PREDICTIVE VALUE OF MORNINGNESS-EVENINGNESS IN PERSONALITY CHARACTERISTICS OF YOUNG HEALTHY ADULTS

Juan Manuel Antúnez[1], José Francisco Navarro[1] and Ana Adan[2,3].

[1]Department of Psychobiology, School of Psychology, University of Málaga, Spain.

[2]Department of Psychiatry and Clinical Psychobiology, School of Psychology, University of Barcelona, Spain.

[3]Institute for Brain, Cognition and Behavior (IR3C), Barcelona, Spain.

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Address correspondence to Ana Adan,

Department of Psychiatry and Clinical Psychobiology,

School of Psychology,

University of Barcelona,

Passeig Vall Hebron 171,

08035 Barcelona, Spain.

E-mail: aadan@ub.edu

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Abstract

We aim to explore for the first time the relationships between circadian typology, the personality dimensions of Cloninger's biological model and Zuckerman's sensation seeking model in healthy adults. A sample of 700 young healthy adults (324 men) aged between 18 and 32 yrs completed the reduced Morningness-Eveningness Questionnaire (rMEQ), the short version of the Temperament and Character Inventory and the Sensation Seeking Scale-form V. Morning-type subjects showed higher scores than the evening- and neither-type in persistence, while evening-type scored higher than morning-type in novelty seeking, experience seeking, disinhibition, and sensation seeking total score (SSS-V), and higher than neither-type in disinhibition and SSS-V. Moreover, there were two significant interactions between sex and circadian typology: One in harm avoidance, where evening- and neither-type men scored lower and the other in SSS-V, where only evening-type men scored higher. Regression analyses revealed that rMEQ scores are a good predictor specifically for the temperament dimensions novelty seeking and persistence, and for the SSS-V and the disinhibition dimension. Our results, together with the known associations between Cloninger's model and Zuckerman's sensation seeking with diverse health problems, emphasize an evening-type personality profile more vulnerable to the development of symptomatology and mental disorders (especially in men).

Keywords: Circadian typology; Morningness-eveningness; Personality; Temperament; Character; Sensation seeking

1. Introduction

For the last decade there has been an increasing interest in studying the relationships between morningness-eveningness and personality dimensions. The Morningness-eveningness dimension, which seems to follow a normal distribution, allows for classifying individuals in three circadian typologies: morning-, neither, and evening-type. The subjects in the morning type tend to wake up and go to bed earlier and show a phase advance of their biological and circadian functions when compared to the evening-type. The population in the neither-type has been scarcely studied, but tends to maintain an intermediate position. The phase differences between extreme groups may vary from 2 to 12 h depending on the parameters being considered (v.g. sleep-wake, body temperature, cortisol, and melatonin) (Adan et al., 2012; Adan, Lachica, Cachi, & Natale, 2010). These differences are associated with individual differences in the functioning of the endogenous circadian system (Levy & Schibler, 2007) which is more oriented to the light-dark cycle in the morning-type. Age and sex differences in circadian typology have been also found. Men have a more pronounced tendency to eveningness than women (Adan & Natale, 2002; Tonetti, Fabbri, & Natale, 2008). Moreover, during puberty and over the years, the tendency to morningness is progressively enhanced (Adan et al., 2012).

The study of the circadian typology and its relationship with personality has increased during the last years. In these investigations different personality models have been employed and, consequently, different measurement instruments. Using the Dickman impulsivity scale, it has been observed that evening- and neither-type subjects display higher dysfunctional impulsivity levels than the morning-type subjects (Adan, Natale, Caci, & Prat, 2010). With the Eysenck personality model, negative associations have been found between morningness and neuroticism and psychoticism (Adan et al.,

2012; Mecacci & Rocchetti, 1998). With the big-five lexical model, positive relationships have been found between morningness and conscientiousness and agreeableness (the latter only in adolescents), as well as negative associations between morningness and neuroticism (Randler, 2008; Tonetti, Fabbri, & Natale, 2009a,b). Studies using Zuckerman's alternative big-five model have observed higher activity scores in the morning-type subjects (Muro, Gomà-I-Freixanet, & Adan, 2009; Muro, Gomà-I-Freixanet, Adan, & Cladellas, 2011) as well as higher aggression-hostility and sensation seeking-impulsivity scores in evening-type women (Muro et al., 2011). Studies with the Zuckerman sensation seeking scale in adults have revealed in evening-type subjects higher scores in thrill and adventure seeking, experience seeking, disinhibition, and general sensation seeking (Prat & Adan, 2013; Tonetti et al., 2010). Similar results were found in adolescents (Muro, Gomà-I-Freixanet, & Adan, 2012). Moreover, ~~in a study using the Portrait Values Questionnaire in adolescents~~ morning-type subjects show~~was found~~ greater acceptance toward social values and emotional repair~~(conservation and self-transcendence) in morning-type~~, while evening-type show~~and~~ greater preference to individual values and emotional attention ~~(openness to change and self-enhancement) in evening-type~~ (Antúnez, Navarro, & Adan, 2013; Vollmer & Randler, 2012).

