Short communication

Sleep pattern and daytime differences in the electromyographic activity and peripheral temperature

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Abstract

For a long time, it has been said that most individuals sleep an average of 8 h. However, there are subjects that usually sleep less than 6 h (the ones placed under the label of short sleep pattern, SSP) and subjects that sleep more than 8 h (those classified by the long sleep pattern, LSP). Starting from this division, several studies have been carried out in order to establish possible differences in terms of psychological and physiological variables. This study is aimed at assessing the differences that might occur in electromyographic activity and temperature in long, medium and short sleep pattern subjects at two moments in the day. From a 300-subject sample, 17 long sleep pattern, nine medium sleep pattern and eight short sleep pattern subjects were selected. The physiological variables were assessed during a constant stimulation task in the morning (between 09.00 and 10.00 h) and in the evening (between 19.00 and 20.00 h). The inter-group analysis showed that the long sleep pattern and the short sleep pattern subjects differed in terms of electromyographic activity in the morning. This same analysis indicated that only long sleep pattern subjects showed changes in electromyographic activity over two measurements taken in the same day. The results point out that long sleep pattern subjects show more sensitivity towards changes, and that sensitivity is expressed in a different manner, depending on the time of the day. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Electromyographic activity; Short sleep pattern; Long sleep pattern; Peripheral temperature; Afternoon; Morning

1. Introduction

The amount of hours of sleep needed for an adequate performance has gained a lot of attraction among scholars. Thus, although it has been established that most individuals sleep an average of 8 h, there are subjects who usually sleep less than 6 h (called short sleep pattern subjects, SSP), and subjects who usually sleep more than 8 h (called long sleep pattern subjects, LSP) (Webb, 1979, 1990). It has been reported that, among subjects of ages 30–50, approximately 2.5% sleep...
less than 6 h at night, and 7.5% reported to sleep more than 9 h (Kripke et al., 1979). Many studies have tried to check the possible differences that might occur among these subjects. Regarding personality variables, the results have been contradictory. It has been found that long sleep pattern subjects are more introverted and neurotic than the short sleep pattern ones (Hartmann et al., 1972; Hicks and Pellegrini, 1977 found that short sleep pattern subjects are considerably more anxious than long sleep pattern subjects). More recently, Chattopadhyay and Dasgupta (1992) reported from a 9 to 12-year old sample of children that higher indexes of trait anxiety and neuroticism may be found in long sleep pattern subjects than in short sleep pattern subjects. On the other hand, two studies carried out on large populations (Webb and Friel, 1970, 1971; Buela-Casal et al., 1992) found no differences between subjects with differing sleep patterns and personality variables. Regarding physiological and psychophysical variables, Benoit et al. (1981) evaluated several variables that were sensitive to circadian changes (axillar temperature, cardiac output, vigilance and temp) before and after sleep deprivation. The results showed that the most significant differences were to be found in long pattern subjects, whereas the short pattern subjects showed only small variations. Following this line of study, Aeschbach et al. (1996), in a sleep deprivation study which included both long and short sleep pattern subjects, reported that subjective indexes showed that long sleep pattern subjects seemed to be more negatively affected by sleep deprivation than short sleep subjects. This way, fatigue indexes (tired vs. recuperated) rose during sleep deprivation only in long sleep pattern subjects, and the subjective energy levels were higher in them. The same authors concluded by saying that short sleep pattern subjects are under higher NREM (short wave sleep) pressure than long sleep pattern subjects, and that this comes as a consequence of a faster accumulation of slow sleep waves and shorter duration of sleep. NREM sleep is characterised by generating an increase in corporal activity and a decrease in cerebral processes, in contrast with the REM sleep characteristics of low voltage rapid waves in the EEG, in which sleep is not interrupted and the wake threshold increases. Consistent with this, studies with psycho-physiological variables have found differences in relation to gender and measurements during the day. Women have been found to have a higher temperature than men, independent from where the measurement is located (Kattapong et al., 1995), being higher in the morning. In this same sense, diverse measurements for example arterial pressure also present gender differences, where women are higher in relation to the evaluation position as in different stressors (Gellman et al., 1990).

