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No effect of mental fatigue on perceived hand weight

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Abstract

Fatigue has a profound impact on various sensory and perceptual processes; yet, its effects differ depending on whether it arises from physical or mental exertion. While physical fatigue is known to alter body weight perception, it remains unclear whether mental fatigue has a similar effect. This study tested the hypothesis that mental fatigue, like physical fatigue, would influence the recently identified perceptual bias of hand weight underestimation, where individuals perceive their hand as lighter than its actual weight. Twenty-four participants completed a validated mental fatigue induction task, followed by pre- and post-fatigue assessments of hand weight perception using a weight judgment paradigm. As expected, the fatigue task significantly increased subjective ratings of mental fatigue. However, contrary to our hypothesis, the degree of hand weight underestimation remained unchanged between pre- and post-fatigue sessions; a Bayesian analysis strongly supported the null hypothesis. These results suggest that mental fatigue, unlike physical fatigue, does not significantly alter sensory mechanisms underlying hand weight perception. This study underscores the distinct pathways through which physical and mental fatigue interact with perceptual processes.

Keywords

Fatigue; mental fatigue; physical fatigue; hand weight underestimation; body perception

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Introduction

After a long day at work, we may feel as though our eyelids are heavier than usual; similarly, after a marathon, our legs might feel like they are made of lead. These sensations are not merely anecdotal but may reflect a critical interaction between fatigue and the perception of our own body. Fatigue is a universal experience, often described as a sense of overwhelming tiredness, exhaustion, and reduced energy (Di Vico et al., 2021). It is a complex, multidimensional phenomenon encompassing both physical fatigue and mental fatigue, which differ in their origins and impacts. Physical fatigue arises from prolonged or intense physical activity, typically involving muscle exertion and peripheral sensory changes (Billones et al., 2021; Pattyn et al., 2018). By contrast, mental fatigue results from sustained cognitive effort, characterized by declines in attention, executive function, and motivation due to the depletion of cognitive resources (Linnhoff et al., 2019; Solomon & Manea, 2022).

Fatigue is known to influence a range of sensory and perceptual processes. For example, physical fatigue has been shown to alter time perception (Goudini et al., 2024; Tonelli et al., 2022), distance perception (Witt et al., 2004), and the perceived weight of external objects (Burgess and Jones, 1997; McCloskey et al., 1974). Recent evidence has also demonstrated its effects on body weight perception, particularly in relation to a newly identified perceptual bias: the underestimation of hand weight. This phenomenon, first quantified by Ferrè et al. (2023), refers to the

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systematic tendency to perceive one's hand as significantly lighter than its actual physical weight, often by as much as 50% (Cadete et al., 2024; Ferrè et al., 2023). This perceptual bias is thought to serve an adaptive function by reducing the perceived effort required for movement, thereby facilitating physical engagement.

Physical fatigue has been shown to significantly modulate this perceptual bias. After physically fatiguing tasks, individuals demonstrate a reduced degree of hand weight underestimation (Ferrè et al., 2023), suggesting that physical fatigue alters body perception by increasing the perceived effort required to move a fatigued limb. However, the impact of mental fatigue on hand weight perception remains unexplored, leaving a critical gap in our understanding of how fatigue influences body-related perceptual processes.

Mental fatigue, like physical fatigue, is known to increase perceived effort, leading to alterations in physical and cognitive task performance, such as reduced endurance and longer task completion times (MacMahon et al., 2014; Marcora et al., 2009; McMorris et al., 2018). This heightened effort perception acts as a motivational signal, reducing drive and willingness to act to conserve cognitive resources (Schiphof-Godart et al., 2018). Unlike physical fatigue, however, the higher effort perception associated with mental fatigue is generalized rather than limb- or body-specific (Domine et al., 2022; Schiphof-Godart et al., 2018). This distinction raises an important question: does mental fatigue influence body weight perception like physical fatigue, or do its effects remain confined to cognitive and motivational domains?

One hypothesis is that mental fatigue, while not directly altering sensory peripheral mechanisms like physical fatigue (Head et al., 2016; Pageaux et al., 2015), could indirectly affect weight perception by increasing the cognitive burden of engaging with physical tasks. This heightened cognitive demand might lead to weights being perceived as heavier, resembling the effects observed with physical fatigue. Alternatively, mental fatigue may act through mechanisms distinct from those of physical fatigue, potentially leaving sensory processes such as hand weight perception unaffected.

The present study aimed to investigate the impact of mental fatigue on hand weight perception. By employing a validated mental fatigue induction task and comparing hand weight perception before and after it, we aim to determine whether mental fatigue would reduce the degree of hand weight underestimation, as observed with physical fatigue in previous research. We hypothesized that participants would replicate the established hand weight underestimation bias in the pre-fatigue session and that mental fatigue would reduce the degree of underestimation in the post-fatigue session, mirroring the effects of physical fatigue. By addressing these hypotheses, this study aims to fill this gap in the literature, advancing our understanding of how mental fatigue influences body weight perception.

