Morningness-Eveningness, Sex, and the Alternative Five Factor Model of Personality
Anna Muro a; Montserrat Gomà-i-Freixanet a; Ana Adan b
a Department of Health Psychology, Universitat Autònoma de Barcelona, Catalonia, Spain
b Department of Psychiatry and Clinical Psychobiology, Universitat de Barcelona, Catalonia, Spain

Online Publication Date: 01 August 2009

To cite this Article Muro, Anna, Gomà-i-Freixanet, Montserrat and Adan, Ana(2009)'Morningness-Eveningness, Sex, and the Alternative Five Factor Model of Personality', Chronobiology International, 26:6, 1235 — 1248

To link to this Article DOI: 10.1080/07420520903240491
URL: http://dx.doi.org/10.1080/07420520903240491
MORNINGNESS-EVENINGNESS, SEX, AND THE ALTERNATIVE FIVE FACTOR MODEL OF PERSONALITY

Anna Muro,1 Montserrat Gomà-i-Freixanet,1 and Ana Adan2

1Department of Health Psychology, Universitat Autònoma de Barcelona, Catalonia, Spain
2Department of Psychiatry and Clinical Psychobiology, Universitat de Barcelona, Catalonia, Spain

Recent research on personality and circadian typology indicates that evening-type subjects are more extraverted, impulsive, and novelty-seeking, while morning ones tend to be more introverted, conscientious, agreeable, and emotionally stable. The purpose of this study was to examine the differences between circadian typologies on the Zuckerman’s Alternative Five Factor Model of personality (AFFM), which has a strong biological basis, controlling for sex and age. A sample of 533 university students (168 men) participated in the study. Results showed that morning-type subjects had significant higher scores than evening-type and neither-type subjects in Activity, and in its subscales General Activity and Work Activity. A significant interaction between circadian typology and sex was found for Neuroticism-Anxiety: morning-type men showed higher scores than evening-type and neither-type, who had the lowest scores. Women presented the opposite pattern: neither-type obtained the highest scores, while morning-type showed the lowest. This is the first time the AFFM has been used in the context of circadian rhythms research. The results suggest that activity is the only trait related to extraversion associated with morningness, while Neuroticism-Anxiety was modulated by sex. These results might help highlight previous results on the association between morningness-eveningness and other models of personality assessment, and they offer new data that calls for further research. (Author correspondence: anna.muro@uab.cat)

Keywords Morningness, ZKPQ, Personality, Sex, Age

INTRODUCTION

In all living species, the circadian system controls the biological activity of daily rhythmic patterns (Dardante & Cermakian, 2007). In mammals, circadian rhythms are expressed in most biological parameters, such as...
sleep-awake cycle, body temperature, hormonal secretion, sexual behavior, alertness, activity, and meal times (Silva et al., 2005; Wehr, 2001). In human beings, the relevance of circadian rhythms on successful psychological adaptation partially explains the biological correlates such as performance and mood (Adan et al., 2008) or personality (Caci et al., 2004; DeYoung et al., 2007; Tonetti et al., 2009). It is well established that human beings are mainly diurnal mammals but show individual differences in the regulation of their circadian rhythms. Accordingly, individuals can be classified in a continuum of morningness-eveningness as morning-type (MT), neither-type (NT), and evening-type (ET). MT are more synchronized with sunrise and reach their peak values of activity, temperature, and skin conductance earlier in the day than do ET; thus, MT wake up and go to sleep earlier than ET and NT, with a difference in the phase position that can vary in a range of 1.5 to 4 h (Adan et al., 2008; Tankova et al., 1994).

Findings indicate there is a higher frequency of ET among men and a higher frequency of MT among women (Adan & Natale, 2002; Natale & Danesi, 2002), suggesting that men show a more pronounced eveningness tendency and that their circadian function amplitude is higher than that of women (Adan & Sánchez-Turet, 2001). Sex-related hormonal differences might underlie the fact that women are more morningness-oriented and thus more synchronized with environmental light input (Adan & Natale, 2002).