Using Cloninger's biological model a positive association has been found between morningness and the temperament dimensions of harm avoidance and persistence, as well as a relationship with the character dimensions of self-directedness, cooperativeness and self-transcendence. A negative relationship has also been detected between morningness and novelty seeking (Adan, Lachica et al., 2010; Caci, Robert, & Boyer, 2004; Randler & Saliger, 2011). However, the physical and mental health of the participants has not been controlled in any of the studies analyzing relationships

between personality and circadian typology. This absence of control in relation to these variables could affect to the sample homogeneity and, therefore, to the results obtained.

The knowledge of the relationships between circadian typology and personality has been scarcely studied in healthy populations. The aim of this work is to examine, for first time, the relationships between circadian typology, Cloninger's temperament and character dimensions and Zuckerman's sensation seeking model, in a wide sample of healthy university students without physical or mental pathology. Likewise, we also explore the predictive roles of sex, morningness-eveningness scores and their interaction along the different personality dimensions. We hypothesize that morning-type will show a higher tendency to persistence than evening-type, whereas these one will exhibit a higher tendency to novelty seeking, disinhibition, as well as higher experience and sensation seeking.

2. Method

2.1. Participants

The participants were 700 Spanish psychology students from the Universities of Barcelona and Málaga, aged 18 to 32 (22.25 ± 3.17), 324 (46.3%) men and 376 (53.7%) women. No significant differences were observed in age between men (22.47 ± 3.22 yrs) and women (22.05 ± 3.12 yrs) ($t_{(698)} = 1.76$; $p = 0.079$). Subjects were not paid for participating in the study, and they all gave their informed consent prior to their inclusion in the study. Subjects completed questionnaires on circadian typology, TCI-56, and SSS-V, provided information on sociodemographic variables and the presence or absence of physical or mental pathology –specifying its typology- together with an exhaustive assessment of possible drug specifying type (tobacco, alcohol, cocaine, ecstasy, amphetamine, hallucinogen, cannabis, coffee, tea, and other stimulant drinks

like “red-bull”) and frequency of intake. Only adult subjects who completed all the questionnaires and did not show relevant physical or mental health problems (specifically drug dependence/abuse) were included. Of the total amount of 726 subjects who participated, 26 (3.58%) were excluded due to failing the inclusion criteria (absence of physical and mental pathology, complete all the questionnaires, and age between 18 and 32 yrs.). The Research Committee of the University of Barcelona approved the protocol, and the present study complied with the tenets of the Declaration of Helsinki and the international ethical standards of chronobiological research (Portaluppi, Smolensky, & Touitou, 2010).

2.2. Measure instruments

Circadian typology was assessed using the reduced Morningness-Eveningness Questionnaire (rMEQ), standardized for the Spanish population (Adan & Almirall, 1991). This test is composed of five items, and the total scores range from 4 to 25 points. Subjects can be assigned to one of the three possible circadian typologies (i.e., morning-, neither-, or evening-type) according to the cutoff score: 4 to 11 points for the evening-type, 12 to 17 for the neither-type, and 18 to 25 points for the morning-type. The Spanish rMEQ is a reliable measure to classify individuals in the morningness-eveningness dimension (Di Milia, Adan, Natale, & Randler, 2013). The rMEQ internal reliability for the present sample was adequate (Cronbach’s $\alpha = 0.75$).