Materials and methods

Participants

To determine the minimum sample size required for this study, we conducted a priori power analysis using G*Power version 3.1.9.7 (Faul et al., 2007). Based on parameters derived from a similar experiment (power: 0.90, effect size: 0.693, significance level: .05; Ferrè et al., 2023, Exp 2), we calculated that a sample size of 24 participants would provide sufficient power to detect meaningful effects, ensuring the robustness of our findings. Consequently, we recruited 24 healthy participants (15 females, mean age $\pm$ *SD* = 33.9 $\pm$ 11.9 years), all of whom provided written informed consent prior to the study. All participants were right-handed, as assessed using the Edinburgh Handedness Inventory (Oldfield, 1971; 73.90 $\pm$ 17.46). They were recruited from the university community and were compensated with either payment or course credit. Eligibility criteria included an absence of neurological or physical impairments that could impact cognitive, sensory, or motor function.

Procedures were approved by the School of Psychological Sciences Research Ethics Committee at Birkbeck, University of London, ensuring adherence to the ethical principles outlined in the Declaration of Helsinki.

Stimuli

The stimuli for the hand weight judgment task were adapted from those used in a previous study using this paradigm (Ferrè et al., 2023). Weighted stimuli consisted of plastic bags filled with rice, set to 16 weight levels logarithmically spaced between 100 and 600 g, and rounded to the nearest gram. The specific weights used were as follows: 100, 113, 127, 143, 161, 182, 205, 231, 260, 293, 330, 372, 419, 472, 532, and 600 g. This weight range was chosen to include values both below and above the typical weight of a human hand (approximately 335 g), thereby allowing participants to engage in a challenging comparison of the experimental weights relative to their perceived hand weight. In each experimental trial, one of the stimuli was hung to a hook attached to a wristband (Senshi Japan; 5 cm in width) secured around the participant's wrist. The wristband and hook together weighed 76.5 g. Each bag's weight was adjusted to achieve the total target weight, accounting for both the wristband and hook.

Mental fatiguing task

The mental fatiguing task (MFT) employed was the standard version of the TloadDback (Borragán et al., 2017;

