Validity of a circadian rhythm scale – sleep/wake cycle for adolescents

Validação da escala de ritmo circadiano – ciclo vigília/sono para adolescentes

Validación de la escala de ritmo circadiano - ciclo vigilia / sueño para adolescentes

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ABSTRACT

Objective: To validate the Portuguese version of the Puberty and Phase Preference Scale, designed by Carskadon, Vieira and Acebo in 1993, which investigates the waking and sleeping time of adolescents and their feelings related to these habits, in order to classify them as morning or evening people.

Methods: The study included 144 elementary school students, 86 boys and 58 girls, aged 13.2±1.6 years-old. The construct was validated by a predictive criterion. The scale of the circadian rhythm was applied to the students in the classroom. One month later, for seven consecutive days, the students were asked to answer another questionnaire regarding the time they slept the day before and when they woke up on the next day. To evaluate the evidence of criterion validity, one-way variance analysis followed by the least significant difference post-hoc test were applied.

Results: The psychometric properties of the scale were satisfactory. The analysis of internal consistency by Cronbach's Alpha was 0.791.

Conclusions: The results indicated good consistency and validity of the allocation preferences in the sleep/wake cycle. All indexes were significant and directed to the time expected, pointing out the scale validity.

Key-words: circadian rhythm; validation; sleep; wake.

RESUMO

Objetivo: Validar a Escala *Puberty and Phase Preference*, de Carskadon, Vieira e Acebo (1993), traduzida para a língua portuguesa, que investiga os horários de acordar e dormir de adolescentes e seus sentimentos com relação a estes, denominando-os matutinos ou vespertinos.

Métodos: Participaram do estudo 144 alunos do ensino fundamental, 86 meninos e 58 meninas, com média de idade de 13,2±1,6 anos. A validade de constructo foi por critério preditivo. A escala de ritmo circadiano foi aplicada na sala de aula; após um mês de tal aplicação, os alunos foram solicitados a responder por sete dias consecutivos outro questionário. Este perguntava, referente ao dia anterior, o horário em que foi dormir e, referente ao próprio dia, o momento em que despertou. Para avaliar as evidências de validade de critério foram realizadas comparadas as médias por análise de variância *one-way* e teste *post-hoc* da diferença mínima significativa.

Resultados: As propriedades psicométricas da escala mostraram-se satisfatórias. A análise de consistência interna pelo alfa de Cronbach foi de 0,791.

Conclusões: Os resultados indicaram fidedignidade e validade nas preferências de alocação do ciclo vigília e sono. Os índices foram significativos e direcionados aos horários esperados, evidenciando a validade da escala.

Palavras-chave: ritmo circadiano; validação; vigília; sono.

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RESUMEN

Objetivo: Validar la Escala *Puberty* and *Phase Preference*, de Carskadon, Vieira e Acebo (1993), traducida al portugués, que investiga los horarios de despertar y dormir de adolescentes y sus sentimientos respecto a esos horarios, nombrándolos matutinos o vespertinos.

Métodos: Participaron del estudio 144 alumnos de la primaria, 86 muchachos y 58 muchachas, con promedio de edad de 13,2±1,6 años. La validez de constructo fue por criterio predictivo. La escala de ritmo circadiano fue aplicada en el aula; después de un mes de esa aplicación, se solicitó que los alumnos contestaran, durante siete días consecutivos, a otro cuestionario. Éste preguntaba, referente al día anterior, el horario en que durmió y, referente al mismo día, el momento en que despertó. Para evaluación de las evidencias de validez de criterio, fueron realizados análisis de comparación de promedios con análisis de variancia *one-way* y prueba post-hoc de la diferencia mínima significativa.

Resultados: Las propiedades psicométricas de la escala se mostraron satisfactorias. El análisis de consistencia interna por el alpha de Cronbach fue de 0,791.

Conclusiones: Los resultados indicaron buena confiabilidad y validez en las preferencias de asignación del ciclo vigilia y sueño. Los índices fueron significativos y dirigidos a los horarios esperados, evidenciando la validez de la escala.

Palabras clave: ritmo circadiano; validación; vigilia; sueño.

