Supplementary material

1. Determination of the sample size

Examining the correlation between the time-on-task effect and the sequential task effect requires to observe both effects in the same study and for the same participants. A previous experiment conducted with the same protocol (Mangin et al., 2021, exp. 3) required 51 participants to observe the sequential task effect and time-on-task effect. We tested the correlation on this sample of participants and obtained a marginal correlation: \( r = .245, p = .081 \). Then, a power analysis on G*Power was conducted to know how many participants it would be required to obtain a significant correlation with the following parameters: one tail, an alpha error probability of .05, and a power of .80. We obtained a sample size of 102 participants. Because of time and budget constraints we decided to conduct a study with 80 participants; i.e., a probability of .70 to obtain a significant correlation. Finally, we recruited 83 participants, but rejected 4 outlier participants.

2. Results concerning mean reaction time (RT) in the Stroop task while mixing the two types of trial

We conducted an ANOVA with Time-on-task (Part 1, Part 2, Part 3, Part 4) as repeated-measure factor on mean RT for correct responses in the Stroop task. We applied a correction of Greenhouse-Geisser on the degrees of freedom to compensate for any problem of sphericity. The effect of TOT was significant: \( F (2.2, 168.8) = 6.55; p = .001; \eta^2_p = .077 \). A post-hoc test with a correction of Holm showed that mean RT in Part 1 was marginally shorter than mean RT in Part 2 [\( t (234) = -2.39; p = .071; d = 0.13 \)], and significantly shorter than mean RT in Part 3 [\( t (234) = -3.62; p = .002; d = 0.19 \)] and Part 4 [\( t (234) = -4.02; p < .001; d = 0.21 \)]. All other differences did not reach significance. Figure A1 illustrates this effect.
3. Results concerning error rates in the Stroop task while mixing the two types of trial

The same ANOVA design was applied to error rate in the Stroop task. The effect of TOT did not reach significance: $F(2.24, 174.67) = 0.44; p = .668$. The mean error rate was .068.

Results on mean RT and error rate showed that participants kept the same strategy during the whole task and that there was no speed-accuracy tradeoff over time.

4. Results concerning mean reaction time (RT) in the Stroop task while differentiating the two types of trial

An ANOVA with Time-on-task (Part 1, Part 2, Part 3, Part 4) and Type of trial (reading the color name, naming the ink color) as within-subjects factors was conducted on the reaction time during the Stroop task. The interaction between these two effects reached
significance: $F (3, 234) = 19.29, p < .001, \eta^2_p = .198$ (see Figure A2). A post-hoc test, revealed that for the ‘naming ink color’ trials, the part 1 ($M = 757.65, \text{SD} = 89.56$) was different from the three others (part 2, $M = 779.86, \text{SD} = 90.65$; part 3, $M = 788.89, \text{SD} = 89.61$; part 4, $M = 794.02, \text{SD} = 87.66$, all $ps < .001$). All the other comparisons concerning the ‘naming ink color’ trials did not reach significance (all $ps > .072$). For the ‘reading color name’ trials, none of the comparison reached significance (all $ps > .600$). These results support the fact that mental fatigue is closely related to cognitive control.

The main effect of Type of stimulus was significant: $F (1, 78) = 570.02, p < .001, \eta^2_p = .880$. Mean RT for ‘reading color name’ trials was consistently shorter than for ‘naming ink color’ trials regardless the part of the task (see Figure A2).

**Figure A2:** Mean reaction time in the incongruent Stroop task as a function of time-on-task and type of trials.
5. Results concerning error rates in the Stroop task while differentiating the two types of trial

An ANOVA with Time-on-task (Part 1, Part 2, Part 3, Part 4) and Type of trial (reading the color name, naming the ink color) as within-subjects factors was conducted on the accuracy during the Stroop task. The interaction and the main effect of TOT did not reach significance: $F(3, 234) = 1.27, p = .285, \eta^2_p = .016$, and $F(3, 234) = 0.49, p = .689, \eta^2_p = .006$, respectively. By contrast, the main effect of the Type of trial was significant: $F(1, 78) = 68.98, p < .001, \eta^2_p = .469$. Participants showed a higher accuracy for the ‘reading color name’ trials ($M = 97.5\%, SD = 2.8\%$) than for the ‘naming ink color’ trials ($M = 91.1\%, SD = 8.6\%$).

