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Morningness–eveningness and depression: Preliminary evidence for the role of the behavioral activation system and positive affect

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ABSTRACT

There is considerable evidence of circadian rhythm abnormalities in mood disorders. Morningness–eveningness, the degree to which people prefer organizing their activity and sleep patterns toward the morning or evening, is related to circadian phase and is associated with mood, with relatively greater psychological distress among evening types. Given that circadian rhythms may also relate to the Behavioral Activation System (BAS) and positive affect (PA), but not to the Behavioral Inhibition System (BIS) or negative affect (NA), it was hypothesized that individual differences in BAS sensitivity and levels of PA, but not BIS and NA, would explain the association between morningness–eveningness and depression in a sample of 208 individuals with a range of depressive symptomatology. As predicted, increasing eveningness was associated with greater depression, lower BAS, and lower PA, but not directly associated with NA. Path analyses supported a model wherein morningness–eveningness is associated with depression via multi-step indirect paths including BAS-Reward Responsiveness, PA, and NA. A path between BIS and depression was distinct from the one involving morningness–eveningness. A variety of alternative path models all provided a weaker fit to the data. Thus, results were consistent with the BAS and PA mediating the effects of morningness–eveningness on depression.

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1. Introduction

More than three decades of research provide compelling evidence of circadian rhythm abnormalities in mood disorders (e.g., Wirz-Justice, 2005). Researchers have advanced a number of hypotheses attempting to relate the circadian abnormality to the other symptoms, including the 'phase advance hypothesis' (early morning awakenings and reduced REM latencies are due to short circadian periods), the 'blunting hypothesis' (reduced amplitudes in a number of circadian rhythms during the depressed phase that normalize upon remission), and the phase-shift hypothesis (PSH; delayed rhythms during winter for individuals with Seasonal Affective Disorder) among others. Although none of these have garnered unequivocal empirical support, tantalizing hints at the circadian-mood disorder link continue to emerge, ranging from the antidepressant effects of circadian-based treatments (e.g., bright light therapy) to preliminary evidence of polymorphisms in genes that influence the circadian cycle in patients with bipolar disorder (Mansour et al., 2005a).

An individual difference in circadian rhythms that is potentially important to understanding mood disorders is the degree to which individuals prefer organizing their activities closer to the morning or evening. Based on diurnal preference, or morningness–eveningness, people can be divided into chronotypes (i.e., "larks" and "owls") with demonstrated differences in sleep–wake patterns and a variety of circadian rhythms, behavioral rhythms such as performance and exercise, and diurnal variation of mood (Kerkhof, 1998). Morningness refers to those who show extreme preferences for daytime activity; in these individuals, peak performance and alertness is associated with the early-morning hours. The opposite is true for those who show eveningness, or extreme preferences for nighttime activities; in these individuals, heightened alertness and peak performance is linked to the evening hours. Chronotypes also appear to differ in less intuitive areas such as personality (e.g., Larsen, 1985), school achievement (Giannotti et al., 2002), general health (Paine et al., 2006), and lifestyle regularity (Monk et al., 2004). Diurnal preference is typically assessed via subjective self-report questionnaires. These measures, which all provide a score that can be left as a continuous scale or assigned to a category (e.g., Definite Evening-type, Intermediate type, etc.) show moderate-to-large correlations with circadian phase using well-validated physiological markers such as melatonin and core body temperature (Bernert et al., 2006). Consequently, some studies have used self-reported morningness–eveningness as a proxy for circadian phase (e.g., Murray et al., 2005). Based on the original Horne and Östberg (1976) scoring criteria, epidemiological studies indicate that 50–60% of the population are morning-types, 2–6% are

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evening-types,[1] and the rest fall in between these two extremes (Taillard et al., 2004; Paine et al., 2006). Also, morningness appears to increase with age (e.g., Paine et al., 2006; Monk and Kupfer, 2007).

Despite demonstrations of the relationship between diurnal preference and physiological, behavioral, and psychological processes, few studies have looked directly at the association between diurnal preference and mood disorders. Drennan et al. (1991) investigated differences in Horne–Östberg morningness–eveningness scores between depressed (per DSM-III-R criteria) outpatients and age- and sex-matched healthy controls. They found a significantly lower mean score (greater eveningness) in the depressed sample compared with the controls. Building on this work, Chelminski et al. (1999) examined diurnal preference and psychometrically defined "depressiveness" in a large sample of college students. They defined "depressiveness" as scoring in the depressed range of at least two out of three depression scales (Beck Depression Inventory (BDI); Geriatric Depression Scale-Short Form (GDS-SF); and the Center for Studies Depression Scale (CESD)). Using this criterion, they found significant negative correlations ($r \approx -0.18$) between the Horne–Östberg questionnaire and responses on all three depression measures (i.e., greater eveningness was related to greater depression) and a significantly higher incidence of evening-types among the "depressive" students.

