Circadian Typology and Sensation Seeking in Adolescents

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The relationship of circadian typology with personality has been largely studied in adults, but there are few studies exploring such relationship in adolescents. Adolescence has been associated with a greater tendency to eveningness preference, sleeping problems, poorer academic achievement, earlier substance use, or risky behaviors, and it is suggested that this association might be mediated by personality factors. Given the relevance of identifying the behavioral outcomes of young evening types to detect and prevent health problems, the present study aimed to explore, for the first time, the relationship between sensation seeking and circadian typology in an adolescent sample of 688 students (51.45% boys) from 12 to 16 yrs old. They answered the Spanish versions of the Morningness-Eveningness Scale for Children (MESC) and the Junior Sensation Seeking Scale (J-SSS), which includes four subscales measuring Thrill and Adventure Seeking, Experience Seeking, Disinhibition, and Boredom Susceptibility. Analyses showed that boys obtained significantly higher scores than girls on J-SSS total score and all subscales except Boredom Susceptibility, whereas evening-type adolescents of both sexes scored significantly higher than neither types and than morning types on J-SSS total score. These results indicate that evening-type adolescents show a greater desire for varied, new, complex, and intense sensations, and they are ready for experiencing more risks than morning types. The implications of this study suggest the need of being aware of individual differences in the SS trait in evening-type adolescents, as well as taking into account the wide variety of behaviors associated with it, either prosocial or antisocial, to design better preventive health and academic programs. (Author correspondence: anna.muro@uab.cat)

Keywords: Adolescence, Circadian typology, Morningness-eveningness, Personality, Sensation seeking, Sex

INTRODUCTION

Morningness-eveningness (M-E) is a dimension that allows classifying individuals according to their diurnal or evening preferences. Along this continuum, individuals can be classified in three circadian typologies or chronotypes: morning types that prefer early rise and bedtimes, evening types that prefer later bed and awakening times, and neither types that wake up and fall asleep later than morning types but earlier than evening types (Adan et al., 2012; Roenneberg et al., 2007). This dimension follows a normal distribution in a continuum in which there is a difference in the phase of biological and behavioral patterns that can vary in range from 2 to 12 h (Adan et al., 2008, 2010a). This individual difference is genetically based and controlled by an endogenous biological clock that regulates physiology at many levels, from gene expressions to more complex behaviors, influencing health and disease (Levi & Schibler, 2007). However, in human beings, other factors such as social and cultural influences might affect individual differences in behavioral rhythms (Gau & Soong, 2003; Randler & Díaz-Morales, 2007; Takeuchi et al., 2001).

Circadian typology has also been found to be influenced by sex and age (Adan & Natale, 2002; Randler et al., 2012; Roenneberg et al., 2007; Tonetti et al., 2008). In relation to circadian rhythms and sex, women are more morning oriented than men for most of their adulthood, although this sex difference disappears at around menopause age. Children and oldest people also are generally more morning oriented, whereas younger adults are more evening oriented, with an eveningness peak in adolescence, suggesting that age and sex differences in circadian typology may be influenced by developmental endocrine factors, such as variations in the secretion levels of gonadal hormones throughout the life span (Randler et al., 2012a).
It has also been suggested that there is a close relationship between M-E and health and disease, reporting that eveningness might be a risk factor for mental and physical health problems, whereas morningness has been associated with healthy habits and psychological well-being (Randler, 2011; Urbán et al., 2011). This relationship is considered to start developing in adolescence, suggesting that in this period of life it is of crucial importance to identify young individuals with evening preferences in order to implement preventive health programs (Prat & Adan, 2011; Tzischinsky & Shochat, 2011). Eveningness in adolescence has been considered a risk factor for earlier alcohol use, smoking, and physical inactivity (Urbán et al., 2011), and it has been related to sleep, attention, and emotional problems, as well as to behavioral maladjustment and poorer school achievement (Giannotti et al., 2002; Goldstein et al., 2007; Tzischinsky & Shochat, 2011). Other authors have found that eveningness in adolescents has been related to anxiety, eating disorders, and overweight (Pabst et al., 2009; Schmidt & Randler, 2010), or to irregular lifestyles (Fleig & Randler, 2009).