The Temperament and Character Inventory-56 (TCI-56) (Adan, Serra-Grabulosa, Caci, & Natale, 2009), based on Cloninger’s model of personality (Cloninger, 1999), contains 56 items, eight for each of the seven dimensions considered. The four dimensions of temperament are harm avoidance (HA), which reflects the activity of the system of behavioral inhibition or punishment; novelty seeking (NS),

related to the system of behavioral activation or reward; reward dependence (RD), related to social reinforcement and sensitivity to social stimuli; and persistence (PS), which involves the tendency to maintain behavior in extinction conditions. The three dimensions of character are self-directedness (SD), seen as the ability to regulate behavior in order to adjust it to one's principles, goals, and personal beliefs; cooperativeness (C), which assesses the subject's pro-social behavior as a measure of social adaptation; and self-transcendence (ST), related to the subject's identification with everything conceived as essential and consequential parts of a unified whole. The participants must respond on a 5-point Likert scale ranging from 1 (definitively false) to 5 (definitively true). Scores for each dimension range from 1 to 40. The internal reliability (Cronbach's α) of the TCI-56 subscales were adequate for the present sample, being 0.76 for HA, 0.64 for NS, 0.76 for RD, 0.73 for PS, 0.73 for SD, 0.71 for C, and 0.84 for ST.

The Sensation Seeking Scale Form V (SSS-V) (Zuckerman, 1994; Zuckerman, Eysenck, & Eysenck, 1978) assesses four sensation seeking dimensions with 40 items in four subscales: thrill and adventure seeking (TAS), understood as the desire to engage in sport or other physical activities involving speed or adventure that provide unusual sensations; experience seeking (ES), which assesses the drive to seek new experiences through the mind and senses and a nonconformist life style; disinhibition (DIS), reflecting interest in socially and sexually uninhibited activities; and boredom susceptibility (BS), which assesses aversion to routine and repetitive actions. Each subscale includes 10 items with scores from 0 to 10. The total score is obtained by adding the scores from each subscale and ranges from 0 to 40. The internal reliability (Cronbach's α) for the present sample was adequate, being 0.74 for the total score, 0.75 for TAS, 0.52 for ES, 0.61 for DIS, and 0.54 for BS.

2.3. Data analysis

The internal consistency of the scales was estimated using Chronbach's α coefficient and the distribution of the scores was analyzed using Kolmogorov-Smirnov tests. Spearman's correlations were computed between the different dimension scores of TCI-56, SSS-V and rMEQ. Two multivariate analysis of covariance (MANCOVA) were performed for the TCI-56 dimensions: one for the temperament dimensions and another for the character dimensions. Two MANCOVA were performed for the SSS-V: one for the total score and another for the dimension scores. Personality scores were considered as dependent variables, taking circadian typology and sex as factors, where age was considered as a covariable to control for possible effects. The partial eta square η_p^2 was obtained as a measure of size effect, considering that a η_p^2 of 0.01 is small, 0.04 moderate, and 0.10 large (Huberty, 2002). Post hoc comparisons were performed by Bonferroni's test and the effect size estimations were calculated using Cohen's *d*. Moreover, multiple regression analyses were performed for each TCI-R and SSS-V dimension in order to examine the predictive value of sex and circadian typology, and the interaction between both. Statistical analyses were performed using the SPSS/PC+ statistics package (version 17.0), and statistical tests were bilateral with type I error set at 5%.

3. Results

3.1. Sociodemographic data

The distribution of subjects in the circadian typology groups was 115 in the morning-type (16.4%; 51 men and 64 women), 409 in the neither-type (58.4%; 184 men, 225 women), and 176 evening-type (25.2%; 89 men, 87 women). The distribution of the total scores in the rMEQ was skewed toward eveningness ($z = 2.13$, $p < 0.001$).

Moreover, the circadian typology groups differed significantly in age ($F_{(2,697)}$ = 12.80; p < 0.001; η_p^2 = 0.035), the morning-type subjects being older than the evening- (1.62, p < 0.001) and the neither-type (1.61, p < 0.001).

3.2. Temperament and Character Inventory (TCI-56)

Descriptive data for the total sample and for sex and circadian typology in the TCI-56 scores are shown in Table 1. Significant differences were obtained for sex in five dimensions of the TCI-56, three of temperament and two of character. Women showed higher scores than men in HA, RD, PS, SD and C.

Main effects of circadian typology were observed in the temperament dimensions of NS and PS. Post hoc comparisons showed higher NS scores in the evening-type group compared to morning-type (1.36, p = 0.039; Cohen's d = 0.32), and higher PS scores in the morning-type compared to the neither- (1.59, p = 0.006; Cohen's d = 0.03) and evening-type (2.26, p < 0.001; Cohen's d = 0.05). Moreover, a significant interaction was found between circadian typology and sex in HA ($F_{(2,693)}$ = 4.48; p = 0.012; η_p^2 = 0.013). Evening- and neither-type men showed lower scores than women in HA, while there were no significant sex differences in the morning-type group (see Figure 1).