Age differences have also been found to influence morningness, showing that an increase in age is related to a higher morningness score (Carrier et al., 1997; Paine et al., 2006). In student samples, there is a skewness toward eveningness (Adan & Natale, 2002; Natale et al., 2005), while the distribution of chronotypes of working adults is skewed toward morningness (Taillard et al., 2004). This pattern was obtained both in eastern and western countries, offering more evidence of the genetic basis of the morningness-eveningness trait (Carpen et al., 2006; Hur, 2007; Mishima et al., 2005; Vink et al., 2001). However, it has also been reported that environmental variables, such as climate, longitude, and latitude, also influence morningness-eveningness preferences (Achari & Patti, 2007; Randler, 2008b).

Some psychiatric disorders have also been related to abnormal circadian functioning. In adults, ET have been related to drug consumption and abuse (Adan, 1994), stress (Langford & Glendon, 2002; Mecacci & Rochetti, 1998), sleep disorders (Richardson, 2005), depression and seasonal affective disorders (Lewy et al., 2006), or attention deficit disorder (Adan et al., 2008). In adolescents, eveningness has also been suggested to be an indicator of behavioral and emotional problems and risky behaviors, such as aggressive and delinquent conduct, habitual substance use, and suicidality (Gau et al., 2007; Goldstein et al., 2007).
Specific research on circadian rhythms and personality has been conducted with different personality and circadian timing assessment methods. Some authors indicate that the observed differences in previous results on the association between morningness and personality might have to do with the different theoretical models used to assess personality (Randler, 2008a), rather than to the different measures used to assess morningness, as none of them seems to be psychometrically superior (DiMilia et al., 2008). Research on this topic initially used the Eysenck’s personality model due to its biological basis (Eysenck, 1992). Tankova et al. (1994) reviewed sixteen studies from 1971 to 1992 and concluded that lower morningness scores were associated to higher scores on Extraversion, although only nine studies reported such results. Other research studies showed contradictory results. Langford and Glendon (2002) reported a significant negative correlation between morningness and Extraversion, while Mecacci and Rochetti (1998) failed to find such an association. These authors suggested that these differences were probably due to the impulsive component inherent to the Extraversion dimension in Eysenck’s original model. More detailed research showed significant negative correlations between morningness and Eysenck’s Impulsivity trait (Caci et al., 2005). Yet, an earlier study by Larsen (1985) found morningness was negatively related to sociability but not impulsivity. Although Hogben et al. (2007) also found significant negative correlations, impulsivity was no longer a significant predictor of diurnal preference when a multiple regression analysis was performed. The results were inconclusive and called for further research for Eysenck’s dimensions of Psychoticism and Neuroticism, although some significant negative correlations with morningness were found for Psychoticism (Mecacci & Rochetti, 1998; Tankova et al, 1994).

Some studies using the Big Five Model of personality (Costa & McCrae, 1992; Rammstedt & John, 2007) found that ET are more extraverted than MT (Jackson & Gerard, 1996) and scored higher on Neuroticism (Tonetti et al., 2009). Other studies offered new data showing that MT are more agreeable (DeYoung et al., 2007) and conscientious than ET, suggesting that Conscientiousness is a better predictor than Extraversion or Agreeableness in diurnal preference (Gray & Watson, 2002; Hogben et al., 2007; Jackson & Gerard, 1996; Randler, 2008a; Tonetti et al., 2009). A positive correlation was also reported between morningness and Stability, which is the metatrait resulting from the shared variance of Neuroticism reversed, Agreeableness, and Conscientiousness (DeYoung et al., 2007).

Studies using Cloninger’s Personality Model with the Temperament and Character Inventory (Cloninger et al., 1993) reported in a male sample that morningness was positively associated with Persistence and negatively related to Novelty Seeking, including negative correlations with Impulsiveness, Extravagance, and Disorderliness (Caci et al., 2004). Accordingly,
it was suggested that morningness is related to temperament but not to character dimensions, indicating a strong association between circadian typology and the biological roots of personality.

