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Original Article

SITTING OR STANDING: EFFECTS ON SUSTAINED ATTENTION OF SLEEP DEPRIVED STUDENTS

SENTADO OU EM PÉ: EFEITOS NA ATENÇÃO SUSTENTADA DE ALUNOS COM PRIVAÇÃO DE SONO

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RESUMO
Introdução: Durante a privação de sono, a atenção sustentada é impactada pela pressão homeostática para dormir e pelo número de tarefas. Objetivo: Comparar os efeitos de 36 horas de privação de sono no desempenho psicomotor durante uma Condição de Tarefa Única (STC) vs Condição de Tarefa Dupla (DTC) em estudantes universitários. Método: Durante 36 horas de privação de sono, a Tarefa de Vigilância Psicomotora (PVT) foi aplicada em 13 universitários do sexo masculino, nas situações de CTS e CDT, sentados em uma cadeira ou em pé sobre uma plataforma de força, a cada 3 horas, totalizando 13 avaliações, de 08:00 do dia 1 até 20:00 do dia 2, em um estudo cruzado. Resultados: Houve efeito do tempo na CTS e na CDT em todos os 13 momentos de avaliação, em todas as variáveis analisadas, exceto *Mean* RT e *Slowest* 10% RT, para um *p-valor* de 0,05. Não foi encontrada diferença significativa nas variáveis do PVT na comparação entre as duas condições, apesar de tendência à significância, nos momentos de pressão homeostática de sono na tarefa (05:00 e 14:00 do dia 2). Conclusão: A privação do sono afetou negativamente o desempenho psicomotor dos participantes em ambas as condições, demonstrando piora da atenção sustentada, maior engajamento da postura em pé e revelando maior relaxamento da postura sentada.
Palavras-chave: Privação de sono. Tarefa de vigilância psicomotora. Dupla tarefa. Desempenho. Postura.

ABSTRACT
Introduction: During sleep deprivation, sustained attention is impacted by homeostatic pressure to sleep and the number of tasks. Objective: to compare the effects of 36h of sleep deprivation on psychomotor performance during a Single-Task Condition (STC) vs Dual-Task Condition (DTC) in university students. Method: During 36 hours of sleep deprivation, the Psychomotor Vigilance Task (PVT) was applied to 13 male university students, in the STC and DTC situations, sitting in a chair or standing on a force platform, every 3 hours, totaling 13 evaluations, from 08am on day 1 to 08pm on day 2. Results: There was an effect of time on the STC and DTC in all 13 evaluation moments, in all variables analyzed, except Mean RT and Slowest 10% RT, for a *p-value* of 0.05. No significant difference was found in the PVT variables in the comparison between the two conditions, despite a trend to significance, in the moments of homeostatic pressure to sleep in the task (05am and 02pm on day 2). Conclusion: Sleep deprivation negatively affected the psychomotor performance of participants in both conditions, demonstrating worsening of sustained attention, greater engagement of standing posture and revealing greater relaxation of sitting posture.
Keywords: Sleep deprivation. Psychomotor vigilance task. Dual task. Performance. Posture.

Introduction

Sleep deprivation causes desynchronization of biological rhythms at psychological and physiological levels, leading to disturbances in body homeostasis, in hormonal levels [1] and metabolism [2], as well as alterations in psychological, behavioral, and cognitive parameters [3]. Among the most affected cognitive parameters, variables such as vigilance, working memory, long-term memory, decision making, inhibitory control, and mainly, sustained attention stand out. This last one is widely investigated [4] for being a direct indicator of vigilance levels and having the ability to respond to stimuli in the shortest possible time [5].

Sustained attention is present in various work demands (driving vehicles, operating machines, writing e-mails), study demands (listening and writing), and sportive demands (listening to the sound and jumping from the block, aiming and hitting the target, cheering sound). Among the most significant aspects of sustained attention there are reaction time, speed of answer and omission of answer index [6]. Besides that, the psychomotor performance, which reflects sustained attention and vigilance, exhibits a circadian behavior (affected by the time of day) [7,8] and it is affected by sleep restriction/deprivation [9], individual engagement in relation to the task, as well as the wake time greater than 17h [10] and motivation levels [11].