[Insert Table 1 and Figure 1]

3.3. Sensation Seeking Scale (SSS-V)

Descriptive data for the total sample and for sex and circadian typology in the SSS-V scores are shown in Table 2. Significant differences were observed in sex for the SSS-V total scores as well as for the four SSS-V dimensions. Men scored higher in SSS-V, TAS, DIS, and BS scores, while women obtained higher scores in ES.

Main effects for the circadian typology were observed in the SSS-V total score as well as in the ES and DIS dimensions. The evening-type subjects scored higher than the morning-type in SSS-V (2.50, $p < 0.001$; Cohen's $d = 0.48$), ES (0.77, $p = 0.002$; Cohen's $d = 0.36$), and DIS (1.27, $p < 0.001$; Cohen's $d = 0.67$), and they also scored higher than the neither-type in SSS-V (1.94, $p < 0.001$; Cohen's $d = 0.38$) and DIS (0.90; $p < 0.001$; Cohen's $d = 0.47$). A significant interaction was found between circadian typology and sex in the SSS-V total score ($F_{(2,693)} = 4.38$; $p = 0.013$; $\eta_p^2 = 0.012$). Evening-type men scored higher than evening-type women in SSS-V, with no sex differences in the neither- and morning-type groups (see Figure 2).

[Insert Table 2 and Figure 2]

3.4. Correlation and regression analyses

The correlation matrix between TCI-56 and SSS-V dimensions with the rMEQ scores is shown in Table 3. rMEQ scores correlate with the NS and PS temperament dimensions scores, and with the SD and C character dimension scores of the TCI-56. Moreover, there are negative correlations between rMEQ scores and SSS-V total scores and DIS scores.

[Insert Table 3]

Table 4 shows the multiple regression analyses performed with rMEQ scores, sex and their interaction. rMEQ scores are good predictors of the NS and PS temperament dimension scores and, to a lesser extent, of the SD and C character dimension scores. Likewise, rMEQ scores are good predictors of the sensation seeking overall (SSS-V) as well as of the DIS, TAS, and ES dimension scores. Finally, the interaction between rMEQ scores and sex is a good predictor of the HA, RD and PS temperament dimension scores, and of the C character dimension scores. This

interaction is also a good predictor of the sensation seeking (SSS-V) as well as of the TAS and DIS dimension scores.

[Insert Table 4]

4. Discussion

In this study we have examined, for first time, the possible relationships among circadian typology, Cloninger's biological model of personality and Zuckerman's sensation seeking model, in a large sample of healthy students with a good representation of both sexes, including subjects belonging to the three circadian typologies and controlling for physical and psychological problems, with an emphasis on excluding addictive disorders. This aspect may be especially relevant since obtained results could be more generalizable to young healthy population.

Sex differences found with Cloninger's model of personality are in accordance with previous results (Adan, Lachica et al., 2010; Chen, Lu, & Kitamura, 2013; Fresán, Robles-García, López-Ávila, & Cloninger, 2011; García, Aluja, García, Escorial, & Blanch, 2012), underlining that women tend to show higher levels of worry and fear of the uncertain (HA), sentimentality, attachment and dependence (RD), perseverance and ambition (PS), responsibility, purposefulness, resourcefulness, and self-acceptance (SD), social acceptance, empathy, helpfulness, compassion and integrated conscience (C). Sex differences were also found in Zuckerman's sensation seeking model, which are also in line with previous works (Muro et al., 2012; Prat & Adan, 2013; Tonetti et al., 2010). Women exhibited a higher tendency to seek new experiences through the mind and senses, as well as a nonconformist lifestyle (ES). Men were more prone to sensation seeking (SSS-V), to participate in risk or speed activities (TAS), to be

interested in socially and sexually disinhibited activities (DIS), and to show aversion to routine and repetitive actions (BS).

The differences observed between circadian typologies in the temperament and character dimensions are also in agreement with previous research (Adan, Lachica et al., 2010; Caci et al., 2004; Randler & Saliger, 2011). The morning-type subjects showed higher persistence and higher resistance to fatigue, frustration and difficulties (PS), characteristics which are associated to lower levels of anxiety and less depressive symptomatology (Hansenne & Bianchi, 2009), together with higher life satisfaction (Goncalves & Cloninger, 2010), higher resistance to substance abuse (Hartman, Hopfer, Corley, Hewitt, & Stallings, 2013), and higher ease for dishabituation from substance abuse (Bishry et al., 2012).

