Cause of Mental Fatigue						
Multitasking in orienteering is cognitively demanding (i.e Read the map, react to the surrounding environment, run on the terrain)?	0%	0%	4.2%	16.7%	79.2%	Yes
Psychological stress will increase the levels of mental fatigue in orienteering, i.e. mood changes due to the external pressure at competition.	4.2%	4.2%	4.2%	33.3%	54.2%	Yes
Physical fatigue and mental fatigue will increase simultaneously	8.3%	16.7%	50.0%	12.5%	12.5%	No
The Impacts of Mental Fatigue						
The conscious decision-making ability of the orienteers is likely to be affected by mental fatigue.	0%	0%	4.2%	29.2%	66.7%	Yes
The following characteristics are likely to be impaired by mental fatigue in orienteering:						
- Endurance performance (ability to maintain an appropriate pacing strategy during orienteering)	0%	20.8%	16.7%	50.0%	12.5%	No
- High speed running performance (ability to run in a high- speed during orienteering)	4.2%	8.3%	29.2%	33.3%	25.0%	No
- Rating of perceived exertion (Subjective feelings towards the loading of the physical task)	0%	4.2%	16.7%	41.7%	37.5%	Yes
- Subjective rating of tiredness	0%	4.2%	12.5%	37.5%	45.8%	Yes
- Reaction (decision) time	0%	0%	0%	41.7%	58.3%	Yes
- The accuracy of decision-making (ability to plan your route/tactics effectively)	0%	0%	4.2%	25.0%	70.8%	Yes
Mental fatigue induces negative psychological changes in orienteering.	0%	8.3%	8.3%	50.0%	33.3%	Yes
The development of mental fatigue in orienteering is related to the duration of the task.	0%	12.5%	20.8%	37.5%	29.2%	No

Table 2. Continued.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
The extent of mental fatigue experienced in orienteering is dependent on the amount of cognitive effort required to complete the event.	0%	0%	8.3%	37.5%	54.2%	Yes
<u>The Methods to Reduce Mental Fatigue in Orienteering</u>						
The fitter an athlete become, the better resistant to mental fatigue in orienteering.	4.2%	8.3%	33.3%	33.3%	20.8%	No
In orienteering, the development of mental fatigue can be delayed through training adaptation.	0%	0%	0%	50.0%	50.0%	Yes
Mental fatigue is more likely to have a negative effect on psychological processes than physiological capacity (e.g. cardiovascular response) in orienteering.	4.2%	8.3%	20.8%	45.8%	20.8%	No

Table 3.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
The Definition of Mental Fatigue						
"Mental fatigue is characterized by the inability to maintain concentration and process information for decision-making efficiently after prolonged periods of cognitive activity." Does this statement describes mental fatigue as experienced in orienteering?	0%	5.3%	5.3%	42.1%	47.4%	Yes
Do you believe mental fatigue will occur in the following situation?						
- Insufficient recovery (i.e sleep deprivation, not taking breaks)	0%	0%	15.8%	15.8%	68.4%	Yes
- After a prolonged period of a cognitive task	0%	0%	5.3%	36.8%	57.9%	Yes
- After a prolonged period of a physical task	0%	10.5%	5.3%	63.2%	21.1%	Yes
- After repetitive task	0%	0%	42.1%	42.1%	15.8%	No
- After a task requiring high levels of concentration	0%	0%	0%	26.3%	73.7%	Yes
- Adapting to a new or unfamiliar situation?	5.3%	0%	10.5%	57.9%	26.3%	Yes
Are the following components affected by mental fatigue in daily life?						
- Level of concentration	0%	0%	0%	42.1%	57.9%	Yes
- Level of motivation	0%	0.0%	15.8%	31.6%	52.6%	Yes
- Emotional stability	0%	5.3%	10.5%	47.4%	36.8%	Yes
The Development of Mental Fatigue						
In orienteering training, is mental fatigue influenced by the following?						
- Complexity of the task	0%	0%	0%	47.4%	52.6%	Yes
- Lower level of fitness §§	0%	10.5%	36.8%	36.8%	15.8%	No
- Technically demanding training	0%	0%	5.3%	26.3%	68.4%	Yes
- Insufficient recovery	0%	0%	10.5%	26.3%	63.2%	Yes
- Non-orienteering challenges (e.g from work/ school)	0%	5.3%	0%	47.4%	47.4%	Yes
In orienteering competition, is mental fatigue influenced by the following?						
- Time of the competition §§	0%	21.1%	21.1%	26.3%	31.6%	No
- Environmental conditions §§	0%	5.3%	26.3%	42.1%	26.3%	No
- Physical condition	0%	10.5%	10.5%	63.2%	15.8%	Yes
- Mental condition	0%	0%	5.3%	31.6%	63.2%	Yes
- Prolonged racing schedule/season	0%	0%	5.3%	42.1%	52.6%	Yes
- Insufficient mental rest during competition	0%	0%	5.3%	47.4%	47.4%	Yes
Can the mental fatigue experienced in competition be replicated in training?**	0%	15.8%	15.8%	63.2%	5.3%	No