Based on these results, the authors of the present study chose a new personality model that is embedded in accumulated biological and genetic data on personality—the Zuckerman’s Alternative Five Factor Model (AFFM; Zuckerman et al., 1993) and its corresponding assessment questionnaire, the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ)—in order to disentangle the results found with other models of personality. In this model, no measures of cultural interests or intellectual styles were included because of Zuckerman’s (1991) conception that basic traits should be easily comparable to traits in other animal species and found throughout the human lifespan. Accordingly, Aggression-Hostility, which is partially considered as the Big Five’s Agreeableness reversed (Zuckerman et al., 1991), was included as a single factor. A distinction between Aggression-Hostility and Neuroticism-Anxiety emerged at the factor analysis level, and it was considered important because both dimensions have different psychobiological bases and should not be confounded within a single factor (Zuckerman et al., 1993). Moreover, the broad dimension of Extraversions was divided into the separated factors of Sociability and Activity, due to the identification of Activity as a basic major developmental trait of temperament in children as well as of personality in adults (Buss & Plomin, 1984; Zuckerman et al., 1991). However, Activity was regarded as a subtrait of Extraversion in the Big Five Model. On the other hand, Impulsivity and Sensation Seeking, which were considered as Conscientiousness reversed, were included together as an independent factor, as they are closely related and have many important and common psychobiological correlates (Zuckerman et al., 1991).

Since its first publication, the ZKPQ has undergone extensive psychometric testing, demonstrating good internal reliability, temporal stability, validity, and cross-cultural replication (Gomà-i-Freixanet et al., 2004, 2005; Zuckerman, 2002). Norms for Spanish samples have recently been published (Gomà-i-Freixanet & Valero, 2008). Some studies have already shown concurrent and discriminant validity in addressing characteristics of drug abusers (Ball, 1995), borderline personality disorder (Gomà-i-Freixanet et al., 2008a), major depression (Wang et al., 2002), and risk taking (Zuckerman & Kuhlman, 2000).

The aim of this study was to assess the personality differences along morningness-eveningness dimension using the biologically anchored Zuckerman’s model of personality. This is the first time the AFFM of personality is used in the context of circadian timing. The obtained results will help to contrast the results concerning previous research on this topic.
METHOD

Participants

The initial sample consisted of 548 college students from two public psychology schools of Barcelona (Catalonia, Spain) with similar cultural background. Accordingly, no differences were found in the analysis of variance of socio-economic status. Only those who completed all the questionnaires and did not show inattention and social desirability responding when answering the personality questionnaire were included in the data analyses. Inattention and social desirability were controlled through the Infrequency scale of the ZKPQ, with participants scoring ≥4 rejected (Goma`-i-Freixanet et al., 2004). The final sample (n = 533) consisted of 168 men (31.5%) and 365 women with age ranging from 18 to 33 yrs (M = 22.31; SD = 3.99). Mean age was significantly different according to sex [t (1, 532) = 8.836; p = 0.0003], men being older than women (men: 23.03 ± 4.73 yrs; women: 21.96 ± 3.54 yrs).

Measures and Procedures

Subjects completed the questionnaires anonymously in classrooms during morning course sessions between the months of September and February. All participants gave informed consent prior to their inclusion in the study and did not receive any credit for their collaboration. The Ethical Committee of the university approved the protocol, and the study met the international ethical standards of chronobiology research (Portaluppi et al., 2008).

Circadian typology was assessed by the Spanish version of the reduced scale of the Morningness-Eveningness Questionnaire (rMEQ; Adan & Almirall, 1991). The Spanish rMEQ is a reliable measure that shows high sensitivity in classifying subjects (Adan & Almirall, 1991). It consists of five items covering daily physical and sleep/awake preferences. Three circadian typologies can be obtained according to the direct cutoff score, with scores from 4 to 11 classifying individuals as evening-type (ET), ones from 12 to 17 as neither-type (NT), and those from 18 to 25 as morning-type (MT).

