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ARTICLE



Assessing circadian preferences in Portuguese adolescents: development and preliminary validation of a reduced Morningness–Eveningness Questionnaire

Pedro F. S. Rodrigues^{a,b*}, Josefa N. S. Pandeirada^{a*}, Pedro Bem-Haja^{a,b*},
Patrícia I. Marinho^c, Natália Lisandra Fernandes^a, Lígia Ribeiro^d and Carlos F. Silva^a

^aCINTESIS.UA, Department of Education and Psychology, University of Aveiro, Aveiro, Portugal; ^bIBILI, University of Coimbra, Coimbra, Portugal; ^cSASUA, University of Aveiro, Aveiro, Portugal; ^dDivision of Local Development, Municipality of Águeda, Águeda, Portugal

ABSTRACT

Our work aimed to provide a validated reduced form of the Morningness–Eveningness Questionnaire to Portuguese adolescents (ages: 12–14 years). Using the dataset from the initial validation study of the full questionnaire (19 items) to Portuguese adolescents, we derived a 10-item reduced form – aMEQ-R (Phase 1); this was the smallest set of items that allowed us to obtain acceptable internal consistency. This reduced version was then submitted to an independent validation study (Phase 2). Participants in this phase responded to our reduced 10-item version and, 3–4 weeks later, the same participants responded to the full Morningness–Eveningness Questionnaire. In both sessions we also assessed trait-anxiety, a variable that has been related to chronotype in order to obtain an additional measure of validation. Acceptable internal consistency was obtained in this dataset, such as Cronbach's $\alpha = .717$, as well as other indexes (e.g. classification agreement). Moreover, we confirmed that the aMEQ-R is sensitive to capture the usually reported relation between an eveningness tendency and higher trait-anxiety. In this preliminary study, we propose a suitable reduced instrument to assess chronotype in Portuguese adolescents.

Abbreviations: aMEQ-R: Reduced form of the Morningness–Eveningness Questionnaire for Adolescents; aMEQ: Morningness–Eveningness Questionnaire for Adolescents; MEQ: Morningness–Eveningness Questionnaire; CSM: Composite Scale of Morningness; TASC: Trait Anxiety Scale for Children; SM: Supplemental Material.

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Chronotype; Portuguese adolescents; reduced form; Morningness–Eveningness Questionnaire; psychometric properties; trait-anxiety

Morningness–eveningness (or chronotype) corresponds to an individual difference related to circadian rhythms which reflects itself in daily fluctuations of several biological and psychological dimensions (Adan et al. 2012; Díaz-Morales and Escribano 2014). Individuals can be classified in three chronotypes: morning- (or “lark”), intermediate-,

CONTACT Josefa N. S. Pandeirada ✉ josefa@ua.pt 📠 Department of Education and Psychology, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

*The first three authors share first authorship in this work.

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and evening- (or “owl”) types. Morning-types are phase-advanced in biological and behavioral parameters, choosing to do mental and/or physical activities early in the day, and also to go to bed and get up early. In contrast, the evening-types prefer to do their activities at late schedules. Individuals who do not have a clear preference for early or late times are classified as intermediate-types (Adan et al. 2012; Tonetti et al. 2015).

Morningness–eveningness preferences change during human development (Randler et al. 2017) with children being more morning-oriented but, as adolescence progresses, individuals begin to show a tendency to eveningness (Tonetti et al. 2015). This shift towards eveningness occurs usually around the age of 12–14 years, and has been mostly explained by biological transformations that occur during adolescence, although environmental factors have also been identified (Díaz-Morales and Escribano 2014; Tonetti et al. 2015). The idea that eveningness increases during adolescence and tends to reduce as adolescence ends is relatively consensual (Giannotti et al. 2002). Regarding sex, no systematic differences between sexes have been reported in adolescents (Gelbmann et al. 2012; Rodrigues et al. 2016).

