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Cross-cultural comparison of seven morningness and sleep–wake measures from Germany, India and Slovakia

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Morningness–eveningness or circadian typology can be viewed as an interesting aspect of individual differences. Morningness–eveningness is a preference for a given time of day for physical or mental performance, but also reflects aspects of affect. Here, we used seven different measures to assess differences in morningness–eveningness between Germany, Slovakia and India. The hypothesis was that Indians should be earliest chronotypes, followed by Slovakia and then Germany, because of higher temperatures in India, and the fact that Slovakia is located farther east compared to Germany. We applied the Composite Scale of Morningness (CSM), the Circadian Energy Scale (CIRENS), the CAEN Chronotype Questionnaire (CCQ), and habitual sleep–wake variables to calculate sleep duration, midpoint of sleep and social jetlag. Sample sizes were $N = 300$ (Germany), $N = 482$ (Slovakia) and $N = 409$ (India). Country had the strongest influence on morningness–eveningness. Germans were latest chronotypes and differed in all seven measures from Indians but differed from Slovakians only in the energy level at the evening and midpoint of sleep. Slovakians and Indians differed in all measures but the energy level (CIRENS). Women scored higher on the CSM, lower on CIRENS, lower on the morningness–eveningness (ME) scale, but higher on distinctness (DI) scale. Women slept longer and had an earlier midpoint of sleep.

Keywords: Chronotype; Morningness–eveningness; Sleep; Cross-cultural comparison; Gender.

Morningness–eveningness and sleep–wake variables have received much attention during the preceding decades. The increase in studies on this topic started with the Horne and Ostberg Morningness–Eveningness Questionnaire (MEQ) and is still an ongoing topic with many relations to different life facets (see for a review: Adan et al., 2012). Different questionnaires have been used and an actual review covers the most recent state (Di Milia, Adan, Natale, & Randler, 2013).

Morningness–eveningness or circadian typology can be viewed as an interesting aspect of individual differences (Adan et al., 2012). Morningness–eveningness (M/E) covers a preference for a given time of day for physical or mental performance, but also reflects aspects of affect, for example by asking for the feeling immediately after awakening or by assessing daily fluctuations in attention (Escribano & Díaz-Morales, 2014) or mood (Jankowski, 2014). These preferences are partly based on a genetic influence and are heritable (e.g. Barclay, Watson, Buchwald, & Goldberg, 2014). Morningness–eveningness is further reflected in physiological measurements. For example, body temperature variation during the day is related to M/E with evening types reaching their nadir of body temperature later than morning types (Baehr, Revelle, & Eastman, 2000) or with later melatonin onset in evening types (Burgess & Fogg, 2008). Age and sex/gender differences have been found in many studies with usually clear age effects but sometimes inconclusive gender effects. Children are morning-oriented at the age of kindergarten (Randler & Truc, 2014) but turn towards eveningness during puberty, reaching their peak of lateness between 17 and 20 years (Randler, 2011; Roenneberg et al., 2004). Then people become progressively more morning-oriented. Concerning gender, some studies found an influence and others not (Randler, 2007), but when differences have been found, usually men and boys scored higher on evening orientation and women and girls slept longer (Duffy et al., 2011;

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Randler, 2007). However, M/E or chronotype is also somewhat flexible and different environmental influences have been reported (Tonetti, Sahu, & Natale, 2012). Some studies also addressed social influence and social schedules on morningness–eveningness. For example, there is an influence of children and work on morningness–eveningness with mothers being forced to be earlier chronotypes (Leonhard & Randler, 2009). Also, having a full-time job and having children lead to a higher morningness score (Vedaa, Bjorvatn, Magerøy, Thun, & Pallesen, 2013).