6. Correlations between subjective variables and behavioral phenomena of interest

A first series of correlations has been examined between subjective variables (boredom and fatigue) and behavioral effects of interest (time-on-task effect, sequential task effect) while mixing the two types of trial for the time-on-task (TOT) effect. In this case the subjective score assessed just after the Stroop task was considered to calculate the correlation (and not the composite score as reported in the article). For these correlations the TOT effect was calculated by subtracting the IES scores of the fourth part from the first part of the Stroop task, and then divided this difference by the IES score of the first part.

TOT effect and boredom score after the Stroop task: $r = -.348, p = .002$.

Sequential task effect and boredom score after the Stroop task: $r = -.174, p = .126$.

TOT effect and fatigue score after the Stroop task: $r = -.184, p = .104$.

Sequential task effect and fatigue score after the Stroop task: $r = -.077, p = .503$.

A second series of correlations has been examined between subjective variables (boredom and fatigue) and behavioral effects of interest (TOT effect, sequential task effect)
while differentiating the two types of trial for the time-on-task effect (see Table A1). For these correlations, the TOT effect was calculated by subtracting the mean reaction time for correct responses when the participants had to name the ink color of the fourth part from the first part of the Stroop task, and then divided this difference by the reaction time of the first part.

**Table A1:** Correlations between TOT effect and other variables of interest. * = significant correlation between the variables.

| Variable     | Time-on-task RT IES | Sequential task effect | Boredom | Fatigue |
|--------------|---------------------|------------------------|---------|---------|
| Time-on-task RT | $r = .821$          | $r = .270$             | $r = -.312$ | $r = -.132$ |
|               | $p < .001^*$        | $p = .016^*$           | $p = .005^*$ | $p = .246$ |

7. **Mediation analysis**

In order to be sure that boredom mediated the relationship between the time-on-task effect and the sequential task effect, we should first obtain a significant correlation between the three variables. As mentioned in Figure A2, the correlation between the boredom index (i.e., the difference between the boredom score after the Stroop task minus the boredom score after the Video task) and the sequential task effect was marginal, $r = -.216$, $p = .055$. By contrast, the correlation between the boredom index and the time-on-task effect was significant: $r = -.332$, $p = .003$. Then, a mediation analysis was conducted with bootstrap for 5000 samples. The total effect was significant, $\beta$ (standardized) = 0.272, $p = .013$. The indirect effect was not significant: $\beta = 0.047$, $p = .249$. Finally, the direct effect, when controlling for the boredom index, was at the limit of significance: $\beta = 0.25$, $p = .050$. This made the mediation analysis inconclusive, because the direct effect was at the limit of significance.
Figure A2: Mediation analysis between the time-on-task effect, the sequential task effect and the boredom index. * = significant correlation between two variables.

8. A systematic review of studies analyzing the time-on-task effect within the sequential task protocol

This systematic review aimed to examine if studies using the sequential task protocol with a long depleting task (duration ≥ 30 min) analyzed the performance in the depleting task as a function of time-on-task and the correlation between the time-on-task effect and the sequential task effect; two phenomena generally interpreted as manifestations of mental or cognitive fatigue.