The dynamics of chronotype during adolescence are of particular interest not only to understand the chronotype changes that occur during this period, but also because morningness–eveningness preferences relate to specific personality traits and to specific physical and psychological problems (Gau et al. 2007). Whereas morning-types are typically described as conscientious, trustworthy, and emotionally stable, the evening-types are more prone to develop emotional problems such as anxiety glitches, eating disorders, low self-esteem, and negative family relationships, as well as to experience attentional difficulties and low school functioning, than morning-types (Prat and Adan 2013; Diaz-Morales et al. 2014). We are particularly interested in the relation between evening-types and anxiety that has been reported in adolescents (Pabst et al. 2009; Díaz-Morales 2016). This relation is particularly noted with trait-anxiety, a relatively stable disposition to experience anxiety. Díaz-Morales (2016) has recently reported that evening-type adolescents (12–16 years) obtained higher trait-anxiety scores than morning-types. Moreover, higher levels of anxiety are usually associated with poor academic performance in adolescents (Mazzone et al. 2007).

This brief review highlights the importance of understanding circadian preferences in adolescence. Self-report measures have dominated the assessment of this variable (Díaz-Morales et al. 2007; Tonetti 2007; Randler et al. 2017). However, “culture may have a general influence on changes in the sleep-wake cycle” (Randler et al. 2017, p. 6), which directly influences chronotype. One evidence of the cultural differences in chronotype is the peak of eveningness: whereas in Germany this occurs around the age of 16, in Russia it occurs around the age of 22 (Randler et al. 2017). Therefore, developing and validating instruments to a given culture and to specific age groups is crucial (Smith et al. 2002).

As far we know there are two validated instruments to assess chronotype in Portuguese adolescents: the Morningness–Eveningness Questionnaire for adolescents (aMEQ) (Rodrigues et al. 2016) composed by 19 items, and the Composite Scale of Morningness (CSM) composed by 13 items (Gomes et al. 2016). We focus our attention on the aMEQ which underwent an initial validation to Portuguese adolescents (12–14 years old) by Rodrigues et al. (2016) (see the instruments section of this work – phase 1 – for a description of this instrument). However, the growing tendency to explore

multiple variables in research, the time constraints researchers often have to face, the need to obtain data from larger samples, and the costs of having participants engaged for long periods of time responding to questionnaires, has motivated the development and validation of shorter forms that would still allow a reliable assessment of individual variables (Jankowski 2013; Randler 2013).

The present study aims to provide a reduced form of the aMEQ for Portuguese adolescents (hereafter designated by aMEQ-R). A 5-item short form of the original MEQ was firstly proposed by Adan and Almirall (1991) for the adult Spanish population and subsequent work has validated it to several other countries (Chelminski et al. 2000; Carciofo et al. 2012; Randler 2013) but always for adults and young-adults. An exception can be found in a study conducted in Hungary which explored the psychometric properties of this 5-item short form for adolescents aged approximately 15 years. Even though they included an extra item in their formulation, they still failed to obtain a satisfactory reliability for this age group (Urbán et al. 2011); these results suggest that this short-form might not be suitable for use with adolescents. Although we could adopt the validation strategy used in most of these studies (i.e. simple translation of the 5-item short form and psychometric characterization), two reasons justified a different approach: (1) the evaluation of chronotype as an individual characteristic has been reported to depend strongly on culture (Smith et al. 2002; Rahafar et al. 2017) and (2) we are considering an age group that differs from the majority of the previous studies and significant differences are likely to be found between the adolescents and adults' daily routines (e.g. the possibility to have less restricted schedules and social dynamics).

As noted before, chronotype has been related to particular psychological dimensions, specifically with trait-anxiety (Díaz-Morales 2016). In this study, besides creating and exploring the psychometric proprieties of a reduced form of the aMEQ to Portuguese adolescents, we also evaluated the sensibility of this instrument to capture this relation. The testing of a previously established relation between variables provides an additional form of validation (Weber 1990).

Our study was developed across two phases which are presented separately for the sake of simplicity. In the first, relying on the results from the previous validation study of the aMEQ (19 items) (Rodrigues et al. 2016), we developed our reduced form following the procedure of Jankowski (2013). A 10-item version of the instrument resulted from this initial phase – the aMEQ-R. In the second phase, the aMEQ-R was administered to an independent sample of 217 adolescents. This same sample completed the full form of the aMEQ (19 items) 3–4 weeks later (see Supplemental Material [SM]1 for a schematic representation of the procedure). Trait-anxiety was assessed in both sessions using the Trait Anxiety Scale for Children (TASC) (Rodrigues et al. 2017).

