Diurnal gait fluctuations in single- and dual- task conditions

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ABSTRACT

Gait is one of the most basic movements, and walking activity accomplished in dual task conditions realistically represents daily life mobility. Much is known about diurnal variations of gait components such as muscle power, postural control, and attention. However, paradoxically only little is known about gait itself. The aim of this study was to analyze whether gait parameters show time-of-day fluctuation in simple and dual task conditions. Sixteen young subjects performed sessions at five specific hours (06:00, 10:00, 14:00, 18:00 and 22:00h), performing a single (walking or counting) and a dual (walking and counting) task. When performing gait in dual task conditions, an additional cognitive task had to be carried out. More precisely, the participants had to count backwards from a two-digit random number by increments of three while walking. Spatio-temporal gait parameters and counting performance data were recorded for analysis. Walking speed significantly decreased, while stride length variability increased when the task condition switched from single to dual. In the single-task condition, diurnal variations were observed in both walking speed and counting speed. Walking speed was higher in the afternoon and in the evening (14:00 and 22:00h) and lower in the morning (10:00h). Counting speed was maximum at 10:00 and 14:00h and minimum at 18:00h. Nevertheless, no significant diurnal fluctuation was substanytiated in the dual task condition. These results confirm the existing literature about changes in gait between single and dual task conditions. A diurnal pattern of single-task gait could also be highlighted. Moreover, this study suggests that diurnal variations faded in complex dual task gait, when the cognitive load nearly reached its maximum. These findings might be used to reduce the risk for falls, especially of the elderly.

KEYWORDS: walking, cognitive task, diurnal variation, stride variability, mobility

INTRODUCTION

Diurnal variation in physical performance has been vastly investigated during the last years, both in sports achievements (Atkinson and Reilly, 1996; Drust et al., 2005; Teo et al., 2011; Thun et al., 2015) and muscular efficiency (Bessot et al., 2007; Küüsmaa et al., 2015; Schroder and Esser, 2013; Sedliak et al., 2008a, 2008b). Studies globally report performance exhibits time-of-day differences, with peak performance of normally daytime active individuals in the late afternoon or evening (Atkinson and Speirs, 1998; Dudek and Meng, 2014; Moussay et al., 2002, 2003; Souissi et al., 2007; Thun et al., 2015). These diurnal fluctuations vary in the same pattern as core body temperature, which is well known to be a biomarker of circadian time structure (Refinetti, 1997; Refinetti and Menaker, 1992; Waterhouse et al., 2005). However, diurnal gait fluctuations have paradoxically not yet been investigated thoroughly, despite constituting the most basic form of physical activity. Only a recent study (Korchi et al., 2019) reported that gait improved from early to late morning in older adults (> 85 years old).

Walking is considered to be an automated rhythmic motor behavior and as a neuromechanical system led by subcortical brain regions. Nevertheless, several studies demonstrated that ensuring a safe and efficient gait needs a little attention (for a review see Beauchet and Berrut, 2006). Processes governing gait are multiple, entailing neuromuscular, somatosensorial, and cognitive control ones (Clark, 2015; Yogev et al., 2005). All of them exhibit variable influence on gait, according to the nature of the investigation. The most realistic setting is the dual task situation. It consists of walking and concomitantly carrying out another activity, for example, texting on one's mobile phone, listening to music, or talking to someone (Beauchet and Berrut, 2006; Magnani et al., 2017). The dual task condition requires more brain concentration capacity than the single-task condition. However, this capacity is limited, since the brain mainly focuses on the second activity and this attentional shift could lead to a less controlled and riskier gait. To better understand gait, it is necessary to closely examine the different parameters that compose it.

It is well established that muscle quality and gait performance are linked (Martinikorena et al., 2016; Pandy and Andriacchi, 2010; Scarborough et al., 1999). Several studies report muscular performance varies as a circadian rhythm, like that in core body temperature. This implies performance is best in the early evening and poorest in the morning (Gauthier et al., 1996, 1997, 2001; Sedliak et al., 2008a; Zbidi et al., 2016).

