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Morningness/eveningness and school performance among Spanish adolescents: Further evidence

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A B S T R A C T

Adolescents shift their time of day preferences from morning to evening during puberty when school schedule becomes earlier. Given that a better performance is obtained when individuals are tested at times that are in synchrony with their chronotype, and optimal sleep duration is positively associated with academic performance, evening-types may obtain worse school performance because of both morning school schedule and a decrease of total sleep time. A group of 1133 adolescents (aged 12–16) participated in this study. School performance was evaluated using subjective level of achievement and self-reported grades measures. Controlling for total sleep time, more evening oriented young adolescents (12–14 years) performed significantly worse in school achievement. Girls among 15–16 years performed significantly better than boys. These results have important implications for intervention and prevention programs during school years.

1. Introduction

Humans differ in their time of day preferences. Morning-types (M-types) or "larks" prefer to wake up and go to bed early and feel at their best moment in the morning (mental, physical, and social activities) whereas Evening-types (E-types) or "owls" prefer later bedtimes and rise times, become progressively more alert across the day and feel at their best moment in the evening. Neither-types (N-types) show an intermediate position.

Because circadian types differ in their sleep–wake patterns as well as in their feeling at their best moment for doing different activities at different times of day, the practical implications of these findings have been applied to diverse fields, such as the design of working schedules (Pisarski et al., 2006) or sport performance (Drust, Waterhouse, Atkinson, Edwards, & Reilly, 2005). Although several studies have analyzed asynchrony between circadian typology and work schedules in adults (see Saksvik, Bjorvatn, Hetland, Sandal, & Pallesen, 2010), less attention has been given to performance among adolescents during the school year in a fixed and continue schedule (Carskadon, 1990; Clarisse, Le Floc'h, Kindelberger, & Feunteun, 2010; Randler & Frech, 2009; Wolfson & Carskadon, 1998).

Previous research has found that a preference for evening hours appears during puberty (Carskadon, Vieira, & Acebo, 1993; Díaz-Morales & Gutiérrez, 2008; Randler, 2011a), consequence of both the maturation processes typical of puberty (Hagenauer, Perryman, Lee, & Carskadon, 2009), and the many changes in the adolescent's relational and social sphere such as school demands, new social opportunities, and diminution of parental supervision (Randler, Bilger, & Díaz-Morales, 2009; Takeuchi et al., 2001). Accumulating evidence indicates that sleep and Morningness/Eveningness (M/E) have effects on school performance. It is well-known that short sleep duration and poor sleep quality are negatively associated with school performance (Gruber et al., 2010; Wolfson & Carskadon, 2003). Adolescents go to bed progressively later and although it may seem that they need less sleep time, they do not get enough sleep, because optimal alertness in adolescents requires on average 9 h of sleep per night (Carskadon & Acebo, 2002). E-types report shorter sleep time than M-types (Megdal & Schernhammer, 2007). On the other hand, M-types tend to be more regular in their lifestyle than E-types (Gaina et al., 2006; Díaz-Morales, Delgado, Escribano, Collado, & Randler, 2011) and higher lifestyle regularity has been associated with better daytime functioning (Wolfson & Carskadon, 1998).

Human cognitive performance changes over the day. Numerous studies have confirmed a synchrony effect with better performance at times that match individuals' preference, in the morning versus in the afternoon (Hasher, Goldstein, & May, 2005; May, 1999). Goldstein, Hahn, Hasher, Wiprzycka, and Zelazo (2007) found that performance was better on Digit Span and Block Design measures when adolescents (11–14 years) were tested at times that were in synchrony with their preferred time of day versus at times that were not.

Taking this line of argument further, one may assume that evening preference increases the risk of poor school performance due to early school schedules. However, few studies have been realized among adolescents aged 12–16 years during the typical (morning) schedule of school environment. Giannotti, Cortesi, Sebastiani, and Ottaviano (2002) found worse performance among evening adolescents aged

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14–18 years, whereas Beşoluk (2011) and Randler and Frech (2006) found that pre-university students with morning preference seemed to be at an advantage in university entrance examinations. Using a wider range of age (11 to 23 years) Borisenkov, Perminova, and Kosova (2010) have recently found that students with low and mean achievement scores had a 55-min phase delay and reported less sleep length.