On the other hand, evening-type subjects tended to be more extravagant, temperamental and impulsive, with a higher tendency to explore the unknown (NS), characteristics which are associated to the development of addictive behaviors (Black et al., 2013; Hartman et al., 2013), suicidal attempts (Perroud et al., 2013), ADHD (Merwood, Asherson, & Larsson, 2013), onset insomnia (Na et al., 2011) and antisocial tendencies (Snowden & Gray, 2010). Moreover, the evening- and neither-type men presented, when compared to the evening- and neither-type women, less ability to anticipate and prevent negative consequences from risk stimuli (HA). These data, considered together with the lower persistence and the tendency to novelty seeking, indicate that the evening-type men may exhibit a high vulnerability to develop substance abuse disorders (Hartman et al., 2013).

The findings obtained in relation to circadian typology and sensation seeking agree with those of adults (Prat & Adan, 2013; Tonetti et al., 2010) and adolescents

(Muro et al., 2012; Vollmer & Randler, 2012) described in previous studies. The evening-type showed higher general sensation seeking (SSS-V), highlighting their tendency to seek new experiences (ES) and to join in socially and sexually uninhibited activities (DIS). These characteristics have been related to drug consumption (Franques et al., 2003; Lillaz & Varescon, 2012; Liraud & Verdoux, 2000), impulse control difficulties (Lejoyeux, Feuché, Loi, Solomon, & Adès, 1998), gambling (Fortune & Goodie, 2010), internet dependence (Rahmani & Lavasani, 2011), and self-reported delinquency (Pérez & Torrubia, 1985).

The regression analyses revealed, as seen previously in adults (Adan, Lachica et al., 2010; Caci et al., 2004) and adolescents (Muro et al., 2012; Randler & Saliger, 2011), that the morningness-eveningness dimension may be a good predictor for personality characteristics, emphasizing the predictive power for novelty seeking (NS), persistence and frustration tolerance (PS), sensation seeking (SSS-V) and the tendency to participate in socially and sexually disinhibited activities (DIS).

Several limitations for this study should be addressed in future research. The small age range of the sample as well as the specific sociodemographic characteristics do not allow to generalize our results to the general population. Moreover, taking into account that the participant distribution is representative for the three circadian typologies of the assessed population (young students), the power of our results would be greater with a higher proportion of morning-type subjects. Finally, the TCI-56 allows an economical but limited assessment of personality when compared to questionnaires such as the TCI or TCI-R, based on Cloninger's temperament and character dimensions. Likewise, due to the low internal reliability of subscales ES and BS of the SSS-V, which is in accordance with previous works (Fortune & Goodie, 2010; Tonetti et al.,

2010; Zuckerman et al., 1978), conclusions drawn from these subscales should be taken with caution.

In sum, this is the first study assessing circadian typology and personality by means of both Cloninger and Zuckerman models, and controlling for the presence of physical and psychological problems. The personality profile obtained attending to the circadian typology groups and their interactions with sex, once the physical and psychological health of the participants has been controlled, confirms some evening-type characteristics that could make the subjects in this group (especially in men) more vulnerable to developing adaptive difficulties and psychological problems (anxiety and affective problems), when compared to morning- and neither-type subjects. Although future research should enhance the study of the relationships between circadian typology, sex, and personality with diverse mental health disorders, especially by using longitudinal designs, the findings obtained to the date suggest that healthcare professionals should take into consideration circadian typology when developing prevention and health promotion programs as well as treatment strategies.

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Declaration of interest

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

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Table 1

Descriptive statistics (mean ± standard error), F-tests and partial eta-square (η_p^2) for the subscales of the Temperament and Character Inventory (TCI-56) for the total sample, by sex and circadian typology, controlling for age.

