ABSTRACT—Children tend to sleep and wake up early and to exhibit daytime sleep episodes. To evaluate the impact of school start times on sleepiness and attention in preschool children, this study compared the temporal patterns of sleep, daytime sleepiness, and the components of attention between children aged 4–6 years that study in the morning (n = 66) and the afternoon (n = 144) shifts. The former get up 1 hr and 30 min earlier on weekdays and show lower efficiency on the sustained attention task than those who study in the afternoon. Thus, the morning shift was associated with a reduction in nighttime sleep, which might have a negative effect on children’s performance in the morning, causing higher levels of daytime sleepiness and a decline in sustained attention. Because only one parameter of one component of attention was negatively affected, further studies are needed to confirm this effect on cognition.

The sleep–wake cycle plays an important role in the cognitive processes of learning, such as attention (Gillberg & Akerstedt, 1998; Thomas et al., 2000; Valdez, Reilly, & Waterhouse, 2008) and memory consolidation (Drosopoulos, Schulze, Fischer, & Born, 2007; Wilhelm, Diekelmann, & Born, 2008), in addition to contributing to restoring physiological and biochemical processes (Benington & Heller, 1995; Ramm & Smith, 1990) and maintaining energy balance (Spiegel, Tasali, Penev, & Van Cauter, 2004; Taheri, Lin, Austin, Young, & Mignot, 2004; Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008).

Sleep has an essential function in cognitive and motor development, especially in children, who are still maturing. A number of changes inherent to this age group occur in the sleep–wake cycle as a result of the maturation process of the nervous system. Children tend to go to bed and wake up early; that is, they have a tendency to morningness (Jenni & Carskadon, 2005). Total sleep duration declines progressively with age, along with an increase in nighttime sleep and a decrease in daytime sleep episodes (naps), which are frequent in young children (Acebo et al., 2005; Jenni & Carskadon, 2005; Louzada, Orsoni, Mello, Benedito-Silva, & Menna-Barreto, 1996; Menna-Barreto, Isola, Louzada, Benedito-Silva, & Mello, 1996).

The sleep–wake cycle is influenced by a series of peculiarities in the child’s social environment, such as behavior before
Attention may be modulated by time of day (Valdez, Ramírez, García, Talamantes, & Cortez, 2010) and sleep deprivation (Rodríguez, 2011), which leads to a decline in attention levels and may compromise school learning. With the changes in current lifestyles, children go to sleep late on weekdays and wake up early to go to school. This results in partial deprivation and irregular sleeping hours and, in turn, daytime sleepiness, primarily in children who study in the morning. However, the relationship between the components of attention, sleep pattern, and daytime sleepiness in children aged between 4 and 6 years remains unknown, as is the effect of school start times on these parameters. The present study aimed to compare sleep habits, daytime sleepiness, and the components of attention in preschool children as a function of school shift (morning and afternoon).

METHODS

The study was approved by the Onofre Lopes University Hospital Research Ethics Committee (CEP/HUOL protocol no. 554/11). The sample consisted of 210 children of both sexes aged between 4 and 6 years, from the city of Natal, Brazil (Latitude: 5° 47’ 42” S and longitude: 35° 12’ 34” W). Seven private schools took part in the research. At all schools, morning classes start at 7 a.m. and finish at 11 a.m., while afternoon classes are between 1 p.m. and 5 p.m.

The following inclusion criteria were adopted: preschool children (1) of both sexes aged between 4 and 6 years, (2) enrolled in private schools in Natal, who study in the morning or afternoon shift, and (3) whose parents or guardians gave their informed consent.

The exclusion criteria were (1) sleep disturbance or any health problem, such as allergies, sinusitis, hypertension or neurological disorders, and (2) incomplete questionnaires.

Sleep habits were characterized using the sleep habits questionnaire applied by Wey (2002), to which were added questions regarding bedtime rituals (Owens, Spírito, & McGuinn, 2000) and information about parents’ schooling level.

Economic level was characterized using a questionnaire adapted from the model proposed by the Brazilian Economic Classification Criterion (CCEB) of the National Association of Research Companies (Associação Nacional de Empresas...
de Pesquisa, 2008). This classification stratifies the population into eight economic classes (A1, A2, B1, B2, C1, C2, D, and E), based on responses related to possession of goods and the head of the family’s schooling level. Classification in points makes it possible to infer mean family income.