To be included in the systematic review, a study should use the sequential task protocol with a depleting task and a control task longer than 20 min. The meta-analysis of Hagger et al. (2010) showed that the literature from social psychology mainly used short-duration depleting tasks (see appendix B of the Hagger’s et al. meta-analysis). This meta-analysis included 198 experiments. A total of 25.3% of these experiments did not report the duration of the depleting task. The mean duration of the 140 remaining experiments was 6.27 min (SD = 3.22 min). Among these 140 experiments, only two used a depleting task with a duration of 20 and 30 min respectively (Tyler & Burns, 2009; Finkel et al., 2006 – exp. 5). None of these two
studies analyzed the performance of the depleting task as a function of time on task.

Consequently, the systematic review focused on studies from sport sciences examining the effect of mental fatigue on a subsequent physical performance.

Sources that was used to identify studies for the systematic review included Academic Search Complete, CINAHL with full text, APA PsycINFO, and SPORTDiscuss with full text through the EBSCO platform. The search strategy was the following: AB ((mental N0 fatigue OR cognitive N0 fatigue) AND (control N0 condition OR control N0 treatment OR control N0 trial OR control N0 task)). The flow chart of the systematic review is represented on Figure A3. The selected studies are listed in Table A2. This table clearly showed that out of the 56 listed studies, 40 (71.43%) observed a sequential task effect on the performance of the dependent task, and only 10 (17.86%) reported a time-on-task effect on the performance of the depleting task. By contrast, only 5 studies (8.93%) observed a practice effect on the performance of the depleting task and 10 (17.86%) did not observe a significant effect on this dependent variable. Concerning our main hypothesis, only 8 studies (14.29%) observed both a time-on-task effect and a sequential task effect and were able to calculate a correlation between these two effects, but none of these 8 studies reported this correlation. The small sample size of these 8 studies (10 < N < 25; M = 16.6; SD = 6.2) can explain why they did not report the correlation between the two effects of interest. Finally, among the 56 studies listed in table A2, 32 (57.14%) did not report the performance of the depleting task as a function of time-on-task and consequently were not interested by the effect of mental fatigue that could be observed in the depleting task.
Figure A3: Flow chart of the systematic review on studies using the sequential task protocols and a depleting task with a duration above 20 minutes.