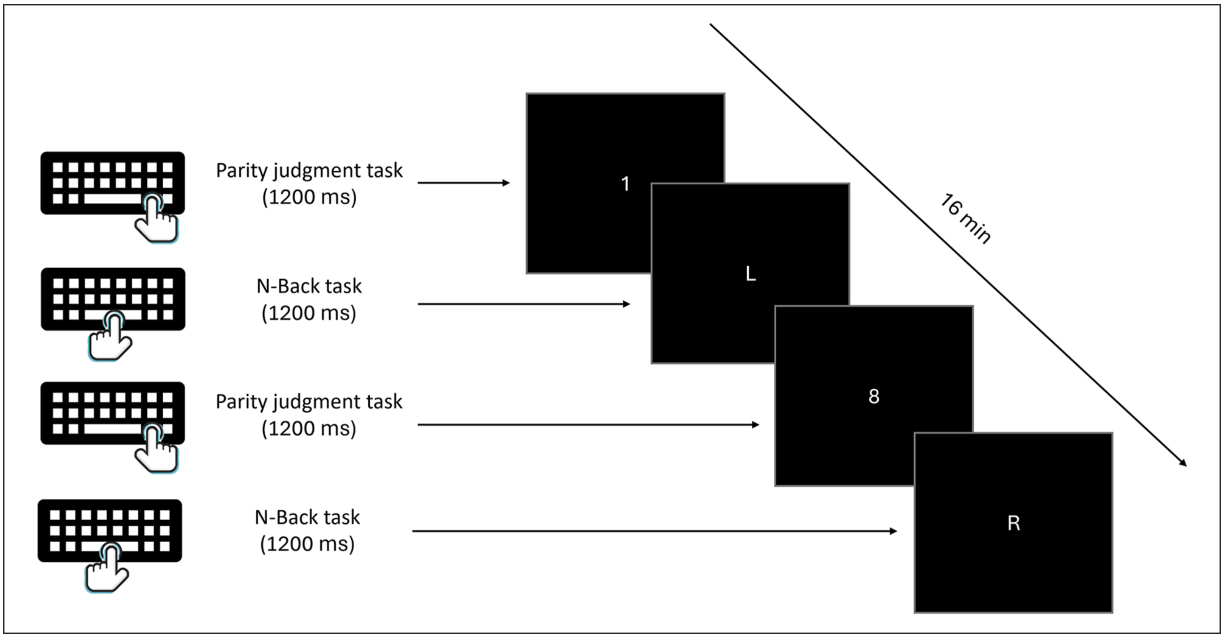

Figure 1. Mental fatiguing task. The 16-min TloadDback task was designed to induce mental fatigue by alternating between a parity judgment task and an N-back task, with each trial lasting 1,200 ms. During the parity judgment task, participants classified numbers as odd or even by pressing "2" or "3" on the keyboard with their right hand. In the N-back task, participants determined whether the current letter matched the one presented in the previous trial by pressing the space bar with their left hand. These tasks were performed continuously in an alternating sequence. This dual-task protocol aimed to induce mental fatigue by maintaining cognitive load throughout.

O'Keeffe et al., 2020). This task is a 16-min dual-task paradigm requiring participants to perform two simultaneous cognitive tasks. One of two tasks is a parity judgment test, where participants distinguish between odd and even numbers: when an even number is presented, the participant must press the number 2, and when an odd number is presented, participants must press the number 3. This task was performed using the right hand. The second task followed the classic N-back paradigm (Kirchner, 1958; Lawlor-Savage & Goghari, 2016), presenting a sequence of letters. Participants pressed the space bar with their left hand when the currently presented letter matched the one immediately preceding it. Familiarization trials were provided for each task individually, followed by a combined practice to ensure participants understood the dual-task requirements. Once familiarized, participants completed the full 16-min task, during which letters and numbers alternated in a single continuous sequence (Figure 1).

The TloadDback task has been validated as an effective method for inducing mental fatigue, as evidenced by both subjective and physiological measures. In a direct comparison of different cognitive fatigue paradigms, O'Keeffe et al. (2020) demonstrated that the standardized (non-individualized) version of the TloadDback elicited performance decline and self-reported mental fatigue. Notably, unlike traditional tasks such as the AX-continuous performance (a 90-min sustained attention task in which participants respond when the letter "X" follows the letter "A" in a stream of random letters), the TloadDback induced fatigue without causing substantial decreases in arousal (measured via galvanic skin conductance), excessive sleepiness, or dramatic reductions in motivation. This suggests that the task is capable of selectively targeting mental fatigue while preserving engagement and alertness (O'Keeffe et al., 2020). These results support the task's sensitivity in inducing mental fatigue within a relatively short time frame, making it a reliable method for experimental research.

Protocol

The experimental procedure for measurement of hand weight, presented in Figure 2, was similar to that used in Experiment 2 in Ferrè et al. (2023). The main goal of this task was to determine the point of subjective equivalence between the actual hand weight and a series of comparison weights. This allows for the quantification of the perceived weight of the hand.

The protocol was divided into two identical sessions: a pre-session conducted before the MFT and a post-session conducted afterward. In both sessions, participants sat comfortably on a chair, with their left arm hidden behind a wooden panel and resting on a cushion. At the beginning of each session, participants were instructed to keep their forearms resting on the cushion and let their left hand hang freely for 30 s, with the back of the hand facing up and no