An adapted version of the sleep diary (Wey, 2002) was used to characterize sleep pattern for 9 consecutive days (from Friday night to Monday morning). The following outcomes were obtained from the sleep diary: (1) sleep at night (bedtimes, wake up times, and time in bed), (2) daytime naps (frequency of children who doze during the week and weekend, duration, and times of start and end); (3) the activity before bedtime (options: watching TV, playing, homework, or other); (4) parent regulation of bedtime (options: the parents regulated the bedtime, or the child goes to bed spontaneously); (5) the way of waking up (options: spontaneously, by an alarm clock, or called by someone); and (6) the reason for wake up time (options: school starting time, physical activities or sports, travel, promenade, or other). Parents or guardians completed the questionnaires on sleep habits, economic classification, and the sleep diary with information on the children’s sleep habits.

In order to assess the sleepiness levels, an adapted version (Belísio, 2014) of the Pictorial Sleepiness Scale Based on Cartoon Faces of Maldonado (Maldonado, Bentley, & Mitchell, 2004) was applied during 6 days, from Monday to Friday and the next Monday, consecutively. The data collected on the first Monday were excluded from analysis to reduce the effects of a new person in the school environment. During questionnaire application children were asked how they were feeling at that moment, that is, whether they felt sleepy or not. Next, the children indicated the face on the scale that best represented how they were feeling at the time. The scale was applied between 8 a.m. and 9 a.m. and 2 p.m. and 3 p.m. to children of the morning and afternoon shifts, respectively.

A continuous performance task (CPT) was used to assess the components of attention in the children. The CPT uses frequent stimuli to track the child’s attention, but also requires responses to infrequent and specific stimuli that occur at random intervals (Riccio, Reynolds, Lowe, & Moore, 2002). A CPT, a simple task that continuously monitors behavior, is sensitive to sleep deprivation and circadian rhythms (Gill, Haerich, Westcott, Godenick, & Tucker, 2006; Mullaney, Kripke, Fleck, & Johnson, 1983; Valdez et al., 2005). It has been demonstrated that this task measures each component of attention and the indices of sustained attention (Smith, Valentino, & Arruda, 2002; Valdez et al., 2005, 2010).

The CPT used in the present study was an adapted version for preschool children (Belísio, 2014) of that applied on university students by Valdez et al. (2005). In this task, three images familiar to children (a green heart, a red circle, and a blue star) were used. Each image was displayed on a computer screen for 200 ms. There were a total of 100 stimuli: 70 green hearts, 20 red circles, and 10 blue stars (each blue star was preceded by an arrow). The images were displayed randomly. Responses were recorded on a keyboard. The child had to press key 1 when a green heart appeared, key 2 when a red circle appeared, and key 3 when a blue star appeared. Each key was covered with an image sticker related to the requested response: key 1 with a green heart, key 2 with a red circle, and key 3 with a blue star. A 100-ms feedback sound (beep) was presented after each correct response.

According to the attention model proposed by Posner and Rafal (1987) and Valdez et al. (2005), responses to the green heart (a frequent stimulus) indicated tonic alertness, the red circle (a different, infrequent, specific stimulus) indicated selective attention, the blue star (a stimulus preceded by an arrow that acted as a warning signal) indicated phasic alertness, while changes in performance during the task indicated sustained attention. Task duration was 5 min.

Training sessions were held on Monday and Tuesday, during which the task was explained to the children as a game in which they would have to press certain keys corresponding to the figures displayed on the screen. Data from this training were excluded from the analysis. The task was applied on three weekdays (Wednesday, Friday, and Monday) between 8 a.m. and 9 a.m. to children of the morning shift and between 2 p.m. and 3 p.m. to their afternoon counterparts. The children responded to the Maldonado daytime sleepiness scale before the task was applied.

**DATA ANALYSIS**

Sleep habits (co-sleeping, room sharing, and bedtime rituals) and economic classification of children in the morning and afternoon shifts were compared using the chi-square test ($\chi^2$).

The sleep parameters obtained from the sleep diary (the bed and wake up times, time spent in bed at night, and total time spent in bed every 24 hr, the latter obtained from the sum of the time spent in bed at night and the duration of nap) were compared between shifts by analysis of variance (ANOVA) for repeated measures and Bonferroni’s posttest. Daytime sleepiness, irregularity of bed and wake up times (calculated from the standard deviation in bed and wake up times, respectively), and the parameters related to naps (start time, end time, and duration) were compared between shifts using the Mann–Whitney test. Comparative analysis of nap-related parameters between week and weekend days was conducted using the Wilcoxon test.