A review of literature indicates there are lots of works that take into account psychological and physiological variables, as well as the usual duration of sleep or of the deprivation of it. Thus, our study is an attempt to assess the possible differences in terms of electromyographic activity and temperature in long, medium and short sleep pattern at two times of the day (09.00 h and 19.00 h). At the same time, we wanted to assess whether the measurements taken differed in the subjects between those two moments in the day.

2. Method

2.1. Subjects

In order to make a selection of subjects, a sleeping habits questionnaire was applied to 300 young healthy subjects in the 18–29-year age range (M = 20, 29 and D.T. = 1.55). From the sample, 34 women were selected, 17 long, nine medium and eight short sleep pattern. Women subjects were used with the purpose of controlling possible physiological differences due to gender.

2.2. Instruments

2.2.1. Sleeping habits questionnaire

We used a questionnaire specifically designed for the assessment of several sleeping habits (Buela-Casal et al., 1992). This way, the subjects were classified into three categories. The short sleep pattern category included those subjects that usually slept 6 h or less a day. The medium
sleep pattern comprised subjects usually sleeping 6–9 h and, finally, long sleep pattern included subjects who usually slept 9 h or more.

2.2.2. Mioback, ND-35
This is an electromyograph with Biofeedback that measures bioelectric potentials generated by the muscles every time they develop some activity; it supplies information in terms of microvolts (µV). Electrodes in this investigation were located on the arm that the subject used to activate the computer key.

2.2.3. Temback CY-60
This is a thermograph with Biofeedback that measures the peripheral temperature of the subject in Celsius grades. The electrode for this variable was located on one finger of the hand of the arm that was not used to activate the computer key.

2.2.4. Constant stimulation task
A program written in BASIC programming language was used. The task required the subject to issue certain responses by pressing a key on a computer keyboard. It was structured so that the subject sat in front of the computer, instructions were then given, and finally he should press the computer key every time he saw the letter A appear on the computer screen. The task duration was of approximately 10 min, depending on the subject’s response time. The task was aimed at standardising the conditions for all subjects while the measurements were taken (Buela-Casal et al., 1990). Information in both tasks is obtained in milliseconds.

2.3. Procedure
All subjects were called in in the morning (between 09.00 and 10.00 h) and in the afternoon (between 19.00 and 20.00 h) in the same day. These hours were chosen due to the fact that they were considered to be the usual University working hours. Night before sleep hours were also controlled, in the sense that the subjects slept and woke up at their usual time (this was controlled through self-report questionnaires). In both sessions, the subject were allowed 10 min for their adaptation to the room and the instruments. Similarly, the task with the computer took approximately 10 min. During the task, the two psychophysiological variables were measured. Temperature and noise were under control, and all statistical analyses were made with the statistics package SPSS version 6.0.

3. Results and discussion
Average figures and typical deviation for all measurements taken are expressed in Table 1.

3.1. Inter-group analysis
In order to analyse the results among the various groups, both in the morning and in the afternoon, a variance analysis (ANOVA) was carried out. The independent variable sleep patterns (long, short and intermediate) are variables that are differentiated. Certain studies have demonstrated that human beings have a characteristic sleep pattern and that these three sleep patterns are clearly differentiated. Thus, to evaluate if

<table>
<thead>
<tr>
<th></th>
<th>Morning sleep patterns</th>
<th>Afternoon sleep patterns</th>
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<tbody>
<tr>
<td></td>
<td>Short</td>
<td>Medium</td>
</tr>
<tr>
<td>Electromyographic activity</td>
<td>35.10</td>
<td>28.29</td>
</tr>
<tr>
<td>(17.13)</td>
<td>(9.99)</td>
<td>(9.06)</td>
</tr>
<tr>
<td>Extremity temperature</td>
<td>23.78</td>
<td>27.50</td>
</tr>
<tr>
<td>(2.92)</td>
<td>(4.18)</td>
<td>(4.82)</td>
</tr>
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</table>
there are differences or not in anxiety and personality variables as a function of sleep pattern, an ANOVA was chosen because it was the most suitable test. This way, it is seen that, regarding electromyographic activity, long, medium and short sleep pattern subjects show differences in the morning $F_{2,31} = 4.09; P < 0.03$. The Sheffe test was carried out, showing that some differences could be found between short and long sleep pattern subjects ($P < 0.05$), the latter showing more reduced activity (Fig. 1).