The mechanisms underlying the association between eveningness and depression remain unknown. The circadian literature has generally focused on physiological or strictly chronobiological mechanisms in attempting to explain the link between mood disorders and circadian abnormalities, thereby neglecting some of the promising ideas to emerge from psychological literature. For example, Watson and colleagues have argued that the absence of positive affect (PA) is relatively specific to depression, thus distinguishing it from anxiety, which shares depression's characteristically high negative affect (NA; reviewed in Watson, 2000). Other formulations suggest that depression involves both an underactive Behavioral Activation System (BAS; also referred to as a Behavioral Approach System or Behavioral Facilitation System), leading to diminished appetitive motivation and decreased PA, and a hyperactive Behavioral Inhibition System (BIS), resulting in increased NA (Fowles, 1994). Integrating the circadian and psychological literatures has the potential to elucidate the connection between chronobiological factors and mood dysregulation. Furthermore, accumulating evidence suggests that PA varies according to a circadian rhythm, but that NA fails to show a systematic daily variation (Clark et al., 1989; Thayer, 1989; Wood and Magnello, 1992; Murray et al., 2002; Hasler et al., 2008). Watson (2000) proposed that the circadian PA variation is a manifestation of activity in the underlying BAS, which promotes engagement with the environment during optimal times for reward (i.e., daytime). In contrast to asserting an adaptive basis for the circadian control of appetitive motivation and PA, the model posits that NA lacks systematic circadian variation because it is the manifestation of a reactive BIS responding to aversive or ambiguous stimuli. Thus, systematic variations in BAS may have adaptive functions in terms of motivating organisms toward goal-seeking activities at optimal times, whereas an endogenous variation in BIS would not clearly be adaptive.

The present study attempted to integrate these previous findings and theoretical models by examining the association among diurnal preference, motivational systems (BAS and BIS), and affect (PA and NA) in an adult sample with a wide range of depressive symptoms. It was hypothesized that diurnal preference (as a proxy for circadian phase) would be related to BAS sensitivity and PA, but not to BIS sensitivity or NA. It also was predicted that greater eveningness would be associated with lower BAS sensitivity and lower levels of PA. Finally, this work investigated whether BAS sensitivity and PA would statistically explain the relationship between diurnal preference and severity of depressive symptoms.

[1] Given that the original scoring criteria were established using a student sample, Taillard et al. (2004) have recommended consideration of their revised scoring criteria based on a working middle-aged sample. Studies using these criteria report relatively equivalent proportions of morning- and evening-types (approximately 25% each) (Paine et al., 2006; Taillard et al., 2004).

2. Methods

2.1. Procedure and participants

Two hundred and eight participants (140 females; mean age = 19.23 years, range = 17 to 33) were drawn from a larger study investigating risk factors for depression. Participants were sampled to represent a broad range of depressive symptoms, from virtually no depressive symptoms to warranting a past or current DSM-IV diagnosis of major depressive disorder (MDD; 106 participants with no past or current MDD or dysthymia, 52 with only past MDD, 6 with only current dysthymia, and 44 with current MDD). Exclusion criteria included current antidepressant pharmacological treatment, comorbidity or conditions that would suggest that the presenting symptoms may be something other than a Major Depressive Episode (any current Axis I disorder other than depression; endocrinological or neurological disorders; any history of psychotic disorders, psychotic symptoms, or mania; and substance abuse or dependence within the past 4 months); current active suicidal potential necessitating immediate treatment. This study was approved by the Institutional Review Board (IRB) of the University of Arizona prior to recruitment.

An intake interview session was administered by a post-masters-level clinician to (1) confirm the absence of exclusionary factors and (2) assess depression using the Structured Clinical Interview for the DSM-IV (First et al., 2002) and the Hamilton Rating Scale for Depression (Hamilton, 1967). In ongoing research across a variety of studies, raters trained by the second author (J.J.B.A.) have obtained inter-rater reliabilities for depression diagnoses utilizing the SCID that meet or exceed 0.90, and for depression severity using the HRSD that exceed 0.95.

2.2. Measures

Eligible subjects – both depressed and nondepressed – completed a variety of questionnaires assessing individual differences in mood and motivation, including the Positive and Negative Affect Schedule, General Version (PANAS-general; Watson et al., 1988), the Behavioral Inhibition and Behavioral Activation Scales (BIS/BAS, Carver and White, 1994), and the Beck Depression Inventory, 2nd Edition (Beck et al., 1996). To examine sleep and circadian factors in association with depression, participants also completed the Morningness–Eveningness Questionnaire (Horne and Östberg, 1976), which is a 19-item self-report scale with questions focusing on habitual waking and bed times, preferred times of physical and mental performance, and subjective alertness upon awakening and prior to initiating sleep. The MEQ yields a total score ranging from 16 to 86 on a morningness–eveningness continuum, with lower scores reflecting less morningness.

2.3. Data analysis

Data analyses proceeded in three steps. First, the association between morning–eveningness, mood symptoms, and motivation was assessed via Pearson correlations, and mean differences were evaluated via a series of one-way ANOVAs. Second, a series of meditational analyses were conducted following the steps outlined by Baron and Kenny (1986), which is a commonly used approach for determining the extent to which any given bivariate association can be statistically explained by another variable. The steps for this analysis are described below just before they are reported. Finally, to examine the possibility that multiple variables explain the association between morning–eveningness and depression, a series of path models were fit to the observed data. As described below, the logic of path analysis involves estimating a series of conceptually related nested models (Bentler and Bonnett, 1980). If setting an estimated parameter to zero does not lead to a significant deterioration of the model's fit to the observed data (as indexed by a non-significant change in the model χ^2), the more parsimonious model is retained as a better characterization of the variance–covariance matrix.

3. Results

Following the presentation of the relationship between morningness–eveningness and depression severity, analyses designed to test the potential mediating role of mood and motivation are presented. Age was assessed as a potential covariate, but was found unrelated to MEQ scores and to BDI-II scores, and thus all results are unadjusted for age; all major findings remain the same if age-adjusted scores are utilized. In order to account for potential circadian rhythm effects, time-of-day of assessment (M = 14:47, range = 9:32 to 20:46) also

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