Introduction

Living organisms are regulated by an internal biological clock, both in daily noticeable activities, and in those which are not perceptible, such as: meal times and sleep and wake cycle patterns[1]. Humans spend one third of their lifetime sleeping, being governed by daily cycles, with strong differences between day and night[2]. In the case of sleep/wake patterns, each person is governed by its own internal clock, resulting in sleeping and waking preferences. According to such preferences, human beings have been classified into: morning (those who wake up early and sleep early), evening (those who wake up late in the morning and go to sleep late at night) and intermediate people[1,3-7].

Circadian rhythms course freely, even when individuals are aware of the time of the day, and are not simply modulations of chemical reactions inside the body, but also a result of the interaction of external synchronizers[8]. At dawn, the adrenal gland secretes cortisol in larger quantity, a hormone that prepares the body for the alert state[9]. The diurnal habits of some individuals are influenced by cultural and psychological aspects[10]. The state of drowsiness presents alterations in mood and behavior, leading to emotional and behavioral difficulties[11]. Thus, the behavior of the pre-adolescent or adolescent may become more aggressive, reducing the ability to control, inhibit or modify emotional answers and causing changes in attention and school performance; and, therefore, leading to symptoms of hyperactivity, which include inattention and impulsivity, especially in adolescents that are undergoing hormonal changes. During adolescence there is a delay of phase preference, i.e., the adolescent tends towards eveningness[5]. Such fact leads, usually, to a discrimination by parents and teachers, for they have no knowledge of the variable 'biological clock'[6].

As there are preferred times for falling asleep and waking, learning can vary depending on the time of day, according to the biological rhythm. Everyone has a chronotype or a characteristic profile and the quality and quantity of sleep have always been an important concern[2]. For instance, in high level sports, when the difference between success and failure is minimal, the circadian variations can have a very significant effect. Some schools are already observing students' needs so that their timing is considered[7]. The school should extend its dimensions, including actions that enable the development and enhancement of all student's skills, whether bodily, spatial, inter and intrapersonal, besides the linguistic and logical-mathematical. The child's time is fundamental for his education, as each one has his own biological time, history and time for staying at school[12]. Thus, the child may suffer behavioral variations during the day, not showing the same production in all periods[13]. Thus, the study of chronobiology aims to obtain and associate information about humans' timing patterns in their environment with students' social and psychological activities, so as to contribute to the discovery of the best time for learning[6]. Furthermore, such information may be related to other variables, so it is important to pass on this knowledge to parents and educators.

Therefore, the aim of this study was to find validity evidence for the Portuguese version of the Puberty and Phase Preference Scale, designed by Carskadon, Vieira and Acebo[14], which investigates the juvenile preferences for the allocation of the sleep-wake cycle. This scale is not validated

in Brazil yet and has as an advantaged the fact that it is an easy and fast instrument to classify the students as morning or evening people.

Method

The sample comprised a group of 144 adolescent students attending elementary school in two public schools in the state of Rio Grande do Sul (municipalities of Esteio and Farroupilha – great Porto Alegre, and Serra Gaúcha from 6th to 9th grade, with 86 boys and 58 girls (60 and 40%, respectively), with ages from 10 to 17 years and mean of 13.2±1.6 years. The sample was chosen by convenience and its size was determined by the size of groups attending elementary school grades. Among students from the two selected schools for inclusion in the study, those who did not participate in one of the two stages of the implementation of the validation tools were excluded. The project was approved by the Research Ethics Committee of Universidade Federal do Rio Grande do Sul (UFRGS), in Porto Alegre, state of Rio Grande do Sul.

The Puberty and Phase Preference scale, proposed in 1993[14], measures the level of morningness and eveningness of adolescents and pre-adolescents, and is also cited by the authors as *Morningness/Eveningness Scale* (M/E). It was translated into Portuguese by the Group of Studies in Education in Sciences of UFRGS, with due care to maintain intended meaning. There was a cognitive and matching discussion of the versions for English/Portuguese and Portuguese/English, since the scale, before being used for the sample in question, was applied as a pre-test with students of another public elementary school, final grades, to check the understanding of the questions. The scale was named Circadian Rhythm Scale – Wake/Sleep Cycle for Adolescents, or, in a more simplified way, Morning/Evening (M/E) Scale.