That way, the longer the wake time or sleep deprivation the bigger are the impairments observed in the reaction time, speed of answer, as well as in the number of omissions of these answers [12]. Impairments in sustained attention during sleep deprivation are perceived even when only one task is performed without distraction or other stimuli [4,13], which simplifies the evaluations and confirms more complex results.

In this sense, a situation where the attention is completely dedicated to the performing of a single task is considered a Single Task Condition (STC), while a situation where the attention is directed to the performing of two or more tasks is considered a Dual-Task Condition (DTC). In everyday life, countless stimuli occur simultaneously, in a way that the need to divide attention between one or more tasks between the waking state is common [13]. For example, reckless drivers who drive and speak on the phone simultaneously, as well as athletes who need to be aware of the visual stimuli of their competition and technician and/or rivals.

On the other hand, in tasks that present learning effects, the cognitive effort to perform them is systematically reduced even in the DTC, according to a meta-analysis conducted by Ghai et al. [14]. Some studies have demonstrated that psychomotor performance is affected when sustained attention is shared both with cognitive and motor tasks [13], cognitive and physical tasks [15], or motor and physical tasks [16], but during sleep deprivation, the sustained attention could also be impacted by homeostatic pressure to sleep [17]. However, as far as it is known, few studies have evaluated the performance of sustained attention during sleep deprivation of 36 hours in a dual-task condition with attentional resources being shared between two cognitive tasks. Besides that, the DTC is present in occupational and leisure activities of one's everyday life, requiring the use of sustained attention in a major part of the waking time. Lee *et al* [18] they reported greater reaction time in students during dual task, as well as Richard *et al* [19] which is our hypothesis for dual cognitive task, while Runnova *et al* [20] reported a greater amount of microsleep during simple and monotonous tasks. That way, the aim of this study is to compare the effects of 36h of sleep deprivation on psychomotor performance during a Single-Task Condition (STC) vs Dual-Task Condition (DTC) in university students.

Material and Methods

Sample and Ethical Aspects

The present study was submitted to the Human Research Ethics Committee of the Universidade Federal de Minas Gerais (UFMG) and approved by the number 1.810.015 and was performed in accordance with the Helsinki Declaration. All volunteers signed the Free and Informed Consent Form after an explanation about the phases and procedures of the project. The volunteers were informed that they could interrupt their participation in the research at any moment without any harms to the project.

Participants

We considered the following inclusion criteria: graduate students enrolled in a face-to-face course, with no report/self-declaration of continuous medication use or psychiatric/neurodegenerative disease, with correct use of the actigraph in the week prior to the sleep deprivation protocol and correct completion of all questionnaires. We also considered the following exclusion criteria: withdrawal from participation during any stage of the research, extreme morning or evening people, and with indication of sleep disorder. Thirty-two individuals were invited to participate in this study, of which 11 have refused to participate, 03 have dropped out during the data collection, 02 have presented disturbances or sleep complaints, and 03 have not properly answered the questionnaires. That way, the study was composed of 13 university male students of physical education from institutions in Belo Horizonte and the region, interns after school hours, aged 24,35±3,67, 75,47±8,65kg, and 1,74±0,05m of height. They were not tobacco or any other psychoactive substances consumers, besides medication of free use, caffeine products, and/or alcohol at least 48 hours before the start of the project. Other than that, they could not present historic of neurodegenerative or psychiatric diseases, superior limb amputation, sleep disturbances (assessed by the Pittsburgh Sleep Quality Index - PSQI) [21], or have realized transmeridian travel in the last 06 months. Volunteers who were extreme morning or extreme evening types assessed by the Morningness and Eveningness Questionnaire [22] or who fell asleep during the sleep deprivation protocol were also excluded. All the participants were oriented to maintain regular sleep and wake times for at least one week before the start of the project, confirmed through actigraph (Actiwatch 2, Philips Respironics®) on the non-dominant wrist and sleep diary.

Sleep Deprivation Protocol

The study was conducted at Center for Studies in Psychobiology and Exercise (CEPE) and Biomechanics Laboratory (BIOLAB) from the School of Physical Education, Physiotherapy and Occupational Therapy (EEFFTO) of the UFMG. The sleep deprivation protocol started at 8am of the first evaluation day (D1) and finished at 8pm of the second evaluation day (D2), totalizing 13 application times (AT) with an interval of 3 hours from each evaluation, on weekends in August and September, in maximum groups of 4 participants. The participants woke up at 6am through the alarm clock and phone calls from the researchers, so that there would be no interference from sleep inertia in the first AT (8am – D1).