Phase 1 – development of the aMEQ-R

Method

Participants

The data used in this phase were obtained from 300 adolescents (167 female) aged 12–14 years ($M_{\text{age}} = 13.17$, $SD = 0.74$) who were recruited from several schools of the

Aveiro district (Portugal); the large majority of the participants (97.7%) were attending grades 7 to 9. These were the data reported in a first validation study of the aMEQ (19 items) for Portuguese adolescents¹. A full characterization of this sample can be found in the corresponding publication (Rodrigues et al. 2016).

Instruments

The aMEQ was validated to Portuguese adolescents by Rodrigues et al. (2016). A direct translation to European Portuguese and adaptation of the original MEQ (Horne and Östberg 1976) was performed. The questionnaire is composed of 19 items. In 14 items, participants choose the option that best describes their circadian preferences from four possible responses; for the remaining five items, participants respond using hourly scales. Participants took about 15 min to complete the aMEQ. Scores range between 16 (eveningness) and 86 (morningness) points. This initial validation study revealed adequate psychometric properties of the aMEQ, such as a Cronbach's alpha value of .692 and a composite reliability of .702 (Rodrigues et al. 2016).

The *reduced version of the Morningness–Eveningness Questionnaire for adolescents* (aMEQ-R) was derived from the full form following the procedure used by Jankowski (2013). The procedural details that led to this solution are presented in the Results section of Phase 1 (see below). The resultant aMEQ-R includes the following 10 items: 1, 2, 4, 5, 7, 8, 9, 10, 18 and 19 (for the sake of simplicity we always refer to the item numbers as in the aMEQ). Four of these items require an answer using hourly scales (items 1, 2, 10 and 18); for the remaining, participants choose one of the four response options. Total scores range between 9 (eveningness) and 46 (morningness) points. Participants took about 10 min to respond to this questionnaire.

Procedure

In the initial validation study, the aMEQ was applied to 300 adolescents in two different moments to assess test–retest reliability. The complete procedural details can be found in Rodrigues et al. (2016). The statistical analyses here reported were done on the dataset from the first administration of this validation study using the IBM SPSS Statistics version 24.0. In all cases, items were scored according to the scoring procedure made available in the original study of the instrument (Horne and Östberg 1976).

Results and discussion

The goal of this procedure was to create a reduced solution that included the smallest number of items while maintaining acceptable internal reliability as measured by Cronbach's alpha ($\alpha > .70$; Nunnally and Bernstein 1994). We achieved such solution with a reduced form composed of 10 items (items 1, 2, 4, 5, 7, 8, 9, 10, 18, and 19 from the aMEQ) for which we obtained a Cronbach's alpha of .706. The descriptive data presented in Table 1, along with the reliability values resulting from the elimination of each of these 10 items (always $< .70$), indicate this is the best solution.

To understand the impact of eliminating the remaining 9 items in the explained variance, a multiple linear regression analysis was performed entering the score from the 19-item instrument. The removal of these 9 items led to the loss of only 18% of the final variance. Our reduced 10-item solution explains 82% of the total variance of the result

Table 1. Characteristics of the 10 extracted items (from the 19-item questionnaire) that compose our reduced form (Phase 1).

	Mean	Std. Deviation	Corrected item-total correlation	Inter-item correlation (mean)	Cronbach's α if item deleted
Q1 – "(...) at what time would you get up (...)?"	2.89	.908	.415	.224	.675
Q2 – "(...) at what time would you go to bed (...)?"	2.98	.959	.399	.194	.677
Q4 – "(...) how easy do you find getting up (...)?"	2.44	.939	.364	.208	.683
Q5 – "how alert do you feel (...) in the morning?"	2.55	.763	.414	.228	.679
Q7 – "(...) in the morning, how tired do you feel?"	2.65	.700	.360	.202	.687
Q8 – "(...) at what time do you go to bed compared to your usual (...)?"	2.12	.973	.410	.224	.675
Q9 – "(...) physical exercise (...) between 7:00am-8:00am (...)")	3.17	.809	.310	.162	.692
Q10 – "at what time (...) feel tired and in need of sleep?"	3.14	.984	.321	.161	.690
Q18 – "at what time of day do you feel your best?"	3.38	.803	.341	.171	.688
Q19 – "do you consider yourself to be a morning or evening type (...)?"	2.83	1.773	.453	.251	.685

$N = 300$. "Q" number corresponds to the number of the item in the 19-item instrument (aMEQ); the formulation here presented for each item represents the main idea of the item and not a verbatim translation.