Some authors suggested that the relationship between M-E and health may be mediated by personality traits that might contribute to explain to what extent diurnal preferences might be associated with mental and physical healthy behaviors. Previous studies with adults and biologically based models of personality (Cloninger et al., 1993; Zuckerman et al., 1993) have shown higher levels of activity, persistence, harm avoidance, and self-directedness in morning types, whereas evening types showed higher levels of impulsivity, aggression-hostility, sensation seeking, and novelty seeking (Adan et al., 2010a, 2010b, 2012; Caci et al., 2004; Muro et al., 2009, 2011; Tonetti et al., 2010).

However, there is only one study with adolescents exploring the association between personality and circadian typology (Randler & Saliger, 2011), reporting that evening types showed lower scores on persistence and cooperation, and higher scores on novelty seeking. Novelty seeking (Zuckerman & Cloninger, 1996) is closely related to one of the most studied traits in biological personality research: sensation seeking (SS), a trait defined by “the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience” (Zuckerman, 1994, p. 27). Such experiences include seeking out a higher amount of variability in the level of stimulation and engaging in exploratory behaviors that modulate individuals’ arousal. This trait correlates with low levels of monoamine oxidase (MAO) and high levels of testosterone and it is highly involved not only in risky behaviors that might lead to negative health outcomes (Legrand et al., 2007) or antisocial behavior (Gomà-i-Freixanet et al., 2001), but also in the practice of risky sports (Gomà-i-Freixanet et al., 2012) and in the enrollment of prosocial behaviors such as those performed by firemen, bodyguards, or lifeguards (Gomà-i-Freixanet, 1995, 2001; Gomà-i-Freixanet & Wismeijer, 2002; Wismeijer & Gomà-i-Freixanet, 2012).

The SS trait is highly stable throughout the life span, with a rise in adolescence that occurs with the first relevant consequences of risky behaviors (Lynne-Landsman et al., 2011; Zuckerman, 2005) increasing the probability of early antisocial behavior (Harden et al., 2012). Interestingly, increases in eveningness are also significant in the adolescence due to hormonal changes and pubertal maturation (Randler et al., 2009; Roenneberg et al., 2007) and some authors suggest that biological factors are important to explain the relationship between circadian typology and sensation seeking (Tonetti et al., 2010). Although recent research reports that SS is associated with evening preferences in adults (Muro et al., 2011; Tonetti et al., 2010), the relationship between SS and eveningness in adolescents has not yet been explored.

The present study aimed to analyze, for the first time, the relationship between the SS trait and circadian typology in an adolescent population. From the above-mentioned studies with adults, we hypothesize that evening-type adolescents would score higher than morning- and neither-type adolescents on the SS trait. Evening-type compared with morning-type adolescents would score higher not only on the total Junior Sensation Seeking Scale (J-SSS), but also on the Experience Seeking, Disinhibition, and Boredom Susceptibility subscales, as these subscales are specifically targeted to assess the seeking of new experiences through a nonconformist lifestyle, the interest in disinhibited activities, and the aversion for routine.

**METHODS**

**Participants**

An initial sample of 750 students from three public high schools from the province of Barcelona participated in this study. Only those participants who answered completely all the questionnaires were included in the data analyses. The final sample (N = 688) consisted of 354 boys (51.45%) and 334 girls, ranging from 12 to 16 yrs old (mean = 13.83; SD = 1.28).

