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Morning people are stable people: Circadian rhythm and the higher-order factors of the Big Five

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Abstract

A personality model based on the Big Five and their higher-order factors or metatraits was used to examine associations between personality and individual differences in circadian rhythm, as assessed by the Morningness–Eveningness Questionnaire (MEQ). Based on previous research with Eysenck's personality model and a neurobiological model implicating serotonergic function in the metatrait Stability (the shared variance of Neuroticism reversed, Agreeableness, and Conscientiousness), we hypothesized that morningness would be positively related to Stability. Structural equation modeling in a sample of 279 undergraduates confirmed this hypothesis.

Keywords: Personality; Circadian rhythm; Stability; Big Five; Morningness–eveningness

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1. Introduction

Some people are early birds; others are night owls – morning people and evening people. This is a common lay observation, but there is also scientific evidence for the validity of these classifications and, additionally, for the existence of people who prefer the middle of the day to either morning or evening. Preferences for time of waking and sleeping, as well as for time of day for accomplishing demanding intellectual and physical tasks, can be reliably measured and appear to have a biological basis. Like most organisms, human beings show circadian rhythms in many behavioral and biological variables. When not exposed to environmental cues providing temporal information, the human circadian cycle has a free-running period of about 25 h. Normally, however, it is entrained to a 24 h period, primarily through exposure to the daily cycle of light and dark (Miller, Morin, Schwartz, & Moore, 1996). Like most characteristics of organisms, circadian rhythm is subject to individual variation. Barring extenuating circumstances, people feel most alert, energetic, and capable at a particular time of day, which varies from person to person but remains reasonably stable in a given individual (although there are regular changes over the lifespan – during early adolescence, for example, peak arousal typically shifts from morning toward later in the day; Kim, Dueker, Hasher, & Goldstein, 2002). These stable differences in time of peak arousal appear to be responsible for the existence of morning people, evening people, and middle-of-the-day people.

Given the importance of circadian rhythms in human functioning (they regulate sleep, appetite, and cognitive function, among other things), it is of interest to know whether their variation is associated with personality more generally. A number of studies have examined associations between time of peak arousal and Eysenck's three personality dimensions, Extraversion, Neuroticism, and Psychoticism. Most attention has been paid to Extraversion because Eysenck originally hypothesized that cortical arousal was the biological factor linked to variation in Extraversion (Eysenck, 1967). Results have been mixed. In a review of 30 years of research on individual differences in circadian rhythms, Tankova, Adan, and Buela-Casal (1994) reported 15 studies examining Extraversion, 11 of which also examined Neuroticism, and two of which also examined Psychoticism. Nine of these studies found a significant association between eveningness (late peak arousal) and Extraversion, and two more reported trends in that direction. Four studies reported a significant association between eveningness and Neuroticism, and one more reported a trend in that direction. Hess, Sherman, and Goodman (2000) demonstrated an association between eveningness and Neuroticism and cited one additional study not covered in Tankova and colleagues' review that also found this association (Mura & Levy, 1986). Finally, the two reviewed studies that examined Psychoticism found it to be significantly associated with eveningness. One later study found associations between eveningness and both Psychoticism and Extraversion, but not Neuroticism (Mitchell & Redman, 1993), and another found associations between eveningness and both Psychoticism and Neuroticism, but not Extraversion (Mecacci & Rocchetti, 1998). Lateness of peak arousal, therefore, may be associated with Extraversion, Neuroticism, and Psychoticism, but the number of null results suggests caution in drawing conclusions.

The apparent association between Extraversion and circadian rhythm is complicated by the history of Eysenck's personality model, which originally contained only two factors, Extraversion and Neuroticism (Eysenck, 1947). When Psychoticism was added to the model (Eysenck &

Eysenck, 1975), the trait of impulsivity was moved from Extraversion to Psychoticism (though Extraversion retained "venturesomeness" and "sensation seeking", which Eysenck deemed related to impulsivity), and the Eysenck Personality Inventory (EPI) was redesigned accordingly, becoming the Eysenck Personality Questionnaire (EPQ). Most of the studies cited by Tankova and colleagues utilized the EPI, thereby confounding Extraversion and Psychoticism. Eysenck himself suggested that the impulsivity dimension of Extraversion was likely to be responsible for individual differences in arousal (Eysenck & Folkard, 1980). Based on this suggestion and the results of the few studies that divided Extraversion into subdimensions of impulsivity and sociability, Tankova et al. (1994) concluded that impulsivity was likely to be responsible for the positive associations found between eveningness and Extraversion. Given this situation, circadian rhythm may be more likely to be related to Psychoticism than to Extraversion.