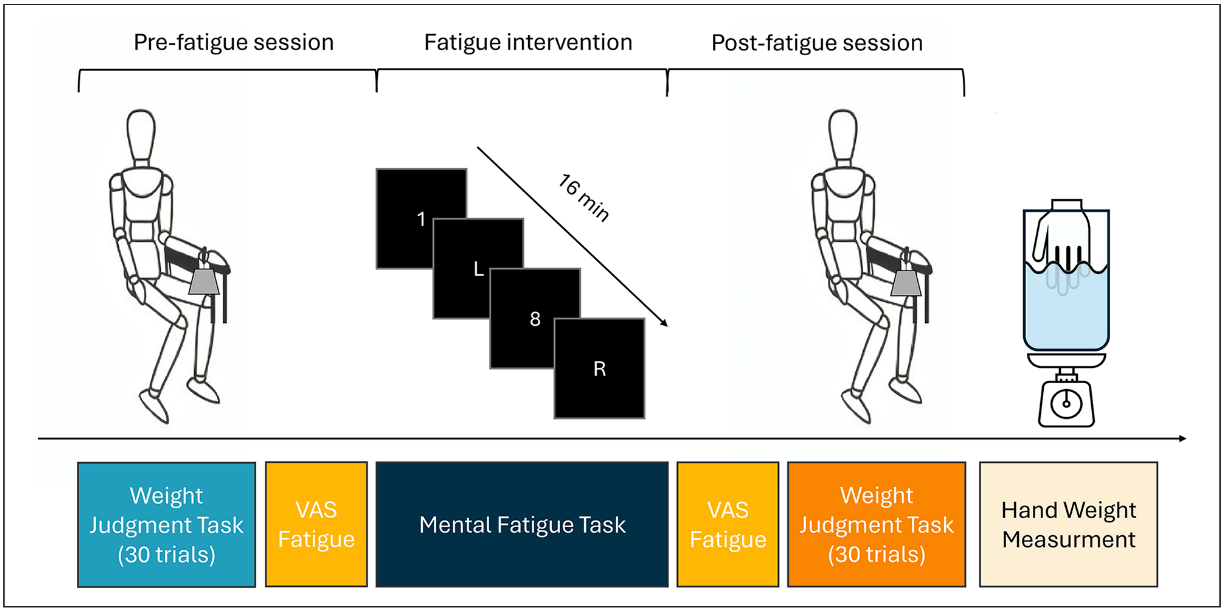

Figure 2. Protocol. The study consisted of a pre-fatigue session, a fatigue intervention, and a post-fatigue session. In the pre-fatigue session, participants performed 30 trials of the weight judgment task, followed by a subjective fatigue assessment using a VAS (0: No Fatigue to 10: Maximum Fatigue). The fatigue intervention involved the 16-min TloadDback. In the post-fatigue session, participants repeated the VAS fatigue assessment and the weight judgment task (30 trials). Finally, hand weight measurements were collected using a water displacement method to quantify actual hand weight.
Note. VAS = visual analog scale.

muscular effort allowed. They were specifically instructed to let the hand hang like a dead weight, exerting no force against gravity, and to focus on their perception of hand weight. This period formed the mental anchor for subsequent weight judgments.

Following this, the arm was laid across two cushions, creating a gap at the wrist to suspend comparison weights. On each trial, one of the weighted stimuli was attached to the wristband, and the participant was asked to compare it to the perceived hand weight from the beginning of the session. Each session comprised 30 trials of the weight judgment task, administered using two interleaved psychophysical staircases governed by the QUEST algorithm in PsychToolbox for MATLAB (King-Smith et al., 1994). This Bayesian adaptive procedure systematically selects the most informative stimulus on each trial based on participants' previous responses, allowing for rapid and efficient threshold estimation with a minimal number of trials (see Ferrè et al., 2023, for a detailed description).

The use of QUEST not only allows easy threshold detection but also serves to minimize learning effects. Stimuli are presented in an adaptive, non-repetitive order, and participants do not receive performance or visual feedback—factors that significantly reduce the likelihood of reinforcement learning or expectation-driven adjustments. Moreover, perceptual learning typically requires extensive exposure and high trial counts (Chen & Op de Beeck, 2021; Fahle & Poggio, 2002; Wolf & Drewing, 2020), conditions that were not met in our protocol (30 trials per session).

Consistent with the intended function of the algorithm, participants in our study typically stabilized their perceptual judgments within the first 5 to 10 trials of each staircase. This early convergence toward a stable internal reference was observed in both the pre- and post-fatigue sessions, supporting the reliability of the task and indicating that performance was not influenced by task-specific learning effects.

Between the pre- and post-fatigue sessions, participants completed the MFT to induce mental fatigue, which was assessed using a 10-cm visual analog scale (VAS) before and after fatigue intervention. The scale ranged from 0 (*No Fatigue*) to 10 (*Maximum Fatigue*). Fatigue evaluation was described to participants as follows:

> Please rate the level of mental fatigue you are experiencing. By mental fatigue, we mean the difficulty to concentrate and the presence of mental fogginess.

At the end of the experiment, hand volume measurements were collected using a water displacement method (Ferrè et al., 2023). Participants submerged their left hand (up to, but not including, the ulnar styloid process) in a beaker of water placed on a digital scale (AMPUT APTP457A 7,500 g, Shenzhen Amput Electronic Technology Co. Ltd, Shenzhen, China). Measured hand volume was converted to an estimate of hand weight using the estimate of hand density (1.09 g/cc) reported by Kaye and Konz (1986). Three consecutive measures of hand volume were collected and averaged (337.21 ± 83.63; 331.04 ± 77.10; 337.08 ± 83.13). On average, participants' hands weighed 335.11 g ± 80.61 g.

Data analysis

Data were analyzed using a combination of frequentist and Bayesian statistical approaches to examine the effects of mental fatigue on hand weight perception. Frequentist analyses were performed using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY 10504, USA), with an alpha threshold of $p < .05$ for significance.

To confirm the effectiveness of the fatiguing intervention, VAS ratings of mental fatigue were analyzed. Paired-samples *t*-tests were conducted to compare ratings before and after the MFT. This ensured that the intervention successfully induced the intended level of mental fatigue.

One-sample *t*-tests were conducted for both the pre- and post-fatigue sessions to determine whether the perceived weight differed significantly from the actual hand weight.