The contribution of cognition and attention to gait has been widely investigated. For example, previous reports indicated gait is primarily an automatic body process. However, now there is substantial evidence to show the importance of cognition and executive control for achieving a safe gait (Clark, 2015; Yogev et al., 2008). The dual task paradigm depicts the impact of cognition on gait, and many studies have showed that gait tends to be altered with increasing complexity of the second task (Ansai et al., 2017; Beauchet et al., 2009; Magnani et al., 2017; Ruffieux et al., 2015; Springer et al., 2006; Yogev et al., 2005). Furthermore, it is now known that cognition follows a diurnal fluctuation. In particular, vigilance and attention of day-active persons are highest at 18:00h and lowest in the morning (Bougard and Davenne, 2014; Wu et al., 2015).

Balance and postural control seem to fluctuate in a reverse way. More precisely, balance parameters display best values in the morning ~06:00h, and they significant decrease thereafter over time (Gribble et al., 2007; Jorgensen et al., 2012; Paillard et al., 2016, Korchi et al., 2019). However, there is some controversy surrounding postural control, because other studies were unable to demonstrate any diurnal variation in balance (Sargent et al., 2010; Zouabi et al., 2016). This divergence could be explained by the fact that there is no consensus as yet on defining the proper study protocol and assessment methods. Hence, findings of different studies are difficult to compare.

In summary, many aspects of gait performance display diurnal variation. Unfortunately, iit is common practice in this type of research to present findings in terms of clock time without reference to the sleep/wake synchronizer schedule of participating subjects. Hence, past findings are not entirely meaningful in terms of biological rhythm phenomena, and therefore they cannot not be precisely compared. Consequently, variations in the variables of gait performance are not necessarily always synchronized. Nonetheless, the collective findings of the many studies suggest gait parameters, depending on the task features, could be circadian rhythmic. Hence, studying diurnal fluctuations of gait performance in challenging conditions, such as dual task ones, is interesting in order to identify if predictable-in-time periods of relative weakness occur during the usual hours of activity. We hypothesized that gait and cognitive task diurnal rhythms of young adults are asynchronous, thereby contributing to dual task performance remaining stable throughout the day. The aim of this study is to analyze the role of circadian time on gait in single and dual task conditions.

METHOD

Subjects

Sixteen subjects (age 21.9 ± 2.2 years, 12 males and 4 females) adhering to a routine of daytime activity and night-time sleep volunteered to participate in the study. All of the subjects were students and unemployed; they had a restrained lifestyle due to their academic schedule, with classes in the morning from 08:00 to 12:30h and in the afternoon from 14:00 to 18:00h. Each subject underwent a medical screening to ensure meeting inclusion and exclusion criteria. Exclusion criteria were orthopedic irregularities or postural, vestibular, or sleep difficulties. Subjects completed the self-assessment questionnaire of Horne and Ostberg (1976) to assesses morningness–eveningness, and were categorized as either ‘‘moderately morning’’ (*n*=4) and ‘‘neither type’’ (*n*=12). A local ethics committee for the protection of subjects approved the research project before its initiations. The project was conducted in accordance with current national and international laws and regulations governing the use of human subjects (Declaration of Helsinki II), and complied with the ethical and methodological standards for laboratory and medical human biological rhythm research (Portaluppi et al., 2008). All subjects provided written consent after being informed about all details of the procedures.

Experimental procedure

Subjects were familiarized with the test procedures during an initial laboratory session. Subjects participated in five tests sessions in total conducted at the following clock times: 06:00, 10:00, 14:00, 18:00, and 22:00h. These test times correspond closely to the wake up time, mid-morning break, post-prandial break, end of the school day, and bedtime, respectively. To avoid the effect of sleep deprivation, no test session was scheduled at 02:00h.

Each subject performed each of the five test sessions one after another. The order of each session was counter-balanced. As suggested by Bougard et al. (2009), the subjects ingested a meal 2 hs before tests scheduled at 14:00 and 22:00h, and were awoken from sleep at 05:00h for the 06:00h test. Before this particular test, subjects were allowed to drink a glass of water. Subjects were asked to maintain their usual sleep patterns, and to ensure a minimum of 6 h of sleep the night preceding testing. Subjects were requested not to engage in any tiring activities during the protocol. However, they were given three tasks, tested three times, each balanced with a Williams square design: (1) Walking along a 12-m walkway at a self-selected speed (the first and last 2-m were not recorded); (2) counting backwards from a two-digit random number

(> 50) by increments of three at free speed while in a standing position; (3) a combination of both tasks (dual task) without instruction as to which task to prioritize.