Several aspects have been discussed with regard to the different circadian types in different countries and environments. Adan and Natale (2002) and Natale, Adan, and Fabbri (2009) found a higher eveningness in Spanish students compared to Italians, Randler and Díaz-Morales (2007) showed higher morningness in German compared to Spanish university students, and Smith et al. (2002) found a higher evening orientation in warmer climates. In a cross-national study, Randler (2008) argued that climate may have an influence on morningness–eveningness with adolescents residing in warmer climates are more morning-oriented. Also, latitude and longitude may have an impact on the sleep–wake cycle with people living in a more eastern region (within the same time zone) should be more morning-oriented. Concerning longitude, sunrise is earlier in the east compared to the west. Thus, longitude should exert an influence on M/E because sunrise is an external synchroniser of the circadian clock (Roenneberg, Kumar, & Merrow, 2007). Latitude has been found a predictor because people living near the equator were earlier chronotypes compared to people living in the northern countries (Randler, 2008). However, it does not follow a clear trend because people living in the subtropics are the latest chronotypes (Randler, 2008). One would expect a clear pattern with earliest chronotypes in the tropics, and latest chronotypes in the North. These results could not be easily explained and temperature could be an explanation, but temperature might also be seen as a proxy or confounder of latitude. Tonetti et al. (2012) argued that climate might be responsible for the higher morningness in Indian compared to Italian students and Smith et al. (2002)—by comparing University students from six countries—reported that those from warmer geographic regions (i.e. Colombia, Spain and India) were more morning-oriented than from colder climates (USA, Great Britain and Netherlands). The question whether it is latitude or temperature is still unresolved because both variables are somewhat confounded. Another aspect might be imprinting by photoperiod shortly after birth (Natale & Di Milia, 2011). These authors found that more evening types were born during the seasons associated with longer photoperiod (spring and summer), and more morning types were born during the seasons associated with shorter photoperiod (autumn and winter).

Current study

We go beyond previous work because we used different instruments to shed light on the cultural differences: the Composite Scale of Morningness (CSM) that is already reviewed by Di Milia et al. (2013), and sleep–wake variables to calculate midpoint of sleep, average sleep duration and social jetlag (Roenneberg et al., 2004; Wittmann, Dinich, Merrow, & Roenneberg, 2006). In addition, we applied the newly developed instruments, CIRENS (Ottoni, Antoniolli, & Lara, 2011) and the CAEN Chronotype Questionnaire (CCQ; Dosseville, Laborde, & Lericollais, 2013) that have not been covered by the review (Di Milia et al., 2013). The CIRENS was especially developed to achieve a short and balanced measure with only two items but focusing on the energy level, an aspect that has been widely neglected in previous work. The CAEN was developed because (a) some measures as the CSM are skewed towards morning items and the M/E scale of the CAEN seeks a more balanced item selection and (b) the CAEN tries to measure amplitude in addition to only M/E.

In addition, these measures are applied in three different countries: Germany, Slovakia and India to assess if differences in sleep–wake behaviour between those countries exist. India differs in temperature from both European countries, and Slovakia is located more easterly in the Central European time zone. The hypothesis is that Indians should be earliest chronotypes, followed by Slovakia and then Germany. To avoid seasonal effects, we sampled data from September to December.

METHODS

Measurement instruments

Composite Scale of Morningness (CSM)

The CSM is a 13-item measurement with 10 items coded 1–4 and 3 items coded 1–5 to assess morningness–eveningness preference. Example items are "How alert do you feel during the first half hour after having awakened in the morning," or "Considering only your 'feeling best' rhythm, at what time would you get up if you were entirely free to plan your day?" High scores represent high morningness. The CSM has been found to be a reliable measurement for circadian typology (Di Milia & Randler, 2013; Di Milia et al., 2013). Cronbach alpha for the present samples was .876 in Germany, .817 in Slovakia and .777 in India. Mean interitem correlations were .356 for Germany, .256 for Slovakia and .218 for India.

Circadian Energy Scale (CIRENS)

This scale was developed by Ottoni et al. (2011) and is designed to measure energy at two times of the day, during the morning and during the evening (e.g. for morning: "In general, how is your energy level in the morning?"). The scale is coded from 1 (*very low*) to 5 (*very high*). Chronotype (morningness–eveningness) classification was determined by subtracting the morning from the evening energy score. Therefore, in the dimensional evaluation, the CIRENS chronotype score ranges from −4 (*most marked morning preference*) to 4 (*most marked evening preference*). Although it is based on only two items, we here report the alpha levels: these are .593 in Germany, .501 in Slovakia and .332 in India. The alpha levels of the scale are low, which is a result of this two-item measure. Other studies did not provide an alpha level but Ottoni et al. (2011) provide convergent validity of their measure with the MEQ (correlation of −.7).