**Materials**

To assess circadian typology, the Spanish version of the Morningness-Eveningness Scale for Children (MESC; Díaz-Morales & Gutiérrez, 2008) was administered. This questionnaire is an adaptation of the Composite Scale of Morningness (Smith et al., 1989) carried out by Caruskadon et al. (1993) for adolescent population. It consists of 10 items in Likert answer format, assessing rise and bedtimes, and subjective physical and cognitive activation throughout the day. The MESC is a reliable tool, with scores ranging from 10 (eveningness) to 43 (morningness) and with the percentiles 20/80 suggested as cutoff criteria to classify individuals into three different circadian
typologies: evening, neither and morning types. In the present sample, the scores corresponding to percentiles 20 and 80 were 21 and 30, respectively. The internal consistency of this scale for the present sample was .67.

To assess the sensation seeking trait, we administered the Spanish version of the Junior Sensation Seeking Scale (J-SSS; Pérez et al., 1986), which is an adaptation for adolescents of the Sensation Seeking Scale for adults (Zuckerman et al., 1978). The J-SSS includes a total score and four subscales assessing: Thrill and Adventure Seeking (TAS), Experience Seeking (ES), Disinhibition (Dis), and Boredom Susceptibility (BS). The TAS subscale contains items expressing a desire to engage in sports or other physically risky activities that provide unusual sensations of speed or defiance of gravity, such as parachuting, scuba diving, or skiing. Because most of the activities are not common, the majority of the items are expressed as intentions (“I would like…”) rather than reports of experience. An attitude item that summarizes the factor is “I like risky sports very much.” The ES subscale encompasses items measuring the seeking of novel sensations and experiences through the mind and senses, traveling, or being unconventional. The Dis subscale contains items describing seeking sensations through social activities such as parties, social drinking, and sex. Finally, the BS subscale measures intolerance for repetitive experiences of any kind, including routine work and boring people. The final total score of the J-SSS is obtained by summing up the four subscales. The scale contains 40 dichotomous items, with scores ranging from 0 to 40 (highest sensation seeking score). This version also includes a Lie subscale (10 items), assessing social desirability. The internal consistency of the J-SSS for the present sample was .83.

Procedure
Researchers contacted three randomized high schools in Barcelona province and asked for their collaboration. Questionnaires were administered during morning sessions by the researchers and participants completed the questionnaires anonymously in classroom settings during springtime. Parents were informed and gave consent prior to participant’s inclusion in this study. All students participated voluntarily and did not receive any academic or economic reward for their collaboration. The Ethical Committee of the university and the high schools’ management teams approved the protocol. The present study also met the international standards of ethical chronobiology research (Portaluppi et al., 2010).

Statistical Analyses
Means and standard errors of the means were computed for the MESC and for age. Cronbach’s alphas were also calculated for the J-SSS and for the MESC. Pearson correlations were computed between age, J-SSS, and MESC. To check for age and sex differences between circadian typologies, an analysis of variance (ANOVA) and a chi-square test were performed, respectively. An univariate analysis of covariance (ANCOVA) considering the total score of the J-SSS and a multivariate analysis of covariance (MANCOVA) considering the J-SSS subscales as dependent variables were performed taking circadian typology (morning, neither, evening type) and sex as factors, whereas age was considered as a covariant in both analyses, to control for possible effects. Post hoc pairwise comparisons were performed by Tukey tests and effect size estimations were calculated using Cohen’s $d$. Partial eta-square ($\eta_p^2$) and observed power were also calculated. Statistical tests were bilateral with Type I error set at 5%.

RESULTS
The distribution of participants by circadian typology was 21.22% in the evening-type group, 60.32% in the neither-type group, and 18.46% in the morning-type group. No statistically significant differences were found among the three circadian types on sex ($\chi^2(2) = .516; p = .773$) or age ($F_{(2,685)} = 2.875; p = .057$). Age correlated with MESC ($r = -.113$) and total J-SSS ($r = .110$), whereas MESC correlated negatively with total J-SSS ($r = -.254$). All correlations, although low, were significant ($p < .01$) due to the high sample size. Descriptive statistics for age and MESC scores for the total sample, by sex, and by circadian typology groups are shown in Table 1.

Table 2 shows means and standard errors of the means of the total J-SSS and subscales by sex, and sex comparisons controlling for age. ANCOVA and MANCOVA showed that boys obtained significantly higher scores than girls on J-SSS total score and all subscales except BS.

