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Review article

The relationship between chronotype and depressive symptoms: A meta-analysis

Jacky Au[a,*], John Reece[b]

[a] School of Psychological Sciences, Australian College of Applied Psychology, Sydney, Australia
[b] School of Psychological Sciences, Australian College of Applied Psychology, Melbourne, Australia

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ABSTRACT

Background: Expanding our understanding of the factors that influence depression is crucial for prognosis and treatment. In light of increasing evidence of an association between disrupted circadian rhythms and affective symptoms, a meta-analysis was used to examine the relationship between an eveningness chronotype and depression.

Methods: Electronic searches of the PsycINFO, Medline, Scopus, and Google Scholar databases were conducted in February 2016. Relevant reviews, related journals, and reference lists were manually searched. Statistical data were reported or transformed to a Fisher's z correlational coefficient for effect size analysis.

Results: Data from 36 studies (n =15734) met the inclusion criteria and were analysed under a random effects model. Nearly all included studies utilised the Composite Scale of Morningness (CSM) or the Morningness-Eveningness Questionnaire (MEQ) as a measure of chronotype. Overall effect size from 58 effect sizes was small (z = −.20; 95% CI: −.18 to −.23). Effect sizes based on the CSM were significantly larger than those based on the MEQ. There was no evidence of publication bias.

Limitations: The number of studies comparing different mood disorders or the potential moderating effects of gender and age were too few to draw conclusions regarding their respective effect sizes. Future research should utilise longitudinal designs to draw causal inferences on the directionality of this relationship.

Conclusions: Findings from this meta-analysis indicate an eveningness orientation is somewhat associated with more severe mood symptoms. Chronobiological approaches may contribute to the prevention and treatment of depressive disorders.

1. Introduction

Mood disorders, which include unipolar depression, bipolar depression, and depressive disorders with seasonal pattern (formerly known as seasonal affective disorder or SAD) are among the most prevalent of all mental illnesses (Kessler et al., 2012; Waraich et al., 2004). Mood disorders have a significant negative impact on quality of life (Brenes, 2007; Rapaport et al., 2005) and are associated with impairments in physical health, social well-being, and work functioning (Wells et al., 1989). Advances in the understanding of the complex interplay among the neurobiological, psychosocial and environmental factors that influence the expression of depression are essential for improving its prognosis. It is well recognised that daily circadian rhythms influence variations in human physiology and behaviour (Roenneberg et al., 2003). Endogenous circadian clocks synchronise with the light-dark cycle of the environment and affect biological, behavioural, and psychological variables that show cyclic rhythmicity. An examination of the recent literature reveals increasing evidence of a notable association between a disrupted circadian system and mood disorders (for reviews, see Germain and Kupfer (2008), Monteleone and Maj (2008), Salgado-Delgado et al. (2011)). Recent research has indicated that alterations in circadian function can have an adverse effect on an individual's psychological well-being (Wulff et al., 2010). Circadian dysfunction may explain the oscillation between depressive and manic phases associated with bipolar disorder (Harvey, 2008) or the endogenous circadian rhythms out of sync with the light-dark cycle, which is

Abbreviations: BD, bipolar disorder; BDI, Beck Depression Inventory; BSDS, Bipolar Spectrum Diagnostic Scale; CI, confidence interval; CLOCK, Circadian Locomotor Output Cycles Kaput; CSM, Composite Scale of Morningness; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; DTS, Diurnal Type Scale; MCTQ, Munich ChronoType Questionnaire; MDD, major depressive disorder; MEQ, Morningness-Eveningness Questionnaire; OR, odds ratio; SAD, seasonal affective disorder; SCID-IV, Structured Clinical Interview for DSM-IV Axis I Disorders; SPAQ, Seasonal Pattern Assessment Questionnaire; US, United States

* Corresponding author.
E-mail address: jackyau11@gmail.com (J. Au).

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implicated in seasonal depression (Lewy et al., 2006). Underlying circadian abnormalities are also frequently related to changes to the sleep-wake cycle. This may explain the high levels of comorbidity between depression and insomnia, with up to 40.5% of depressed patients meeting the diagnostic criteria for primary or secondary insomnia (Stewart et al., 2006). It has been proposed that circadian abnormalities, particularly delayed rhythms, play a role in the pathogenesis of depressive disorders (Bunney and Bunney, 2000).

Considering the potential clinical significance of dysregulated circadian rhythms, it is important for potential abnormalities in circadian processes to be easily measured and accurately detected. Behavioural variations in circadian rhythms have been conceptualised in the form of circadian typologies. Also known as chronotypes, these typologies are expressed as personal preferences in the timing of daily activities and sleep, which lie on a continuum between morningness and eveningness on opposite extremes (Natale and Cicogna, 2002). Morning types or individuals with a morningness chronotype prefer waking up early, are more active during the early morning and go to bed earlier in the evening. In comparison, evening types or individuals with an eveningness chronotype favour waking up later in the morning, are more alert in the afternoon and evening, and have a preference for nocturnal activities and staying up late. The majority of the population lie between the two extremes and can be described as intermediate types (Adan et al., 2012). An individual's chronotype is determined by genetic variations in clock genes (Ko and Takahashi, 2006) and environmental factors (Hur, 2007; Hur et al., 1998). Demographic factors such as gender and age appear to moderate the morningness-eveningness trait. Meta-analytic research reveals a small significant effect of gender with females more inclined towards morningness than males (Randler, 2007), though this trend was not observed at a population level in a recent study which suggested females are more likely to be evening types (Merikanto et al., 2012). Age is an influential factor with time-of-day preferences varying across the human lifespan. Children (Wickersham, 2006) and adults (Carrier et al., 1997) are more likely to be morning types, which is attributed to biological changes and changing societal demands associated with aging (Broms et al., 2014; Paine et al., 2006). Adolescence and young adulthood are associated with an eveningness orientation, which could be due to social factors (Gaina et al., 2006) and developmental maturation processes (Carskadon et al., 1993).