The present study attempted to integrate and clarify past findings and to provide a more comprehensive assessment of the associations between circadian rhythm and personality, by using a hierarchical model of personality based on the Big Five and their higher-order factors (DeYoung, 2006; DeYoung, Peterson, & Higgins, 2002). Over the past 20 years, the Five Factor Model or Big Five, which divides personality traits into five broad domains (Neuroticism, Agreeableness, Conscientiousness, Extraversion, and Openness/Intellect), has become one of the most widely used taxonomies of personality (Costa & McCrae, 1992; Digman, 1990; John & Srivastava, 1999). Fortunately for the sake of integration, the Big Five are not incompatible with Eysenck's dimensions. Extraversion and Neuroticism remain very similar in both models, and Eysenck's misleadingly named Psychoticism corresponds to a combination of low Agreeableness and low Conscientiousness (Eysenck, 1992; Goldberg & Rosolack, 1994). Openness/Intellect primarily reflects individual differences in cognitive functioning (DeYoung, Peterson, & Higgins, 2005; Pytlik Zillig, Hemenover, & Dienstbier, 2002), which Eysenck excluded from his model because he felt them to be the domain of intelligence testing (though Openness/Intellect is a broader construct than intelligence; DeYoung et al., 2005; McCrae & Costa, 1997).

Although the Big Five were originally conceived as orthogonal factors and the highest level of a taxonomy of trait descriptors, they have proven to be regularly intercorrelated and to demonstrate a consistent higher-order factor solution (DeYoung, 2006; DeYoung et al., 2002; Digman, 1997). Neuroticism (reversed), Agreeableness, and Conscientiousness form a first factor, labeled *Stability*, while Extraversion and Openness/Intellect form a second, labeled *Plasticity* (DeYoung et al., 2002).[1] Stability is evident in emotional (Neuroticism), social (Agreeableness), and motivational (Conscientiousness) domains. Plasticity denotes an exploratory tendency in both behavioral

[1] Digman (1997) gave these factors the labels Alpha and Beta, which do not convey much content. He also suggested that they might be related to socialization and personal growth. Similar factors found in lexical analysis of personality descriptors have been labeled Morality (or Social Propriety) and Dynamism (Saucier, Georgiades, Tsaousis, & Goldberg, 2005). We prefer the labels Stability and Plasticity because they suggest basic dispositions, rather than outcomes, and thus seem more in keeping with the sizable genetic component and relative stability of personality (cf. McCrae & Costa, 1999).

(Extraversion) and cognitive (Openness/Intellect) modalities. The higher-order factors have been dubbed "metatraits" (Digman, 1997) and may provide a useful starting point for the development of a psychobiological model of personality based on the Big Five (DeYoung, 2006; DeYoung et al., 2002). Evidence suggests that Stability is associated with variability in serotonergic function while Plasticity is associated with variability in dopaminergic function (DeYoung, 2006; DeYoung et al., 2002, 2005).

This neurobiological model is of potential relevance to the link between circadian rhythm and personality because serotonin is heavily implicated in the control of circadian rhythm. The brain's primary clock mechanism is the suprachiasmatic nucleus (SCN) in the anterior hypothalamus, and its three major afferent pathways are from the retina, the intergeniculate leaflet, and the midbrain serotonergic system (Miller et al., 1996). Serotonergic inputs to the SCN modulate the entrainment of circadian rhythms to light and also appear to mediate activity-induced shifts in circadian rhythm (Miller et al., 1996; Mistleberger, Antle, Glass, & Miller, 2000; Yuan, Lin, Zheng, & Sehgal, 2005). Serotonin may be responsible for stabilizing circadian rhythms, making them less likely to shift in response to light exposure during what would normally be the dark half of the daily cycle (e.g., from electric lights in the evening) (Yuan et al., 2005). Given the putative link between serotonergic function and the personality trait Stability, one might expect Stability to be related to individual differences in circadian rhythm, with individuals higher in Stability showing higher levels of morningness.