The scale consists of ten multiple-choice questions, related to time preferences for the performance of activities such as: sleeping and waking, exercising, having breaks, school activities, among others. The score is obtained by adding up the points of each answer (a=1, b=2, c=3, d=4 e=5), except in the questions 1, 3 to 6, 8 and 10, in which the values are inverted. The maximum score is 43 (maximum morning preference) and the minimum is ten (minimal morning preference).

After one month, we applied a questionnaire relating to bed and rise times to be confronted with the validated instrument. This questionnaire presents questions and answers about rise time, if the student makes use of an alarm clock, and how he feels when he wakes up and when he falls asleep.

Initially, there was contact with the schools in two municipalities. After the authorization to conduct the research and the issue of the informed consent, the instruments were administered in the classroom, in which, primarily, students answered the Circadian Rhythm Scale – Wake/Sleep Cycle, having a mean time of ten minutes to answer the questions.

After a month of the administration of the Circadian Rhythm Scale – Wake/Sleep Cycle, we returned to schools to ask about bed and rise times (drowsiness while going to bed, getting up in a good mood or sleepy, waking spontaneously or with the aid of an alarm clock). Such questioning was performed for seven consecutive days, always answering regarding the previous day (bedtime) and about the present day (rise time).

For data analysis, we used Microsoft Excel (to develop the database) and the *Statistical Package for the Social Sciences* (SPSS), version 18.0, 2010. For internal consistency, we performed Cronbach's alpha. To evaluate the evidence of criterion validity, we performed comparison of the means of the total among the answers of the questionnaire (ANOVA one-way with minimal significance *post-hoc* test, when necessary).

Results

To evaluate the psychometric properties of the scale, there was an analysis of internal consistency with Cronbach's alpha. The result (α=0.791) was satisfactory, indicating adequate internal consistency.

Regarding the circadian rhythm scale – sleep/wake cycle, the higher the score, the higher the morningness; the lower the score, the greater the eveningness. The scores found in the scale ranged from 13 to 40. Such results indicated proximity with the original scale, in the article published by Carskadon, Vieira, and Acebo[14], in which the variation of scores ranged from 14 to 42 points, and indicate the morning or evening preference of adolescents. There was no difference between males (27.5±5.6) and females (27.6±6.4). The same was found in a research by Carskadon, Vieira and Acebo[14]: male 28.5±5.6 and female 28.7±5.3. Table 1 describes the 10 questions, together with mean and standard deviation of the total sample and for both genders.

In order to demonstrate the criterion validity of the M/E scale, we compared the mean obtained by students with their answers in the questionnaire related to bedtime and rise time,

applied a month later. Therefore, we performed variance analysis, comparing the scale scores and the questionnaire scores for each student. Although the results refer to all days of the week, the days chosen to be presented in the current article were Saturday and Sunday, whose rise and bed times are independent of the school hours. The results indicate that, the sooner the student goes to bed at night and wakes up in the morning, the higher is the average achieved in the M/E scale. The opposite occurs with students that present minimal preferences for morning and/or lower means, for the evening ones. This data are exemplified and demonstrated in Tables 2 to 4.

Table 1 - Morning/evening scale in Portuguese (values expressed as mean±standard deviation)