CAEN Chronotype Questionnaire (CCQ)

This scale is a further development and improvement of Oginska's (2011) scale. Initially, the questionnaire was aimed at describing two dimensions of chronotype: subjective phase, that is, morning–evening preference (ME scale, eight items) and subjective amplitude, that is, distinctness of the diurnal rhythm of activation (DI scale, six items). Dosseville et al. (2013) improved and validated this scale with a balanced number of items (eight for each construct). These 16 items were applied in this study. The items are coded from 1 (*totally disagree*) to 5 (totally agree). Example items are "I can work efficiently at any time of the day" (DI, reverse coded), or "I feel sluggish in the morning and I warm up slowly during the day" (ME). The ME scale had four reversed items, and the DI scale five reversed items. High scores on the ME dimension represent eveningness—which is different from the other well-established scales where high scores represent high morningness. A high score of the DI scale represents a high amplitude (i.e. differences between morning and evening). Cronbach alpha for the ME part was .797 in Germany, .688 in Slovakia and .600 in India; interitem correlations were .372 in Germany, .248 in Slovakia and .181 in India. Cronbach alpha for the DI part was .849 in Germany, .683 in Slovakia and .615 in India; interitem correlations were .421 in Germany, .216 in Slovakia and .166 in India.

Habitual sleep–wake variables

Habitual sleep–wake variables were asked with open-ended questions based on clock times: Wake time, get-up time, bed time, sleep onset time; both for weekdays and for weekends/free days. From these raw data it is possible to calculate three variables: average sleep duration, midpoint of sleep and social jetlag. Average sleep duration is calculated by 5 × weekday sleep duration + 2 × weekend sleep duration divided by 7. Midpoint of sleep is a measure of chronotype because it has been reported as phase anchor point for melatonin onset (Roenneberg, Wirz-Justice, & Merrow, 2003). Midpoint of sleep is the midpoint ("half way") between awakening and sleep onset in clock time. We calculated midpoint of sleep based on sleep onset time (after subtracting sleep onset latency) and awakening time. Midpoint of sleep on free days appears to represent best one's internal chronotype. We applied an algorithm to correct for the midpoint of sleep because people sleep longer at the weekends compared to weekdays. This algorithm was proposed by Roenneberg et al. (2004): $MSF_{sc} = MSF - 0.5 \times [SD_F - (5 \times SD_W + 2 \times SD_F)/7]$. SD_W is sleep duration on weekdays and SD_F is sleep duration on free days. MSF is the midpoint of sleep on free days. MSF_{sc} is the corrected midpoint of sleep on free days (corrected for longer sleep duration on free days). Social jetlag is the difference between midpoint of sleep on free days and midpoint of sleep on week days (Wittmann et al., 2006).

Participants and data collection

Germany

Data were collected from October to December 2013 from students and older adults ($N = 300$; male: 67, females: 231) around Heidelberg, southwest Germany. Mean age was 29.37 ± 13.78, range 16–75 years, but 75% were between 18 and 30 years. The average actual temperature was 16 (September), 12 (October), 5.8 (November) and 5°C (December), respectively (www.wetterkontor.de). Data were collected during different days and at different clock times between 8:00 and 19:00. Participation was voluntary, unpaid and anonymous. Usually there is no University schedule on Saturday and most people work Monday–Friday.

Slovakia

Data were collected from Trnava University students in Slovakia between October and December 2013 ($N = 482$; male: 87, females: 395). Mean age was 20.56 ± 4.27, range, 15–52 years, but 95% between 18 and 30. The average actual temperature in October, November and December were 13, 7 and 2°C, respectively (www.shmu.sk). The questionnaires were administered to groups of students (approximately 30–50 students per group) by one of the investigators (PP). Students were not time-limited during the completion of the questionnaire. The participation was anonymous, voluntary and unpaid. All students were prospective teachers, predominantly from first grade. Data were collected on Monday, between 08:00 and 15:00. Most people work Monday–Friday.