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| #  | Authors                  | N  | Depleting task | Task duration | TOT effect | Control task                                      | Dependent task                                      | ST effect | Correlation between TOT and ST effects |
|----|--------------------------|----|----------------|---------------|------------|--------------------------------------------------|-----------------------------------------------------|-----------|--------------------------------------|
| 1  | Marcora et al. (2009)    | 16 | AX-CPT         | 90 min        | Yes        | Watching a documentary                           | Time to exhaustion while cycling at 80% PPO         | Yes       | Not reported                         |
| 2  | Brownsberger et al. (2013) | 12 | Vigilance task consisting responding to selected letters | 90 min      | NR         | Watching a documentary                           | Two bouts of self-paced cycling exercise at RPE 11 and RPE 15 | Yes       | Not reported                         |
| 3  | Pageaux et al. (2013)    | 10 | AX-CPT         | 90 min        | No         | Watching a documentary                           | Time to exhaustion while performing an isometric contraction at 20% MVC | Yes       | Not reported                         |
| 4  | Persson et al. (2013)    | 32 | High interference recognition task | > 20 min    | NR         | Low interference recognition task                | Verb Generation Task                                | Yes       | Not reported                         |
| 5  | MacMahon et al. (2014)   | 20 | AX-CPT         | 90 min        | No         | Watching a documentary                           | Time to perform a 3-km run                          | Yes       | Not reported                         |
| 6  | Pageaux et al. (2014)    | 12 | Incongruent Stroop task | 30 min      | No         | Congruent Stroop task                            | Time to perform a 5-km run                          | Yes       | Not reported                         |
| 7  | Duncan et al. (2015)     | 8  | Vigilance task consisting completing concentration grids | 40 min     | NR         | Watching a documentary                           | Four 30-second Wingate Anaerobic Tests + Coincidence anticipation timing task + Minnesota Manual Dexterity Turning Test | Yes       | Not reported                         |
| 8  | Martin et al. (2015)     | 12 | AX-CPT         | 90 min        | No         | Watching a documentary                           | Countermovement jump, isometric leg extension,      | No        | Not reported                         |
|   | Study                                | Sample Size | Intervention | Duration | Training | Pre-intervention Test | Post-intervention Test |     |
|---|--------------------------------------|-------------|--------------|----------|----------|-----------------------|------------------------|-----|
| 9 | Pageaux et al. (2015)                | 12          | Incongruent Stroop task | 30 min   | No       | Congruent Stroop task | 6-min bout of cycling at 80% PPO | No  |
| 10| Rozand et al. (2015)                 | 10          | Incongruent Stroop task | 90 min   | NR       | Watching a documentary | Movement time in a Fitt’s pointing task | Yes |
| 11| Smith et al. (2015)                  | 10          | AX-CPT       | 90 min   | Yes      | Watching a documentary | Running velocity in an intermittent running exercise | Yes |
| 12| Azevedo et al. (2016)                | 8           | AX-CPT       | 90 min   | NR       | Watching a documentary | Endurance capacity in a cycling exercise at 80% MPO | No  |
| 13| Badin et al. (2016)                  | 20          | Stroop task  | 30 min   | NR       | Watching a documentary | Technical performance in small-sided soccer games | Yes |
| 14| Martin et al. (2016)                 | 11 PC + 9 RC| Incongruent Stroop task | 30 min   | PE       | 10-min at focusing on a centered black cross | Power output in a 20-min time trial on a cycle ergometer | Yes, in RC only |
| 15| Smith et al. (2016) Study 2          | 14          | Incongruent Stroop task | 30 min   | NR       | Reading magazines | Loughborough soccer passing and shooting tests | Yes |
| 16| Greco et al. (2017)                  | 16          | Use of smartphones (Brain It on App) | 30 min   | NR       | Carrying out usual activities before training | Yo-Yo Intermittent Recovery Test + Loughborough Soccer Passing Test | Yes |
| 17| Van Cutsem et al. (2017)             | 10          | Incongruent Stroop task | 45 min   | No       | Watching a documentary | Flanker task + 45-min bout of cycling at 60% + 15-min bout of cycling at 80% | No  |
|   | Authors                        | Sample Size | Task                  | Duration | Treatment Before | Treatment After | Additional Tests | Exercise Duration | Max VO2peak | Notes         |
|---|--------------------------------|-------------|-----------------------|----------|------------------|-----------------|------------------|-------------------|-------------|---------------|
|18 | Veness et al. (2017)           | 10          | Incongruent Stroop task | 30 min   | Yes              | Reading magazines | Cricket run-two test + Batak Lite hand-eye coordination test + Yo-Yo-IR1 test | Yes          | Not reported |
|19 | Coutinho et al. (2018)         | 10          | Incongruent Stroop task | 30 min   | NR               | No specific treatment before | Small-sided games | Yes          | Not reported |
|20 | Le Mansec et al. (2018)        | 22          | AX-CPT                | 90 min   | NR               | Watching a movie    | Table tennis performance | Yes          | Not reported |