During the sleep deprivation protocol, the participants were accompanied by researchers from CEPE all the time, to avoid naps, psychoactive substances, physical exercise performing, or activities of major energy expenditure (>1,6 METs) [23]. The participants were allowed to surf the internet, read books, and play cards in the laboratory. In the same way, allowed the interaction between participants to keep them awake during the study. The food intake and hydration were maintained according to the routine of each participant, *ad libitum*. The participants were evaluated every 3 hours by the Psychomotor Vigilance Task (PVT) when applied the STC, and the PVT associated with force platform (FP) when applied the DTC, in the order chosen by the person being evaluated at each assessment moment, with a minimum interval of 5 minutes between assessments. After the protocol, participants were taken home by car ride or taxi, to ensure their safety.

Data Collection Instruments

In the week prior to the protocol (D1 and D2), the volunteers answered a personal identification and health sheet, as well as the following questionnaires: Morningness and Eveningness Questionnaire (MEQ) and PSQI. Besides that, each participant wore an actigraph (Actiwatch 2, Philips Respironics®) on the non-dominant wrist until the last AT, and the body mass and height were measured by an anthropometric scale with an attached stadiometer (Filizola®).

Morningness and Eveningness Questionnaire – MEQ

This questionnaire was developed by Horne & Ostberg [22], and validated for the Portuguese language by Benedito-Silva *et al.* [24]. It characterizes the circadian preference of an individual and it is composed of 19 questions which sum vary between 16 and 86 points. This characterization is based on several criteria, such as the preference to sleep, to wake up, and to execute physical and cognitive tasks in a determined period of the day. Ultimately, this instrument classifies the individual as an extreme morningness (points between 70 and 86), moderate morningness (points between 59 and 69), indifferent (points between 42 and 58), moderate eveningness (points between 31 and 41), and extreme eveningness (points between 16 and 30).

Pittsburgh Sleep Quality Index – PSQI

This questionnaire was developed by Buysse *et al.* [25] to evaluate the individuals sleep quality in the last 30 days and classifies them as "good sleepers" and "bad sleepers". Besides that, it enables the identification of possible sleep disturbances or sleep complaints, as well as the presence of excessive somnolence during waking time. This questionnaire is composed of 24 questions, 19 being auto related, grouped into 7 components which vary between 0 and 3 points, besides, there are 5 questions directed to the roommate (if exists). In the end, the punctuation obtained in each component is summed and a global score is generated, which vary from zero to 21, in a way that the greater scores indicate the poorest sleep quality (0 to 4 = good sleep quality, ¬5 to 10 = bad sleep quality and >10 is indicative of the presence of a sleep disturbance). In this study, the participants answered the Portuguese version validated by Bertolazi *et al.* [21], and it was used to verify the selection criteria.

Psychomotor Vigilance Task - PVT

The PVT is a test sensitive to circadian variations [26]and measures the psychomotor and sustained attention performance along with one, two, or ten minutes [27,28]. The visual stimuli, which consists of a count in milliseconds on the instrument display, occurs randomly each 2-10 seconds. Said that, the participants were oriented to press the button as quickly as possible as soon they noticed the stimulus.

The PVT generates data related to reaction time in milliseconds (ms) so that the button pressed over 500ms after the appearance of the visual stimulus are considered Lapses, and pressed, when there are no stimuli, are considered False Starts. To the present study, it was applied the 5-minute PVT and to the statistical analyses were considered 8 variables: Mean RT (mean of reaction time), Slowest 10% RT, Fastest 10% RT, Lapses, Mean 1/RT (mean of the reaction time speed), Slowest 10% 1/1RT, Fastest 10% 1/RT, and False Starts (presses of the response button before the appearance of any visual stimuli, approximately ≤100ms). The PVT was used to evaluate the psychomotor performance during both single and dual-task conditions.