In relation to attention task data, the Mann–Whitney test was applied to compare the percentage and reaction
time for correct responses in each attention component (tonic alertness, selective attention, phasic alertness, and sustained attention—concentration); sequences of hits and errors during the attention task (obtained by a sequence of hits and errors over the course of the test; e.g., 1 hit, 2 hits, 3 hits, until achieving 100 hits, which refers to the total number of stimuli in the task), and omissions (no response to the stimulus) between children who study in the morning and afternoon.

Furthermore, the time on task stability, which is an index of sustained attention, was obtained from a linear regression of the percentage of correct responses and reaction time in all attention components throughout the task (tonic alertness, selective attention, and phasic alertness). Negative values represent a decrease in correct answers/reaction time over the task. On the other hand, positive values represent an increase in these parameters across the task. The Mann–Whitney test was used to compare the indices between the shifts. A significance level of 5% was set in all tests applied.

RESULTS

Co-Sleeping, Room Sharing and Bedtime Ritual
There was no difference in the frequency of co-sleeping, room sharing, or bedtime rituals between children who study in the morning and afternoon ($\chi^2$, $p > .05$) (Table 1).

Economic Classification
Most of the morning shift children belonged to classes A2 (24%) and B1 (44%), whereas those from the afternoon shift were in B1 (22%) and B2 (40%) ($X^2 = 37.32$, $p < .0001$).

Children’s Activity Before Bedtime
A higher percentage of children who studied in the morning watch TV on Monday (51%; $\chi^2 = 30.74; p < .0001$), Tuesday (51%; $\chi^2 = 13.72; p = .0174$), and Friday (72%; $\chi^2 = 37.13; p < .0001$), whereas a greater percentage of those who studied in the afternoon watch TV on Wednesday (60%; $\chi^2 = 11.73; p = .0386$), Thursday (51%; $\chi^2 = 27.47; p < .0001$), and Saturday (50%; $\chi^2 = 31.40; p < .0001$).

Parent Regulation of Children’s Bedtime
A greater percentage of morning shift students have their bedtime regulated by their parents on Tuesday (52%; $\chi^2 = 8.48; p = .0035$), Wednesday (50%; $\chi^2 = 17.36; p < .0001$), Thursday (50%; $\chi^2 = 1107; p = .0008$), and Saturday (49%; $X^2 = 10.55; p = .0011$), whereas this occurred only on Friday (43%; $\chi^2 = 6.55; p = .0104$) for children who study in the afternoon.

Reason for Wake Up Time
A higher percentage of parents of children who study in the morning report school as the reason for wake up time on weekdays (Monday: 97%; $\chi^2 = 401.20$; Tuesday: 98%; $\chi^2 = 397.12$; Wednesday: 95%; $\chi^2 = 394.03$; Thursday: 95%; $\chi^2 = 393.05$; Friday: 92%; $\chi^2 = 390.02$).

Table 1
Frequency of Co-Sleeping, Room-Sharing, and Bedtime Rituals During the Week in Children Who Study in the Morning and Afternoon Shifts ($\chi^2$ test, $p > .05$).  