|21 | Moreira et al. (2018)          | 32          | Incongruent Stroop task | 30 min   | PE               | 10-min at focusing on a centered black cross | Small-Sided-Games (SSG) technical performance | Yes          | Not reported |
|22 | Penna et al. (2018a)           | 12          | Modified Stroop task  | 30 min   | NR               | Watching a documentary | Yo-Yo IR1 test | Yes          | Not reported |
|23 | Penna et al. (2018b)           | 16          | Incongruent Stroop task | 30 min   | NR               | Watching a documentary | 1500-m time trial of swimming | Yes          | Not reported |
|24 | Salam et al. (2018)            | 11          | Incongruent Stroop task | 30 min   | NR               | Reading a magazine  | Time to exhaustion while cycling at 40%, 60%, 80% or 100% VO2peak | Yes          | Not reported |
|25 | Slimani et al. (2018)          | 10          | Incongruent Stroop task | 30 min   | NR               | Reading magazines | d2 test + 20-m multistage fitness test | Yes          | Not reported |
|26 | Brown et al. (2019)            | 25          | AX-CPT                | 50 min   | Yes              | Watching a documentary | 30-min cycling exercise at a self-selected intensity | Yes          | Not reported |
|27 | Staiano et al. (2019)          | 13          | Incongruent Stroop task | 60 min   | NR               | Watching a documentary | 2000-m kayaking time trial | Yes          | Not reported |
|28 | Filipas et al. (2019)          | 23          | Incongruent Stroop task | 30 min   | No               | Watching a documentary | Distance covered in a 30-min cycling exercise | Yes          | Not reported |
|29 | Van Cutsem et al. (2019)       | 11 HC + 9 BP| Incongruent Stroop task | 90 min   | Yes              | Watching a documentary | Flanker task + Visuomotor task | Yes          | Not reported |
|   | Study                           | Participants | Task Description                                      | Duration | Stimuli | Reaction Time Task | Additional Tasks                                             | Manual | Notes |
|---|---------------------------------|--------------|--------------------------------------------------------|----------|---------|--------------------|-------------------------------------------------------------|--------|-------|
|30 | Ferreira et al. (2020)          | 20           | Modified incongruent Stroop task                        | 30 min   | NR      | Yes                | Not reported                                                |        |       |
|31 | Gantois et al. (2020)           | 20           | Stroop task                                            | 30 min   | NR      | Yes                | Not reported                                                |        |       |
|32 | Hachard et al. (2020)           | 20           | AX-CPT                                                 | 90 min   | Yes     | No                 | Not reported                                                |        |       |
|33 | Kosack et al. (2020)            | 19           | Incongruent Stroop task                                | 60 min   | PE      | No                 | Badminton-Specific Test + Countermovement-jump               |        |       |
|34 | Morris & Christie (2020)        | 16 YA + 16 OA| Psychomotor vigilance task                             | 20 min   | Yes in YA | No                 | Neurocognitive functional performance tests                 |        |       |
|35 | Verschueren et al. (2020)       | 14           | Incongruent Stroop task                                | 90 min   | No      | No                 | Time to perform an orienteering race                        |        |       |
|36 | Batista et al. (2021)           | 15           | Stroop task                                            | 30 min   | NR      | No                 | Countermovement jump + Half-back squat exercise             |        |       |
|37 | De Queiros et al. (2021)        | 10           | Stroop task                                            | 30 min   | NR      | Yes                | Not reported                                                |        |       |
|38 | Ferris et al. (2021)            | 8            | AX-CPT                                                 | 60 min   | NR      | Yes                | Not reported                                                |        |       |
|39 | Filipas et al. (2021)           | 12 U14 + 12 U16 + 12 U18 | Incongruent Stroop task                              | 30 min   | No       | Reading magazines | Loughborough Soccer Passing and Shooting Tests             |        |       |
| Study (Year) | Participants | Duration | Intervention | Task | Additional Activities | Outcome | Notes |
|--------------|--------------|----------|--------------|------|-----------------------|---------|-------|
| Gantois et al. (2021) | 20 | 30 min | NR | Watching a documentary | Three sets of Back-squat test with 80% of 15RM | No | Not reported |
| Gergelyfi et al. (2021) | 26 | 90 min | NR | Reading health magazines | Missing Number task + Simple reaction time task | Yes | Not reported |
| Habay et al. (2021) | 11 | 60 min | No | Watching a documentary | Flanker task + Visuomotor task | Yes | Not reported |
| Holgado et al. (2021) | 30 | 90 min | NR | Watching a documentary | Time to exhaustion while cycling at 80% VO2max | No | Not reported |
| Van As et al. (2021) | 20 | 45 min | NR | Watching a documentary | Effort-Based Decision-Making task | No | Not reported |