Considering these aspects, it seems relevant to analyze adolescents' school performance because of their shift to evening preference and earlier school schedules during Compulsory Secondary Education (12–16 years). Using a large sample of adolescents who were tested under their daily educational routine, contribute to further evidence about this topic.

The aim of this study was to assess school performance according to chronotype (Morning, Neither or Evening-type) in a large sample of Spanish adolescents aged 12–16 years. The most high-school in Spain begins between 8.00 and 8.30 am and ends between 2.15 and 3.00 pm with a traditional Spanish school week from Monday to Friday.

One would expect better school performance in M-types who go to school in synchrony with their preferred time of day, in a morning and fixed school schedule whereas E-types would obtain worse school performance because of early morning scholar schedule.

2. Method

2.1. Participants

In this study participated 1133 adolescents aged between 12 and 16 years (M = 14.07, SD = 1.26). 50.5% were girls. All adolescents were studying Compulsory Secondary Education in six schools of Madrid (Spain). The board of directors authorized the study after obtaining the parents' consent. Participation was voluntary and anonymous.

2.2. Instruments

2.2.1. Morningness/eveningness

Participants completed the *Morningness/Eveningness Scale for Children* (*MESC*; Carskadon et al., 1993). This scale is a validated adaptation of the Composite Scale of Morningness (Smith, Reilly, & Midkiff, 1989) that is used to measure *M/E* orientation in adolescents. The scale has 10 items about the preferred timing of such activities as recess, tests, sleep timing, and so forth. It has a response scale with four or five response options for each item. Score ranges from 10 (*eveningness*) to 43 (*morningness*). Spanish version was used (Díaz-Morales & Gutiérrez, 2008). Previous psychometric and cross-cultural studies have reported good internal consistence for *MESC* (Caci, Robert, Dossios, & Boyer, 2005; Díaz-Morales, Dávila, & Gutiérrez, 2007; Gau & Soong, 2003; Kim, Dueker, Hasher, & Goldstein, 2002). The reliability of the scale was .69 (Cronbach's alpha).

2.2.2. School performance

The Spanish grading system is coded from 0 (the worst) to 10 (the best). Two different measures to evaluate school performance were used. *Subjective level of achievement*: adolescents were asked to indicate their subjective level of achievement from last year from 0 to 10. *Self-reported grades*: last year grades in the common subjects for all grades of Compulsory Secondary Education (Spanish language, mathematics, English language and social sciences) were reported and the mean of grades was calculated. Several studies have also used this method (see Wolfson & Carskadon, 2003).

2.2.3. Sleep habits

Because of the association between academic performance and total sleep time, this one was controlled. Adolescents reported their habitual bedtime and rise time during weekdays.

2.3. Procedure

All participants were tested in groups ranging in size from 20 to 30 students in school schedule and in their own classroom.

2.4. Data analysis

Data were analyzed using analysis of variance (*ANOVA*) to contrast the effect of age and gender on *M/E*, *school performance* and *total sleep time*. Association between *M/E* and age was tested using Pearson correlation coefficient. Partial correlations were used to examine the association between total sleep time, school performance, and *M/E* (controlling for age). *ANCOVA* was used to analyze differences in *total sleep time* according to chronotype (age as covariate) and to calculate differences *in school performance* according to gender and circadian typology (age and total sleep time as covariates). *Bonferroni test* was used in multiple post-hoc comparisons.

3. Results

3.1. Preliminary data

In order to detect possible effects of age and gender on *M/E* and *school performance* preliminary analyses were performed. The range for MESC's scores was from 12 to 38. The frequency of distribution was similar to the normal distribution: skewness (value = .01, error = .07) and kurtosis (value = −.27, error = .14). Analysis for *M/E* revealed a significant effect of age, $F(4,1123) = 6.77$, $p < .001$, $\eta^2_p = .024$, but no significant effect of gender, $F(1,1123) = 1.31$, $p = .25$, or interaction age × gender, $F(4,1123) = .84$, $p = .50$. The 12 years-old reported the highest *M/E* score (see Table 1). Next, the association between *M/E* and age was calculated. *M/E* was negatively associated to age ($r = -.11$, $p < .001$).