ANCOVA and MANCOVA also showed significant differences between circadian typologies scores on J-SSS total scale and subscales after controlling for age

### TABLE 1. Descriptive statistics (mean ± standard error) of age and MESC for the total sample, by sex and circadian typology

<table>
<thead>
<tr>
<th></th>
<th>Evening type (n = 146)</th>
<th>Neither type (n = 415)</th>
<th>Morning type (n = 127)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>13.94 ± .10</td>
<td>13.86 ± .06</td>
<td>13.59 ± .11</td>
</tr>
<tr>
<td><strong>MESC</strong></td>
<td>19.01 ± .17</td>
<td>26.01 ± .12</td>
<td>33.08 ± .18</td>
</tr>
</tbody>
</table>

MESC = Morningness-Eveningness Scale for Children.
Tonetti et al., 2008). Circadian typologies did not differ significantly neither on age nor on sex, probably because all participants were still under similar characteristics of school schedules and parental monitoring (Gau & Soong, 2003; Randler et al., 2009). Sex differences in the SS trait were replicated as previously found in both adolescent and adult samples, with boys scoring higher than girls in total J-SSS and in all its subscales, except BS (Pérez et al., 1986; Simó et al., 1990; Tonetti et al., 2010; Zuckerman, 1994). The SS trait is a sex behavioral difference that correlates with basal testosterone levels, being stable and consistent throughout the life span (Zuckerman, 2005). However, sex differences on circadian typology were not found, a result that reinforces the hypothesis that the different speed of pubertal development by boys and girls during early adolescence might also influence morningness-eveningness scores (Díaz-Morales & Gutiérrez, 2008; Steinberg & Sheffield, 2001).

Sex differences in the SS trait were replicated as previously found in both adolescent and adult samples, with boys scoring higher than girls in total J-SSS and in all its subscales, except BS (Pérez et al., 1986; Simó et al., 1990; Tonetti et al., 2010; Zuckerman, 1994). The SS trait is a sex behavioral difference that correlates with basal testosterone levels, being stable and consistent throughout the life span (Zuckerman, 2005). However, sex differences on circadian typology were not found, a result that reinforces the hypothesis that the different speed of pubertal development by boys and girls during early adolescence might also influence morningness-eveningness scores (Díaz-Morales & Gutiérrez, 2008; Steinberg & Sheffield, 2001). With regard to differences among circadian typologies on the SS trait, our findings support the hypothesis that evening types would score higher on the total J-SSS than morning types and neither types irrespective of sex and age. These results are also in line with previous studies on the relationship between circadian typology and novelty seeking, a trait that significantly correlates with SS (Zuckerman & Cloninger, 1996) and which has

(see Table 3). Post hoc comparisons showed that evening types scored significantly higher than neither types on the total J-SSS (3.42; p < .001; Cohen’s $d = .56$) and on all the subscales: TAS (.64; $p < .05$; Cohen’s $d = .24$), ES (.58; $p < .05$; Cohen’s $d = .33$), Dis (1.44; $p < .001$; Cohen’s $d = .58$), and BS (.80; $p < .001$; Cohen’s $d = .34$), respectively. Evening types also obtained significant higher scores than morning types on the total scale (4.38; $p < .001$; Cohen’s $d = .68$) and on ES (.58; $p < .05$; Cohen’s $d = .35$), Dis (2.15; $p < .001$; Cohen’s $d = .83$), and BS (1.34; $p < .001$; Cohen’s $d = .53$) subscales, but not on TAS subscale (.40; $p = .536$). Finally, neither types differed significantly from morning types only on the Dis subscale (.71; $p < .05$; Cohen’s $d = .25$), obtaining higher scores.