To assess personality, the Spanish adaptation of the ZKPQ (Gomà-i-Freixanet & Valero, 2008) was administered. This questionnaire has proved to be reliable in Spanish samples, with internal consistency alpha coefficients ranging from 0.67 to 0.84, and to display convergent, discriminant, and consensual validity (Gomà-i-Freixanet et al., 2004, 2008b). The ZKPQ consists of 99 dichotomous items covering five scales and an additional Infrequency (Infreq, 10 items) scale that allows eliminating subjects with careless responding or social desirability; this scale ensures that
none of the basic traits are affected by this response set bias (i.e., “I have always told the truth”, “I have never lost anything”).

The five personality dimensions are Neuroticism-Anxiety, Activity, Sociability, Impulsive Sensation-Seeking, and Aggression-Hostility. Neuroticism-Anxiety (N-Anx, 19 items) describes frequent emotional upset, tension, worry, fearfulness, indecision, lack of self-confidence, and sensitivity to criticism (i.e., “I frequently get emotionally upset”, “I often worry about things that other people think are unimportant”). Activity (Act, 17 items) has two sub-scales. The first one, General Activity, describes the need for general activity and impatience or restlessness when there is nothing to do (i.e., “I like to be doing things all of the time”). The second, Work Activity, measures a preference for challenging and hard work, an active busy life, and a high energy level (i.e., “I like a challenging task much more than a routine one”). Sociability (Sy, 17 items) also involves two subscales. Parties and Friends describes the number of friends and amount of time spent with them, outgoingness at parties and a preference for being with others (i.e., “At parties, I enjoy mingling with many people whether I already know them or not”), while Isolation Intolerance indicates intolerance for social isolation and for engaging in solitary activities (i.e., “I would not mind being socially isolated in some place for some period of time”). Impulsive Sensation-Seeking (ImpSS, 19 items) is a factor that describes Impulsivity as a lack of planning, the tendency to act impulsively without thinking (i.e., “I usually think about what I am going to do before doing it”), and Sensation Seeking as the seeking of excitement, novel experiences, and the willingness to take risks for these types of experiences (i.e., “I would like the kind of life where one is on the move and travelling a lot, with lots of change and excitement”). Finally, Aggression-Hostility (Agg-Host, 17 items) reflects a readiness to express verbal aggression, rude, thoughtless or antisocial behavior, vengefulness and spitefulness, having a quick temper, and impatience with others (i.e., “When people disagree with me I cannot help getting into an argument with them”, “It’s natural for me to curse when I am mad”).

**Statistical Analysis**

A Pearson’s correlation analysis was performed between age, morningness, and ZKPQ’s scales, and reliability coefficients were estimated by the Cronbach’s coefficient. A multiple analysis of covariance (MANCOVA) was performed considering the total score of each scale of the ZKPQ as a dependent variable, and taking circadian typology and sex as factors, while age was considered as a covariable to control for possible effects. A second MANCOVA was performed with the subscales of the ZKPQ. The partial eta-squared ($\eta^2_p$) was obtained as a measure of size effect, considering that a partial eta-squared of 0.01 was small, 0.04 moderate, and 0.1
large (Huberty, 2002). The observed statistical power for significant effects ranged from 0.5 to 1.0. Data are expressed as mean and standard error of mean. Post-hoc comparisons were performed by Scheffe’s tests. Statistical tests were bilateral with Type I error set at 5%. All analyses were carried out with the SPSS 13.0 package.

**RESULTS**

Age showed a significant positive correlation with rMEQ scores ($r = .188; p < .01$) and a significant negative correlation with Neuroticism-Anxiety ($r = -.192; p < .01$) and Aggression-Hostility ($r = -.110; p < .01$). Activity appeared as the only personality scale significantly correlated with rMEQ ($r = .145; p < .01$). The internal reliability of the rMEQ for the present sample was 0.71. Internal consistencies for the ZKPQ scales ranged from 0.69 to 0.86 (see Table 1), being similar to those found in other groups with the same cultural background and similar age ranges (Gomà-i-Freixanet et al., 2004).