Given that previous analysis indicated that morningness decreased progressively until the age of 14 years, and then remained on a stable level, the sample was split into two age groups (12–14 and 15–16 years) and the association between *M/E* and age was calculated. In the youngest group (12–14 years), *M/E* was negatively associated to age, $r = -.17$, $p < .001$, but in the oldest group (15–16 years), no significant association was found, $r = .03$, $p = .57$.

Subsequently, we tested the association between *subjective level of achievement* and *self-reported grades*. High positive correlation was

Table 1
Means, standard deviations, and number of adolescents in Morningness/Eveningness (M/E), self-reported grades (SRG), and total sleep time (TST) as a function of age.

Age	*M/E*	Post-hoc $p<.01$	SRG	Post-hoc $p<.05$	TST	Post-hoc $p<.01$	n
12	26.60 (4.63)	> 14, 15, 16	6.92 (1.56)	> 13, 14, 15, 16	8:45 (0:50)	> 13, 14, 15, 16	148
13	25.57 (4.47)		6.15 (1.76)	> 15, 16	8:26 (0:47)	> 14, 15, 16	248
14	24.55 (4.26)		5.81 (1.81)	> 15, 16	8:08 (0:46)	> 16	287
15	24.64 (4.32)		5.41 (1.86)	> 16	8:01 (0:50)		274
16	24.88 (4.35)		4.67 (1.31)		7:50 (0:57)		176
Total	25.11 (4.43)		5.75 (1.83)		8:12 (0:52)		1133

Note: Standard deviations in parentheses; Post-hoc comparisons, *Bonferroni Test*.

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found, $r=.74$, $p<.001$, for this, only one set of results referred to *self-reported grades* are presented here.

The frequency of distribution of *self-reported grades* showed slight skewness (value = .12, error = .07) and kurtosis (value = −.38, error = .14). Analysis indicated significant effects of age, $F(4,1123)=41.79$, $p<.001$, $\eta^2_p=.13$, and gender, $F(1,1123)=4.86$, $p<.05$, $\eta^2_p=.004$, but no significant effect of age × gender interaction, $F(4,1123)=.95$, $p=.44$. *Self-reported grades* became worse with age. Girls reported higher grades than boys (M = 5.88, SD = 1.80; M = 5.63, SD = 1.85, respectively).

With regard to *total sleep time*, the frequency of distribution showed slight skewness (value = −.56, error = .07) and kurtosis (value = 1.68, error = .15). Analysis indicated significant effect of age, $F(4,1123)=32.41$, $p<.001$, $\eta^2_p=.10$, but no significant effect of gender, $F(1,1123)=2.63$, $p=.10$, or interaction age × gender, $F(4,1123)=1.55$, $p=.19$. *Total sleep time* decreased with age.

3.2. Relationship between total sleep time, school performance, and M/E

First, relationship between *total sleep time* and *school performance* was calculated. The results indicated slight, but significant, positive correlation between *total sleep time* and *self-reported grades* ($r=.07$, $p<.05$). *MESC* values of 22/28, corresponding to 33/66th percentiles, were used to categorize circadian types. Considering circadian typology, a positive correlation was only found for E-types, $r=.14$, $p<.05$.

Second, relationship between *M/E* and *total sleep time* was also calculated. A statistically significant correlation was found ($r=.26$, $p<.001$), for this, differences in *total sleep time* according to chronotype were analyzed. The results indicated a significant effect of chronotype, $F(2,1129)=31.84$, $p<.001$, $\eta^2_p=.055$. M-types reported more total sleep time than N- or E-types. Levene's test indicated not differences in variability according to chronotype in *self-reported grades*, $F(2,1130)=.071$, $p=.93$ or *total sleep time*, $F(2,1130)=2.42$, $p=.09$.