India

Data were collected from male and female University students of University of Kalyani and colleges affiliated to this University, India between September and November (post-monsoon season) 2013 ($N = 409$; male: 189, females: 220). Mean age was 20.02 ± 1.23, range, 18–23 years. The average actual temperature in September, October and November were 30, 28 and 24°C respectively (www.accuweather.com). The questionnaires were administered during classes by the investigators or research scholars with groups ranging from 10 to 20 students. The participation was anonymous, voluntary and unpaid. Students provided informed consent prior to participation in the study. The questionnaires were in English. The students read and wrote English from primary level, so they were quiet acquainted with English language and understood the questionnaire. Only some terms such as morning type, evening type were explained in Bengali. The University of Kalyani is located at a semiurban area. Students mainly from nearby districts (Nadia and Murshidabad) are studying here. The subjects are mainly day boarders or residential and they do not have an access to temperature controlled environment. The University lesson starts at 10.30 and ends at 17.00 hours but in science department sometimes the schedule time extended up to 19.00 hours for practical classes. The University schedules classes for 5 days per week (Monday–Friday) but sometimes special classes are arranged on Saturdays also.

Statistical analyses

There were about 1% missing data that were imputed by the replace-by-mean procedure. This procedure was applied separately for every country. Chi-square test was used to assess differences in the distribution of gender across countries with standardised residuals of the test larger than 2.6 considered as significant. We used general linear models (multivariate with subsequent univariate models) based on age as covariate, gender and country as fixed factors. Owing to the high sample size, we considered .001 as a significance level for the multivariate analyses and Bonferroni adjustment was made for the univariate models. We discuss only effect sizes of 1% and higher (partial η^2). To visualise the differences between the countries based on all variables, multidimensional scaling was used (proxscal). We used the mean scores of every scale, separated for gender and country for the multidimensional scaling. SPSS 20 was used for all analyses.

RESULTS

Participants differed in their age, one-way ANOVA F (2, 1187) = 165, $p < .001$, with Germans being older compared to Indians (*post-hoc* test $p < .001$) and Slovakians (*post-hoc* test $p < .001$) but with no difference between Indians and Slovakians ($p = .86$). Therefore, age was used as covariate in the linear models. Gender distribution was significantly different between the countries ($\chi^2 = 93.33$, $p < .001$, $df = 2$). In Slovakia and Germany there were more women than men, but in India it was balanced. The correlation between the different measures are shown in Table 1 (please note that the ME scale of the CAEN is inverted). Country had the highest effect in the multivariate model, followed by age and gender (Table 2). The interaction between gender and country was significant but effect size was low (1.3% of variance explained). In the univariate models, age and country had a significant effect on all variables (Table 3). Gender had a significant influence on MSF, ME and DI; significant yet negligible effects (1%) on CSM scores, CIRENS and average sleep duration. The Country × Gender interactions were non-significant with the exceptions of ME and DI, however, their effect sizes were below the threshold of 1% and will not be discussed further.

Post-hoc comparisons revealed significant differences in CSM scores between India and Germany ($p < .001$) and Slovakia ($p < .001$) but not between Germany and Slovakia ($p = .160$). Indians had an earlier preference. CIRENS difference was found between Germany and India ($p < .001$) and Slovakia ($p = .043$), but no difference existed between Slovakia and India ($p = .087$). Germans scored higher on evening orientation. Concerning the ME scale of the CAEN, we found differences between India and Germany ($p < .001$) as well as Slovakia ($p < .001$). The Indian participants scored lower on evening orientation compared to the both European countries. Similarly, the DI scale differed between Indians and Germans ($p < .001$) and Slovakians ($p < .001$) but not between Germans and Slovakians ($p = .9$). These differences on the DI scale suggest that Indians have a lower amplitude, thus the differences between evening and morning are attenuated. Average sleep duration was similar in comparison between Germany and Slovakia ($p = .195$) but participants from both countries slept longer than participants from India (both $p < .001$). Concerning midpoint of sleep, there were differences among all countries ($p < .001$). Germans had the latest midpoint of sleep and Indians the earliest. Social jetlag was lower in India compared to Germany ($p < .001$) and Slovakia ($p < .001$), whereas there was no difference between Germany and Slovakia ($p = .096$).

Gender differences existed in all variables except in social jetlag (see Table 4). Women scored higher on the CSM, lower on CIRENS, lower on the ME scale of the CAEN but higher on DI. Women slept longer and had an earlier midpoint of sleep.

