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Effects of longitude, latitude and social factors on chronotype in Turkish students

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ABSTRACT

The aim of this research was to investigate whether morningness–eveningness, midpoint of sleep and average sleep duration are associated with longitude, latitude, age, gender, inhabitation and school start times in Turkish students. 15,362 students from 9 to 21 years participated in this study. Eveningness and midpoint of sleep – but not sleep duration – increased from east to west, suggesting that longitude has an effect on chronotype. Adolescents from the southern parts of Turkey were more morning oriented, suggesting an influence of climate or latitude. Morningness was negatively and midpoint of sleep was positively related with age. Females had higher morningness scores and students from urban localities showed higher eveningness and a later midpoint of sleep.

1. Introduction

Humans have an internal clock which oscillates with a roughly 24-h rhythm. This rhythm is endogenous and functions even in temporal isolation when external zeitgeber are absent (Aschoff, 1965; Duffy et al., 2011). However, the internal body clock needs input from an external zeitgeber to synchronize the rhythm to the 24-h light–dark cycle of the earth. The human circadian clock is sensitive to light and dose–response curves have demonstrated that even dim artificial light has an influence (Boivin, Duffy, Kronauer, & Czeisler, 1996). Also, Wright et al. (2013) showed that a removal of artificial light has a major impact on entrainment because humans have a reduced exposure to sunlight during the day coupled with increased light exposure after sunset. They reported further that after exposure to only natural light, the internal circadian clock synchronizes to solar time in such a way that the beginning of the internal biological night occurs at sunset and the end of the internal biological night occurs before wake time just after sunrise. Therefore, there are two important light components. First, the natural sunlight may synchronize the human clock by sunrise and sunset. Second, artificial light at night may impact on the synchronization and on chronotype (Vollmer, Michel, & Randler, 2012).

Artificial light has been found to influence adolescents' chronotypes with adolescents living in more urbanized areas, and hence, experiencing more light at night, were later chronotypes. From this, two hypotheses arise. From the first one, we expect an earlier chronotype in the eastern parts of Turkey because of an earlier sunrise (which is directly linked to longitude), and from the second one we hypothesize later chronotypes in urban areas. The first hypothesis has been investigated only in Germany (Roenneberg, Kumar, & Merrow, 2007), where the east–west difference in longitude is approximately 9° (Germany is situated between 6° and 15°E), and the resulting difference in sunrise at 21 June is 36 min (Roenneberg et al., 2007).

Latitude has also been proposed as an influential factor of chronotype in adolescents (Randler, 2008a). Adolescents in the tropics were earlier chronotypes compared to adolescents in the North; however, adolescents in the subtropics had the highest eveningness. Within the same time zone of Europe, morningness increased from southeast to northwest. However, the study was carried out in different countries, and therefore, basing a study on only one given country seems worthwhile. In this study our third hypothesis was earlier chronotype preference to increase from northern to southern parts of Turkey because of warmer climate in the south. Smith et al. (2002) suggested that in warmer regions people start the day earlier in order to cope with increasing heat.

Also, age and gender effects are well-known influential factors with an increasing eveningness from childhood to puberty, and a change

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back towards morningness in the later years of life (Adan et al., 2012; Randler, Vollmer, Beşoluk, Önder, & Horzum, 2014). In addition, many studies found gender effects with girls sleeping longer and being earlier chronotypes, however, there is only a small effect size and studies are less consistent compared to studies with the age effects (Adan et al., 2012; Randler et al., 2014).

Social factors have often been neglected in the association of chronotypes, but meal times as well as school start times can be zeitgeber for the circadian rhythm (Leonhard & Randler, 2009; Jankowski, Vollmer, Linke, & Randler, 2014). Randler et al. (2014) indicated that familial demands, school environment and university entrance examination may have an effect in students' chronotype preference.

In the current study, we used data from Turkey, which provides a large east–west extension within one given time zone and moderate north–south extension. The difference in longitude is 19° (between 26°E and 45°E) which is twice the range of Germany and the difference in latitude is 6° (between 36°N and 42°N) which is similar to Germany. Turkey has only one time zone which is important because time zones may reflect social times (e.g. when lunch is at 12:00; Jankowski et al., 2014). In addition, Turkey is situated in the Mediterranean, rendering the seasonal fluctuations in photoperiod smaller compared to Germany. Sampling within one country sharing the same language is beneficial because questionnaires may be influenced by translations into different languages (Randler & Díaz-Morales, 2007) which, in turn, could influence the results.

2. Method

2.1. Participants

A total of 15,362 students from 25 cities participated in this study. These cities were selected according to their longitude and latitude. The sampling was carried out considering the location of the students' home within a given city to ensure that urban and suburban units from the same district are represented with an approximately equal proportion. Approximately, 8 to 10 schools from each city were included. The geographic coordinates were from 26°E to 44°E and from 36°N to 42°N; thus comprising 18° longitude and 6° latitude. Participation was voluntary, unpaid and anonymous. The age ranged from 9 to 21 and the average age of students was 14.26 (±2.07, SD) years. 7167 (46.65%) participants were elementary school students from 121 schools in 4th through 8th grade while 8195 (53.35%) were high school students from 101 schools in 9th through 12th grade. Oral informed consent from the participants has been obtained.