Table 1 shows the means and standard error of the means of each ZKPQ scale and subscale for the total sample, by sex and circadian typology. Women scored significantly higher than men on Neuroticism-Anxiety [$F(1,532) = 3.80, p < .05$, $\eta^2_p = .007$], Sociability [$F(1,532) = 12.47, p < .0001$, $\eta^2_p = .023$], and its Parties [$F(1,532) = 4.57, p < .05$, $\eta^2_p = .009$] and Isolation Intolerance subscales [$F(1,532) = 13.67, p < .0001$, $\eta^2_p = .025$]. Men obtained significantly higher scores on Sensation Seeking [$F(1,532) = 4.84, p < .05$, $\eta^2_p = .009$] and Infrequency [$F(1,532) = 25.70, p < .0001$, $\eta^2_p = .047$]. The distribution of subjects was slightly skewed toward eveningness, with 20.1% being ET, 63.7% NT, and 16.2% MT. Moreover, circadian typology groups differed significantly in age [$F(2,532) = 21.55; p < .0001; \eta^2_p = .073$]. Post-hoc comparisons showed that MT were older ($24.76 \pm 5.78$ yrs) than NT ($21.82 \pm 3.47$ yrs) and ET ($21.89 \pm 2.95$ yrs).

The main effects of circadian typology were obtained for each one of the ZKPQ scales after controlling for age (see Table 1). The three circadian typologies differed significantly in Activity [$F(2,532) = 3.49, p < .05$, $\eta^2_p = .013$] and its General Activity [$F(2,532) = 3.14, p < .05$, $\eta^2_p = .012$] and Work Activity subscales [$F(2,532) = 3.13, p < .05$, $\eta^2_p = .012$]. In all three scales, post-hoc comparisons showed that MT obtained higher scores than NT, and that NT obtained higher scores than ET.

As shown in Figure 1, a significant interaction between sex and circadian typology was obtained for Neuroticism-Anxiety [$F(2,532) = 4.14, p < .05$, $\eta^2_p = .015$]. MT men showed the highest scores ($8.34 \pm 0.75$) compared to ET ($7.31 \pm 0.72$) and NT ($5.94 \pm 0.41$), who had the lowest scores. The opposite pattern was found in women: lowest scores were
<table>
<thead>
<tr>
<th>ZKPQ</th>
<th>α</th>
<th>M</th>
<th>SE</th>
<th>M</th>
<th>SE</th>
<th>F</th>
<th>Observed power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total sample</td>
<td></td>
<td>Men</td>
<td>Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n = 533)</td>
<td></td>
<td>(n = 168)</td>
<td>(n = 365)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-Anx</td>
<td>.86</td>
<td>7.66 .23</td>
<td>7.22 .37</td>
<td>8.11 .27</td>
<td>3.80*</td>
<td>.49</td>
<td>7.73 .44</td>
</tr>
<tr>
<td>Act</td>
<td>.75</td>
<td>7.99 .19</td>
<td>8.18 .31</td>
<td>7.81 .23</td>
<td>.90</td>
<td>.16</td>
<td>7.28 .37</td>
</tr>
<tr>
<td>GenAct</td>
<td>—</td>
<td>4.06 .12</td>
<td>4.18 .20</td>
<td>3.95 .14</td>
<td>.81</td>
<td>.15</td>
<td>3.71 .27</td>
</tr>
<tr>
<td>WorkAct</td>
<td>—</td>
<td>3.93 .10</td>
<td>4.00 .16</td>
<td>3.85 .11</td>
<td>.56</td>
<td>.12</td>
<td>3.58 .18</td>
</tr>
<tr>
<td>Sy</td>
<td>.78</td>
<td>8.33 .19</td>
<td>7.68 .30</td>
<td>8.98 .22</td>
<td>12.47†</td>
<td>.94</td>
<td>8.49 .35</td>
</tr>
<tr>
<td>Parties</td>
<td>—</td>
<td>3.19 .11</td>
<td>2.95 .18</td>
<td>3.43 .13</td>
<td>4.57*</td>
<td>.57</td>
<td>3.35 .22</td>
</tr>
<tr>
<td>Isol</td>
<td>—</td>
<td>5.14 .11</td>
<td>4.73 .18</td>
<td>5.55 .13</td>
<td>13.67†</td>
<td>.96</td>
<td>5.15 .21</td>
</tr>
<tr>
<td>ImpSS</td>
<td>.80</td>
<td>8.32 .23</td>
<td>8.73 .38</td>
<td>7.93 .27</td>
<td>2.99</td>
<td>.41</td>
<td>8.78 .44</td>
</tr>
<tr>
<td>Imp</td>
<td>—</td>
<td>2.45 .19</td>
<td>2.51 .19</td>
<td>2.40 .14</td>
<td>.19</td>
<td>.07</td>
<td>2.44 .22</td>
</tr>
<tr>
<td>SS</td>
<td>—</td>
<td>5.87 .16</td>
<td>6.22 .26</td>
<td>5.52 .19</td>
<td>4.84*</td>
<td>.59</td>
<td>6.33 .30</td>
</tr>
<tr>
<td>Agg-Host</td>
<td>.69</td>
<td>7.66 .19</td>
<td>7.51 .31</td>
<td>7.81 .22</td>
<td>.63</td>
<td>.13</td>
<td>7.52 .364</td>
</tr>
<tr>
<td>Infreq</td>
<td>—</td>
<td>1.43 .06</td>
<td>1.75 .10</td>
<td>1.11 .07</td>
<td>25.70†</td>
<td>.99</td>
<td>1.35 .12</td>
</tr>
</tbody>
</table>