Force Platform (FP)

The participants were instructed to remain barefoot, in the anatomic position and feet apart to maintain an alignment with the shoulders, keeping the body as static as possible, just with the elbows flexed and holding the PVT. The FP surface was individually delimited for each participant to repeat the feet position in every evaluation. The participants remained in the FP for 5 minutes to the complete realization of the PVT. The FP contains sensors that register the force applied by the feet of the participant in the anteroposterior (x), mediolateral (y), and vertical (z) directions, indicating the pressure center (COP). The COP displacement data for these variables were collected by an acquisition board (AMTI® Model OR6) in an acquisition frequency of 100 Hz and were analyzed by the MATrix LABoratory software (MATLAB-The Mathworks, Natick, MA). Conducting the assessment of the PVT over the FP only generates movement of one finger (in the dominant hand) to press the button and to stare at the PVT display, and no more in a fixed point ahead, which originally changes the head position in favor of the PVT test. The verbal command for the DTC was standardized so that the participant did not start the PVT before being properly positioned on the FP. At the end of the test, the participants only left the platform after the authorization of the researcher. The data obtained by the FP (COP variables) were not considered in the present study.

Conditions

Simple Task and Dual-Task

In the Single Task Condition (STC), the 5-minute PVT was applied with the seated participant holding the equipment, while maintaining the elbow flexed, in a similar way from studies validated and consolidated in literature [6,7]. The participants individually realized the test in a closed, silent, and with temperature and humidity controlled (23 - 25ºC, and 60% - 70%, respectively) room.

The Dual-Task Condition (DTC) consisted in realizing the 5-minute PVT on a force platform in an upright position. All participants were oriented to hold the PVT in their hands, maintain the elbows flexed, and the body relaxed and as static as possible during the task, maintaining the following posture: bipedal, semi-static, eyes opened, and looking to the PVT display.

Data Analyses

Data are presented as mean and standard deviation (M±SD), relative frequency (%), and confidence interval ($CI_{95\%}$). The data normality was verified by the Shapiro-Wilk test. To compare the PVT variables in the Single Task and Dual-Task conditions in all the 13 assessment moments, it was realized the General Linear Model (GLM). The effect size (ES) of Cohen was calculated to assess the effect magnitude of the variables. The obtained values were utilized to define the effects sizes as trivial (d<0,2), small (0,2<d<0,5), medium (0,5<d<0,8) and large (d>0,8) [29]. The significance level adopted was p<0,05. The software SPSS for Windows version 21.0 was used for the analyses.

Results

The PSQI results (6,92±2,39) indicated that, on average, the participants reported poor sleep quality. However, none of them presented an indication of complaints or sleep disturbances. Besides that, for the selection criteria, the participants did not present circadian preferences of extreme morningness or eveningness, following the MEQ results (49,43±8,68).

Table 1. Comparison between condition and time in the PVT variables.

	Condition effect (STC and DTC)				Interaction effect (Condition *vs* Time)				Time Effect (13 Application Times – D1 and D2)			
	F	*p-value*	η^2	ω	*F*	*p-value*	η^2	ω	*F*	*p-value*	η^2	ω
Mean RT (ms)	0.90	0.35	0.04	0.15	1.41	0.25	0.06	0.33	8.49	<0.01	0.26	0.98
Slowest 10% RT (ms)	1.04	0.32	0.04	0.16	1.39	0.25	0.05	0.38	11.85	<0.01	0.33	1
Fastest 10% RT (ms)	0.16	0.69	<0.01	0.07	2.00	0.09	0.08	0.62	7.92	<0.01	0.25	1
Lapses (n)	0.60	0.45	0.02	0.11	1.02	0.4	0.04	0.32	17.9	<0.01	0.43	1
Mean 1/RT (ms)	0.02	0.89	<0.01	0.05	1.61	0.15	0.06	0.58	30.87	<0.01	0.56	1
Slowest 10% 1/RT (ms)	0.37	0.55	0.01	0.09	0.88	0.51	0.03	0.35	34.12	<0.01	0.59	1
Fastest 10% 1/RT (ms)	0.20	0.66	<0.01	0.07	1.87	0.09	0.07	0.68	5.91	<0.01	0.02	1
False Starts (n)	0.15	0.71	<0.01	0.07	1.00	0.43	0.04	0.38	9.24	<0.01	0.28	1

PVT= Psychomotor Vigilance Task. STC= Single Task Condition. DTC= Dual Task Condition. D1= Day 1. D2= Day 2. RT= Reaction Time. ms= milliseconds. n= number. η^2=Partial Eta Square. ω = Observed Power.
Source: Authors.