Data collection and analysis

For each task, gait and counting performance data were recorded. Gait and mean walking speeds (m.s^{-1}) were recorded using a photocell chronometer (Brower Timing Systems, Draper, USA). Mean spatio-temporal data of walking were recorded using the Optogait system (Microgate, Bolzano, Italy). Mean stride length variability (SD/mean, percent) and stride rate variability (SD/mean, percent) were used for analysis. Concerning counting performance, the numbers of correct digits generated per second (digits.s^{-1}) were measured. At each test session, vertical jump height (cm), Karolinska Sleepiness Scale (KSS), Visual Analogue Scale (VAS) for fatigue, and oral temperature (°C) were assessed. Oral temperature was measured with a digital clinical thermometer (Comed, Strasbourg, France; accuracy ± 0.1°C) inserted sublingually for at least 3 min. These measures were always done before the test sessions, with subjects having rested beforehand in a supine position for at least 15 min. Vertical jump height was recorded for each of three attempts using the Optogait system. The highest of the three trials was used for analysis.

Statistical analysis

Statistical analyses were carried out using the R-3.5.1 software (www.r-project.org). The data analyzed are of longitudinal structure characterized by the possible presence of both random and fixed effects. We first selected linear mixed effects models to capture these effects. We used the Akaike information criterion (AIC) and the Bayesian Information Criterion (BIC) as indicators for the most appropriate correlation structure. The time series typical AR(1) form was selected. Moreover, heteroscedasticity of the residuals, both in time as well as induced by different levels of the fixed effects, was considered for the model structure.

The duplication effect (task order) was systematically tested. When a significant duplication effect was observed, it was included into the model in order to separate this effect from the time-of-day factor. To assess whether a variable exerted significant effect, the approach of Pinheiro & Bates (2000) was followed, i.e. models with and without the respective variable were compared by means of the likelihood ratio test (LRT). If the LRT showed a significant effect, the more complex model, including the variable of interest, was judged to be superior. For analyses with several variables, these were included stepwise into the model. We started with the variable exerting strongest effect in terms of improvement of the model log-likelihood. Then, successive additions were made by including those variables with weaker effect (the variables investigated were factors “time-of-day” and “task order”). More precisely, we started by setting up the null model, which contained only intercept and random effects as model components. The model equation is given by:

$$y_{it} = \beta_0 + \gamma_i + \varepsilon_{it},$$

where β_0 corresponds to the “fixed” intercept, $\gamma_i \sim N(0, \tau^2)$ are subject-specific deviations from the population intercept, and the error terms ε_{it} follow the above mentioned AR(1) process (we refrain from introducing more complex settings for the variance components here). Then, we employed two univariate models, each containing one of the factor variables “time-of-day” and “task order”. This leads to the model equation:

$$y_{it} = \beta_0 + \beta_1 x_{it} + \gamma_i + \varepsilon_{it},$$

with “slope” coefficient β_1 of the factor variables x_{it} (effectively modeled via dummy coding). To determine if these models contained a significant effect, we compared each of the univariate models to the null model. Subsequently, the best of the two univariate models and the only-intercept model became the new null model. This new model served as basis for testing for effects in multivariate models. The statistical result of this model comparison is represented as the likelihood ratio (*L.r.*) value and the associated *p* value of the LRT (e.g. *L.r.* = XX; *p* = XX).

When a time-of-day effect was detected by linear mixed models, a nonlinear model was used to test the sine wave adjustment to the time series (COSINOR). Parameter estimation was carried out via the generalized least squares method, taking an AR(1) structure in the error term. This allowed us to determine the best fit of a combined 24 h period cosine function of the form:

$$Y(t) = mesor + ampl \cdot \cos\left[\frac{(t - phase) \cdot \pi}{12}\right],$$

where the *mesor*, *ampl*, and *phase* parameters correspond, respectively, to the average level (estimated 24h time series mean), amplitude (value of variable at the acrophase – that of the mesor), and acrophase (estimated peak time referenced to local midnight).

In order to select the most appropriate model, we again relied on the LRT, AIC, and BIC. When the LRT indicated the COSINOR model was superior to the null model, the coefficients of the model were further examined and represented as the *t* and *p* values for the mesor, amplitude, and acrophase (Table 3). In cases where a time effect could not be modelled by the cosinor function, the different time of the day means were compared pairwise using Tuckey’s HSD test. In the results section, presented *p* values were adjusted on the basis of the

Holm's method to account for the potential impact of multiple comparisons. The level of statistical significance for all analyses was set at $p<0.05$.