3.3. Differences on academic performance according to gender and chronotype

Analyses were calculated separately for the two age groups described above (see Table 2). In the youngest group, M- and N-types reported higher grades than E-types, $F(2,675)=7.21$, $p<.001$, $\eta^2_p=.022$, but there were no gender differences, $F(1,675)=1.68$, $p=.19$, and the age × gender interaction was also non-significant, $F(2,675)=1.13$, $p=.32$. Post-hoc comparisons among chronotypes indicated significant differences between M- and E-types ($p<.001$), N- and E-types ($p<.05$), and no differences between M- and N-types ($p=.51$).

In the oldest group, N-types reported higher grades than E-types, $F(2,442)=3.86$, $p<.05$, $\eta^2_p=.018$. Girls reported higher grades than boys, $F(1,442)=4.13$, $p<.05$, $\eta^2_p=.009$. Age × gender interaction was non-significant, $F(2,442)=.30$, $p=.74$. Post-hoc comparisons among chronotypes indicated significant differences between N- and E-types ($p<.05$), but not between M- and N-types ($p=1.0$), neither M- and E-types ($p=.19$).

4. Discussion

This study confirms that *M/E* was related to *school performance* in a large sample of Spanish adolescents aged 12–16 years. E-types obtained worse *school performance* compared to both M- and N-types in the youngest group (12–14 years), and compared to N-types in the oldest group (15–16 years). On the other hand, *school performance* and *total sleep time* decreased with age. Finally, in the oldest group, girls scored better than boys in *school performance*.

Adolescents shift their time of day preferences from morning to evening. The significant negative correlation between *M/E* score and age among the youngest pupils was similar to correlation coefficients obtained by other researchers in adolescents (Díaz-Morales et al., 2007; Giannotti et al., 2002), although was non-significant for the oldest group. Because of *M/E* is a continuum, the shift toward eveningness could be gradual and pupils would tend to be N-types before becoming E-types (Andershed, 2005). We found no gender differences in *M/E*, although the tendency of the means indicates that girls scored lower in *M/E*. The same tendency has previously been found by other researchers (Caci et al., 2005; Díaz-Morales & Gutiérrez, 2008; Gaina et al., 2006). Nevertheless, other studies suggest that girls (and women) are more morning oriented than boys (and men) (see Randler, 2007). These inconsistent results may be explained by physical changes during puberty which may alter the behavior in adolescents and their families in a different way for boys and girls (Randler et al., 2009) as the result of gender-related social roles (Díaz-Morales & Sánchez-López, 2008).

School performance is worse in E-types. Similar results were obtained by Randler and Frech (2009) in German sample. School schedules are earlier during Secondary Education, coinciding with a shift toward eveningness. E-types are forced to get up early in the morning even though they find it very difficult. In the evening, they are more active so they find it difficult to fall asleep accumulating a considerable sleep debt. Optimal sleep duration is positively associated with academic performance (Wolfson & Carskadon, 1998), although the correlation obtained in this study was slight for total sample, it was only significant for E-types. Furthermore, E-types reported shorter total sleep time than M- and N-types. It is possible that those E-types who sleep more obtain better school achievement because their total sleep duration is closer to optimal sleep time. On the other hand, optimal level of achievement happens when subjects are tested in synchrony with their circadian rhythms (Goldstein et al., 2007). Because a typical school day in Spain usually begins early in the morning (8.00–8.30 am) and ends between 2.15 and 3.00 pm, E-types are no tested during the afternoon (their optimal time of day) so they seem to be at a disadvantage compared to M-types

Table 2
Estimated marginal means, standard error, statistical data (F's and signification level), *Bonferroni test*, and number of adolescents in self-reported grades (SRG) according to *M/E* and gender in two age groups.