We applied a multidimensional scaling on the variables and on the countries. The scaling showed that the three measures that were based on the clock times clustered together, CIRENS and the ME scale of the CAEN

TABLE 1
Correlations between the seven different measures of morningness, sleep and chronotype, separately for each country (Germany: $N = 300$, Slovakia: $N = 482$, India: $N = 409$)

		CSM	*CIRENS*	*ME*	*DI*	*Average sleep duration*	*Midpoint of sleep*
Germany							
CIRENS	*r*	−.696					
	p	<.001					
ME	*r*	−.800	.800				
	p	<.001	<.001				
DI	*r*	−.311	.077	.215			
	p	<.001	.184	<.001			
Average sleep duration	*r*	−.115	.013	.121	.243		
	p	.046	.823	.036	<.001		
Midpoint of sleep	*r*	−.564	.343	.412	.133	.164	
	p	<.001	<.001	<.001	.021	.004	
Social jetlag	*r*	−.286	.237	.249	.119	−.121	.619
	p	<.001	<.001	<.001	.039	.037	<.001
Slovakia							
CIRENS	*r*	−.496					
	p	<.001					
ME	*r*	−.643	.665				
	p	<.001	<.001				
DI	*r*	−.221	.001	.143			
	p	<.001	.989	.002			
Average sleep duration	*r*	.095	−.239	−.130	.125		
	p	.037	<.001	.004	.006		
Midpoint of sleep	*r*	−.429	.232	.292	.046	−.113	
	p	<.001	<.001	<.001	.318	.013	
Social jetlag	*r*	−.270	.105	.212	.038	−.204	.608
	p	<.001	.021	<.001	.410	<.001	<.001
India							
CIRENS	*r*	−.712					
	p	<.001					
ME	*r*	−.595	.598				
	p	<.001	<.001				
DI	*r*	−.167	.061	.194			
	p	.001	.219	<.001			
Average sleep duration	*r*	−.122	−.001	.126	.217		
	p	.013	.985	.011	<.001		
Midpoint of sleep	*r*	−.718	.498	.372	.052	−.009	
	p	<.001	<.001	<.001	.294	.850	
Social jetlag	*r*	−.308	.149	.152	.043	−.011	.489
	p	<.001	.002	.002	.391	.828	<.001

TABLE 2
Results of the multivariate general linear model with the seven measures of chronotype as dependent variables

	Wilks' lambda	F	p	*Partial* η^2
Constant	.008	21358.548	<.001	.992
Age	.848	30.097	<.001	.152
Country	.615	46.252	<.001	.216
Gender	.938	11.19	<.001	.062
Country × Gender	.974	2.198	.006	.013

were close together, whereas the CSM and the DI scale of the CAEN appeared different (Figure 1). Normalised raw stress was very good (.0048) and Tucker's coefficient was high .997. Another scaling was applied on the six groups of country and gender (Figure 2). Raw stress was .0015, Tucker's coefficient was .999. Indian men and women clustered together, whereas Slovakian and German men built a separate group from German and Slovakian women.

DISCUSSION

This study compared the sleep–wake behaviour of participants from Germany, Slovakia and India. In general, differences between the two European countries were smaller when compared with India. The results showed that Indians are more morning-oriented than Germans and Slovakians. These country effects could be best explained with differences in temperature because Slovakia and Germany have a more or less similar climate

TABLE 3
Results of the univariate analyses

	Dependent variable	df	F	*Sig.*	*Partial* η^2
Corrected model	CSM score	6	25.644	<.001	.115
	CIRENS score	6	5.782	<.001	.029
	ME score	6	16.252	<.001	.076
	DI score	6	31.185	<.001	.137
	Average sleep duration	6	42.317	<.001	.177
	Midpoint of sleep corrected	6	36.159	<.001	.155
	Social jetlag	6	69.825	<.001	.262
Age	CSM score	1	55.549	<.001	.045
	CIRENS score	1	17.963	<.001	.015
	ME score	1	37.278	<.001	.031
	DI score	1	74.079	<.001	.059
	Average sleep duration	1	38.311	<.001	.031
	Midpoint of sleep corrected	1	98.738	<.001	.077
	Social jetlag	1	48.903	<.001	.04
Country	CSM score	2	55.538	<.001	.086
	CIRENS score	2	9.838	<.001	.016
	ME score	2	27.013	<.001	.044
	DI score	2	19.111	<.001	.031
	Average sleep duration	2	80.558	<.001	.12
	Midpoint of sleep corrected	2	86.724	<.001	.128
	Social jetlag	2	186.041	<.001	.239
Gender	CSM score	1	11.863	.001	.01
	CIRENS score	1	11.315	.001	.009
	ME score	1	20.626	<.001	.017
	DI score	1	30.667	<.001	.025
	Average sleep duration	1	9.041	.003	.008
	Midpoint of sleep corrected	1	20.889	<.001	.017
	Social jetlag	1	3.149	.076	.003
Country × Gender	CSM score	2	2.666	.070	.004
	CIRENS score	2	2.852	.058	.005
	ME score	2	5.041	.007	.008
	DI score	2	3.733	.024	.006
	Average sleep duration	2	2.229	.108	.004
	Midpoint of sleep corrected	2	1.401	.247	.002
	Social jetlag	2	.867	.421	.001