		Sex				Circadian typology				
TCI-56	**Total sample (n = 700)**	**Men (n = 324)**	**Women (n = 376)**	**F**	η_p^2	**Evening-type (n = 176)**	**Neither-type (n = 409)**	**Morning-type (n = 115)**	**F**	η_p^2
Temperament										
HA	24.43 ± 0.20	23.46 ± 0.28	25.27 ± 0.27	9.41**	0.013	24.55 ± 0.40	24.43 ± 0.25	24.28 ± 0.53	0.14	0.000
NS	22.42 ± 0.17	22.61 ± 0.25	22.26 ± 0.24	0.28	0.000	23.19 ± 0.34	22.28 ± 0.22	21.73 ± 0.43	3.63*	0.010
RD	29.93 ± 0.20	28.42 ± 0.30	31.22 ± 0.25	49.80**	0.067	29.55 ± 0.41	30.09 ± 0.26	29.93 ± 0.50	0.53	0.002
PS	26.94 ± 0.18	26.39 ± 0.27	27.41 ± 0.24	7.67**	0.011	26.14 ± 0.40	26.85 ± 0.22	28.46 ± 0.48	7.64**	0.022
Character										
SD	28.35 ± 0.19	28.15 ± 0.26	28.52 ± 0.27	3.91*	0.006	28.06 ± 0.37	28.26 ± 0.24	29.09 ± 0.49	0.24	0.001
C	31.84 ± 0.16	30.70 ± 0.24	32.82 ± 0.21	38.76**	0.053	31.11 ± 0.34	32.10 ± 0.21	32.02 ± 0.42	2.75	0.008
ST	18.69 ± 0.23	18.77 ± 0.36	18.62 ± 0.31	0.02	0.000	19.13 ± 0.49	18.47 ± 0.29	18.80 ± 0.61	0.67	0.002

*$p < 0.05$; **$p < 0.01$

HA = harm avoidance; NS = novelty seeking; RD = reward dependence; PS = persistence; SD = self-directedness; C = cooperativeness; ST = self-transcendence.

Table 2

Descriptive statistics (mean ± standard error), F-tests and partial eta-square (η_p^2) for the total score and subscales of the Sensation Seeking Scale (SSS-V) for the total sample, by sex and circadian typology, controlling for age.

		Sex				Circadian typology				
SSS-V	**Total sample (n = 700)**	**Men (n = 324)**	**Women (n = 376)**	**F**	η_p^2	**Evening-type (n = 176)**	**Neither-type (n = 409)**	**Morning-type (n = 115)**	**F**	η_p^2
SSS-V TS	21.30 ± 0.21	22.05 ± 0.31	20.66 ± 0.27	7.83**	0.011	22.92 ± 0.41	20.91 ± 0.26	20.22 ± 0.56	10.32**	0.029
TAS	5.90 ± 0.10	6.31 ± 0.15	5.55 ± 0.13	10.02**	0.014	6.19 ± 0.19	5.87 ± 0.13	5.58 ± 0.26	1.10	0.003
ES	6.71 ± 0.07	6.55 ± 0.11	6.86 ± 0.09	5.14*	0.007	7.04 ± 0.13	6.67 ± 0.09	6.37 ± 0.18	5.96**	0.017
DIS	4.86 ± 0.08	5.15 ± 0.12	4.62 ± 0.10	7.89**	0.011	5.63 ± 0.16	4.70 ± 0.10	4.25 ± 0.19	17.70**	0.049
BS	3.82 ± 0.08	4.04 ± 0.12	3.63 ± 0.11	6.91**	0.010	4.06 ± 0.16	3.66 ± 0.10	4.02 ± 0.20	2.80	0.008

*$p < 0.05$; **$p < 0.01$

SSS-V TS = SSS-V total score; TAS = thrill and adventure seeking; ES = experience seeking; DIS = disinhibition; BS = boredom susceptibility.

Table 3

Spearman correlations among the short version of the Temperament and Character Inventory (TCI-56) subscales and Sensation Seeking Scale form V (SSS-V) subscales and total score, as well as between these and the total score of the reduced Morningness-Eveningness Questionnaire (rMEQ).

	HA	NS	RD	PS	SD	C	ST	rMEQ
rMEQ	-0.007	-0.127**	0.010	0.138***	0.089*	0.081*	-0.055	
SSS-V TS	-0.229***	0.295***	-0.039	-0.036	-0.060	-0.062*	0.204***	-0.153***
TAS	-0.294***	0.159***	-0.087*	0.034	0.027	0.029	0.159***	-0.069
ES	-0.133***	0.234***	0.074	0.003	0.016	0.211***	0.233***	-0.069
DIS	-0.090*	0.281***	0.064	-0.146***	-0.092*	-0.108**	0.104**	-0.214***
BS	-0.030	0.105**	-0.126**	0.006	-0.111**	-0.279***	0.039	-0.047

*$p < 0.05$; **$p < 0.01$, ***$p < 0.001$.