Table 3. Continued.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
<u>The Cause of Mental Fatigue</u>						
Is the following orienteering technical task a cause of mental fatigue in orienteering?						
- Map reading (including map visualisation)	0%	0%	0%	52.6%	47.4%	Yes
- Navigation (react to surround environment/ features/ terrain)	0%	0%	10.5%	63.2%	26.3%	Yes
- Route choice selection	0%	5.3%	15.8%	42.1%	36.8%	Yes
Would intentionally increasing the volume of work on the following component induce mental fatigue in orienteering?						
- Map reading (including map visualisation)	0%	0%	0.0%	42.1%	57.9%	Yes
- Navigation (react to surround environment/ features/ terrain)	0%	0%	26.3%	26.3%	47.4%	Yes
- Route choice selection	0%	5.3%	15.8%	26.3%	52.6%	Yes
Is the following component the main cause of mental fatigue in orienteering competition?						
- Concentration level (amount of focus required for the task)	0%	0%	0%	31.6%	68.4%	Yes
- Repeated action	0%	11.1%	61.1%	22.2%	5.6%	No
- Complexity (difficulty of the task)	0%	0%	22.2%	33.3%	44.4%	Yes
- External pressures/ stress	5.6%	5.6%	11.1%	38.9%	38.9%	Yes
In orienteering competition, does that the following component act as an external stress that Increases mental fatigue?						
- Fear of losing	0%	15.8%	31.6%	36.8%	15.8%	No
- Losing concentration	0%	5.3%	31.6%	47.4%	15.8%	No
- Losing attentional focus	0%	5.3%	21.1%	47.4%	26.3%	Yes
- Distraction (e.g. commentator/ other athletes)	0%	10.5%	21.1%	36.8%	31.6%	No
You can experience mental fatigue without being physically fatigued	0%	0%	0%	36.8%	63.2%	Yes
Mental fatigue is worse when you are physically fatigued	0%	0%	26.3%	36.8%	36.8%	Yes
<u>The Impacts of Mental Fatigue</u>						
Mental fatigue alters your pacing strategy by increasing your intention to walk and/or run slower than you expected during orienteering**	0%	26.3%	21.1%	47.4%	5.3%	No
Mental fatigue negatively affects your high-speed running performance during orienteering**	5.3%	15.8%	31.6%	36.8%	10.5%	No
In orienteering, the following psychological responses can occur when you are mentally fatigued.						
- Demotivated	0%	10.5%	5.3%	52.6%	31.6%	Yes
- Distraction §§	0%	5.3%	5.3%	26.3%	63.2%	Yes
- Stressed (e.g pressure from action and/or environment) §§	0%	10.5%	31.6%	21.1%	36.8%	No
- Confusion	5.3%	0%	5.3%	31.6%	57.9%	Yes
- Tension (e.g worried, nervous) §§	0%	10.5%	26.3%	52.6%	10.5%	No