<table>
<thead>
<tr>
<th>Behaviors</th>
<th>Morning</th>
<th></th>
<th></th>
<th></th>
<th>Afternoon</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequently</td>
<td>Sometimes</td>
<td>Rarely</td>
<td></td>
<td>Frequently</td>
<td>Sometimes</td>
<td>Rarely</td>
<td></td>
</tr>
<tr>
<td>Co-sleeping and room-sharing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-sleeping with brother/sister</td>
<td>5.0</td>
<td>4.0</td>
<td>91.0</td>
<td></td>
<td>7.0</td>
<td>7.0</td>
<td>86.0</td>
<td>2.06</td>
</tr>
<tr>
<td>Co-sleeping with parents/guardians</td>
<td>41.0</td>
<td>27.0</td>
<td>33.0</td>
<td></td>
<td>41.0</td>
<td>27.0</td>
<td>32.0</td>
<td>0.40</td>
</tr>
<tr>
<td>Room-sharing with brother/sister</td>
<td>20.0</td>
<td>3.0</td>
<td>76.0</td>
<td></td>
<td>20.0</td>
<td>5.0</td>
<td>75.0</td>
<td>0.52</td>
</tr>
<tr>
<td>Room-sharing with parents/guardians</td>
<td>29.0</td>
<td>10.0</td>
<td>59.0</td>
<td></td>
<td>26.0</td>
<td>12.0</td>
<td>61.0</td>
<td>0.67</td>
</tr>
<tr>
<td>Sleeping alone</td>
<td>31.0</td>
<td>17.0</td>
<td>53.0</td>
<td></td>
<td>30.0</td>
<td>16.0</td>
<td>54.0</td>
<td>0.09</td>
</tr>
<tr>
<td>Bedtime rituals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking milk</td>
<td>44.0</td>
<td>22.0</td>
<td>33.0</td>
<td></td>
<td>40.0</td>
<td>24.0</td>
<td>35.0</td>
<td>0.73</td>
</tr>
<tr>
<td>Listening to stories</td>
<td>17.0</td>
<td>51.0</td>
<td>32.0</td>
<td></td>
<td>18.0</td>
<td>50.0</td>
<td>32.0</td>
<td>0.09</td>
</tr>
<tr>
<td>Going to the bathroom</td>
<td>64.0</td>
<td>27.0</td>
<td>9.0</td>
<td></td>
<td>58.0</td>
<td>32.0</td>
<td>10.0</td>
<td>1.26</td>
</tr>
<tr>
<td>Requires the parents in the room</td>
<td>57.0</td>
<td>25.0</td>
<td>18.0</td>
<td></td>
<td>61.0</td>
<td>23.0</td>
<td>17.0</td>
<td>0.55</td>
</tr>
<tr>
<td>Sleeping with the lights on</td>
<td>25.0</td>
<td>14.0</td>
<td>62.0</td>
<td></td>
<td>23.0</td>
<td>19.0</td>
<td>59.0</td>
<td>1.48</td>
</tr>
<tr>
<td>Using a special object</td>
<td>40.0</td>
<td>15.0</td>
<td>45.0</td>
<td></td>
<td>32.0</td>
<td>18.0</td>
<td>50.0</td>
<td>3.38</td>
</tr>
<tr>
<td>Others</td>
<td>29.0</td>
<td>19.0</td>
<td>50.0</td>
<td></td>
<td>38.0</td>
<td>15.0</td>
<td>46.0</td>
<td>3.73</td>
</tr>
</tbody>
</table>

Note: Frequently = behavior occurs 5 or more times during the week; Sometimes = behavior occurs 2–4 times during the week; rarely = behavior occurs once or never during the week.
Sleep, Sleepiness, and Attention in Children

Fig. 1. Mean and standard deviation of bedtime, wake up time, and time in bed at night, and total time in bed (night and daytime nap) during the week in children of morning and afternoon shifts (ANOVA, *p < .05).

Way of Waking Up

A greater number of children who study in the morning are woken up by someone on weekdays (Monday: 76%; χ² = 180.28; Tuesday: 76%; χ² = 128.92; Wednesday: 68%; χ² = 140.76; Thursday: 76%; χ² = 123.17; Friday: 63%; χ² = 193.39, p < .0001), whereas more children who study in the afternoon wake up spontaneously on these days (Monday: 78%; χ² = 180.28; Tuesday: 73%; χ² = 128.92; Wednesday: 79%; χ² = 140.76; Thursday (72%; χ² = 123.17; Friday: 82%; χ² = 193.39, p < .0001).

Temporal Sleep Patterns

Bedtimes did not differ between shifts (F(6,462) = 0.97, p = .4438). Nevertheless, children in the morning shift usually went to bed 40 min earlier than those who studied in the afternoon. Children who studied in the morning went to bed earlier on Monday, Tuesday, and Thursday than on Saturday (F(6,462) = 8.47; Bonferroni, p < .0001) (Figure 1).

Children from the morning shift woke up about 1 hr and 30 min earlier from Monday to Friday compared to those who studied in the afternoon, with no difference on weekends (F(6,450) = 7.06; Bonferroni, p < .0001). Children in the morning shift woke up earlier during the week than on Saturday and Sunday (F(6,450) = 11.34; Bonferroni, p < .0001), whereas those in the afternoon shift showed no difference between weekdays and weekends (F(6,450) = 11.34; Bonferroni, p < .0001) (Figure 1).

Morning shift students spent 1 hr less in bed on Monday and Sunday nights than their afternoon shift counterparts (ANOVA F(6,456) = 7.01; Bonferroni, p < .0001). Time spent in bed for children who studied in the morning was shorter on Tuesday, Thursday, and Sunday than on Saturday. On the other hand, children who studied in the afternoon spent more time in bed from Monday to Friday than on Saturday (ANOVA F(6,456) = 1.10; Bonferroni, p < .0001) (Figure 1).