| Weerakkody et al. (2021) | 25 | 30 min | Yes | Watching a documentary | Standing vertical jump + running vertical jump + AFL agility test + 20 m-sprint test + Matthew Lloyd clean hands test + Brad Johnson goal kicking test + Yo-Yo IR1 | Yes | Not reported |
| Budini et al. (2022) | 29 | 100 min | NR | Watching a movie | Postural, isometric and kinetic tremor, pinch force and steadiness tests + Purdue pegboard test | No | Not reported |
| Campos et al. (2022) | 13 | 30 min | NR | Watching a documentary | Special Judo Fitness Test | No | Not reported |
| Ciocca et al. (2022) | 10 | 30 min | NR | Watching a documentary | Small-sided game | No | Not reported |
| Dallaway et al. (2022) | 90 | 40 min | PE | Watching a documentary | Self-paced rhythmic handgrip exercise | Yes | Not reported |
|   | Study                                      | Participants | Duration | Task Type | Task Details                                                                 | Watching a documentary | Visuomotor Task | Incongruent Stroop task + Decision-making task | Watching a documentary | 20-min bout of cycling at a level of 13 on the Borg’s scale | 10 s isometric dorsiflexion contractions at 10, 20 and 50% MVC | Seating in a comfortable chair | Cycling at 80% PPO until exhaustion | Watching a documentary | Small-sided games | Flanker task | Not reported |
|---|-------------------------------------------|--------------|-----------|-----------|-------------------------------------------------------------------------------|------------------------|----------------|------------------------------------------------|------------------------|------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------|----------------|-------------|------------|
| 50 | Fortes et al. (2022a)                     | 18           | 30 min    | NR        | Visuomotor Task                                                               | Yes                    | Not reported |                                              |                        |                                              |                                                |                                                |                                                |                    |
| 51 | Fortes et al. (2022b)                     | 16           | 60 min    | NR        | Incongruent Stroop task + Decision-making task                               | Yes                    | Not reported |                                              |                        |                                              |                                                |                                                |                                                |                    |
| 52 | Hakim et al. (2022)                       | 12           | 60 min    | NR        | Watching a documentary                                                        | No                     | Not reported | 20-min bout of cycling at a level of 13 on the Borg’s scale |                        |                                              |                                                |                                                |                                                |                    |
| 53 | Kowalski et al. (2022)                    | 30           | 30 min    | Yes       | Watching a documentary                                                        | No                     | Not reported | 10 s isometric dorsiflexion contractions at 10, 20 and 50% MVC |                        |                                              |                                                |                                                |                                                |                    |
| 54 | Schlichta et al. (2022)                   | 12           | 30 min    | NR        | Watching a documentary                                                        | Yes                    | Not reported | Seating in a comfortable chair                |                        |                                              |                                                |                                                |                                                |                    |
| 55 | Trecroci et al. (2022)                    | 9            | 30 min    | NR        | Watching a documentary                                                        | Yes, for CS PE for MS | Not reported | Watching a documentary                        | Small-sided games |                                              |                                                |                                                |                                                |                    |
| 56 | Van Cutsem et al. (2022)                  | 20           | 90 min    | Yes, for CS PE for MS                                                          | Watching a documentary | Not reported | Flanker task                                   |                        |                                              |                                                |                                                |                                                |                    |

Note: BP = Badminton players; CS = Color stimuli; HC = Healthy controls; MPO = Maximal power output; MS = Meaning stimuli; MVC = Maximal voluntary contraction; NR = Not reported; OA = Older adults; PC = Professional cyclists; PPO = Peak power output; RC = Recreational cyclists; ST = Sequential task; PE = Practice effect; TOT = Time-on-task; U14 = Soccer players under 14 years; U16 = Soccer players under 16 years; U18 = Soccer players under 18 years; YA = Young adults.