To examine the effect of mental fatigue on hand weight perception, we used the percentage of overestimation of the perceived hand weight, quantified as:

$$\text{Overestimation}\,\% = \frac{\text{Weigh Estimation} - \text{Actual Weight}}{\text{Actual Weight}} * 100$$

A paired-samples *t*-test compared the percentage of overestimation between the pre- and post-fatigue sessions.

To further explore whether mental fatigue affected weight perception like physical fatigue, a Bayesian paired-samples *t*-test was conducted using JASP 0.19.1.0 (Rouder et al., 2009; Wagenmakers et al., 2018). An informed normal prior distribution was used for the effect size, with a mean of 0 and a standard deviation of 0.346. This prior was derived from Ferrè et al. (2023), who reported a moderate within-subject effect size ($d_z \approx 0.693$) for the impact of physical fatigue on perceived hand weight. Following the recommendations of Dienes (2019), the standard deviation was set to half of the maximum plausible effect size, reflecting a theory-driven expectation of a moderate directional effect. The null hypothesis (H0) posited no change in the degree of underestimation between the pre- and post-fatigue sessions, while the alternative hypothesis (H1) predicted a reduction in underestimation following the MFT.

To investigate the relationship between mental fatigue and weight perception, Pearson correlation analyses were conducted between VAS scores and the overestimation percentages in both pre- and post-fatigue sessions. These analyses explored whether mental fatigue predicted changes in hand weight perception.

Results

VAS ratings of mental fatigue showed a significant increase following the MFT (Figure 3). Before the task, fatigue ratings averaged 2.54 ± 1.87, whereas post-task ratings increased to 5.84 ± 2.53. This difference was statistically significant ($t_{(23)} = -6.909$, $p < .001$, $d_z = 1.41$), confirming the effectiveness of the fatiguing intervention in inducing mental fatigue. Notably, the magnitude of this effect aligns with findings from O'Keeffe et al. (2020), further validating the use of this paradigm as a reliable method for inducing mental fatigue and demonstrating its consistency across studies.

The reliability of hand weight perception was confirmed by strong correlations between the high and low weight estimates from the two interleaved psychophysical staircases. In the pre-fatigue session, a robust correlation was observed ($r_{(22)} = .935$, $p < .001$), and this reliability persisted in the post-fatigue session ($r_{(22)} = .959$, $p < .0001$), demonstrating consistent hand weight estimates across sessions. Average psychophysical staircases starting from low (200 g) and high (600 g) weight initial estimates quickly converged on a common estimate of perceived hand weight, both before and after the MFT (Figure 4A).

Our results confirmed that participants significantly underestimated the weight of their hand in both the pre- and post-fatigue sessions (Figure 4A), consistent with prior findings on physical fatigue (Ferrè et al., 2023). The results of the one-sample *t*-tests comparing perceived hand weight to the actual hand weight found significant underestimation in both pre-fatigue session (overestimation percentage: 32.119 ± 28.408) ($t_{(23)} = 5.683$, $p < .001$, $d_z = 1.16$) and post-fatigue session (overestimation percentage: 39.877 ± 33.966) ($t_{(23)} = 5.690$, $p < .001$, $d_z = 1.16$), suggesting a consistent bias in hand weight estimation that replicate previous finding (Ferrè et al., 2023).

More interestingly, although a slight increase was observed, no significant difference was found in the overestimation percentage between pre- and post-fatigue sessions ($t_{(23)} = 1.325$, $p = .198$, $d_z = 0.27$) (Figure 4B), suggesting the absence of influence of mental fatigue on hand weight perception.

Bayesian analysis further reinforced these findings. The Bayesian paired-samples *t*-test yielded a Bayes Factor (BF_{-0}) of 0.252, demonstrating that the data were approximately 4 times more likely under the null hypothesis (H0: no difference in underestimation between sessions, $BF_{0-} = 3.962$) than under the alternative hypothesis (H1: reduced underestimation in the post-session). This result moderately supports the null hypothesis (95% credible interval), using a theory-driven prior.