HA = harm avoidance; NS = novelty seeking; RD = reward dependence; PS = persistence; SD = self-directedness; C = cooperativeness; ST = self-transcendence; SSS-V TS = SSS-V total score; TAS = thrill and adventure seeking; ES = experience seeking; DIS = disinhibition; BS = boredom susceptibility.

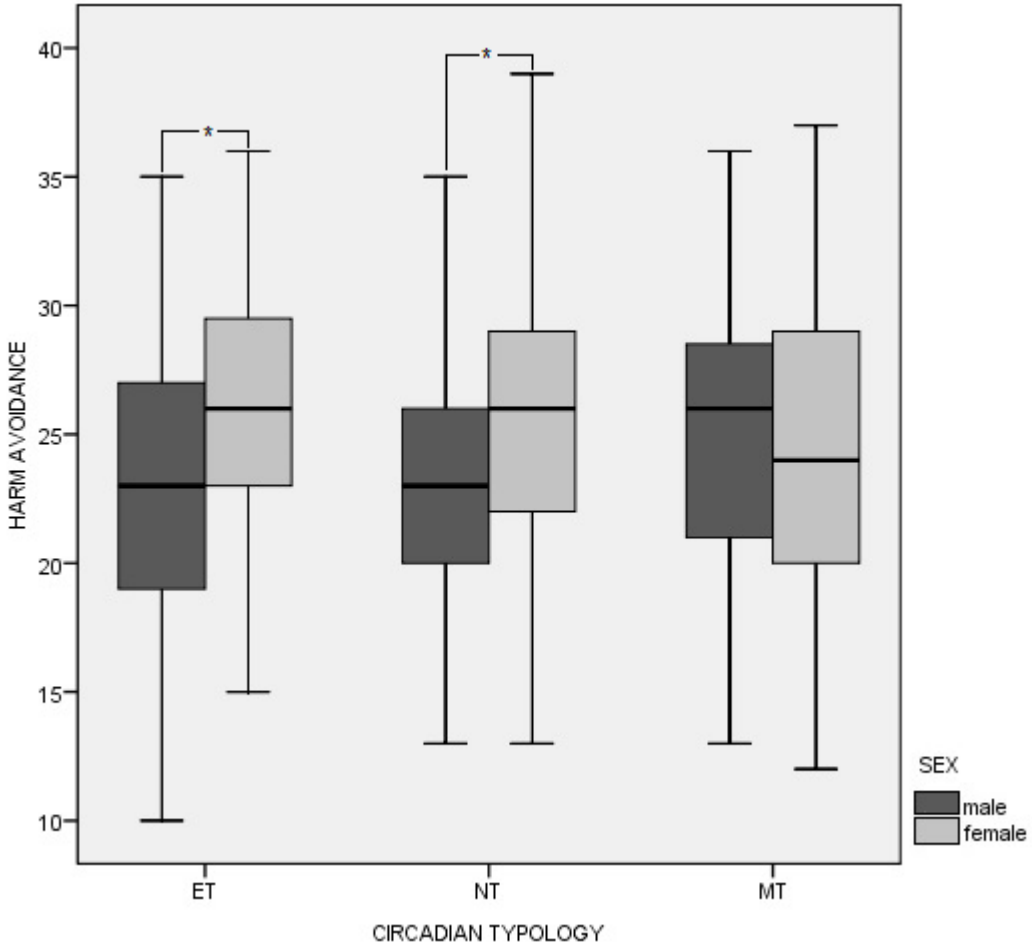
Table 4

Change statistics (R^2, F) from multiple regression performed for each scale of the short version of the Temperament and Character Inventory (TCI-56) and the Sensation Seeking Scale-Form V (SSS-V). The variables considered were sex, the reduced Morningnes-Eveningness Questionnaire (rMEQ) scores, and their interaction computed as the product of the two centered variables.