Table 3. Continued.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
- Fatigue (e.g worn out, exhausted, sleepy, tired)	0%	0%	0%	73.7%	26.3%	Yes
- Anger (e.g annoyed, bad tempered) §§	5.3%	10.5%	36.8%	42.1%	5.3%	No
You can experience mental fatigue in the following orienteering situation.						
- Long course with easy terrain	5.3%	15.8%	36.8%	42.1%	0%	No
- Short course with easy terrain	10.5%	36.8%	36.8%	15.8%	0%	No
- Long course with tricky terrain	0%	0%	5.3%	31.6%	63.2%	Yes
- Short course with tricky terrain	0%	5.3%	5.3%	36.8%	52.6%	Yes
- Easy route choice	10.5%	31.6%	47.4%	10.5%	0%	No
- Difficult route choice	0%	5.3%	5.3%	63.2%	26.3%	Yes
Pre-competition mental readiness affects the amount of mental fatigue experienced during orienteering	0%	0%	5.3%	52.6%	42.1%	Yes
<u>The Methods to Reduce Mental Fatigue in Orienteering</u>						
The following training methods are effective in reducing mental fatigue in orienteering:						
- Combined physical and orienteering technical training (i.e. running with map)	0%	0%	5.3%	42.1%	52.6%	Yes
- Physical training only (Improve physiological tolerance)**	5.3%	15.8%	36.8%	42.1%	0%	No
- Orienteering technical training only (i.e. improve the accuracy and efficiency of map reading skills and route choices)	0%	5.3%	10.5%	68.4%	15.8%	Yes
- Mental training (i.e. practice planning route and visualise the race using a map)	0%	5.3%	15.8%	52.6%	26.3%	Yes
The following training parameters need to be manipulated to induce mental fatigue:						
- Training intensity (e.g. prescribe a higher rating of perceived exertion (RPE) training session)	0%	15.8%	5.3%	47.4%	31.6%	Yes
- Training frequency (more training session)	0%	5.3%	26.3%	47.4%	21.1%	Yes
- The complexity of the training (i.e more advanced technique is needed to complete the task)	0%	0%	5.3%	26.3%	68.4%	Yes
- Training volume	0%	5.3%	42.1%	36.8%	15.8%	No
The following methods could reduce the amount of mental fatigue during orienteering:						
- Supplementation (e.g. energy gel, caffeine)	5.6%	11.1%	11.1%	72.2%	0%	Yes
- Mental breaks (i.e. mental rest between cognitively demanding activities)	0%	0%	5.3%	57.9%	36.8%	Yes
- Distraction (e.g. setting up a watch alarm)	5.3%	36.8%	36.8%	21.1%	0%	No

**: The items that failed to reach a consensus for two consecutive rounds; §§: No specific comments were received to revise the items

Table 4.

Statements	Totally disagree	Disagree	Neutral	Agree	Totally agree	Consensus
<u>The Definition of Mental Fatigue</u>						
"Mental fatigue is characterized by the inability to maintain concentration and process information for decision-making efficiently and effectively after a prolonged period of cognitively loaded activity." Do you agree this statement describe the mental fatigue you experienced in orienteering?	11.1%	0%	0%	44.4%	44.4%	Yes
Do you agree mental fatigue in daily life can occur when engaging the activity that you do not enjoy?	0%	16.7%	27.8%	33.3%	22.2%	No
<u>The Cause of Mental Fatigue</u>						
Do you agree a competitive environment is a cause of psychological stress that induces mental fatigue in orienteering?	5.6%	5.6%	11.1%	61.1%	16.7%	Yes
<u>The Methods to Reduce Mental Fatigue in Orienteering</u>						
Do you agree the higher perceived importance of orienteering competition affects the level of mental fatigue athletes experience during orienteering?	0%	16.7%	33.3%	22.2%	27.8%	No
Repeated high intensity and/ or high-quality orienteering technical training can help automating the actions in orienteering.	0%	0%	0%	27.8%	72.2%	Yes
Repeated high intensity and/ or high-quality orienteering technical training can improve the efficiency of decision-making during orienteering.	0%	0%	0%	22.2%	77.8%	Yes