There was no difference in the irregularity of bedtimes (Mann–Whitney, p = .9588) and wake up times (Mann–Whitney, p = .4067) between the shifts (Table 2). Children who studied in the morning napped more frequently on weekdays and weekends (χ², p < .0001) and naps were longer on weekdays (Mann–Whitney, p = .008) (Table 2). It is important to underscore that the children
napped at home. In children who studied in the morning, the naps occurred after they returned from school; while those in the afternoon shift napped, for example, when they missed school to go to the dentist or to accompany their parents to solve personal problems.

**Time Spent in Bed**

There was no difference between shifts \( F(6.480) = 4.05, p = .3828 \) or weekdays \( F(6.480) = 1.62, p = .1388 \) for time spent in bed every 24 hr (nighttime sleep and naps) (Figure 1).

**Daytime Sleepiness**

The level of daytime sleepiness in children who study in the morning was higher on Monday (Mann–Whitney, \( p = .05 \)) and Friday (Mann–Whitney, \( p = .004 \)) compared to those who studied in the afternoon (Figure 2).

**Components of Attention**

Children in the morning shift exhibited a higher percentage of correct answers for phasic alertness than those from the afternoon shift (Mann–Whitney, \( p = .05 \)) (Figure 3). However, over the course of the test children who studied in the morning had fewer correct answers and a lower increase in reaction time than those who studied in the afternoon. This can be visualized in the time on task stability in Figure 4. The negative values observed represent a decrease in correct answers throughout the task. On the other hand, the positive values represent an increase in reaction time during the task. The decrease in the percentage of correct answers across the task was higher in morning shift children. However, reaction time increased less in this group (Mann–Whitney, \( p = .05 \)) (Figure 4). Nevertheless, there was no difference between shifts in relation to omissions (Figure 5) and the sequence of hits and errors across the test (Mann–Whitney, \( p > .1777 \)) (Figure 6).

**DISCUSSION**

This is a pioneering investigation on comparing the habits and temporal patterns of sleep, daytime sleepiness, and the components of attention in preschool children enrolled in the morning and afternoon shifts. Sleep habits did not differ between shifts, but there were differences in temporal sleep patterns, daytime sleepiness, and some components of attention between children who studied in these shifts.

It was observed that most of the children co-slept and engaged in bedtime rituals regardless of the shift in which they studied. Thus, school start time did not change these behaviors, probably because they are part of family dynamics that increase child–parent interactions (Beltramini & Hertzig, 1983; Buckley, Rigda, Mundy, & McMillen, 2002; Silva et al., 2005).

With respect to temporal sleep patterns according to school start time, it was observed that during the week children who studied in the morning woke up 1 hr and 30 min earlier than those who studied in the afternoon. Thus, they spent 1 hr less in bed at night and tended to be sleepier on Monday and Friday than their afternoon shift counterparts. Furthermore, a higher frequency of children from the morning shift napped with longer episodes than those who studied in the afternoon.
In more sleep deprived teenagers, this corresponds to a difference of nearly 2 hr of sleep between school days and weekends (Carskadon, 2002; Carskadon, Acebo, & Jenni, 2004; Sousa, Araújo, & Azevedo, 2007). The difference between children and teenagers may be due to the natural predisposition of children to go to bed and wake up earlier, and the stronger influence of parents in determining their sleep–wake times (Iglowstein et al., 2003; Meijer et al., 2000). This difference in temporal sleep patterns between weekdays and weekend in children who studied in the morning may be due to acute sleep deprivation associated with a shorter time in bed at night in consequence to the school starting time in the morning, which may contribute to a
higher level of daytime sleepiness. It is important to underscore that most of the children who studied in the morning were woken up by their parents during the week and most who studied in the afternoon woke up spontaneously, reaffirming the signs of acute sleep deprivation in the former group. Thus, the increase in sleepiness on Monday may be a consequence of the shorter time in bed from Sunday to Monday, whereas on Friday it may result from accumulated tiredness during the week. This sleepiness pattern may lead to the long nap episodes observed in the children enrolled in the morning shift.

With regard to naps and the shorter time spent in bed, it was observed that after adding time spent in bed at night and the daytime nap, the total sleep time of morning shift students was similar to that of afternoon students. This shows that children who studied in the morning slept less at night than those from the afternoon shift, but they seemed to compensate this deprivation by taking daily naps. These results corroborate those observed by Silva et al. (2005), who reported that 7- to 10-year-old children who studied in the morning took more naps than those who studied in the afternoon. These sleeping patterns demonstrate acute sleep deprivation during the week that is compensated by taking daily naps. Thus, school start time influenced the children’s sleeping patterns, given that they spent less time in bed and woke up earlier to go to school in the morning.

