



Research report

Chronotype and seasonality: Morningness is associated with lower seasonal mood and behavior changes in the Old Order Amish



Layan Zhang^{a,b}, Daniel S. Evans^c, Uttam K. Raheja^{a,b}, Sarah H. Stephens^d, John W. Stiller^{a,b}, Gloria M. Reeves^e, Mary Johnson^f, Kathleen A. Ryan^d, Nancy Weizel^e, Dipika Vaswani^a, Hassan McLain^a, Alan R. Shuldiner^d, Braxton D. Mitchell^d, Wen-Chi Hsueh^g, Soren Snitker^d, Teodor T. Postolache^{a,h,i,*}

^a Mood and Anxiety Program, University of Maryland School of Medicine, Baltimore, MD, USA

^b Saint Elizabeths Hospital, Psychiatry Residency Training Program, Washington, D.C., USA

^c California Pacific Medical Center Research Institute, San Francisco, CA, USA

^d Division of Endocrinology, Diabetes and Nutrition, Department of Medicine, University of Maryland School of Medicine, Baltimore, MD, USA

^e Division of Child and Adolescent Psychiatry & University of Maryland Child and Adolescent Mental Health Innovations Center, University of Maryland School of Medicine, Baltimore, MD, USA

^f Department of Ophthalmology & Visual Sciences, University of Maryland School of Medicine, Baltimore, MD, USA

^g Phoenix Epidemiology and Clinical Research Branch, NIDDK, National Institutes of Health, Phoenix, AZ, USA

^h VISN 5 Capitol Health Care Network Mental Illness Research Education and Clinical Center (MIRECC), Baltimore, MD, USA

ⁱ VISN 19 MIRECC, Denver, CO, USA

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ABSTRACT

Background: Several studies documented that lower scores on the Morningness–Eveningness Questionnaire (MEQ) are associated with a higher global seasonality of mood (GSS). As for the Modern Man artificial lighting predominantly extends evening activity and exposure to light, and as evening bright light phase is known to delay circadian rhythms, this chronic exposure could potentially lead to both lower Morningness as well as higher GSS. The aim of the study was to investigate if the MEQ–GSS relationship holds in the Old Order Amish of Lancaster County, PA, a population that does not use network electrical light.

Methods: 489 Old Order Amish adults (47.6% women), with average (SD) age of 49.7 (14.2) years, completed both the Seasonal Pattern Assessment Questionnaire (SPAQ) for the assessment of GSS, and MEQ. Associations between GSS scores and MEQ scores were analyzed using linear models, accounting for age, gender and relatedness by including the relationship matrix in the model as a random effect.

Results: GSS was inversely associated with MEQ scores ($p=0.006$, adjusted).

Limitations include a potential recall bias associated with self-report questionnaires and no actual light exposure measurements.

Conclusion: We confirmed the previously reported inverse association between MEQ scores and lower seasonality of mood, for the first time in a population that does not use home network electrical lighting. This result suggests that the association is not a byproduct of exposure to network electric light, and calls for additional research to investigate mechanisms by which Morningness is negatively associated with seasonality.

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1. Introduction

Chronotype refers to an individual's preference for morning or evening activities as a consequence of diurnal variation in physical and mental abilities (Mongrain et al., 2004; Stiller and Postolache, 2005). This preference of activities for a particular time of day is regulated in

part by the endogenous circadian pacemaker located in the hypothalamic suprachiasmatic nucleus, and by a variety of biological and social environmental stimuli (Klerman, 2005; Takahashi et al., 2008). Chronotype is usually evaluated by a Morningness–Eveningness Questionnaire, dividing individuals into three distinct categories, i.e. morning, intermediate, and evening types (Horne and Ostberg, 1976). A higher score is consistent with Morningness, and a lower score with Eveningness.

Morning types ("Larks") are persons who are more alert and active in the morning. They have a tendency to go to bed early, and wake up and perform better during the early part of the day. On

* Corresponding author at: University of Maryland School of Medicine, Mood and Anxiety Program, Department of Psychiatry, 685 West Baltimore Street, MSTF Building Room 930, Baltimore, MD 21201, USA. Tel.: +1 4107062323; fax: +1 4107060751.

E-mail address: teopostolache@gmail.com (T.T. Postolache).

the other end of the chronotype continuum, evening types ("Owls") have a relatively later schedule with later bed and wake-up times (Biss and Hasher, 2012; Mongrain et al., 2004; Roenneberg et al., 2003). These preferences appear to be predominantly driven by physiological rather than psychological or social factors. Core body temperature minimum (T_{min}) and dim light melatonin onset (DLMO), the two most commonly used physiological markers of endogenous circadian rhythmicity, display an earlier phase of rhythm in morning types compared to evening types (Baehr et al., 2000; Bailey and Heitkemper, 2001; Duffy et al., 1999). Chronotypes tend to shift with individual development. While there is considerable individual variability, children tend to have elevated Morningness, with a decrease during puberty and again elevation with advancement in age (Carskadon et al., 1993; Colrain and Baker, 2011; Hagenauer et al., 2009; Roenneberg et al., 2007, 2004).