RESULTS

When the condition changed from single to dual task, walking speed decreased and stride length variability increased significantly. Stride time variability and counting speed were not dependent on task condition (See Table 1)

Table 1

We observed a significant time-of-day effect only for walking and counting speed in single task conditions (see Table 2). However, these time effects (Figure 1 and 2) could not be modelled by the COSINOR method (see Table 3). The pair-wise comparison analysis only reported that walking speed was significantly lower ($p=0.019$) at 006:00 than 22:00h and that counting speed was significantly lower ($p=0.006$) at 18:00 than 14:00h (Figure 1)

Table 2

Significant time-of-day effects were observed for core temperature, jump height, KSS score, and VAS fatigue score (see Table 2). The COSINOR method successfully approximated the raw data and permitted estimation of the mesor, amplitude, and acrophase of each of these variables (see Table 3).

In addition, diurnal fluctuation of the walking speed in single task conditions was partly explained by that in oral temperature (*L.r.* = 6.66; p = 0.0098), jump height (*L.r.* = 18.02; $p<0.0001$), and KSS (*L.r.* = 4.32; p = 0.038), but not VAS fatigue score (*L.r.* = 0.95; $p=0.33$). The fluctuation of the counting speed could neither be explained by the diurnal fluctuation in KSS (*L.r.* = 0.17; p = 0.75) nor VAS fatigue score (*L.r.* = 2.09; p = 0.44).

Figure 1

Figure 2

DISCUSSION

The present study investigated the effects of time-of-day on gait in single and dual task conditions. We observed a time-of-day effect in gait speed only in single task conditions. We also found a time-of-day effect on counting task performance, oral temperature, jump height, sleepiness, and fatigue.

Oral temperature attained its peak in the afternoon (16:48h), which is consistent with the literature (Refinetti and Menaker, 1992; Reilly et al., 2007; Waterhouse et al., 2005; Winget et al., 1985). Temperature is considered to be a major biomarker of the human circadian time structure. The acrophase of this and other circadian rhythms is linked to one's chronotype. In this study, we studied subjects who were either "moderately morning type" or "neither type" in order to homogenize our results.

Jump height exhibited diurnal variation with an acrophase at 18:19h, which approximates the results usually reported in other studies and confirms the diurnal changes of muscle power during the day that occurs in close synchrony with core body temperature (Bessot et al., 2007; Callard et al., 2000; Gauthier et al., 1996; Martinikorena et al., 2016; Sedliak et al., 2008a; Zbidi et al., 2016).

KSS is an indication of sleepiness and attention, and appears to evolve with the time-of-day. Subjects were the most wakeful at 15:54h. The VAS fatigue score also demonstrates subjects felt more vigorous in the afternoon, the acrophase being 15:09h. However, the diurnal pattern of sleepiness and fatigue is not related to that of counting speed observed in single task condition. Lack of sleep and fatigue negatively impacts on cognitive functions (Galliaud et al., 2008), and sleep deprivation causes cognitive impairment (Dingues, 1992, Jasper et al., 2010, Zhao et al., 2017).

Walking speed decreases whereas stride length variability increases in dual task compared to single task conditions. In contrast, counting speed was not altered by the task condition. This can be explained by cognitive interference between gait and the cognitive task in favor of the cognitive task: the brain focuses on the tasks to be executed (Magnani et al., 2017; Ruffieux et al., 2015; Yogev et al., 2005; Yogev-Seligmann et al., 2013). Furthermore, stride length variability increases under dual task conditions, which means that gait is less steady in such conditions (Springer et al., 2006; Yogev et al., 2008). It is proven that gait impairment increases the risk of falls (Beauchet et al., 2009; Bridenbaugh and Kressig, 2015; Lundin-Olsson et al., 1997; Yogev-Seligmann et al., 2017). Elderly people have highest fall risk, and as a group they are experience in greatest number in the early afternoon (López-Soto et al., 2015, 2016, 2019). However, our study only included young adults; it would therefore be interesting to carry on with this type of research focussing on older people.