Concerning the psychomotor performance, as exposed in Table 1, it was not found any significant difference in the PVT variables when comparing the two conditions (STC vs DTC). However, there was a time effect in the STC between the 13 assessment moments in every variable analyzed, as presented in Figure 1 and Table 1.

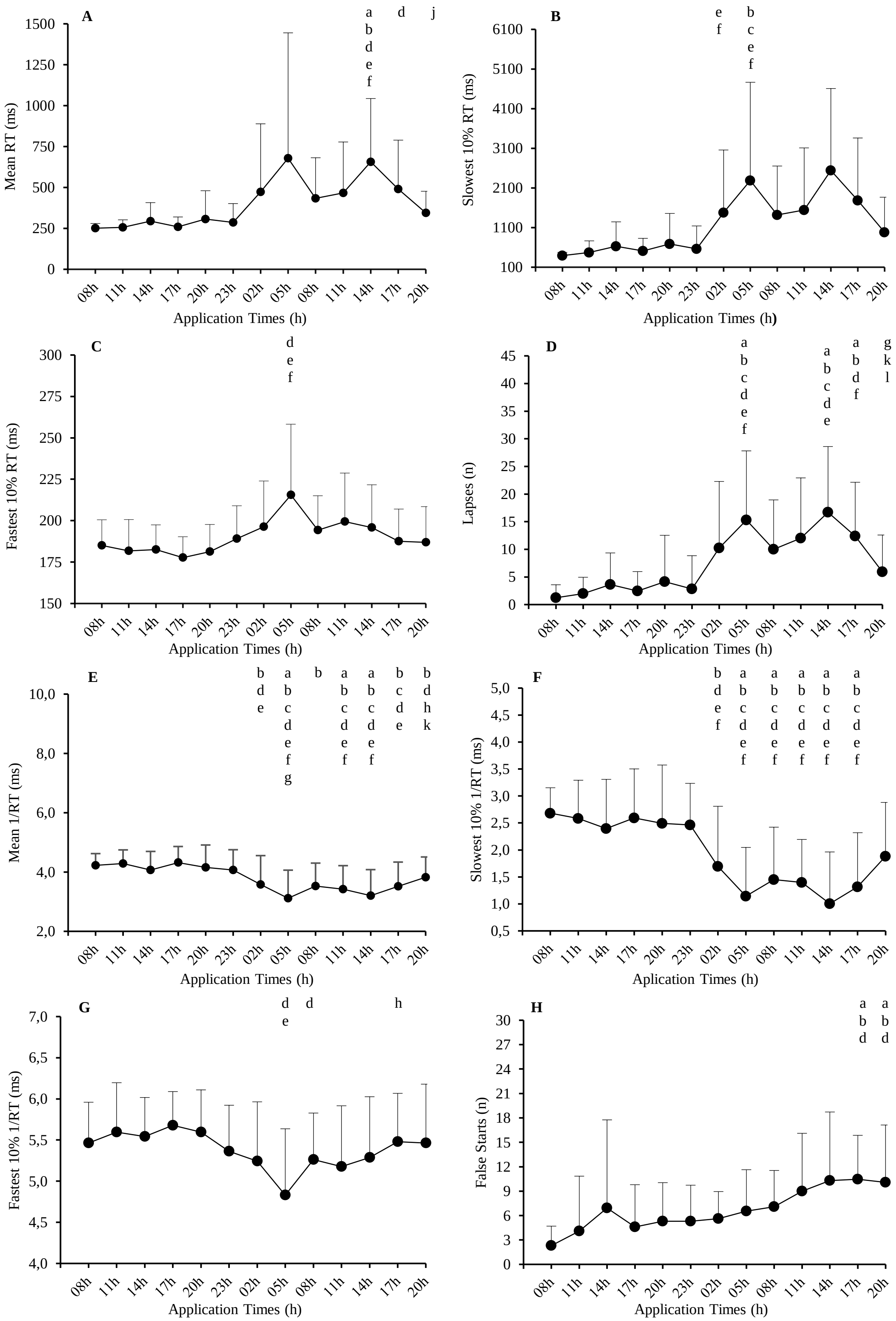

Figure 1. PVT variables in the Simple Task Condition - STC

PVT= Psychomotor Vigilance Task. RT= Reaction Time. AT= Application Times. a=difference in relation to AT08h. b=difference in relation to AT11h. c=difference in relation to AT14h. d=difference in relation to AT17h. e=difference in relation to AT20h. f=difference in relation to AT23h. g=difference in relation to AT02h. h=difference in relation to AT05h. i=difference in relation to AT08hD2. j=difference in relation to AT11hD2. k=difference in relation to AT14hD2. $p<0{,}05$. **Source:** Authors.