**Notes:** *p < .05, †p < .0001

those for MT (7.87 ± 0.58) compared to ET (8.14 ± 0.49) and NT (8.30 ± 0.27), who obtained the highest scores on Neuroticism-Anxiety.

**DISCUSSION**

The descriptive statistics of the ZKPQ in this sample are similar to those obtained in student samples. The means of the scales and magnitude of the reliability coefficients are in accordance with those previously found in samples of similar age and cultural background (Gomà-i-Freixanet et al., 2004, 2008b). Our results regarding sex differences in personality are in accordance with those obtained in other Spanish studies using student and adult samples (Gomà-i-Freixanet et al., 2004; Gomà-i-Freixanet & Valero, 2008); that is, women score higher on Neuroticism-Anxiety and Sociability scales, and men score higher on Sensation Seeking and Infrequency scales. This trend follows the one found in the literature; however, sex differences found in the original American sample (Zuckerman et al., 1993), such as men being significantly higher on Activity and on Aggression-Hostility, were not replicated even in other European samples (Gomà-i-Freixanet et al., 2004; Ostendorf & Angleitner, 1994). These differences may have to do with the sample itself, composed mainly of women with specific demographic characteristics, such as taking college education studies (Gomà-i-Freixanet & Valero, 2008).

The distribution of the sample showed a skewness towards eveningness, and the three typologies differed in age, MT being the oldest. These results are in accordance with other studies involving student samples, showing that an increase in age corresponds to an increase in morningness scores (Natale et al., 2005; Paine et al., 2006; Taillard, 2004). However, according to the findings of previous studies assessing

![FIGURE 1 Sex x circadian typology in Neuroticism-Anxiety scores](image-url)
circadian typology and sex, the general trend of a higher frequency of MT among women or a higher frequency of ET among men was not found (Adan & Natale, 2002; Natale & Danesi, 2002). These results might be because our student sample, comprised of morning classroom groups, shared homogenous schedules, and daily habits.