After translating from Eysenck's model to the Big Five, the personality associations reviewed above are consistent with our hypothesis regarding Stability. Because the few examinations of Psychoticism in relation to circadian rhythm have all found it to be associated with eveningness, morningness (early peak arousal) should be associated with Agreeableness and Conscientiousness. Additional evidence to suggest an association between Conscientiousness and morningness comes from a study of sleep habits (Gray & Watson, 2002), which did not include a direct measure of circadian rhythm, but did find that Conscientiousness was associated with sleep schedule, such that conscientious individuals both went to bed and awoke earlier. Taken with the sporadic findings of association between Neuroticism and eveningness, the likely link with Agreeableness and Conscientiousness suggests that morningness might most accurately be considered a correlate of the metatrait Stability. The inconsistent findings with Neuroticism would be more explicable if it were the case that only the variance that Neuroticism shares with Agreeableness and Conscientiousness was associated with morningness. Additional evidence that the association with Neuroticism may be valid comes from studies showing that depression is associated with eveningness (Chelminski, Ferraro, Petros, & Plaud, 1999; Drennan, Klauder, Kripke, & Goyette, 1991). In the Five Factor Model, depression is a facet of Neuroticism (Costa & McCrae, 1992). In sum, the variety of associations found between personality and circadian rhythm suggests that the metatrait level of personality structure may be the most appropriate and parsimonious level at which to examine their interrelation.

In the present study, we used structural equation modeling to examine the associations between morningness and the metatraits. We hypothesized that Stability would be positively related to morningness. Little evidence exists to suggest any association between circadian rhythm and Plasticity, particularly given doubt about the association of eveningness with Extraversion (resulting from Eysenck's initial conflation of Psychoticism and Extraversion).

2. Method

2.1. Participants

Participants were 279 students (87 male, 192 female) in an introductory psychology course at the University of Toronto, who participated in the study for course credit. They ranged in age from 17 to 30 years ($M = 18.80$, SD = 1.93).

2.2. Measures

Participants completed the Big Five Inventory (BFI; John & Srivastava, 1999), which is a standard measure of the Big Five, and the Morningness–Eveningness Questionnaire (MEQ; Horne & Ostberg, 1976). The MEQ was completed by participants in a group setting, while the BFI was completed individually during subsequent laboratory testing. The MEQ is a well-validated and widely used self-report measure of circadian rhythm, which yields a morningness (versus eveningness) score based on the time of day at which individuals feel most alert, energetic, and capable, plus the times when they prefer to wake up and go to sleep. MEQ scores predict circadian timing of numerous biological variables, including body temperature, blood pressure, sleep patterns, and hormone secretion (e.g., Bailey & Heitkemper, 2001; Carrier, Monk, Buysse, & Kupfer, 1997; Nebel et al., 1996). The MEQ contains 19 Likert-scale items, each with between three and six response options. Items are summed to yield scores ranging from 16 (extreme eveningness) to 86 (extreme morningness). For the purposes of structural equation modeling, MEQ items were divided into three packets, two containing six items and one containing seven.

2.3. Analysis

Structural equation modeling was used to examine the relation, in latent space, between morningness and the metatraits (Fig. 1). The metatraits were allowed to correlate and used as independent predictors of morningness. The model was analyzed using Amos 5.0 (Arbuckle, 2003) with maximum likelihood estimation based on the full covariance matrix.

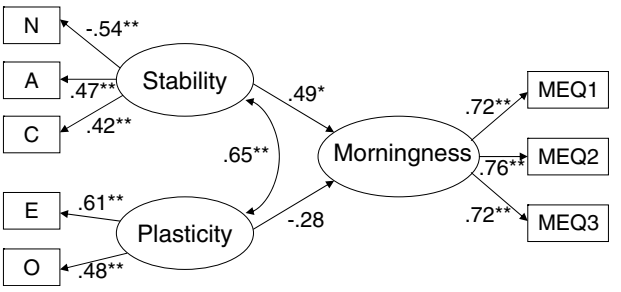

Fig. 1. Structural equation model of the associations between the higher-order factors of the Big Five and morningness. $N = 279$; χ^2 (df = 17) = 18.25, $p = .37$. MEQ, Morningness–Eveningness Questionnaire. $^{*}p < .05$, $^{**}p < .01$.