**DISCUSSION**

The present results replicate the normal distribution of morningness-eveningness dimension. The frequency of evening types was a bit higher than that of morning types, as expected from a sample of adolescents, suggesting that pubertal maturation brings a shift towards eveningness that might act as a marker for the beginning of adolescence (Roenneberg et al., 2004; Tonetti et al., 2008). Circadian typologies did not differ

**TABLE 2. Means, standard errors, $F$s, partial eta-squared ($\eta_p^2$), and observed power for the J-SSS total scale and subscales for the total sample and by sex, controlling for age**

<table>
<thead>
<tr>
<th></th>
<th>Total sample (N = 688)</th>
<th>Boys (n = 354)</th>
<th>Girls (n = 334)</th>
<th>F</th>
<th>$\eta_p^2$</th>
<th>Observed power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>J-SSS</td>
<td>17.60</td>
<td>.26</td>
<td>19.45</td>
<td>.35</td>
<td>15.75</td>
<td>.37</td>
</tr>
<tr>
<td>TAS</td>
<td>5.84</td>
<td>.12</td>
<td>6.70</td>
<td>.17</td>
<td>4.98</td>
<td>.18</td>
</tr>
<tr>
<td>ES</td>
<td>4.02</td>
<td>.08</td>
<td>4.25</td>
<td>.11</td>
<td>3.79</td>
<td>.11</td>
</tr>
<tr>
<td>Dis</td>
<td>3.58</td>
<td>.10</td>
<td>4.18</td>
<td>.13</td>
<td>2.98</td>
<td>.14</td>
</tr>
<tr>
<td>BS</td>
<td>4.16</td>
<td>.10</td>
<td>4.32</td>
<td>.14</td>
<td>4.01</td>
<td>.14</td>
</tr>
</tbody>
</table>

J-SSS = Junior Sensation Seeking Scale; TAS = Thrill and Adventure Seeking; ES = Experience Seeking; Dis = Disinhibition; BS = Boredom Susceptibility.

*p < .01; †p < .0001.

**TABLE 3. Means, standard errors, $F$s, partial eta-squared ($\eta_p^2$), and observed power for the J-SSS total scale and subscales, by circadian typology and controlling for age**

<table>
<thead>
<tr>
<th>Circadian typology</th>
<th>Evening type (n = 146)</th>
<th>Neither type (n = 415)</th>
<th>Morning type (n = 127)</th>
<th>F</th>
<th>$\eta_p^2$</th>
<th>Observed power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>J-SSS</td>
<td>20.19</td>
<td>.48</td>
<td>16.77</td>
<td>.29</td>
<td>15.85</td>
<td>.52</td>
</tr>
<tr>
<td>TAS</td>
<td>6.27</td>
<td>.23</td>
<td>5.57</td>
<td>.14</td>
<td>5.66</td>
<td>.25</td>
</tr>
<tr>
<td>ES</td>
<td>4.39</td>
<td>.15</td>
<td>3.84</td>
<td>.09</td>
<td>3.83</td>
<td>.16</td>
</tr>
<tr>
<td>Dis</td>
<td>4.69</td>
<td>.18</td>
<td>3.31</td>
<td>.11</td>
<td>2.73</td>
<td>.20</td>
</tr>
<tr>
<td>BS</td>
<td>4.83</td>
<td>.19</td>
<td>4.05</td>
<td>.11</td>
<td>3.62</td>
<td>.20</td>
</tr>
</tbody>
</table>

J-SSS = Junior Sensation Seeking Scale; TAS = Thrill and Adventure Seeking; ES = Experience Seeking; Dis = Disinhibition; BS = Boredom Susceptibility.

*p < .05; †p < .0001.
also been found to correlate with eveningness in both adult and adolescent samples (Adan et al., 2010a; Randler & Saliger, 2011).

The evening types also showed the highest scores on all the subscales of the J-SSS. Accordingly, evening-type adolescents manifested a higher tendency for the seeking of varied, novel, complex, and intense sensations and experiences, and show a willingness to take risks for the sake of such experience. They are also more uninhibited individuals modulating their arousal levels through social activities such as parties, social drinking, and sex experiences, a behavior mediated by the Dis subscale, which might be the one that could act as a risk factor for early substance use in adolescents evening types (Urbán et al., 2011). Evening types also show a more pronounced intolerance for repetitive experiences of any kind, including routine tasks.