Question	Male (n=86)	Female (n=58)	Total (n=144)
Imagine your class was canceled. You can wake up anytime you want. What time would you do it? a) 05:00 a.m. and 06:30 a.m.; b) 06:30 a.m. and 07:45 a.m.; c) 07:45 a.m. and 09:45 a.m.; d) 09:45 a.m. and 11:00 a.m.; e) 11:00 a.m. and after noon.	2.6±1.0	2.4±0.7	2.5±0.9
Do you find it easy to wake up early in the morning? a) I find it quite difficult; b) I find it more or less difficult; c) I find it more or less easy; d) I find it very easy.	2.8±0.8	2.6±0.9	2.7±0.9
The Physical Education class is scheduled for 07:00 a.m. How would you feel so early? How will your performance be? a) very good; b) good; c) worse than usual; d) bad.	3.1±0.8	2.9±0.8	3.1±0.8
Bad news: you have a test lasting 2 hours. Good news: you can take the test anytime you want. What time would you choose? a) 08:00 a.m. to 10:00 a.m.; b) 11:00 a.m. to 01:00 p.m.; c) 3:00 p.m. to 5:00 p.m.; d) 7:00 p.m. to 9:00 p.m.	3.2±1.1	3.3±1.1	3.2±1.1
When are you feeling better – well – to make your favorite activities? a) In the morning! I feel tired in the evening; b) In the morning, better than in the afternoon; c) In the afternoon, better than the morning; d) In the afternoon! I feel tired in the morning.	2.4±0.8	2.5 ±0.9	2.4±0.9
Guess what? Your parents let you choose bedtime. What time would you choose? a) 08:00 p.m. and 09:00 p.m.; b) 09:00 p.m. and 10:15 p.m.; c) 10:15 p.m. and 00:30; d) 00:30 and 01:45 a.m.; e) 01:45 a.m. and 03:00 a.m.	2.4±1.2	2.7±1.2	2.5±1.2
How do you feel half an hour after having woken in the morning? a) Sleepy; b) A little confused; c) Normal; d) Ready to conquer the world.	2.5±1.0	2.6±1.1	2.5±1.1
Atw what time do you feel sleepy? a) 08:00 p.m. and 9:00 p.m.; b) 9:00 p.m. and 10:15 p.m.; c) 10:15 p.m. and 00:30; d) 00:30 and 01:45 a.m.; e) 01:45 a.m. and 03:00 a.m.	3.0±1.1	3.1±1.1	3.0±1.1
Say you have to get up at 6 o'clock in the morning, how would it feel? a) Bad; b) Not very good; c) Good; d) Nice, no problem.	2.4±1.1	2.6±1.1	2.5±1.1
When you wake up in the morning, how long does it take you to feel completely alert? a) 0 to 10 minutes; b) 11 to 20 minutes; c) 21 to 40 minutes; d) More than 40 minutes.	3.2±1.0	2.9±1.1	3.1±1.1

Table 2 - Day of the week: Sunday – bedtime

Sunday – At what time did you sleep last night?	n	$\bar{X}$±SD
Between 9:00 p.m. and 10:15 p.m.	22	29.6±5.2
Between 10:15 p.m. and 00:30	69	28.5±5.5
Between 00:30 and 01:45 a.m.	25	26.2±6.4
After 01:45 a.m.	17	24.9±6.3

n: number of subjects; $\bar{X}$±DP: mean±standard deviation of the values obtained on the scale; *post-hoc* power of the sample evaluated – 71.5%

Table 3 - Day of the week: Sunday – Rise time

Sunday – What time did you wake up today?	n	$\bar{X}$±SD
Between 06:00 a.m. and 07:45 a.m.	13	31.9±4.6
Between 07:45 a.m. and 09:45 a.m.	62	28.7±5.4
Between 09:45 a.m. and 11:00 a.m.	36	26.1±6.2
After 11:00 a.m.	22	25.6±5.9

n: number of subjects; $\bar{X}$±SD: mean±standard deviation of values obtained in the scale; *post-hoc* power of the sample evaluated – 91.9%

As for bedtime on Saturday night (Table 2), there were significant differences between groups (p=0.02). The *post-hoc* analysis showed significant difference between the group from 9:00 p.m. to 10:15 p.m. with the group from 00:30 to 01:45 a.m. (p=0.045) and with that after 01:45 a.m. (p=0.012); there was also significant difference in the group from 10:15 p.m. to 00:30 with the group after 01:45 a.m. (p=0.023).

Regarding rise time on Sundays (Table 3), there was significant difference between the groups (p=0.020). The *post-hoc* analysis showed significant difference in the group from 06:00 a.m. to 07:45 a.m. with that from 09:45 a.m. to 11:00 a.m. (p=0.002) and with the group after 11:00 a.m. (p=0.002); there was also significant difference between the group from 07:45 a.m. to 09:45 a.m. with the group from 09:45 a.m. to 11:00 a.m. (p=0.027) and with the group after 11:00 a.m. (p=0.026).