2.2. Instruments

The Composite Scale of Morningness (CSM; Smith, Reilly, & Midkiff, 1989) was used to assess morningness–eveningness preferences. The CSM is composed of 13 Likert scale items and the total score varies from a minimum of 13 (extreme eveningness) to a maximum of 55 (extreme morningness). The CSM was adapted to Turkish by Önder, Beşoluk, and Horzum (2013). Cronbach's Alpha coefficient of the scale was .73 in this study. In addition, we asked for habitual sleep–wake variables (wake time, rise time, bed time, sleep onset time; referring to the past school weeks) on weekdays and on weekends to calculate sleep duration and corrected midpoint of sleep in free days (MSF_{sc}) (see Roenneberg et al., 2004). We used a proxy for MSF_{sc} as we corrected mid-point of sleep for sleep debt on weekends rather than on free days. Average sleep duration (ASD) was calculated (5*weekday + 2*weekend sleep duration)/7.

The CSM has been found to be a valid scale in adults (Di Milia, Adan, Natale, & Randler, 2013), while in adolescents and children, there is an ongoing discussion about the usefulness of different instruments (Tonetti, Adan, Di Milia, Randler, & Natale, 2015). These authors suggest using the children's version of the Morningness–Eveningness-Questionnaire, but their suggestion was just available after the study has been conducted. Nevertheless, the CSM might still be considered an applicable instrument because it has good internal consistency, and also some convergent validity evidence (such as cortisol measures, see, Tonetti et al. for the review). Also, the CSM and the MEQ for children have some items in common. To our knowledge, the two scales have never been applied together, which should be urgently done to check to what extent they are correlated [only Önder et al. (2013) correlated CSM and MEQ in a high school sample with 0.75].

2.3. Procedure and data analysis

The scales were administered between December 2012 and March 2013. We used linear regression analyses in SPSS 20 and 439 cases with missing data were not included in the analyses.

While investigating the distribution of chronotypes with respect to longitude and latitude; and performing separate age groups (prepubertal/postpubertal) regression analysis, the sample was divided into age groups by the help of data presented in the studies of Yazıcı, Dolgun, Öztürk, and Yilmaz (2011) and Ersoy, Balkan, Gunay, Onag, and Egemen (2004). Before dividing the groups, the distribution of each age (9–21) were investigated and it was found that there were few students at age 9, 10, 19, 20 and 21. Therefore, we have excluded students of these ages. Yazıcı et al. (2011) presented the average age at which puberty begins as 8–13 for girls and 9–14 for boys. Meanwhile, Ersoy et al. (2004) presented that the mean menarcheal age of Turkish girls in Turkey is around 12.8 years. Therefore, the age of 13 for girls and the age of 14 for boys were selected as cut off points for the puberty. Ages below that cut off points were categorized as prepubertal and ages above that cut off points were categorized as postpubertal. Moreover, students were categorized as evening, neither and morning types using 10th and 90th percentiles as suggested by Smith et al. (1989). The cut off points for CSM scores in this study emerged as 29 and 45, respectively. The distribution of chronotypes with respect to longitude/latitude, inhabitation and age groups were presented in the Appendices 3, 4, 5 and 6.

3. Results

Descriptive statistics of the sample are presented in Table 1. In addition, distribution of chronotypes with respect to age groups (prepubertal/postpubertal), inhabitation and longitude/latitude are presented in Appendices 3 and 4. First, we conducted three linear regressions with age, gender, inhabitation (urban vs. rural), school start time,

Table 1
Descriptive statistics.

		n	Mean	SD
Female	Age	7855	14.30	2.06
	CSM	7855	37.46	6.06
	MSF	7855	3:50	1:04
	ASD	7855	8:59	0:50
Male	Age	7068	14.22	2.09
	CSM	7068	37.11	6.14
	MSF	7068	3:54	1:07
	ASD	7068	8:57	0:49
Urban	Age	10,717	14.37	2.03
	CSM	10,717	36.98	6.20
	MSF	10,717	3:58	1:08
	ASD	10,717	8:58	0:51
Suburban	Age	4645	14.03	2.14
	CSM	4645	38.03	5.80
	MSF	4645	3:37	0:57
	ASD	4645	8:58	0:48
Total	Age	15,362	14.26	2.07
	CSM	15,362	37.30	6.10
	MSF	15,362	3:52	1:06
	ASD	15,362	8:58	0:50

CSM = Composite Scale of Morningness, MSFsc = midpoint of sleep (corrected), ASD = average sleep duration.