TABLE 4
Estimated marginal means (derived from the linear model) with SE according to gender and country

	Germany						*Slovakia*						*India*					
	Men		*Women*		*Total*		*Men*		*Women*		*Total*		*Men*		*Women*		*Total*	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
CSM	31.01	0.76	33.94	0.43	32.48	0.45	33.32	0.65	33.90	0.31	33.61	0.36	37.11	0.44	37.94	0.41	37.53	0.31
CIRENS	0.72	0.19	0.06	0.11	0.39	0.11	0.20	0.16	−0.15	0.08	0.026	0.09	−0.21	0.11	−0.26	0.10	−0.23	0.08
ME	3.30	0.10	2.91	0.05	3.10	0.06	3.31	0.08	3.00	0.04	3.154	0.05	2.76	0.06	2.74	0.05	2.75	0.04
DI	3.29	0.08	3.59	0.05	3.44	0.05	3.26	0.07	3.62	0.03	3.44	0.04	3.11	0.05	3.21	0.05	3.16	0.03
Average sleep duration	7:54	0:08	8:12	0:05	8:03	0:05	7:41	0:07	8:02	0:03	7:52	0:04	6:59	0:05	7:01	0:04	7:00	0:03
Midpoint of sleep	05:37	0:10	05:00	0:05	05:19	0:06	04:48	0:08	04:30	0:04	04:39	0:05	03:59	0:06	03:42	0:05	03:50	0:04
Social jetlag	2:07	0:07	1:56	0:04	2:02	0:04	1:54	0:06	1:46	0:03	1:50	0:03	0:42	0:04	0:42	0:04	0:42	0:03

in Central Europe, whereas India differs strongly from Central Europe. We could confirm the hypothesis of Tonetti et al. (2012), who argued that climate might be responsible for the higher morningness in Indians compared to Central Europeans. Also, these results are in line with Smith et al. (2002), where students from warmer geographic regions were more morning-oriented than students from colder climates. Differences between Slovakia and Germany were small but occurred in CIRENS with more evening energy in Germans, and in midpoint of sleep with an earlier midpoint of sleep in Slovakians. This suggests that Slovakians are rather similar in their sleep behaviour when compared to Germans, but are slightly earlier chronotypes in two of seven measures.