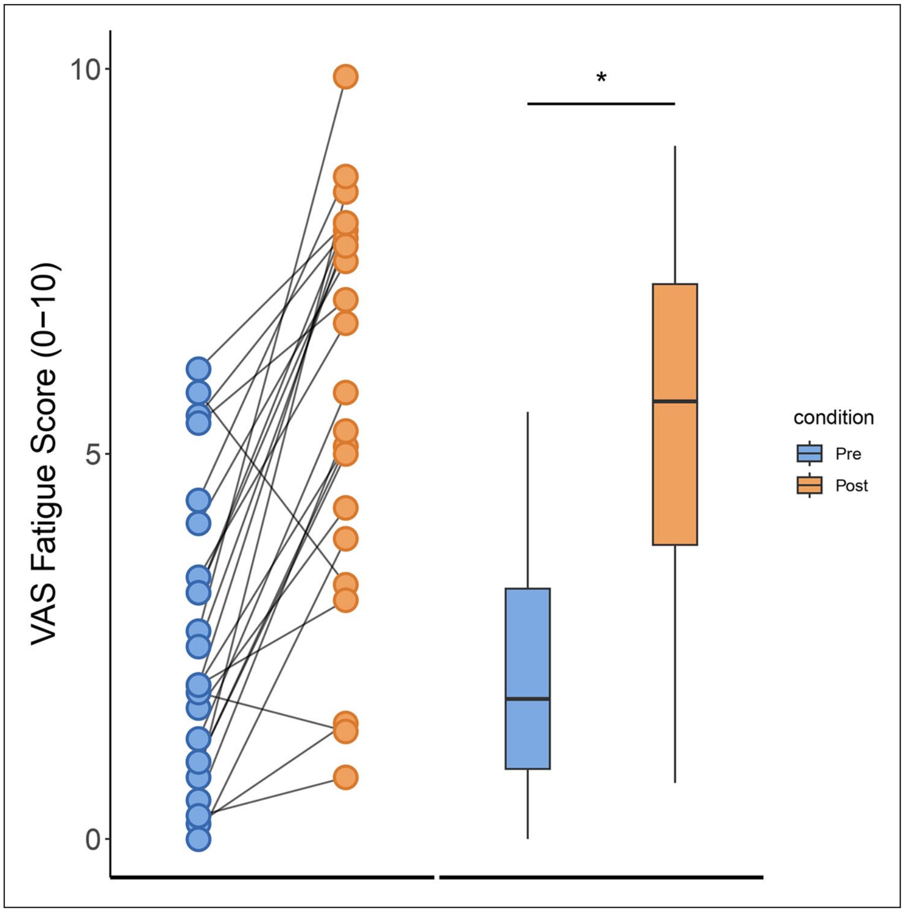

Figure 3. VAS ratings of fatigue before and after the MFT. Individual participant scores are shown for both the pre- and post-task conditions (blue and orange dots, respectively), with lines connecting paired observations. Boxplots represent the distribution of VAS scores in each condition. Fatigue scores significantly increased following the MFT (*$p < .05$), indicating that the mental fatigue manipulation was effective in elevating subjective fatigue levels.
Note. VAS = visual analog scale; MFT = mental fatiguing task.

Correlation analyses between subjective fatigue ratings and hand weight perception revealed no significant relationships. In the pre-fatigue session, the correlation between VAS mental fatigue scores and the degree of hand weight underestimation was not significant ($r = .004$, $p = .986$). Similarly, in the post-fatigue session, the correlation remained non-significant ($r = .266$, $p = .210$). These results suggest that subjective ratings of mental fatigue do not predict changes in hand weight perception.

Discussion

Our study aimed to investigate the impact of mental fatigue on hand weight perception. The systematic underestimation of hand weight is a recently discovered perceptual bias, with individuals perceiving their hands to weigh significantly less than their actual physical weight. For instance, Ferrè et al. (2023) demonstrated an average underestimation of approximately 50% of actual hand weight. In this study, we successfully replicated this effect, with participants underestimating their hand weight by 30% to 40% in both pre- and post-fatigue sessions. These results reinforce the reliability of this perceptual bias and the robustness of our paradigm in detecting it.

We also further validated the effectiveness of the standard TloadDBack task in inducing mental fatigue, as evidenced by a significant increase in subjective fatigue ratings following the task. This aligns with previous research establishing this paradigm as a reliable method for inducing mental fatigue, increasing the cognitive load over time (Borragán et al., 2017; O'Keeffe et al., 2020).

Despite the confirmed induction of mental fatigue, we found no significant differences in the extent of hand weight underestimation between pre- and post-fatigue sessions. In contrast to our hypothesis, participants consistently underestimated their hand weight to a similar degree, regardless of their cognitive fatigue state. This finding stands in contrast to the effects of physical fatigue, which