from the full questionnaire. A mean score of 28.15 ($SD = 5.24$) points was obtained from the selected 10 items and the data revealed a normal distribution (skewness = $-.164$, $SE = .141$; kurtosis = $-.059$, $SE = .281$). Considering the cut-offs (Mean $\pm 1SD$) for eveningness and morningness of the aMEQ (≤ 45 and ≥ 60), and of the aMEQ-R (≤ 23 and ≥ 33), we calculated the level of agreement in the chronotype classification between the two versions. The contingency coefficient was of .683 and the sensitivity indicator 81.7%; 245 out of the 300 participants obtained the same classification considering the scores obtained with the aMEQ and the aMEQ-R which denotes good sensitivity (see SM-2 for the distribution of the three chronotypes according to each version of the questionnaire). Additionally, a Pearson's correlation revealed a strong correlation between the total scores obtained using the aMEQ and the extracted aMEQ-R ($r = .90$, $p < .001$). In sum, this initial assessment of the viability of this 10-item solution using the data set from which it was derived produced good results.

Phase 2 – validation of the aMEQ-R using an independent sample

To further establish the validity of the proposed 10 items reduced form we conducted the second phase of this study using an independent sample and a new database. In this phase, participants responded to the new reduced form (aMEQ-R; 10 items) and, a few weeks later, they responded to the full version (aMEQ; 19 items). Additionally, we investigated if the reduced form was sensitive to capture the relation between trait-anxiety and chronotype typically reported (Díaz-Morales 2016).

Method

Participants

This new sample included 217 (110 female) adolescents aged 12–14 years ($M_{\text{age}} = 12.84$, $SD = 0.78$). This number of participants ensures that we have a minimum of 20 participants per number of items (Hair et al. 2010). Participants were recruited from several schools (five public and two private) from the Aveiro district (Portugal) and were attending grades 7 to 9. The recruitment method was similar to that used in the validation study of the aMEQ: participants were selected by convenience but, in an effort to increase the representativeness of our sample regarding different educational environments, we incorporated schools from rural and urban areas. There was no overlap between the current sample and that used in the validation study of the aMEQ. Written consent was previously obtained from the participants' parents and all adolescents participated voluntarily. The study was also previously authorized by the Portuguese Directorate-General for Education and by the school directors.

Instruments

Two questionnaires were used to evaluate chronotype preferences: the full version of the aMEQ (19 items) (Rodrigues et al. 2016) and its reduced form which resulted from Phase 1 (10 items; aMEQ-R). Both were described in the Instruments section of Phase 1.

To assess trait-anxiety we used the *Trait Anxiety Scale for Children*® (TASC) which has been validated for Portuguese children and adolescents (Rodrigues et al. 2017). This scale includes 16 items and revealed good psychometric proprieties, such as Cronbach's alpha (.873) and test–retest reliability (.757).

Procedure

Similarly to the procedure adopted in other studies (Chelminski et al. 2000), the administration of the questionnaires occurred in two moments. Participants first completed the aMEQ-R and, 3–4 weeks later, the same sample responded to the aMEQ. In both sessions, the TASC was completed after the chronotype questionnaire. The instruments were administered to groups of 25 or fewer adolescents in schools. At least one of the research team members was available during the administration to clarify any questions. The first session lasted about 20 min and the second about 30 min².

Results and discussion

The mean of the aMEQ-R was 27.76 ($SD = 5.12$) and the data revealed a normal distribution (*Skewness* = $-.282$, $SE = .165$; *kurtosis* = $.094$, $SE = .329$). The cut-off points ($\text{Mean} \pm 1SD$) for the classification of the evening- and morning-types were ≤ 23 and ≥ 33 , respectively. The cut-off points considering the percentiles 10/90 were 22/34 and considering the percentiles 20/80 were 24/32. Regarding sex differences, boys presented a higher score value than girls ($M = 27.93$, $SD = 5.42$, and $M = 27.59$, $SD = 4.82$, respectively), but the difference was not statistically significant, $t(215) = .494$, $p = .622$. The result of the aMEQ-R correlated negative and significantly with age ($r = -.185$, $p < .01$) indicating a trend for older participants to become more evening-oriented, as expected.

Table 2. Items characteristics of the aMEQ-R (Phase 2).