3. Results

Table 1 contains the correlations among all variables in the model depicted in Fig. 1, plus the total score for the MEQ, as well as means and standard deviations for all variables. None of the variables differed significantly by gender, except Neuroticism, on which females ($M = 3.25$, $SD = 0.70$) scored slightly higher than males ($M = 3.06$, $SD = 0.78$), $t_{(277)} = 2.00$, $p < .05$. Only Agreeableness showed a significant zero-order correlation with the MEQ total score, but examination of the MEQ packets revealed that one was significantly negatively correlated with Neuroticism and another positively correlated with Conscientiousness, suggesting associations that might be revealed once structural equation modeling was used to remove error variance from the assessment of morningness and to model the shared variance of Neuroticism, Agreeableness, and Conscientiousness. No zero-order associations were evident between the MEQ and Extraversion or Openness/Intellect.

As hypothesized, the structural model reveals a significant positive association between Stability and morningness. The association between Plasticity and morningness did not achieve significance, $p = .21$. Consistent with previous findings (DeYoung et al., 2002), the metatraits were fairly strongly correlated, but this correlation is unlikely to be substantively meaningful. Rather, it appears to be an artifact associated with the biases of individual raters, as it is not evident when the Big Five and metatraits are assessed as latent variables representing the shared variance of ratings from multiple informants (DeYoung, 2006). The strength of this correlation highlights the importance of using Stability and Plasticity as simultaneous predictors and examining their independent contributions; this technique controls for their shared variance (which might be a product of social desirability), thus allowing only their unique variance (which should be more valid) to predict morningness.

Table 1
Correlations, means, standard deviations, and reliabilities for the BFI and MEQ

	N	A	C	E	O	MEQ1	MEQ2	MEQ3	MEQ Tot
Neuroticism	–								
Agreeableness	−.25**	–							
Conscientiousness	−.23**	.19**	–						
Extraversion	−.24**	.18**	.14*	–					
Openness/Intellect	−.18**	.09	.16**	.29**	–				
MEQ packet 1	−.04	.19**	.13*	.05	−.03	–			
MEQ packet 2	−.06	.15*	.09	−.01	−.05	.55**	–		
MEQ packet 3	−.14*	.18**	.06	.06	.08	.52**	.54**	–	
MEQ total	−.09	.21**	.11	.04	.00	.87**	.81**	.81**	–
Mean	3.19	3.52	3.36	3.24	3.58	2.35	2.49	2.42	45.85
Standard deviation	0.73	0.59	0.61	0.77	0.54	0.58	0.47	0.51	8.28
Alpha	.80	.76	.76	.85	.71	–	–	–	.67

Note: $N = 279$. MEQ, Morningness–Eveningness Questionnaire. MEQ1–3, item packets for structural equation modeling. MEQ Tot, total MEQ score.

* $p < .05$.

** $p < .01$.

The structural model fit the data extremely well, χ^2 (df = 17) = 18.25, $p = .37$. The nonsignificant p value indicates that the covariance matrix predicted by the model did not differ significantly from the observed covariance matrix. Other indices of fit were also excellent, Adjusted Goodness of Fit Index (AGFI) = .97; Tucker–Lewis Index = .99; Comparative Fit Index (CFI) = .996; Root Mean Square Error of Approximation (RMSEA) = .016. AGFI, TLI, and CFI values above .90 indicate good fit, whereas RMSEA values below .08 indicate acceptable fit and below .05 indicate close fit (Kline, 2005). No correlated error terms were used, and the model did not require modification.

Because Agreeableness was more strongly associated with morningness than Neuroticism or Conscientiousness, in zero-order correlations (Table 1), we also fit a model to test whether it might contribute unique variance to MEQ scores, above and beyond what it contributed by virtue of its shared variance with Neuroticism and Conscientiousness (i.e., through Stability). This model was identical to that in Fig. 1, except for the addition of a direct path from the variance uniquely associated with Agreeableness to the latent morningness variable. This model fit the data well, χ^2 (df = 18) = 14.95, $p = .53$, but it did not fit significantly better than the original model, χ^2-difference (df = 1) = 3.30, $p = .07$. Further, the path from Agreeableness directly to morningness was not significant. One may conclude, therefore, that the association between Stability and morningness is responsible for the zero-order association between Agreeableness and morningness.