We observed that walking speed is slowest in the morning at 10:00h and that it increases during the day, being fastest in the afternoon and evening. Counting speed at 18:00h is faster than at 10:00 and 14:00h. Nonetheless, a time-of-day effect does not impact stride parameters. In addition, gait speed does not exhibit sinusoidal 24 h fluctuation, contrary to muscular strength and core temperature (Gauthier al., 1997; Zbidi et al., 2016). These findings are in agreement with our hypothesis that walking speed follows a specific diurnal pattern because of the many parameters linked to time-of-day differences in gait performance. Muscular strength (Gauthier et al., 1996, 1997, 2001; Sedliak et al., 2008a; Zbidi et al., 2016), vigilance, and attention (Bougard and Davenne, 2014; Wu et al., 2015) are highest around 18:00h and lowest in the morning. These factors should be key components in the determination of walking speed. Surprisingly, walking speed fluctuates in a reverse way during the daytime than balance and postural control; it is fastest in the morning ~06:00h (Gribble et al., 2007; Jorgensen et al., 2012; Paillard et al., 2016, Korchi et al., 2019).

Counting speed also fluctuates throughout the day with better performance at 18:00h than 10:00 and 14:00h. Cognitive performance exhibits a diurnal pattern in a variety of ways, depending on the involved cognitive domains (for review see Schmidt et al., 2007). Performance of counting tasks is best usually in the late afternoon (Gupta and Pati, 1994; Venugopal et al., 2010). Consequently, gait and counting speed seem to be better in the afternoon and early evening than in the morning.

In dual task conditions, diurnal variations were not detected, neither in gait nor cognition variables. The dual task condition appears to eliminate the time-of-day effect on gait and cognition. This suggests no diurnal fluctuations are measureable when the brain is functioning at its maximal cognitive ability. Similar trends are reported for the physical variables (Davies and Sargeant, 1975; Moussay et al., 2002; Nicolas et al., 2008). More precisely, no time-of-day effects can be found when an exercise is performed at maximal or near maximal level, while one can observe diurnal fluctuations under submaximal level conditions. To our knowledge, there has been only one previous study exploring diurnal fluctuation of performance in dual task conditions (Van Eekelen and Kerkhof, 2003). It reported diurnal fluctuation of N-back and memory search performance is maintained in dual task conditions. This suggests that diurnal variation of performance in dual task conditions depends on the type of task.

We present our results in terms of clock time without reference to the sleep/wake synchronizer schedule, which was not recorded in this study. Without information on the circadian synchronizer sleep-wake routine of subjects, the findings can only be related as time-of-day phenomena. However, our subjects are students who are subject to a restrained lifestyle due to their academic schedule. Moreover, they were selected with the self-assessment questionnaire of Horne and Ostberg (1976) as either ‘‘moderately morning’’ and ‘‘neither type’’. We could therefore suppose that their normal waking time is between 06:00 and 07:00h. In the future, the accrophase (peak time) and batyphase (trough time) of detected circadian rhythms should be reported with reference to the sleep/wake cycle of the study cohort. This will require wrist actigraphy recordings or filling out a sleep diary.

Gait variability and speed are associated with risk of falls, particularly in elderly individuals. Studies suggest the occurrence of falls by the elderly exhibit 24 h patterning. The findings of some investigations suggest they occur more frequently in the morning (Cantwell et al., 2016; Hill et al., 2010; Simpson et al., 2013, 2014); however, some others suggest they are most frequent in occurrence in the early afternoon hours (López-Soto et al., 2015, 2016, 2019). Interestingly, postural control and gait performance have been shown to decline in the afternoon in elderly individuals (Korchi et al., 2019). We also substantiated diurnal variation in gait of young adults. Study of diurnal fluctuations of gait performance in challenging (such as in dual task) conditions in elderly individuals seems worthwhile in order to better understand linkage between the phasing of the 24 h patterns of gait and falls. This information would be very helpful for informing fall prevention programs. Our findings represent a new approach to the problem, but it is insufficient to explain the reported variation during the 24 hs of falls by the elderly. However, they hopefully motivate research for that purpose.

CONFLICT OF INTEREST:

The authors declare no conflict of interest.