Seasonality refers to changes in mood and behavior with change of season. Seasonal affective disorder of winter type (SAD) was first described as recurrent depressive episodes occurring in autumn and winter with remission in spring and summer (Rosenthal et al., 1984a). In DSM-5, the essential feature for the diagnosis of depressive disorders with seasonal patterns is the onset and remission of major depressive episodes at characteristic times of a year, which have occurred at least during a 2-year period, without any non-seasonal episodes occurring during this period (American Psychiatric Association, 2013). Typical symptoms of SAD include low energy, hypersomnia, hyperphagia (with a predominant increase in carbohydrate craving and intake), weight gain and decreased libido in winter (Jacobsen et al., 1987; Rosenthal et al., 1984b, 1984a; Workman and Nelson, 2011). A milder form of seasonal depression, at times with isolated neurovegetative symptoms (sleep and appetite changes), has been described as sub-syndromal SAD (Kasper et al., 1989).

According to the current literature, lower Morningness/higher Eveningness are linked with higher seasonality of mood and higher prevalence of SAD compared to a non-evening chronotype (Murray et al., 2003; Natale et al., 2005; Tonetti et al., 2012), and an extreme form of Eveningness, the delayed sleep phase syndrome (DSPS), has been associated with syndromal and subsyndromal SAD (Lee et al., 2011).

All previous studies examining the relationship between evening chronotype and seasonality took place in populations using network electrical lighting (lighting powered by the electric grid). It has been shown that exposure to even low levels of ordinary room light (about 180 lx) can phase-shift circadian rhythms in humans (Boivin et al., 1996; Gooley et al., 2011; Vollmer et al., 2012; Zeitzer et al., 2000, 2005). It follows that the exposure to network electrical light during evening hours may play a role in both circadian phase delay and seasonality of mood. If evening light exposure is a key factor in the relationship between evening chronotype and seasonality, the association would be expected to be attenuated in the Older Order Amish, as their exposure to network electrical lighting is prohibited by cultural norms. Previously, we have reported a lower than expected frequency of winter SAD (Raheja et al., 2013) as well as lower than expected frequency of evening chronotype (Evans et al., 2011) in the Amish. We now examine, for the first time in the Amish, associations between chronotype and seasonality of mood.

2. Methods

We investigated the association between Morningness–Eveningness scores and seasonality in an Amish population from Lancaster County, PA (40°02'23"North, 76°18'16"West). There are approximately 30,000 Old Order Amish in Lancaster County. They constitute a rural and primarily agrarian community (Kraybill,

2008). Their religion prohibits use of certain technologies they perceive as conflicting with their tradition, beliefs and practices (Kraybill, 2008). Among the defining cultural prohibitions, the use of network electrical lighting is forbidden, and is replaced by lower-intensity alternative devices (Scott and Pellman, 1999). Therefore, studying seasonality or chronotype in the Old Order Amish benefits from the possible reduction of the effects of bright electric light exposure during late evening and night hours.

Seasonality of mood was assessed by SPAQ administered to 1306 subjects during 2010–2011, representing a response rate of 57.8% (Raheja et al., 2013). Test–retest reliability of SPAQ in the Amish is adequate. 868 participants completed the Morningness–Eveningness Questionnaire (MEQ) during 2003–2006 with a response rate of 89%, including 723 in whom rest–activity was measured with accelerometers, enabling validation of reported Morningness–Eveningness patterns with objectively measured activity levels (Evans et al., 2011). Details on the recruitment of participants have previously been described (Evans et al., 2011; Raheja et al., 2013).

The current analysis is based on 489 subjects (239 women and 250 men), ranging in age from 24 to 87 years who had completed both the SPAQ and MEQ. The mean age (\pm SD) of the sample was 49.7 ± 14.2 (52.1 ± 14.4 and 47.3 ± 13.7 years for women and men, respectively). The study was approved by the University of Maryland Institutional Review Board (IRB).

2.1. Morningness–Eveningness Questionnaire (MEQ)

The MEQ (Horne and Ostberg, 1976) is the most commonly used research tool to assess an individual's chronotype. The MEQ consists of 19 items, and individuals can score from 16 to 86. The evening types have the lowest score; morning types have the highest score and the intermediate types are in between. The MEQ can divide individuals in three categories according to their MEQ scores: evening chronotype (16–41), intermediate chronotype (42–58), and morning chronotype (59–86), (Adan and Natale, 2002; Chelminski et al., 1999; Gaspar-Barba et al., 2009). The validity of the MEQ in the Amish population is supported by an association between MEQ scores and activities monitored by Actiwatch and Actical accelerometers (Philips Respironics, Bend Oregon) used to determine wake time and bed-time previously reported in the Amish by our group (Evans et al., 2011).

MEQs in this study were obtained from 2003 to 2006, with 60.3% completed in spring, 20.1% in summer, 9.6% in fall and 10.0% in winter. The season of completion of questionnaire had no effect on the MEQ scores $F(3,738)=0.177$, $p=0.91$.

2.2. Seasonal Pattern Assessment Questionnaire (SPAQ)

The SPAQ, developed by Rosenthal et al. (1984a), is the most widely used retrospective self-report measure to estimate seasonality of mood and behavior. The SPAQ was designed principally as a screening tool rather than a diagnostic test (Rosenthal et al., 1987). Its test–retest reliability has been shown to be acceptable in the Old Order Amish (Cronbach's $\alpha=0.87$) (Kuehner et al., 2013). In addition, when asked about seasonal patterns on SPAQ the Amish participants' responses showed a high degree of internal consistency, specifically by the presence of mirror images in seasonal distribution of "feeling best" with "feeling worst", "eating least" with "eating most", gaining most weight with losing most weight, and "socializing least" with "socializing most" (Patel et al., 2012). The timing of the administration of the SPAQ had no significant effect on the distribution of GSS scores in cross-sectional (unpublished data) and longitudinal analysis in a subsample of individuals with repeat SPAQ administration (Kuehner et al., 2013).

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