		Sex		rMEQ scores		rMEQ scores x sex	
		R^2	F	R^2	F	R^2	F
TCI-56	HA	0.029	21.61***	0.000	0.097	0.018	13.90***
	NS	0.000	1.05	0.014	11.03***	0.002	2.69
	RD	0.068	52.30***	0.000	0.14	0.065	49.66***
	PS	0.010	7.84**	0.023	17.51***	0.018	13.81***
	SD	0.000	0.95	0.006	5.06*	0.003	3.29
	C	0.059	44.68***	0.004	3.94*	0.056	42.73***
	ST	0.000	0.10	0.001	1.90	0.000	0.13
SSS-V	SSS-V TS	0.015	11.43***	0.028	21.28***	0.019	14.40***
	TAS	0.020	15.11***	0.005	4.48*	0.021	16.32***
	ES	0.005	4.68*	0.004	3.93*	0.004	3.67
	DIS	0.015	11.69**	0.049	37.22***	0.022	16.99***
	BS	0.008	6.78**	0.003	2.77	0.008	6.68*

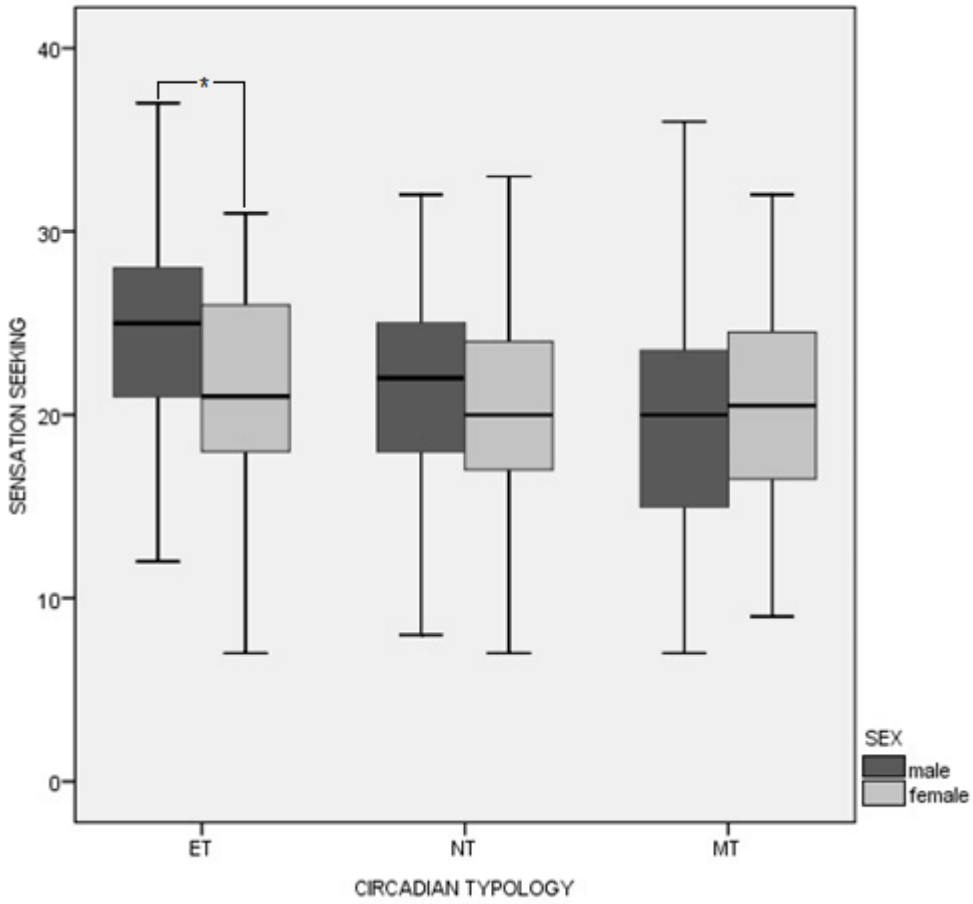
*$p < 0.05$; **$p < 0.01$, ***$p < 0.001$

HA = harm avoidance; NS = novelty seeking; RD = reward dependence; PS = persistence; SD = self-directedness; C = cooperativeness; ST = self-transcendence; SSS-V TS = SSS-V total score; TAS = thrill and adventure seeking; ES = experience seeking; DIS = disinhibition; BS = boredom susceptibility.



*$p < 0.01$.

Fig. 1. Circadian typology (MT: morning-type, NT: neither-type, and ET: evening-type) and sex interaction in the Harm Avoidance (HA) dimension of the Temperament and Character Inventory-56 (TCI-56). Scores range from 8 to 40.



*$p < 0.01$.

Fig. 2. Circadian typology (MT: morning-type, NT: neither-type, and ET: evening-type) and sex interaction in the Sensation Seeking Total Score of the Sensation Seeking Scale form V (SSS-V). Scores range from 0 to 40.