FIGURES CAPTION:

Figure 1: Time-of-day effect on walking speed (clock time Mean ± SD; n=16)

Figure 2: Time-of-day effect on counting speed (clock time Mean ± SD; n=16)

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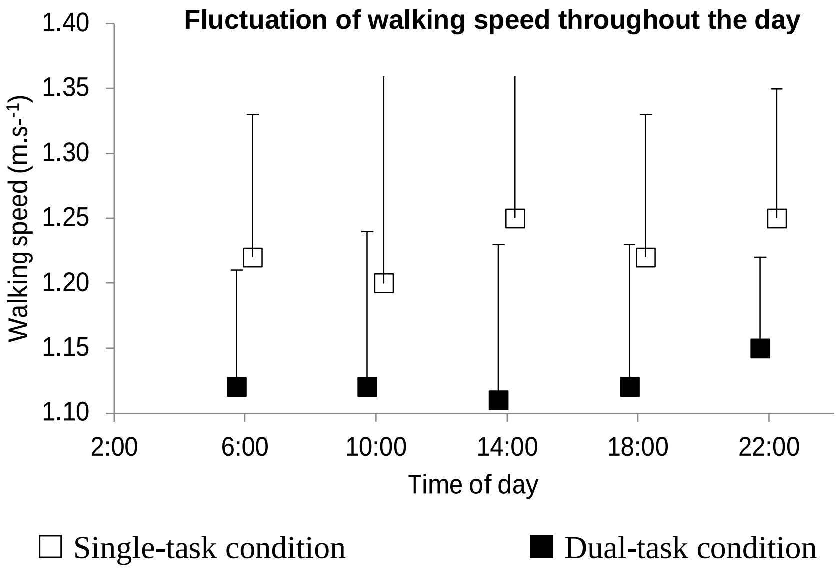
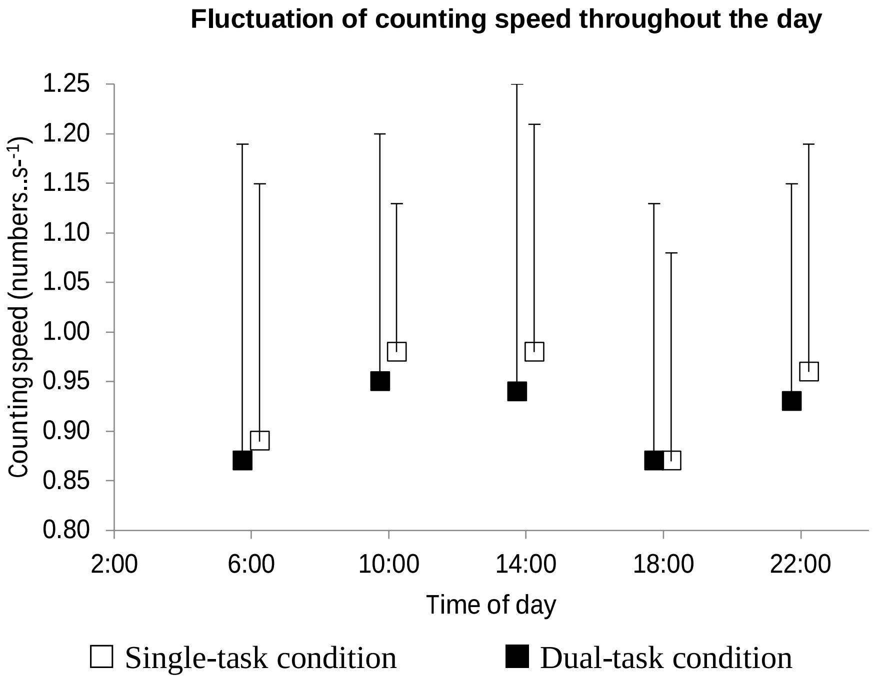


Fluctuation of walking speed throughout the day
Walking speed (m.s-1)
1.40
1.35
1.30
1.25
1.20
1.15
1.10
2:00
6:00
10:00
14:00
18:00
22:00
Time of day
☐ Single-task condition
■ Dual-task condition


Fluctuation of counting speed throughout the day
Counting speed (numbers..s-1)
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
2:00
6:00
10:00
14:00
18:00
22:00
Time of day
Single-task condition
Dual-task condition

Figures caption:

Figure 1: Time-of-day effect on walking speed (clock time Mean ± SD; n=16)

Figure 2: Time-of-day effect on counting speed (clock time Mean ± SD; n=16)