Regarding the DTC, there was a time effect in 06 from 08 of the PVT variables within the 13 assessment moments (Table 1). The variables Mean RT and Slowest 10% RT did not present statistical difference in this condition in time effect, as presented in Figure 2, differing of STC.

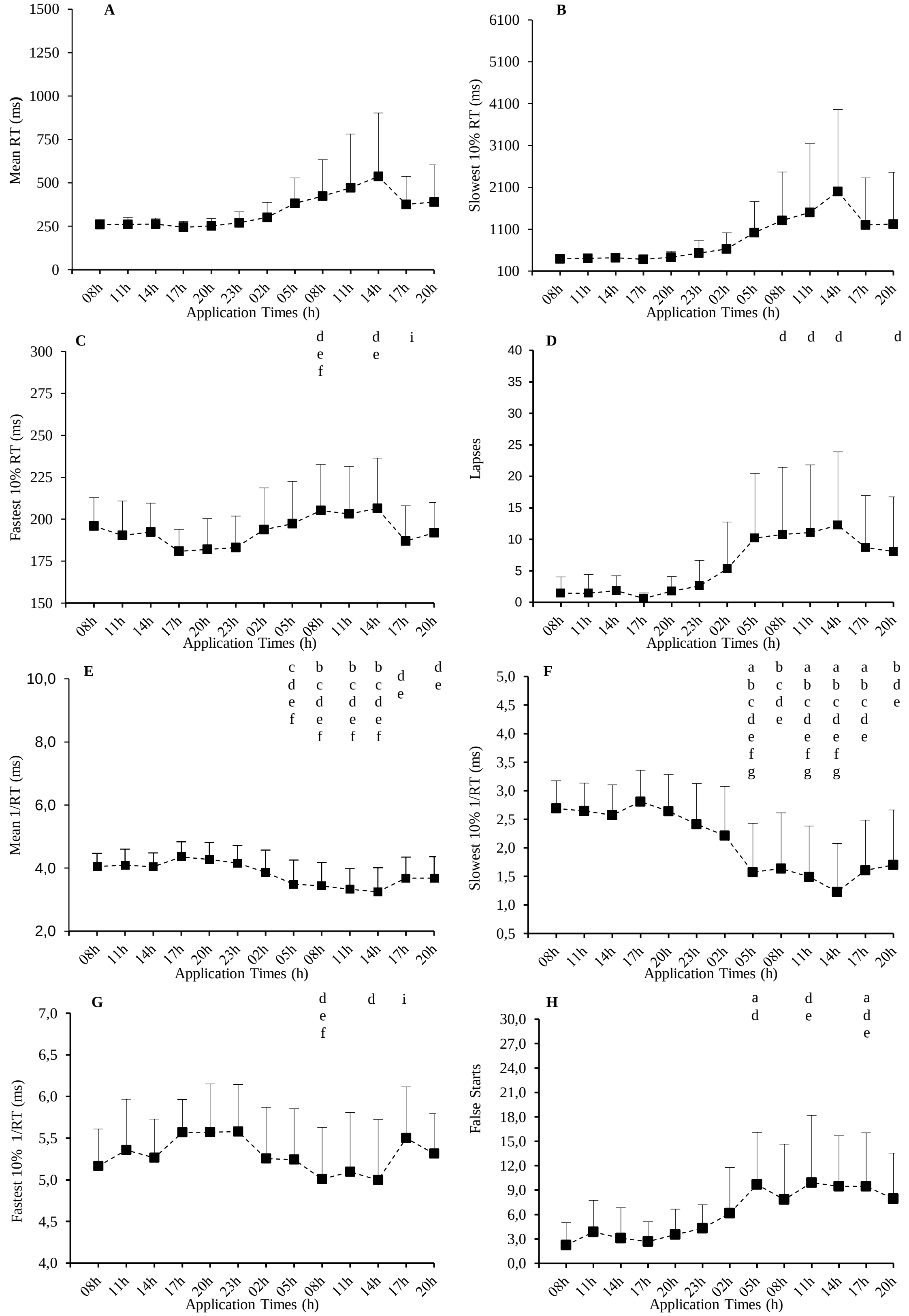

Figure 2. PVT variables in the Dual-Task Condition

PVT= Psychomotor Vigilance Task. RT= Reaction Time. AT= Application Times. a=difference in relation to AT08h. b=difference in relation to AT11h. c=difference in relation to AT14h. d=difference in relation to AT17h. e=difference in relation to AT20h. f=difference in relation to AT23h. g=difference in relation to AT02h. h= difference in relation to AT05h. i=difference in relation to AT08Hd2. j=difference in relation to AT11hD2. k=difference in relation to AT14hD2. l=difference in relation to AT17hD2. p<0,05.
Source: Authors.

Discussion

In this study, we assessed the effects of sleep deprivation on psychomotor performance of university students in a Single Task Condition, and in a Dual-Task Condition. The main results indicate decreasing in the psychomotor performance due to sleep deprivation in the PVT variables analyzed in both conditions, pointing out that, even in activities where attention resources are not divided, the sleep deprivation effects occur. The variables related to RT speed (Mean 1/RT, Slowest 10% 1/RT, and Fastest 10% 1/RT) represent the greater harms observed. The first signals of psychomotor performance reduction were observed starting at 02am of D2, but the assessment of 05am on D2, when compared to preceding moments, was the evaluation that presented the greater performance decrements. That way, we believe that the psychomotor performance was influenced by circadian oscillations from core temperature, which normally occurs between 02am and 05am [17], and maybe by the reduction of cognitive performance and attentional resources at that moment [8].

When we compared the result of variables between conditions (STC and DTC), no difference was observed (p>0,05). However, the differences found between assessment times of the STC were different from the DTC, in a way that STC have shown to be more sensitive to sleep deprivation decrements, showing differences in all 8 variables in a time course when compared to the STC (Figures 1 and 2), as also reported in previous studies [30]. It is possible that relaxing the sitting posture negatively affects performance in a sleep-deprived situation. Understanding that college students may be sitting in a relaxed posture and engaged in monotonous activity, which may cause [20] cognitive impairment, our data indicates that single task may not be interesting in the context of sleep restriction and deprivation.