In addition, morning shift students had fewer correct answers, even though they exhibited a shorter increase in reaction time during the CPT compared to their afternoon shift counterparts. Nevertheless, in this investigation no intershift differences were observed in omissions, the sequence of hits and errors during the test, or the number of correct answers and reaction time for tonic alertness and selective attention, although an increase in the percentage of correct answers for phasic alertness was observed in children enrolled in the morning shift.

The decrease in one of the sustained attention indices (percentage of correct answers across the task) in children from the morning shift may have been caused by acute sleep deprivation associated to the shorter time they spent in bed at night due to the school start time. In the school context, this negative effect might compromise learning.

However, both groups of children showed an increase in reaction time across the task, but this increase was less marked in children who studied in the morning. This increase across the task was expected in cognitive assessment tests due to the fatigue effect. The lower increase in morning shift students may be due to a motivational effect (Valdez et al., 2008), as a consequence of a higher activity level associated with methodological differences in school tasks. Motivation and the higher activity level might have stimulating effects on cognitive development (Wojtczak-Jaroszowa & Jarosz, 1987).

The absence of intershift differences in some attention parameters may result from the level of daily sleep deprivation observed in children (about 1 hr), which might not have been sufficient to interfere in attention levels. Furthermore, the time the tasks were applied could have influenced the responses obtained. Children from each shift answered the tasks at different circadian moments (morning or afternoon). Additionally, those who studied in the morning should have exhibited a higher homeostatic pressure level since they had less nighttime sleep, but afternoon shift students displayed a higher number of previous waking hours. These factors may lead to more rapid fatigue in both groups and might have influenced the results obtained for attention.

In other studies, it was observed that university students had increased attention levels during the day and a decline between 4 a.m. and 6 a.m. (Valdez et al., 2005, 2010). The continuous application task presented in this study was applied between 8 a.m. and 9 a.m. to the morning group and 2 p.m. and 3 p.m. to the afternoon group. Based on the study with university students, it was expected that both shifts would exhibit high attention levels, while sleep-deprived children would not perform well on the task. However, children are characterized by an advanced circadian phase in relation to college students. Thus, circadian variation in attention should be assessed considering the ontogenetic differences that could cause different results in each age group.

The reduction in sustained attention efficiency observed in this study is similar to the levels identified in previous research with children starting at 7 years of age that sought to identify cognitive development. Shorter sleep duration and poorer sleep quality have been associated with low performance (Paavonen et al., 2009; Sadeh, Gruber, & Raviv, 2008).
2002; Touchette et al., 2007). However, these studies measured performance using scores on tests or tasks that only assessed sustained attention.

This study had a number of limitations: (1) sleep–wake cycle analysis using questionnaires completed by parents may have contained inaccuracies regarding their child’s habits (according to Lam, Mahone, Mason, and Scharf [2011], because parents tend to overestimate the sleep time of children, actigraphy is one of the best ways to evaluate sleep patterns); (2) the different task application times could have influenced intershift results; (3) some participants abandoned the study at different stages, contributing to a decrease in the number of participants; and (4) the absence of chronotype evaluation due to the lack of an instrument validated for Portuguese that could have been applied to the children. Finally, an actigraphic assessment of sleeping patterns, using sleepiness variables, such as sleep–wake times to classify the chronotypes of children younger than 8 years old, is suggested for future studies. The attention components in this age group should be analyzed more often throughout the day to verify whether the findings of the present investigation really had an influence on daily sleep compensation, and motivation or were due to a circadian effect.

It is suggested that school start time influences temporal sleep patterns and daytime sleepiness in preschool children. Changes in sleeping patterns due to the morning start time have been assessed in teenagers (Andrade, 1997; Carskadon, 2002; Carskadon et al., 2004; Sousa et al., 2007) and preteenagers aged 10–12 years (Epstein, Chillag, & Lavie, 1998), but we observed that school start time also influences younger children, despite their natural tendency to morningness. In addition to the negative impact on sleep patterns, there were signs of negative effects on sustained attention, which may compromise learning. Since only one parameter of one component of attention was negatively affected, further studies evaluating the attention components in this age group at different times of the day are needed to confirm this effect on cognition. Nevertheless, the results obtained reinforce the importance of broadening the discussion regarding changing school start times, which is focused on teenagers, to other age groups, such as preschool children. To that end, it is essential to take into account the biological characteristics of each age group.

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