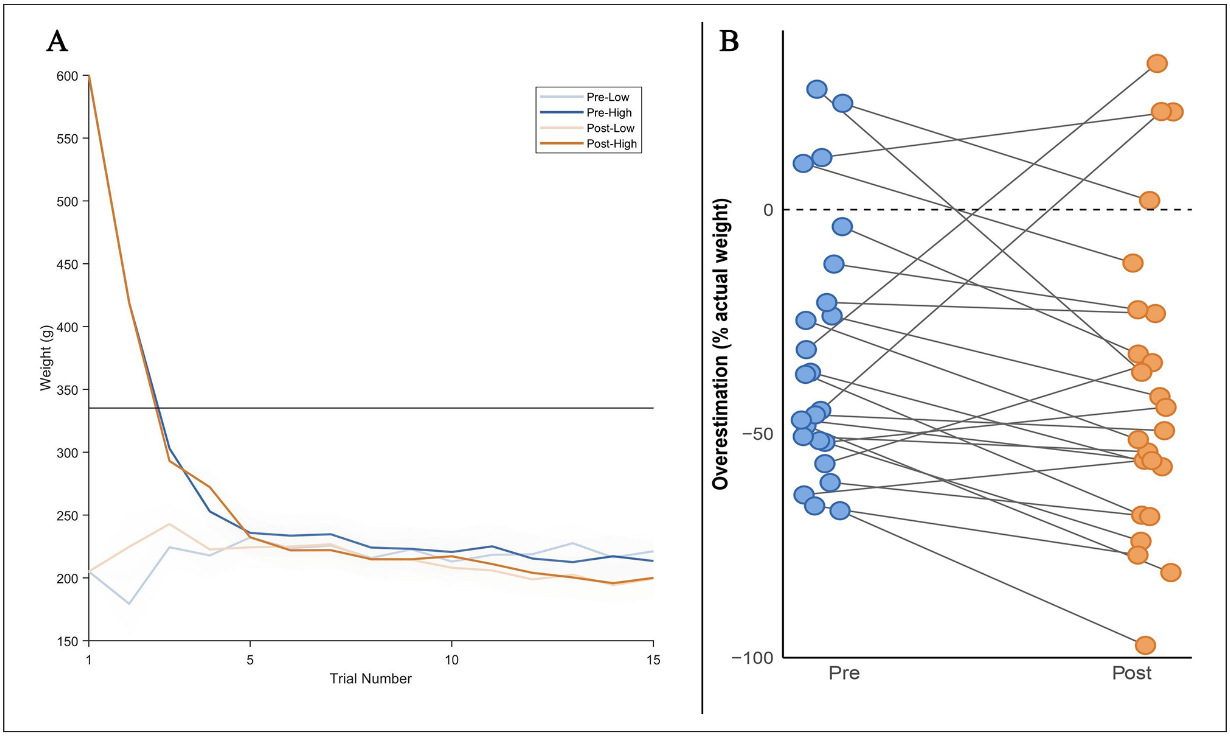

Figure 4. Hand weight underestimation in pre- and post-fatigue sessions. (A) Convergence of weight estimates over 15 trials in both pre- and post-fatigue sessions, shown separately for high and low staircases. The curves illustrate the reliability of the hand weight judgment task across conditions, with estimates stabilizing by the first 5 to 10 trials. The horizontal line represents the average of the actual hand weight. (B) Overestimation percentage (% actual weight) in pre- and post-fatigue sessions. Each point represents an individual participant, with connecting lines illustrating paired pre- and post-session data. The dashed line at 0% indicates accurate weight estimation.

has been shown to alter the perceived weight of both external objects (Burgess & Jones, 1997; McCloskey et al., 1974) and body parts (Ferrè et al., 2023).

Hand weight perception is a process that likely relies on the integration of proprioceptive input, which integrates sensory feedback from muscles, tendons, and joints to provide a sense of body position in space. Physical fatigue appears to disrupt these sensory pathways (Ferrè et al., 2023), potentially altering peripheral sensory feedback or central integration mechanisms (Amann et al., 2013). This alteration may impair the brain's ability to process proprioceptive signals accurately, leading to reduced underestimation of hand weight (Ferrè et al., 2023). By contrast, mental fatigue appears to engage higher-order cognitive processes, such as decision-making (Smith et al., 2016; Verschueren et al., 2020) and attentional control (Csathó et al., 2012; Slimani et al., 2018), rather than directly influencing sensory pathways. As a result, proprioceptive inputs remain relatively unaffected in mental fatigue, which explains the lack of significant changes in hand weight perception observed in our study. This distinction underscores the specificity of physical fatigue in altering sensory feedback mechanisms (Goudini et al., 2024; Tonelli et al., 2022; Witt et al., 2004).

This framework is in line with findings showing that while mental fatigue affects endurance performance (Brown et al., 2020; Mortimer et al., 2024) and task-related effort perception (Pageaux et al., 2015; Van Cutsem et al., 2017), it does not significantly alter physiological measures such as heart rate, oxygen uptake, and blood lactate (Head et al., 2016), measures that, on the other hand, are affected by physical fatigue (Kay et al., 2001; Minder et al., 2023). Similarly, motor performance metrics like maximal voluntary contraction (Pageaux et al., 2015) or power output (Van Cutsem et al., 2017) remain unaffected by mental fatigue, further highlighting how its effects differ from those of physical fatigue.