In the afternoon, the ANOVA indicated that there were no statistically significant differences $F_{2,31} = 0.18; P < 0.83$.

Regarding extremity temperatures, the results suggest that, in the morning, the three groups of subjects did not show statistically significant differences $F_{2,31} = 2.12; P < 0.14$. Nor were they found among them in the afternoon $F_{2,31} = 0.50; P < 0.61$.

3.2. Inter-group analysis

Several Wilcoxon trials for independent samples were carried out inside the inter-group analysis. The data show that long pattern subjects differ in their electromyographic activity between the two measurements taken in the day $Z = -2.49, P < 0.01$, showing higher activity in the afternoon (Fig. 2). However, no changes were found in temperature $Z = -0.07, P < 0.94$. In medium pattern subjects, no differences were found in the two moments of the day neither in their electromyographic activity $Z = -1.01, P < 0.31$, nor in their temperature $Z = -1.13, P < 0.26$. Lastly, for short sleep pattern subjects, data show that their electromyographic activity does not differ $Z = 0.00, P < 1.00$ in the two measurements carried out. Regarding temperature, the data show that there was no variation either in the two moments of the day $Z = -0.56, P < 0.58$.

As may be seen from the results, the differences among subjects with different sleep pattern are to be found in just one of the variables studied. It is important to stress, however, that when these possible differences are compared at two moments of the day, we may see that the results are different. This way, the differences in electromyographic activity between short and long sleep pattern subjects can only be found in the morning, but not in the afternoon.

Using these results as a starting point, we may suggest that there is a particular effect depending on the hour of the day, and that this variable may be having some influence upon the results obtained. It could be thought that these differences may be found independent from the performance of the computer task; in other words, as possible basal differences; however, to control intervening variables, we used the same task for all subjects. In this way if basal differences existed they were controlled through the procedure. A feasible hypothesis would be that biological (circadian) rhythms might be different among subjects with
differing sleeping patterns. It is known that there are differences between morning and evening type subjects regarding arousal and reaction time levels (Buela-Casal et al., 1990). If that were the case, the differences would then vary depending on the moment and the biological cycles in which the assessment tests are made. The possibility that circadian rhythms might have an influence on the differences between subjects with differing sleeping patterns was already put forward by Benoit et al. (1981) and Aeschbach et al. (1996).

On the other hand, no differences were found regarding the temperature variable. A first sight analysis could render the above statement invalid, as the body temperature variable has been considered to be sensitive to circadian rhythms. Thus, if we followed the hypothesis of the influence of biological rhythms, we could have expected to find a bigger number of differences in this variable. An explanation for this absence of variation could lie in the evaluation method. We must remember that, in order to control the biggest amount of situational variables, the assessment was carried out while the subjects were performing a task at a computer. We could then introduce the hypothesis that the task was influential enough in the subjects’ temperature, be it due to its novelty or to the light activation characteristics its performance carried out. Therefore, the task could also have acted as a leveller of the temperature of all subjects, in this way preventing the finding of any differences among the various subjects.

The inter-group analysis of the subjects revealed that only long pattern subjects showed differences in electromyographic activity during the day, the response being smaller in the afternoon. Once again, analysing the data in this way, we may observe that the moment in the day had an influence on the assessed variable, and that the latter affected long sleep pattern subjects.

We could then say that, while in the morning some differences could be found between long and short pattern subjects, the response of short sleep pattern subjects did not vary during the day (at least if we consider the analysis of only the two measurements), whereas long pattern subjects did show a difference. Once again, the most interesting feature about this is that long sleep pattern subjects seem to be more open to influences, something that was also reported by Benoit et al. (1981) and Aeschbach et al. (1996) as a difference with respect to short sleep pattern subjects. The data gathered led us to think of the possible influences different circadian rhythms could have among subjects with differing sleeping patterns, as Benoit et al. (1981) and Aeschbach et al. (1996) also stated. Thus, these fluctuations could have an influence upon the differences found and, secondly, it seems that the highest fluctuations and influences are reported in long sleep pattern subjects, as was pointed out in other studies. Hence, there is a need for further studying in order to identify the possible relationships between sleeping patterns and circadian rhythms, in case there were any.

References


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