Initially, we hypothesized that the psychomotor performance in the DTC would be worse during the sleep deprivation protocol, due to greater cognitive demand and the necessity to split attentional resources between two tasks, mainly in the sample of university students, whose performance is impaired during dual tasks where one of them is cognitive [18,19]. However, this hypothesis has been refuted. Nevertheless, the tasks characteristics may have influenced this result, since the STC was performed in a seated position, leading to greater comfort and body relaxation, and consequently less engagement in the task. Contrary, the DTC was performed in a bipedal position, leading to great discomfort and unbalance sensation when compared to the seated position used in the STC [31]. These sensations could lead to greater attention to the task and greater postural control demand for the individual not to fall on the ground [31]. For this, the participants were oriented to stay with the body as static as possible (semi-static posture) to the assessment in the FP. We believe that the smaller engagement generated by a simple task (STC), allied to the harms caused by sleep deprivation [32] could lead to similar results found in the dual-task condition (PVT + FP) which, hypothetically, determines greater cognitive demand and greater engagement of task, which could mask the negative effects of sleep deprivation, such as fatigue and sleepiness. Noticing the results obtained, we must pay attention to the type of test and posture at the time of evaluation so that they are like the function performed during the day, in the case of workers, and to the technical gesture, in the case of athletes.

Therefore, we observed better psychomotor performance in the STC in the following variables, and in these different moments: The Mean RT at 8pm in D2 was smaller when compared to 11am in D2; the number of Lapses at 8pm of D2 was smaller when compared to

02am of D2, 2pm of D2, and 5pm of D2; the Fastest 10% 1/RT at 5pm of D2 was greater when compared to 5am of D2. The Mean 1/RT was one variable that presented the biggest harm due to sleep deprivation, presenting a smaller velocity at 8pm of D2, which is a time closer to the circadian nadir of performance [33], in comparison to 11am, and 5pm of D1. However, when compared to 05am (nadir of human performance and body core temperature), and 2pm (post-prandial time which is accompanied by a reduction in core temperature) of D2, the Mean 1/RT presented greater velocity.