Further evidence in favor of this interpretation is offered by studies that explored the distinction between physical and mental fatigue in the perceptual domain. For instance, Goudini et al. (2024) examined the impact of mental and physical fatigue on time perception and found that mental fatigue did not significantly alter this process, whereas physical fatigue led to time misjudgment. Specifically, under the physical fatigue condition, participants underestimated time intervals during post-test and follow-up assessments, while no such effects were observed under mental fatigue or control conditions. These findings confirmed that, in contrast to physical fatigue, mental fatigue has no impact on sensory mechanisms underlying body weight awareness and temporal perception. This highlights the specificity of mental fatigue's influence on cognitive rather than sensory domains, contrasting with the effects of physical fatigue, which alters both sensory and motor function (Ferrè et al., 2023; Goudini et al., 2024; Tonelli et al., 2022). Overall, our findings extend previous results and support the notion that mental and physical fatigue interact with perceptual systems through partially independent pathways. This distinction emphasizes the need for targeted approaches that address mental and physical fatigue as separate phenomena.

Limitations

While our study offers valuable insights into the relationship between mental fatigue and hand weight perception, it is not without limitations.

One important limitation of the present study is the absence of a control group or condition that could help disentangle the specific effects of mental fatigue from potential influences of task repetition. Although we observed no systematic change in perceived hand weight across sessions, it remains theoretically possible that repeated exposure to the weight judgment task could interact with the experimental manipulation. However, prior work using the same paradigm (Ferrè et al., 2023) provides compelling evidence against this concern. In Experiment 1, participants completed three consecutive blocks of weight judgments without any experimental manipulation, and a stable, robust underestimation of hand weight was observed throughout. This suggests that the perceptual bias is reliable and not substantially affected by repetition or habituation. Crucially, in Experiment 2 of the same study, a significant reduction in underestimation was observed only when a physical fatigue manipulation was introduced. This indicates that the task is sensitive enough to detect perceptual changes when a relevant manipulation is applied, further supporting the interpretation that the absence of change in our study reflects a true null effect of mental fatigue, rather than a ceiling, floor, or masking effect from task repetition.

A second limitation concerns our reliance on subjective ratings to assess mental fatigue. While such measures are widely used in the fatigue literature (Ferrè et al., 2023; Verschueren et al., 2020) and offer a scalable means of capturing internal states, they lack the precision and objectivity provided by physiological or behavioral markers. The inclusion of objective indicators, such as neurophysiological or performance-based metrics, would strengthen future investigations. However, it is important to note that the MFT employed in the present study—the standardized TloadDback task—has been thoroughly validated in prior research (O'Keeffe et al., 2020). That study demonstrated that the task reliably induces mental fatigue, as evidenced by both subjective self-reports and objective measures, including performance decrements and physiological changes. These findings provide strong support for the task's sensitivity and specificity in eliciting mental fatigue, reinforcing the validity of our experimental manipulation.

Despite these limitations, our study presents notable strengths. Chief among them is our commitment to publishing a null result—a decision that aligns with current calls for greater transparency and integrity in scientific research (Bik, 2024; Mlinarić et al., 2017; Wedderkopp & Rutz, 2024). Null findings are essential for correcting publication bias, refining theoretical models, and informing meta-analytic evidence (Bik, 2024; Fanelli, 2012; Mlinarić et al., 2017). By showing that mental fatigue does not significantly influence perceived hand weight, our findings clarify the boundaries of fatigue's impact on body perception. This contributes to a growing body of work that distinguishes the sensory consequences of different fatigue types (Ferrè et al., 2023; Goudini et al., 2024; Tonelli et al., 2022) and, more generally, improves our understanding of how distinct cognitive and physiological states selectively shape perceptual experiences.

Conclusion

In conclusion, our findings highlight the resistance of hand weight underestimation to mental fatigue, reinforcing the reliability of this perceptual bias and its independence from changes in cognitive state. The divergence in the effects of mental and physical fatigue underscores the importance of distinguishing between these two types of fatigue when investigating their impact on sensory and motor processes. This study contributes to a growing understanding of fatigue's multifaceted nature and lays the groundwork for future research exploring the unique mechanisms underlying different fatigue domains.

Data availability statement

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

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical considerations

This study was approved by the School of Psychological Sciences Research Ethics Committee at Birkbeck, University of London (Approval Code: 2223017). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Consent to participate

Informed consent to participate was obtained in writing from all participants prior to their inclusion in the study.

Consent for publication

Not applicable. This study does not contain any data from individual participants (e.g., identifying details, images, or videos).

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