Various self-report instruments have been developed to identify individual differences in circadian preferences. The Morningness-Eveningness Questionnaire (MEQ; Horne and Östberg, 1976) and the Composite Scale of Morningness (CSM; Smith et al., 1989) are the most frequently used measures for evaluating circadian typologies. These questionnaires utilise a multiple-choice format to assess the respondent's propensity for sleep and wakefulness throughout a typical day. Individuals are categorised into specific circadian typologies according to a composite score, with lower scores favouring an eveningness orientation and higher scores indicative of a morningness orientation. In comparison to biological assessments which are not readily available (Boudebesse et al., 2013) and may be potentially inaccurate (e.g., Stoschitzky et al., 1999), chronotype questionnaires are accessible and useful as an indirect measure of intrinsic circadian function rhythms (Duffy et al., 2001; Kerkhof and Van Dongen, 1996).

A growing literature in the last decade has identified eveningness as a potential factor associated with mood disorders, including major depressive disorder (MDD; e.g. Chan et al., 2014; Merikanto et al., 2015), bipolar disorder (BD; Baek et al., 2014) and SAD symptoms (e.g. Bullock et al., 2014; Sandman et al., 2016). Evening preferences correlate with more severe depressive symptoms (e.g. Chan et al., 2014) and are associated with increased odds of a mood disorder (e.g. Merikanto et al., 2015). Detailed summaries documenting the circadian disturbances observed in depressive psychopathology are available in the literature (e.g. Bunney and Bunney, 2000; Germain and Kupfer, 2008; Monteleone and Maj, 2008), but the lack of comprehensive reviews addressing circadian preferences is worth highlighting. Recent reviews have briefly covered the relationship between circadian rhythms and mood disorders (Abreu and Bragança, 2015; Adan et al., 2012; Baron and Reid, 2014; Etain et al., 2011; Melo et al., in press; Milhiet et al., 2011), but they do not explore the topic in detail. Etain et al.'s review briefly mentioned several studies as evidence of an association between eveningness and mood spectrum disorders but was otherwise focused on circadian genes. Milhiet et al. discussed the relationship between morningness-eveningness typology and bipolar disorders; however, they also reported on other circadian parameters and neuroendocrine biomarkers theorised to be markers of the disease. Likewise, the literature reviews of Baron and Reid, and Abreu and Bragança, and their coverage of chronotypes were too brief to fully understand the correlation between the variables of interest. Adan et al.'s overview of circadian typologies reported on the clinical implications of the evening typology in relation to depressive disorders and other psychiatric disorders. However, the paper lacked the detail and specificity to sufficiently summarise the existing literature on chronotypes and mood disorders. In comparison, Melo et al.'s systematic review presented evidence of the evening orientation being more common among those with bipolar disorder. Still, the association between chronotype and depressive symptoms was reported as inconsistent. Moreover, the specific focus on bipolar disorders also limits the generalisability of their findings to other types of mood disorders.

Based on previous investigations, the morningness-eveningness trait appears to be related to the development of depressive disorders. In particular, the evening chronotype seems to be related to mood symptomatology. However, the vast majority of literature reviews utilised narrative methods (e.g. Milhiet et al., 2011). The selective nature of non-systematic reviews makes it is difficult to draw unbiased conclusions about the relationship between circadian typologies and depressive symptoms. As such, the paucity of relevant reviews justifies the need for a more detailed and rigorous critical evaluation of the empirical research. A meta-analytic approach would provide an objective and evidence-based appraisal of this relationship. The meta-analysis technique synthesises existing findings to provide a holistic view of the empirical literature using statistical methods. Such an approach provides an opportunity to address the following research question: are individuals who are evening types more likely to be associated with more severe depressive symptoms? This topic is of clinical importance as examining previous findings from a statistical perspective could establish the role of circadian typologies in the context of depressive symptomatology. Understanding the factors that contribute to the onset and maintenance of mood disorders could have practical implications for identifying individuals at risk of depression, and potentially facilitate improvements in the prevention, diagnosis, and treatment of depressive disease.

Given the lack of meta-analyses addressing this topic, the aim of the present study was to synthesise findings that investigated chronotype and depressive illnesses. As such, the current study seeks to quantify the potential relationship between circadian rhythm differences and the presence and severity of mood symptomatology. In accordance with the findings of previous reviews, it is expected that evening-type individuals will have more severe depressive symptoms on self-report measures than intermediate- or morning-types. As humans are generally diurnal, it is predicted that individuals with an eveningness chronotype or those with a greater preference for activities in the afternoon and evening will report greater depressive symptomatology from psychometric measures. To address the focus of recent reviews, which have either been too generalised or too narrowly focused on specific disorders, the strength and direction of this association will be examined for all mood disorders. Given that BD (Abreu and Bragança, 2015) and SAD (Levitan, 2007) are known to be related to circadian rhythm disturbances, it is predicted that effect sizes will indicate that BD and SAD have stronger associations with an eveningness-oriented chronotype than other mood disorders including MDD. A range of