In the DTC was observed a better psychomotor performance in 6 variables in the following moments: the Fastest 10% RT at 5pm of D2 was smaller when compared to 8am of D2; the Fastest 10% 1/RT at 5pm of D2 presented greater velocity when compared to 8am of D2, which are times compatible with the acrophase of human performance [33], as well as the STC. Thus, all the worst psychomotor performance results (greater response time) found occurred in circadian moments of core temperature nadir, peak secretion of melatonin hormone [17] and subsequent (02am, 05am, and 08am of D2). Again, the need to maintain a standing posture can mitigate the dual task condition. Besides that, at 08pm D2, it could have the interference of the core temperature acrophase, which consequently enhances alert and attention states [33], as well as the motivation levels [34] for being close to the end of the project (last assessment).

Contrary to the present study, some authors have found the worst cognitive performance in dual task when compared to single task conditions [5]. However, other authors have not found any differences when performing cognitive tests in dual-task condition [35], which is like our results. Buckley *et al.* [5] propose that exists an ideal level of cortical activation to achieve optimal cognitive performance, following a model like the inverted U theory [36], which supposes the existence of a margin to the optimal performance. The findings of Kimura *et al.* [37] report that the cognitive performance in the single task could be explained by the greater engagement (willing and interest) necessary to realize a dual task when compared to a single task, corroborating our results. However, in this study, the participants were not submitted to a sleep deprivation condition.

Moreover, other authors who assessed the cognitive performance in a single and dual-task conditions during sleep deprivation situations reported worse results in the DTC compared to the STC [13]. Chua *et al.* [13] used two cognitive tasks (visual and auditory Go-No-Go), and a motor tracking task to assess the reaction time through cognitive overload. The authors observed that the effort and cognitive engagement induced by the tasks were sufficient to reduce the harm caused by the sleep deprivation protocol of 48 hours. The results also presented a circadian rhythmicity, in a way that the harms caused by the DTC also followed this biological curve.

Given the above, our results corroborate the data presented in a study conducted by Van Dongen and Dinges [6]. In this study, the authors observed that sleep deprivation led to harms in psychomotor performance unequally and individually, justifying the higher standard deviation of the variables analyzed in our study (figures 1 and 2). That way, it was proposed that some individuals are more sensitive to sleep deprivation and could be more affected by this condition. Additionally, we could perceive that the results of the STC and the DTC resembled, which reinforces that an equipment sensitive and of easy handling is capable to distinguish between less attentive individuals in sustained vigilance conditions, such as at work, at school, in transmeridian travels, in night competitions as others. Sustained vigilance conditions, and sleep restriction/deprivation compromise activities of daily life, occupational tasks, workouts, and sportive competitions [38], and evaluations must consider the practical application of their results in relation to posture and psychophysiological conditions of the test taker.

If athletes and workers need more quickly reaction time, sustained attention and vigilance to avoid errors and to maintain the performance in activities, university students too, and a diary assessment of the psychomotor performance is essential in this population, aiming to avoid injuries and accidents. Aware of this, we must turn our attention to posture during activity, which has an impact in the moment when there will be a greater chance of decreased performance. Some highlights of this study are the possibility of practical application of the findings and the short time interval between TAs, which allows analysis in situations of sleep deprivation for shorter periods. We can also highlight that the routine of students often alternates between single task and dual task, as we reproduce and present the results. The main limitation of the study is the sample size, which is for convenience and has low power for comparison between conditions (5%~28%), even with strong power between times (Table 1).

Conclusion

The sleep deprivation negatively affected the psychomotor performance of participants in both task conditions (STC and DTC), showing that along the 36 hours there was a worsening of sustained attention. Moreover, the DTC could generate greater cognitive engagement, leading to greater attention and motivation to the performing of the task, approaching the results of cognitive tasks in the STC, even during a sleep deprivation protocol. From that, it was possible to observe that a simple task performed in the PVT could identify the cognitive performance of individuals who perform two or more activities simultaneously, while posture during the evaluation can impact the test result, bringing the practical application of the result closer or further away. Finally, it is important to emphasize the need for restorative sleep and reducing sleep deprivation time to maintain sustained attention during daily life, occupational, sports, and student activities, especially those that bring monotony and postural relaxation.

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