Regarding morningness-eveningness and personality, the three circadian typologies differed in Activity and its subscales General Activity and Work Activity, showing that MT individuals are more active than NT and ET. These results are relevant because it is the first time that Activity is included in personality analyses of circadian typologies differences, suggesting that the peak value differences of biological activity rhythms (Adan et al., 2008) might be closely related to the activity component of personality differences found in morningness. With the identification of Activity as a basic developmental trait (Buss & Plomin, 1984), it is suggested that future personality development studies take into account the implications of morningness on adult and child personality. However, in spite of the high correlation between Zuckerman’s Impulsive Sensation Seeking and Cloninger’s Novelty Seeking (Zuckerman & Cloninger, 1996), the results obtained by Caci et al. (2004), which report a negative association between Novelty Seeking and morningness, have not been replicated, although they follow the same trend. On the other hand, results on Impulsivity and Sociability did not follow any previous trend, showing no significant differences among circadian typologies (Caci et al., 2005; Hogben et al., 2007; Larsen, 1985). This is an important point of this study, because it is suggested that previous correlations between morningness and Eysenck’s Extraversion were probably due to the Activity component inherent to Extraversion, rather than impulsivity or sociability components (Caci et al., 2005; Larsen, 1985; Tankova et al., 1994). Furthermore, it is also suggested that aggressive behavior is not related to eveningness (DeYoung, 2007; Goldstein et al., 2007), because Aggression-Hostility—the equivalent factor to Agreeableness reversed and part of the negative pole of Conscientiousness (Costa & McCrae, 1992; Zuckerman et al., 1991)—did not show any significant difference among circadian typologies in the present study.

The sex interaction found among the three typologies on Neuroticism-Anxiety shows opposite patterns for men and women: MT men obtained the highest and MT women the lowest scores, while NT women showed the highest and NT men the lowest scores in Neuroticism-Anxiety, keeping ET aside of any extreme association with Neuroticism-Anxiety. These results differ partially from the ones obtained by Tonetti et al. (2009), who also reported that ET scored higher than MT on Neuroticism but without sex interaction. According to Randler (2008a), the different measures that have been used to assess personality might explain the inconsistencies found on this topic. Thus, it is important to choose a
personality model that would also be biologically embedded, such as the AFFM, the roots for which derive from Eysenck’s three-dimensional and other genetically based personality models (Zuckerman et al., 1993). It is worth noting that the Big Five model, which is a lexical theoretical approach, relies only on the encoding of personality traits in language. This encoding probably reflects the observability of these traits in social interactions, but it may not necessarily mirror their proportional biological relevance (Eysenck, 1992; Gomà-i-Freixanet et al., 2004; Zuckerman et al., 1993).

The conclusions of this study are relevant because this is the first time that the AFFM is used in circadian research, and the results highlight a new focus on this topic. Activity and Neuroticism-Anxiety might be associated with the circadian system through the biological clock of the hypothalamus, which plays a central role, not just in circadian regulation but also in the development of personality (Zuckerman, 1991). Hypothalamic monoamine turnover, hormones such as melatonin or cortisol levels, and responsiveness to light cycle synchronization might underlie the observed personality differences between circadian typologies (Caci et al., 2004; Hogben et al., 2007; Netter, 2004).

Although the obtained results are important, some limitations have to be considered: the sample should be larger and more balanced between men and women; it should include a wider age range with different decades; and the sample should include the general population, not just college students. Furthermore, cross-cultural analyses from different samples are also needed to contrast the effects of environmental factors, such as climate, longitude, or latitude (Randler, 2008b).

The present results suggest that future research should control for age and sex and include the NT group in the study of morningness-eveningness, because NT, who represent 60% of the population, do not just show medium positions among the extreme groups of MT and ET, but have a different personality profile (Adan & Natale, 2002; Adan et al., 2008). Finally, according to the biological basis of circadian timing, future studies on this topic should also take into account the relevance of choosing a theoretical personality model that is biologically embedded. Therefore, in contrast to the lexical approach, the use of psychobiological data might help researchers to explore the biological origins of personality (Eysenck, 1992).

DECLARATION OF INTEREST

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