Table 1: Walking speed, Stride variability and counting performance in single and dual task conditions (Mean ± SD; n = 16)

	Single task	Dual task	*L.r.*	Adjusted *p* value
Walking speed ($m.s^{-1}$)	1.23 ±0.12	1.13 ±0.10	233.41	<0.001
Stride length variability (%)	2.07 ±0.11	2.44 ±0.18	24.77	<0.001
Stride time variability (%)	2.90 ±0.11	2.95 ±0.13	0.08	1
Counting speed ($numbers.s^{-1}$)	0.94 ±0.22	0.91 ±0.27	0.20	1

Table 2: Time-of-day effects on spatio-temporal gait parameters, counting speed and chronobiological markers (Mean ± SD; n = 16)

	06:00	10:00	14:00	18:00	22:00	*L.r.*	Adjusted *p* value
			Single task				
Walking speed (m.s^{-1})	1.22 ± 0.11	1.20 ±0.16	1.25 ±0.12	1.22 ±0.11	1.25 ±0.10	19.76	**0.012**
Stride length variability (%)	2.20 ±0.74	2.02 ±0.75	1.95 ±0.94	2.00 ±0.59	2.17 ±0.75	4.71	1
Stride time variability (%)	2.96 ±0.26	2.96 ±0.15	2.98 ±0.23	2.89 ±0.21	2.70 ±0.23	4.44	1
Counting speed (numbers.s^{-1})	0.89 ±0.26	0.98 ±0.15	0.98 ±0.23	0.87 ±0.21	0.96 ±0.23	70.25	**<0.001**
			Dual tasks				
Walking speed (m.s^{-1})	1.12±0.09	1.12±0.12	1.11±0.12	1.12±0.11	1.15±0.07	5.61	1
Stride length variability (%)	2.28±0.69	2.26±0.62	2.39±0.90	2.56±0.79	2.69±1.12	4.09	1
Stride time variability (%)	2.85±0.87	2.87±0.89	2.88±0.86	3.15±0.81	3.01±0.59	3.22	1
Counting speed (numbers.s^{-1})	0.87±0.32	0.95±0.25	0.94±0.31	0.87±0.26	0.93±0.22	8.91	0.507
			Additional variables				
Oral temperature (C°)	35.65±0.45	35.99±0.44	36.44±0.34	36.14±0.34	36.24±0.35	497.8	**<0.001**
Jump height (cm)	34.08±5.7	34.31±6.67	36.16±6.78	35.42±5.74	35.86±6.20	260.1	**<0.001**
KSS	6.25±2.02	4.75±1.98	4.31±2.09	4.00±1.9	5.38±1.75	209.9	**<0.001**
VAS for fatigue	3.69±2.47	4.82±2.08	5.44±1.99	5.13±2.34	4.11±2.02	162.2	**<0.001**

Table 3: Statistical parameters of chronobiological markers (Mean ± SD; n = 16). When the LRT (through the *L.r.* statistic and corresponding adjusted *p* value) indicated that the COSINOR model was superior to the null model, the coefficients of the COSINOR model were further examined and represented as the *t* and *p* values for the mesor, amplitude and acrophase.

	L.r.	**Adjusted *p* value**		**Value**	**Standard error**	***t* value**	***p* value**
Walking speed in simple task	3.73	0.309					
Counting speed in simple task	1.22	0.543					
Oral temperature (C°)	101	**<0.001**					
			Mesor (C°)	36.03	0.07	495	**<0.001**
			Amplitude (C°)	0.23	0.02	10.31	**<0.001**
			Phase (H)	16.81	0.33	50.6	**<0.001**
Jump height (cm)	67.58	**<0.001**					
			Mesor (cm)	36.27	1.38	26.23	**<0.001**
			Amplitude (cm)	1.03	0.12	8.37	**<0.001**
			Phase (H)	18.31	0.39	46.41	**<0.001**
KSS	133.97	**<0.001**					
			Mesor	5.27	0.25	20.7	**<0.001**
			Amplitude	1.33	0.11	11.98	**<0.001**
			Phase (H)	3.9	0.30	13.07	**<0.001**
VAS for fatigue	104.34	**<0.001**					
			Mesor	4.27	0.33	13.04	**<0.001**
			Amplitude	1.07	0.10	10.43	**<0.001**
			Phase (H)	15.15	0.36	42.04	**<0.001**