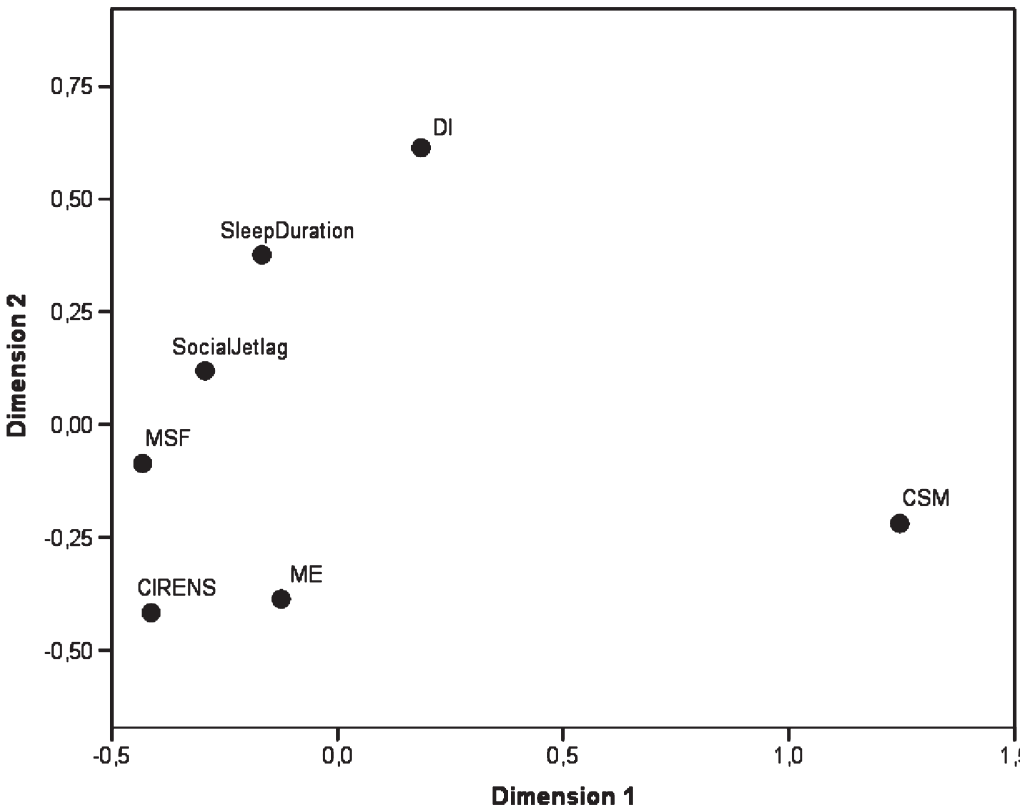

Figure 1. Two-dimensional scaling (proxscal) of the seven measures of sleep–wake behaviour and morningness–eveningness.

As temperature might not be an adequate explanation for the Germany–Slovakia comparison, we hypothesise that Slovakians tend to be earlier chronotypes because they are located more easterly within the same time zone, suggesting an influence of longitude, which suggests that sunrise acts as a synchroniser of the circadian clock (Roenneberg et al., 2007). This study, thus, contributes to our knowledge of chronotype and sleep behaviour and it is based on an adequate sample size and on many different measurements.

Other interpretations might be observed in social factors. For example, Vedaa et al. (2013) reported that in Norwegian nurses, the number of children and full-time job are predictors of morningness scores. We did not assess these variables, because the study was based mainly on students (although some of the students have part-time jobs), and most of the students did not have children. The study could be repeated based on working adults, and thus, these predictors might have a significant influence because the number of children is higher in India compared to Slovakia and Germany, which could explain the earlier chronotype. In addition, countries differ in their social values and this could be related to chronotype. For example, Vollmer and Randler (2012) showed that morningness was related to higher social values, whereas eveningness was related to higher individual values.

This study confirms well-known gender effects with women belonging to an earlier chronotype and with longer sleep duration. Some previous studies could not establish gender differences but this could be mainly because of lower sample sizes or because of high age variation (see here Randler, 2007, for a meta-analysis). Men and women differ in morningness orientation when it is based on physiological measurements, such as body temperature, tau (“internal body clock”) and melatonin secretion. Duffy et al. (2011) found that the intrinsic circadian period was significantly shorter in women than in men. Non-significant results may arise from a large variance in age (Randler, 2007) or from the questionnaire, because some morningness questionnaires might be better suited to detect differences (Randler, 2007). The negligible interaction effects between gender and country suggest that the differences between men and women are similar in all three countries.

The multidimensional scaling showed that the scales are different and that the three measures calculated from the clock times clustered well together—average sleep duration, midpoint of sleep and social jetlag. This is interesting because sleep duration is independent of the midpoint of sleep in most studies (Roenneberg et al., 2004). However, as both variables are calculated from the same clock times, this might be the reason why they cluster together. CSM is closest to ME and to DI, and