	Mean (SD)	Corrected item-total correlation	Inter-item correlation (mean)	Cronbach's α if item deleted	Scale mean if item deleted	Scale variance if item deleted
Q1	2.75 (1.01)	.498	.272	.669	25.012	20.597
Q2	2.90 (0.91)	.379	.207	.690	24.862	22.083
Q4	2.62 (0.83)	.399	.224	.688	25.143	22.364
Q5	2.62 (0.72)	.394	.227	.690	25.143	22.938
Q7	2.79 (0.71)	.479	.267	.681	24.972	22.416
Q8	2.16 (0.95)	.292	.166	.704	25.600	22.621
Q9	3.23 (0.82)	.308	.167	.701	24.535	23.083
Q10	2.99 (0.84)	.280	.157	.705	24.770	23.197
Q18	3.13 (0.70)	.420	.204	.688	24.627	22.874
Q19	2.58 (1.75)	.465	.259	.695	25.180	16.509

$N = 217$.

Reliability

Regarding the aMEQ-R reliability, we obtained an acceptable value of internal consistency, as measured by Cronbach's $\alpha = .717$ (Nunnally and Bernstein 1994). This value did not increase when the elimination of items was tested (Table 2).

In order to assess the sensitivity of our reduced form, participants were classified into morning-, intermediate- or evening-types considering the cut-off points obtained in this sample for each of the instruments administered in the two moments. The aMEQ revealed a mean value of 51.31 ($SD = 8.34$), with acceptable values of skewness (*Statistic* = $-.200$, $SE = .165$) and kurtosis (*Statistic* = $-.109$, $SE = .329$). The cut-off points ($Mean \pm 1SD$) were ≤ 43 and ≥ 60 , for the classifications of eveningness and morningness, respectively. As noted above, the cut-off points for the aMEQ-R ($Mean \pm 1SD$) were ≤ 23 and ≥ 33 for the same classifications. The sensitivity indicator showed that 71.9% (156 out of the 217 participants) obtained the same classification with the two instruments administered in the two distinct moments (see SM-3 for the distribution of the three chronotypes according to each questionnaire). The contingency coefficient obtained the value of .586. The correlation between the total score of the two instruments was high and significant ($r = .790$, $p < .001$).

Relation between chronotype and trait-anxiety

As mentioned above, eveningness has been related to higher anxiety in adolescents. Our sample reported an anxiety value of 27.53 ($SD = 5.98$) in the first administration. Also, as is typical of trait-anxiety (e.g. Rodrigues et al. 2017), females reported significantly higher anxiety than males ($M_{\text{females}} = 28.95$, $SD = 6.03$; $M_{\text{males}} = 26.08$, $SD = 5.60$), as revealed by an independent samples *t*-test, $t(215) = 3.634$, $p < .001$, Hedges's $g_s = 0.492$. Therefore, to explore the relation between chronotype and trait-anxiety, we conducted partial correlations between the aMEQ-R score and trait-anxiety while controlling for the variable sex. The usual negative and significant correlation between chronotype and anxiety was replicated in our data ($r = -.231$, $p < .01$), indicating that more evening-oriented participants tend to report more anxiety. Additionally, an independent samples *t*-test comparing the level of anxiety reported by the morning-type participants with that reported by the evening-type participants revealed that the former indicated significantly lower levels of anxiety than the

later ($M = 25.83$, $SD = 7.12$, and $M = 28.93$, $SD = 5.71$, respectively), $t(79) = 2.16$, $p = .034$, Hedges's $g_s = 0.476$. Further analyses exploring this relation between chronotype and anxiety are presented in the SM-4.

General discussion

The aim of our study was to develop a reduced version of the aMEQ for Portuguese adolescents (12–14 years old). Following the procedure used by Jankowski (2013), we extracted the minimal number of items from the aMEQ that allowed us to obtain a Cronbach's alpha of at least .70 (Nunnally and Bernstein 1994). This analysis resulted in a 10-item scale (aMEQ-R). Interestingly, our reduced version includes all of the 5 items used in the short-form of the MEQ for adults proposed by Adan and Almirall (1991), suggesting that they are indeed important but probably not sensible enough to assess chronotype in Portuguese adolescents on their own. The poor psychometric properties obtained by Urbán et al. (2011) using a similar formulation with older adolescents points in the same direction.