	Morningness/Eveningness (M/E)					Gender		
12–14 years	M n = 226	N n = 280	E n = 177	*F*	*Bonferroni*	Girls n = 333	Boys n = 350	*F*
SRG	6.47 (.12)	6.26 (.10)	5.80 (.13)	7.21**	M, N > E	6.26 (.10)	6.09 (.09)	1.68
15–16 years	M n = 117	N n = 201	E n = 132	*F*	*Bonferroni*	Girls n = 239	Boys n = 211	*F*
SRG	5.19 (.16)	5.30 (.12)	4.77 (.15)	3.86*	N > E	5.26 (.11)	4.92 (.12)	4.13*

Note: Standard error in parentheses; M, morning-types; N, neither-types; E, evening-types.
** $p<.001$.
* $p<.05$.

(Randler & Frech, 2006, 2009). Additionally, association between *M/E* and thinking styles (Fabbri, Antonietti, Giorgetti, Tonetti, & Natale, 2007) could contribute to a better understanding of differences in performance.

According to Adan (1991) it is interesting to include N-types because they represent the majority of the population and it will permit us to know if they are independent of M- and E-types or if they appear in an intermediate position. In this study no differences between M- and N-types in school performance were found. Moreover, in the oldest group, N-types, but not M-types, scored significantly better than E-types. It may be that the oldest group was progressively adjusting to school schedules because they have been conditioned to an early start time during their previous Secondary Education years, which may act as an external factor that entrains biological rhythms (Wittmann, Dinich, Merrow, & Roenneberg, 2006). Results obtained for pre-university population are not inconsistent with results obtained here; instead, it may suggest that comparing early with middle and late adolescence appears to be an interesting question in *M/E* and school performance because biological and social changes occurring during this stage of life are presumably not abrupt.

Apart from chronotype and school performance, it is worth noting that school performance decreases with age. As it was indicated above, optimal sleep duration is positively associated with academic performance, and adolescents tend to sleep less when they become older (Gradisar, Gardner, & Dohnt, 2011). Moreover, less parental supervision and more social activities could interfere with time spent studying.

Recently, Steinmayr and Spinath (2009) have emphasized the importance of motivation in school context. Gender differences have been found in study motivation. Girls are interested in increasing their competence and advancing in their studies whereas boys are more interesting in obtaining approval or avoiding rejection by parents or teachers (Inglés et al., 2011), for this, it is possible that gender differences in school achievement tend to be more visible during their last years of secondary education before entering university.

Concluding, the permanent social jet-lag among evening adolescents and early school times deserves more attention. Several consequences of the discrepancy between biological and social clock can indirectly affect school performance. E-types adolescents have often been considered at greater risk of suffering from negative relationships with parents (Andershed, 2005), report higher levels of substance use (Fernández-Mendoza et al., 2010; Negriff, Dorn, Pabst, & Susman, 2011), their health is worse (Delgado, Díaz-Morales, Escribano, Collado, & Randler, 2012; Randler, 2011b), and have higher behavioral difficulties (Lange & Randler, 2011). Behavioral and academic problems would exert reciprocal influences on one another (Barriga et al., 2002).

Limitations of this study are the use of self-reported grades instead of objective data, nevertheless previous researchers have found a positive correlation between school and self-reported grades (Dornbusch et al., 1985, in Wolfson & Carskadon, 2003; Meijer, 2008). Additionally, instructions guaranteeing anonymity of the self-reported data increase the validity (Mabe & West, 1982). Moreover, the use of two different measures of academic achievement, and the high correlation between them permit us to say with some certainty that data are valid and trustworthy. Sleep reported data have also been found as a reliable measure (see Wolfson et al., 2003). Here, time of testing was not controlled and it is not possible to know phase differences among chronotypes. As future perspectives, time of testing should to be considered. Furthermore, longitudinal studies are necessary in order to consider how the shift toward eveningness differs by age as well as the influence of other factors (i.e. parental supervision, social activities) upon school achievement using a regression approach. Finally, given that M- and E-types differ in personality (Díaz-Morales, 2007) as well as intelligence (Kanazawa, 2010), and both factors have been proposed to predict school achievement and performance (Furnham & Monsen, 2009), they should be taken into account in future studies.

Conflict of interest

The authors indicate no conflicts of interest.

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