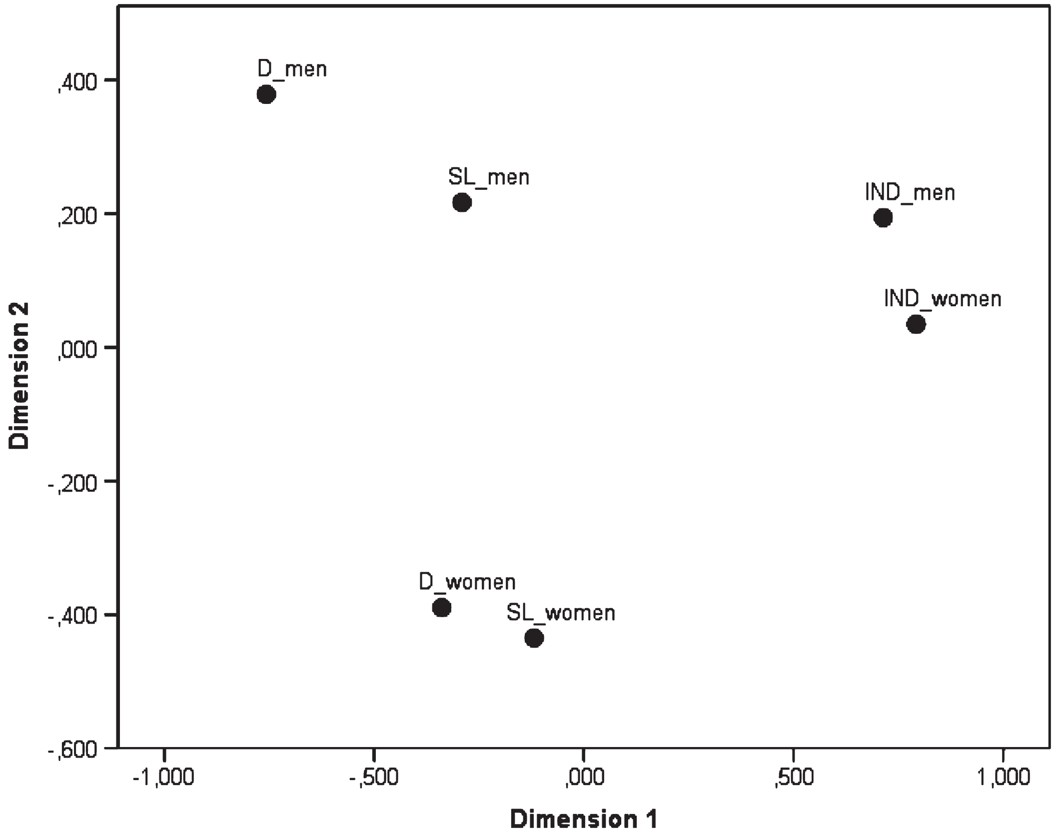

Figure 2. Two-dimensional scaling (proxscal) of the six different groups of participants (men/women) from three countries. D = Germany, SL = Slovakia, IND = India.

this confirms that both are measuring a related construct. CSM and ME both assess morningness–eveningness, but the ME scale has some items especially designed for the evening that lack in the CSM.

Concerning the measures of the new scales, the DI scale measures some kind of amplitude that could be seen as an advancement of the previous scales (e.g. the CSM) but rather as an addition than as a replacement. This different measure is reflected in the correlations of this scale with the CSM or the MSF—they are lower and thus suggest that it is an independent measure or construct. Using a scale dealing with amplitude during the day may advance our knowledge about circadian rhythm fluctuations (Oginska, 2011). In addition, using the CIRENS might be helpful for future work because it was one of the two measures that revealed differences between Germans and Slovakians.

One strength of this study was that we assessed morningness–eveningness and chronotype with many different measures and that the sampling was made from September to December 2013, to avoid seasonal effects and to avoid effects by different years of sampling. One limitation is that the data were sampled by self-report questionnaires and that no objective behavioural measures, such as actigraphy, have been applied. However, this is difficult in large samples and Thun et al. (2012) have shown that the self-report scales have a good convergent validity with actigraphically measured behaviour.

A weakness is the low reliability (Cronbach alpha) of some of the Indian scales. This might be a matter of translation, however, the Indian CSM had acceptable psychometrics, so the issue for further research might be to specifically analyse and refine the Indian versions of the other questionnaires. Probably, some aspects such as the fluctuations and/or the amplitude might be different because of the climate. The CIRENS has a low reliability, which may be a result of its only two items. However, the CIRENS showed good correlations with the well-established measure CSM in Germany and India (Table 1). Concerning the CAEN, high scores on the ME scale represent higher eveningness. This is a bit counterintuitive, because other scales are different and high scores represent high morningness. Probably, future studies might use the inverted score of the ME scale. Further studies should assess which of these measures—and especially of the new measures—are better suited to measure morningness and chronotype.

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