The discussion of our results becomes limited due to the scarcity of studies using short-forms of the MEQ in adolescents, and so we discuss some of our results mostly in light of studies with adults and young-adults that have validated the 5-item short version of Adan and Almirall (1991). Overall, the data obtained from the application of our reduced form (Phase 2) revealed acceptable reliability that is better than that obtained in other validation studies, such as .701 (Chelminski et al. 2000) and .593 (Carciofo et al. 2012). About 72% of our participants were classified in the same chronotype when relying on the aMEQ-R and the full aMEQ score, a value that is comparable to that reported in other studies, such as 73% (Chelminski et al. 2000) and 67.5% (Carciofo et al. 2012). One additional positive aspect of our results was the fact that there were no cases where the participant's classification changed from morning- to evening-type, or vice versa. The correlation between the aMEQ-R and the full aMEQ scores was high ($r = .790$) and analogous to that reported in other studies that have reported similar analysis (e.g. $r = .786$) (Chelminski et al. 2000). Our contingency coefficient (.586) was slightly higher than that obtained in studies with comparable phases (e.g. .55) (Chelminski et al. 2000). In sum, our results are similar to those reported in validation studies of the short-version of the MEQ in adults and young-adults. On the other hand, the study with adolescents that used a similar instrument failed to obtain good psychometric properties (Urbán et al. 2011). Overall, our results suggest that our proposed 10-item aMEQ-R is adequate to assess chronotype in Portuguese adolescents.

Regarding age, we found a negative correlation between age and the overall score. This result corroborates the conclusions from previous studies with adolescents (Díaz-Morales 2016) and is in agreement with the idea that adolescence is marked by a gradual shift from morningness to eveningness (Randler et al. 2017). On the other hand, no sex differences were obtained, a result that parallels some studies that have used the MEQ with adolescents (Gelbmann et al. 2012; Díaz-Morales 2016; Rodrigues et al. 2016).

We also provide an exploratory analysis regarding the criterion-related validity of our reduced form. In agreement with previous research proposing that eveningness is a risk factor to anxiety (Díaz-Morales 2016), our evening-oriented participants reported higher

levels of trait-anxiety than our morning-oriented participants. These results confirm that the aMEQ-R is sensitive to capture this relation. The tendency for evening-types to experience higher anxiety could be related, for example, to a higher desynchronization between the adolescents' social schedules and their endogenous sleep/wake cycle (Díaz-Morales 2016). Furthermore, the results of both the aMEQ and aMEQ-R relate in a consistent way to the "anxiety" classification (see SM-4), adding to the validity of the both instruments.

This study should be seen as an initial effort to validate the aMEQ-R and is not free from limitations. For example, we used a sample from a small geographical area. In spite of our efforts to include participants from various educational environments, future studies should be conducted using a more geographically and educationally representative sample. This form of the instrument should also be compared with concurrent measures. Also, future studies should aim to explore the test-retest reliability of this instrument, an index not provided in the current work due to the adopted procedure.

In sum, the aMEQ-R revealed generally good psychometric proprieties and sensitivity to measure chronotype. The results obtained with this version were sensitive to capture two results typically reported in the literature: that older participants tend to be more evening-oriented, and that evening-type participants tend to report higher trait-anxiety. Providing an instrument that allows an easier and faster assessment of chronotype in a reliable form will encourage the consideration of this variable both in research and in practice. To the best of our knowledge, this is the shortest instrument currently available to assess chronotype in Portuguese adolescents. As briefly noted in the Introduction, this variable impacts the adolescents' lives in many ways and should not be overlooked. For example, it can be used to support interventions aiming to promote a better adaptation to the school schedules and demands directed at adolescents at higher risk of developing behavioral or psychological problems. By recognizing the importance and impact of this individual difference in adolescents and how it relates to cognitive nuances, professors can adjust their teaching strategies in a way that would be more beneficial to each adolescent (Díaz-Morales and Escibano 2014). We hope that by presenting a more efficient way to measure chronotype, this variable will be brought to the desk of both researchers and practitioners more frequently.

Notes

1. The original datasets will be provided upon request to the corresponding author.
2. In each session, one additional questionnaire not related to the aims of the present study was administrated. © 1970 Charles D. Spielberger. All rights reserved in all media. Published by Mind Garden, Inc., www.mindgarden.com.

Disclosure statement

No potential conflict of interest was reported by the authors.

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