4. Discussion

This study utilized the Big Five model to examine links between personality and the individual differences in circadian rhythm that lead some people to be morning people and others to be evening people. Based on previous research with Eysenck's personality model and a neurobiological model of the higher-order factors of the Big Five (DeYoung, 2006; DeYoung et al., 2002), we hypothesized that morningness would be positively related to the metatrait Stability, which represents the shared variance of Neuroticism (reversed), Agreeableness, and Conscientiousness. Structural equation modeling confirmed this hypothesis. Morningness was not significantly related to either Extraversion or Plasticity (the shared variance of Extraversion and Openness/Intellect), suggesting that most previous findings of association between eveningness and Extraversion probably resulted from the conflation of impulsivity and Extraversion inherent in Eysenck's original model, prior to his addition of Psychoticism (Eysenck & Folkard, 1980; Tankova et al., 1994).

The excellent fit of the structural model suggests that the higher-order factor model of the Big Five is a powerful and efficient way to represent the relation of circadian rhythm to personality. Indeed, the finding that Stability is associated with morningness serves to organize and clarify the results of many previous studies, most of which used Eysenck's personality model. Eysenck's dimensions of Psychoticism (which incorporates impulsivity) and Neuroticism have been associated with eveningness, and these two personality factors both correspond, in Big Five terms, to Stability reversed. Although the metatrait level of personality structure appears highly effective at capturing the relations between personality and circadian rhythm, future research might examine whether any correlations with circadian rhythm are particularly strong at a level of personality structure lower and more specific than the Big Five, such as the 30 facet-level traits measured by the NEO PI-R (Costa & McCrae, 1992).

The link between Stability and morningness is consistent with a neurobiological model that posits individual differences in serotonergic function as a primary source of Stability as a trait (DeYoung, 2006; DeYoung et al., 2002). Serotonin is strongly involved in the modulation of circadian rhythm in the SCN (Miller et al., 1996; Yuan et al., 2005), and thus individual differences in serotonergic function may well be reflected in individual differences in circadian rhythm. Our findings suggest that the same differences in serotonergic functioning that are hypothesized to underlie the personality trait Stability may also be responsible for morningness. Individuals with higher levels of serotonergic function may be more stable in their personality processes as well as more strongly entrained to the daily cycle of light and dark in their circadian rhythms.

Findings that aggressive and antisocial behavior is associated with eveningness in adolescents (Goldstein, Hahn, Hasher, Wiprzycka, & Zelazo, 2007) are consistent with this hypothesis. Aggressive and antisocial behavior is also associated with reduced serotonergic function (Brown, Goodwin, Ballenger, Goyer, & Major, 1979; Kruesi et al., 1990; Soderstrom, Blennow, Manhem, & Forsman, 2001) and with low Agreeableness, low Conscientiousness, and high Neuroticism (Miller, Lynam, & Leukefeld, 2003).

The present study was merely correlational, of course, and cannot be used to draw any strong inference about cause. It could be the case that people who are more stable, hence less neurotic and more agreeable and conscientious, show their peak of circadian arousal earlier in the day for reasons unrelated to neurobiology. Conscientiousness, for example, might encourage early rising to conform with social norms and maximize potential work time (cf. Gray & Watson, 2002). Nonetheless, both circadian preference and the Big Five are substantially heritable (Hur, Bouchard, & Lykken, 1998; Reimann, Angleitner, & Strelau, 1997), indicating genetic contributions, and our findings may help to guide research on biological links between personality and circadian rhythm. The involvement of serotonin in this relation is highly plausible, and future studies may test this neurobiological hypothesis through investigations utilizing pharmacological manipulations or molecular genetic analyses. Future studies would also do well to include biological indices of circadian rhythm, in addition to self-reports.

Even without a potential neurobiological explanation, our findings would serve to organize a relatively sparse area of research on circadian rhythms, namely their association with personality. Knowing that morningness is associated with the metatrait Stability can explain the association of circadian rhythm with a variety of lower-level traits and provides a useful broad framework in which to carry out future research. One limitation of the present study is that our subjects were all young adults in a university setting. Future research should determine whether Stability is also the primary personality correlate of morningness in other populations. Such an extension of our investigation is particularly important because of the regular shifts in circadian rhythm that occur over the lifespan.

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