Concerning the question "Do you feel sleepy while going to bed?", there was significant difference between groups (p≤0.005): the mean and standard deviation for the sleepy ones was of 28.7±5.60 and for those who did not feel sleepy, 25.5±6.1.

In the question regarding feelings when waking up (Table 4), there was significant difference between groups (p<0.001). The *post-hoc* analysis showed difference between all groups with p<0.003.

Regarding the way of waking up, there was significant difference between groups (p=0.030). The mean and the standard deviation for those who woke up spontaneously was 28.3±5.6 and for those who woke up with the aid of an alarm clock, 25.4±6.7.

The sample power of Tables 3 e 4 was satisfactory, and it was possible to detect any existing effect in the sample, however, in Table 2 the power was not satisfactory as expected.

Table 4 - Day of the week: Sunday – How did you feel when you woke up?

Sunday – How did you feel when you woke up?	n	$\overline{X}$±SD
Well	102	28.8±5.5
A little sleepy	26	25.6±5.2
Very sleepy	5	17.8±3.9

n: number; $\overline{X}$±SD: mean±standard deviation of the values obtained in the scale; *post-hoc* power of the sample evaluated – 99.5%

Discussion

This study sought to demonstrate evidence of validity of the M/E scale. One way to demonstrate the suitability of the translated scale with the original was the comparison of results obtained within the Brazilian reality; in two cities in the state of Rio Grande do Sul. Both the amplitude and the averages obtained are close to those obtained in the study of Carscadon, Vieira, and Acebo[14]. Another way was through the analysis of internal consistency, which was adequate, similarly to the original version of the M/E scale[14].

The purpose of the evaluation in Brazil was to have a valid and reliable instrument, that would allow diagnosing the circadian rhythm – sleep/wake cycle of adolescents. One way to determine the validity of a test is verifying its efficacy degree in predicting a specific performance[15]. This way, we sought to evaluate evidence of construct criterion-related validity, based on predictive validity, i.e., associations between test scores and predicted criteria[16]. Therefore, we used the scale in students from two public elementary schools and, after a month, we questioned the same students regarding bed and rise times during 1week.

To check the construct criterion-related validity, we chose a direct form of evaluation, i.e., asking the hours of sleep and wakefulness. The 1-month interval between the administration of the scale and the questionnaire was deliberate in order to control a possible interference between them. The results indicated the scale's good quality, differentiating groups according to the answers in the questionnaire. The levels were significant and directed to the expected hours, demonstrating the scale's validity to assess the circadian rhythm of adolescents.

There were no gender differences regarding minimum or maximum preferences for morning in the M/E scale.

This scale was used by Goldstein *et al*[17], and was applied in 259 young Canadians from 11 to 14 years old, with 12.5±1.1 years. The research[17] showed a consistent decrease in the mean according to age: 11 (29.7±5.0; n=59); 12 (27.8±4.6; n=73); 13 (27.3±5.5; n=70) and 14 years (26.2±4.1; n=57). According to the mentioned study, the movement that distances the morningness preference associated with the increasing age was reliable (p=0.001). The cited study also presents very close results to those observed in 13-year-old Canadians, in 2007[17]. Another research with the M/E scale was performed by Chung and Cheung[18], with a sample of 1,629 Hong Kong Chinese adolescents aged from 12 to 19 years. The coefficient of the test-retest reliability,

applied after one month, was of 0.81, indicating good temporal stability. Cronbach's alpha for the M/E Scale was 0.63, showing moderate internal consistency. The median of the M/E scale was 26±4.8.

Accordingly, we may conclude that the circadian rhythm scale – wake/sleep cycle is an instrument with validity and reliability coefficients, similar to the international comparisons, presenting significant associations. The validity and reliability results of this study are promising; so, its translation into Portuguese makes the instrument specific for the use in the identification of adolescents regarding the circadian rhythm – sleep/wake cycle. Even when administered in a different population, the results of the present study were similar to those reported in Canada and China[17,18]. The current results are useful to confirm the reliability of the M/E scale for adolescents, that may be used in future researches. The M/E scale may also be useful for schools that offer the same grades in the morning and evening shifts, in the attempt to adjust their students' school shifts, considering their circadian rhythms.

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