Post hoc comparisons showed that evening-type adolescents compared with morning-type adolescents scored significantly higher on the total J-SSS and on all subscales, but TAS. It is interesting to mention this fact because the two extremes of the morningness-eveningness dimension differed in the three subscales that are more related to antisocial or inconformist behaviors, whereas the TAS subscale is related to sports and physical activities involving speed. It is also worth mentioning that the Dis subscale is the only one that differed between the three chronotypes, being evening types the ones with the highest scores and morning types the ones with the lowest scores. From the results obtained on the Dis subscale, we can conclude that evening-type adolescents are the ones with the higher risk for being engaged in non-normative behaviors.

Our findings suggest that the rise in the SS trait in evening-type adolescents might be related to social and biological changes in exploratory behaviors that occur in adolescence (Romer et al., 2011; Somerville et al., 2010) and probably these behaviors might require a different approach from behaviors characterized by impulsivity and early signs of acting without thinking. Although impulsivity and SS are correlated, they are two different personality traits (Zuckerman et al., 1993), impulsivity being more related to externalizing behavioral problems than SS, and thus suggestive of different intervention strategies. Moreover, adolescence is a life period in which there is an increasing vulnerability to externalizing behaviors due to the fast maturational changes in the sensitivity to novelty and rewards compared with the slower maturational time course of behavioral inhibition or long-term planning (Harden et al., 2012).

Notwithstanding, the implications of SS in evening-type adolescents must be interpreted with caution, since the SS trait by itself does not explain individual vulnerability in engaging in antisocial behaviors or substance abuse. Accordingly, wider analyses of the personality profile of adolescents would be needed to predict behavioral consequences of sensation seeking in a more reliable way (Gomà-i-Freixanet, 2001; Romer et al., 2011). On the one hand, it is known that SS is a common personality trait of individuals engaged in prosocial activities of the helping professions such as policemen, firemen, or volunteers (Gomà-i-Freixanet & Wismeijer, 2002; Wismeijer & Gomà-i-Freixanet, 2012) as well as of risky sports persons (Gomà-i-Freixanet et al., 2012), suggesting that this trait is not exclusively related to antisocial or delinquent behavior (Gomà-i-Freixanet, 1995, 2001; Gomà-i-Freixanet et al., 2012; Zuckerman, 2005). On the other hand, both SS and eveningness have also been found to be linked with creativity, artistic preferences, and differences in learning styles and routines that could also mediate academic achievement in adolescence (Fabbri et al., 2007; Giampietro & Cavallera, 2007; Rawlings et al., 1998; Schroth & Lund, 1994; Wang & Chern, 2008).

Nevertheless, the limitations of this study, such as the initial exclusion of participants who did not answer all questionnaires that might act as a selection bias and not having registered the health habits or the professional future preferences of the participants, should be considered for future research in the relationship between circadian typology and the SS trait. Future studies should also be conducted comparing adolescents of different socioeconomic, physical, and mental characteristics, and assessing other personality traits that could allow researchers explore those factors that differentiate groups of individuals with similar levels of SS. It would also be important to identify other personality variables such as dysfunctional impulsivity (Adan et al., 2010b; Romer et al., 2011) or other variables related to antisocial behavior (Gomà-i-Freixanet, 1995) that could exert a negative influence on social and psychological maladjustment of evening types from early adolescence.

The implications of this study suggest the need of being aware of individual differences in the SS trait in evening-type adolescents, as well as taking into account the wide variety of behaviors associated with the SS trait, either prosocial or antisocial, to design better preventive health and academic programs (Clarisse et al., 2010). It is suggested that these programs should promote more flexible timetables, respecting the daily rhythms of central arousal and including activities involving seeking out a great variability in the level of stimulation and more creative and exploratory experiences.

Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES


