DR. HELEN J BURGESS (Orcid ID : 0000-0003-3816-8194)

Article type : Clinical Curiosity (BDI)

Daily Ratings of Mood and Sleep Duration over 3.3 Years are Associated with the Lunar Illumination Cycle in a Rapid Cycling Bipolar Patient

Helen J. Burgess[1,3], Peisong Han[2], Holli Bertram[3] and Melvin G. McInnis[3]

[1] Sleep and Circadian Research Laboratory, Department of Psychiatry, University of Michigan, Ann Arbor, MI 48109

[2] Department of Biostatistics, School of Public Health, University of Michigan, Ann Arbor, MI 48109

[3] Depression Center, Department of Psychiatry, University of Michigan, Ann Arbor, MI 48109

Correspondence:

Helen J. Burgess, Ph.D.

Sleep and Circadian Research Laboratory

Department of Psychiatry

University of Michigan

Rachel Upjohn Building

4250 Plymouth Rd

Ann Arbor, MI 48109

Ph: 734-615-8303

Fax: 734-936-7868

Email: bhelen@med.umich.edu

Running head: Lunar Cycling in Sleep and Mood

Acknowledgements

We thank the patient for his detailed daily reporting, without which this case report would not be possible. We also thank Zoey Jopling for her assistance in transferring the years of written daily diary data into a data file. This research was supported by the Heinz C. Prechter Bipolar Program, the Richard Tam Foundation, the Department of Psychiatry and Depression Center at the University of Michigan. With gratitude, we acknowledge the Prechter Bipolar Longitudinal Research participants for their contributions and the research staff for their dedication in the collection and stewardship of the data used in this publication.

Key Message

We confirm previous reports by others of oscillations in mood and sleep duration in a rapid-cycling bipolar 1 patient that were in synchrony with the lunar cycle. Near the full moon sleep shortened and mood was more positive, whereas near the new moon sleep lengthened and mood was more negative.

Key words: sleep, mood, light

Learning Points

- Increased night-time light exposure around the time of the full moon may account for the observed lunar cycling, but this needs to be further investigated.
- Changes in sleep duration may contribute to some of the changes in mood.

1. Introduction

Previous reports from a single research group have described changes in mood in rapid cycling bipolar patients that are associated with the lunar cycle (1). In many cases, there is more positive mood around the time of the full moon, and more negative mood around the time of the new moon, in accordance with the lunar illumination cycle period of ~29.5 days (the equivalent of two spring-neap cycles). Similar patterns in objectively measured sleep were recently observed in young healthy adults, where longitudinal wrist actigraphy recordings revealed that sleep occurred up to 25 minutes later and was up to 30 minutes

shorter in duration around the time of the full moon versus the new moon (2). Thus, it is possible that changes in sleep during the lunar cycle drive changes in mood (1). Here we report an independent observation of a lunar cycle influence on mood and sleep duration in a rapid-cycling patient, in the longest assessment of this phenomena to date, for over 3.3 years.

2. Case Presentation

The patient was a 48-year-old man with rapid cycling bipolar disorder 1. At his family's encouragement he completed daily ratings of his overall mood, anxiety, irritability (each on a scale of "low mood" (-3 to -1), "normal" (0), and "high mood" (+1 to +3)), sleep duration (hours), and medications continuously from 6/10/2016 to 9/30/2019. In February 2017, after learning of the Heinz C. Prechter Longitudinal Study of Bipolar Disorder (3) through media reports, he applied and was enrolled into the study. At his study enrolment it was determined his bipolar disorder began with a manic episode when he was 21 years old. His first depressive episode occurred when he was 43 years old. He reported no childhood trauma. As part of his study participation he completed the Altman Self-Rating Mania (ASRM) questionnaire and the Patient Health Questionnaire-9 (PHQ-9) every 2 months, beginning on March 16, 2017. The patient has provided written approval that his daily data can be published as a case report. The Heinz C. Prechter Longitudinal Study of Bipolar Disorder is approved by the University of Michigan Institutional Review Board, and the participant provided written informed consent.

The lunar illumination cycle, overall mood ratings and sleep duration are shown in Figure 1. The patient did not rate his mood on only 2/1208 days (0.2%). Sleep duration was either not recorded or not described in numerical form on 82/1208 days (6.8%). Mood on average was 0, but varied between +3 to -2.5, and was often recorded in the 1 to -1 range. On average across all lunar cycles, mood was rated 0.17 points higher on 2-3 days near a full moon (illumination ≥98%) than on 2-3 days near a new moon (illumination ≤ 2%). The difference in mood between each pairing of full and new moon days significantly correlated with the corresponding photoperiod, suggesting that in this individual, the amplitude of lunar cycling in mood was greater during longer photoperiods, as occurs in summer ($r=0.39$, $p<0.02$). Of the 16 times the patient completed the bimonthly questionnaires during the daily ratings, there were 7 time points where mania (ASRM >5) was indicated and 8 time points where mild depression (PHQ-9 score of 5-9) was indicated (Figure 1). There were no time points where PHQ-9 indicated moderate to severe depressive symptoms (PHQ-9 ≥ 10). The daily

mood ratings correlated as expected with the standardized questionnaires (PHQ-9 r=-0.71, p=0.002; ASRM r=0.69, p=0.003). Sleep duration on average was 7.9 hours, but varied from 0 to 18 hours. On average across all lunar cycles, sleep duration was 8.7 minutes shorter on days near a full moon (illumination ≥98%) than on days near a new moon (illumination ≤2%). Overall mood, anxiety and irritability were each associated with sleep duration (r=-0.60,; r=0.46, and r=-0.10, all $p<0.01$ respectively), such that longer sleep duration was associated with more negative overall mood, and more anxiety.. Cross-lagged correlations revealed a slightly higher correlation (r=-0.63, $p<0.001$) between sleep duration on one day and overall mood rated on the following day, raising the possibility that the sleep duration changes contributed to mood changes. However, the same effect was not observed for anxiety and irritability ratings. The patient reported the use of 11 different medications, with lithium taken throughout the time period apart from two separate periods of 1-2 days where its use was not noted. Notably, the patient reported losing his job in the second last month of data recording due to manic symptoms and having taken too much time off work. This occurred 3 days after a full moon.

In accordance with previous reports, we analyzed the daily ratings in overall mood, anxiety, irritability and sleep duration with Chi-square periodograms (4). Specifically, Lomb-Scargle periodograms were generated using the R software package "lomb". Periodicities between 29 to 30 days were interpreted as reflecting oscillations in synchrony with the lunar illumination cycle of 29.5 days (4). Statistical significance was set at an alpha of 0.01. The resulting periodograms revealed a significant periodicity of 30 days in overall mood, anxiety irritability and sleep duration (Figure 2). The patient reported that his bedroom had 2 windows, and window coverings were used at night time. He was not certain if his bedroom light intensity varied with the lunar cycle, and reported that on a typical night the room was light enough to see to the end of his bed. He reported not sleeping with any lights turned on.

3. Discussion

This report independently confirms previous reports by a single research group of synchrony between mood and the lunar illumination cycle in rapid cycling bipolar patients (1, 4). Specifically, we found a lunar cycle periodicity in overall mood, anxiety, irritability and sleep duration. Mood grew more positive around the time of the full moon, and became more negative around the time of the new moon, with larger effects observed during longer photoperiods. We were fortunate that this participant's daily tracking of mood partially

overlapped with bimonthly assessments of his mood with standardized questionnaires. The daily ratings of overall mood correlated with the standardized questionnaire scores as expected. It remains possible of course that symptoms of both mania and depression occurred in between the bimonthly questionnaires. Nonetheless, these results suggest that the oscillations in the daily mood ratings were at times clinically meaningful. Furthermore, the patient reported that given the influence of the lunar cycle on him, he and his wife planned their activities around the lunar cycle.

This report also confirms a previous report of sleep duration shortening by up to 30 minutes around the time of the full moon and lengthening around the time of the new moon in young healthy controls (2). On average, we found self-reported sleep duration shortened by almost 9 minutes per night around the time of the full moon as compared to on nights around the time of the new moon. As hypothesized (1), there was some suggestion that the changes in sleep duration contributed to mood on the following day.

Bipolar disorder is inherently a dynamic and cyclical illness. There are many influences on the clinical patterns of mood, the amount of light exposure over the course of time being significant. Our findings highlight the additional insights obtained when people with bipolar disorder are assessed longitudinally with daily ratings over many years. To date lunar cycling in bipolar disorder has only been observed in rapid cycling bipolar patients, but with observations of sleep changes in healthy controls, non-rapid cycling bipolar patients should also be examined for an influence of the lunar cycle, Furthermore, we recognize that this participant was consciously aware of the lunar cycle, and his family had recognized this pattern for some time and was the impetus behind gathering the data: “We plan our family life around the lunar cycle”. Future research might consider gathering data in the context of a general outcome study of mood patterns, with post-hoc inclusion of lunar and environmental data to limit observational biases during collection. While the participant tracked sleep length, sleep timing was not documented and thus we could not determine if sleep timing also shifted later around the time of the full moon, and if this contributed to the shorter sleep duration at this time as previously observed in healthy controls (2). This effect may be due to increased light intensity in the night around the time of the full moon, and it remains possible that the patient was exposed to more light on nights around a full moon. Indeed, patients with bipolar disorder are more sensitive to night-time light than healthy controls (5). Future research should objectively and longitudinally assess sleep in bipolar patients with wrist

actigraphy, and also objectively assess the nighttime light exposure of patients to determine if their nighttime light intensity is higher around the full moon. Finally, future studies should expand beyond the assessment of mood and sleep to other biomarkers known to associate with mood and sleep, such as hormones and measures of inflammation. The driving questions are centered around determining the nature of cyclicity in the bipolar individual and generating data for subsequent modeling of patterns. People with bipolar disorder are often exquisitely sensitive to changes in light, changes in seasons, and this example provides support that the lunar cycle influenced this patient's pattern. The unifying hypothesis, which remains to be fully explored, centers around light exposure, even at low levels.

References

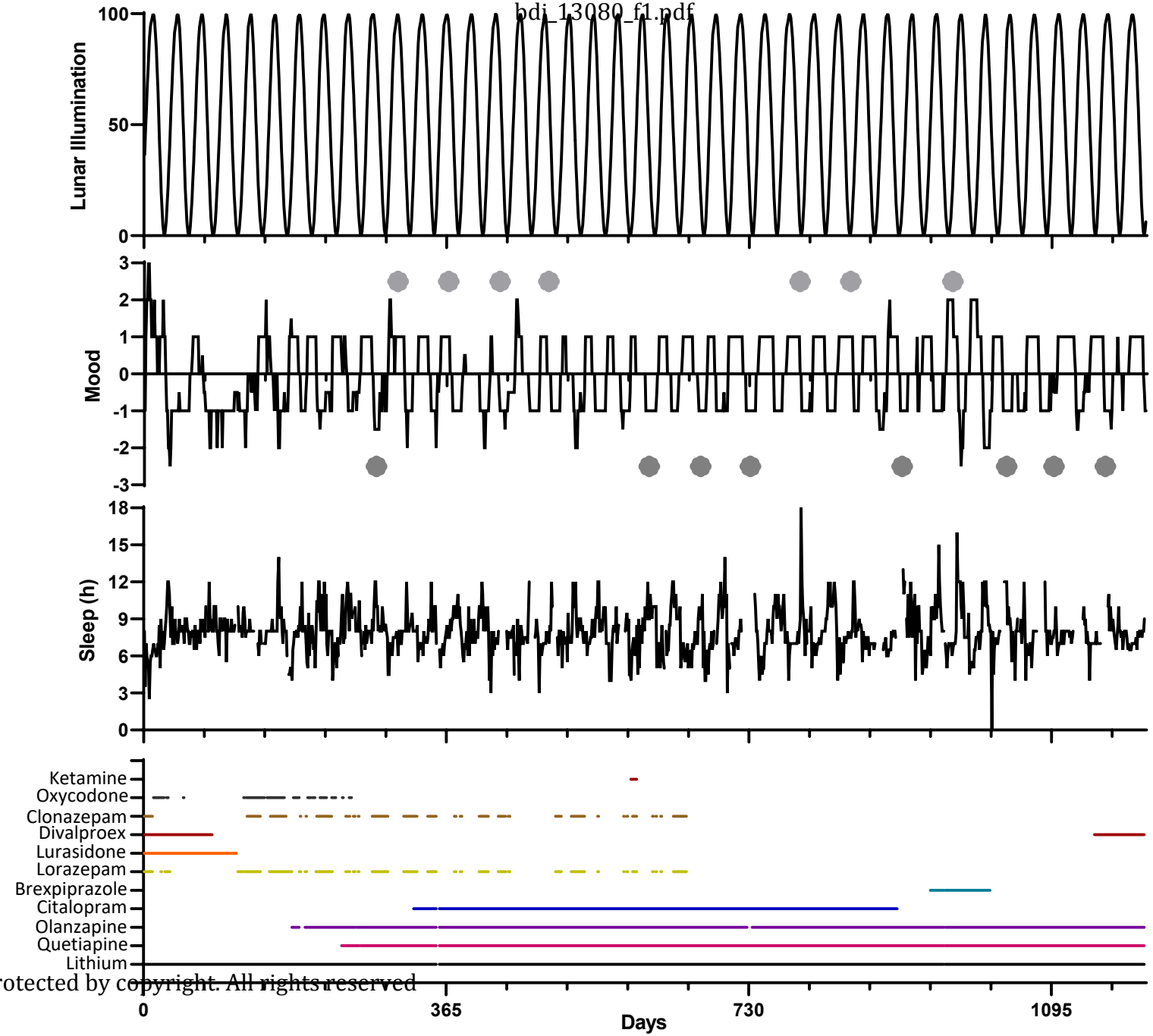
1. Avery DH, Wehr TA. Synchrony of sleep-wake cycles with lunar tidal cycles in a rapid-cycling bipolar patient. Bipolar Disord. 2018;20:399-402.

2. Casiraghi LP, Spiousas I, Dunster G, Fernández-Duque E, Valeggia CR, de la Iglesia HO. Modulation of human sleep by the moon cycle in a natural environment. Abstract from Society for Research on Biological Rhythms, virtual meeting 2020.

3. McInnis MG, Assari S, Kamali M, Ryan K, Langenecker SA, Saunders EFH, Versha K, Evans S, O'Shea KS, Mower Provost E, Marshall D, Forger D, Deldin P, Zoellner S, Prechter Bipolar Clinical Research C. Cohort Profile: The Heinz C. Prechter Longitudinal Study of Bipolar Disorder. Int J Epidemiol. 2018;47:28-28n.

4. Wehr TA. Bipolar mood cycles and lunar tidal cycles. Mol Psychiatry. 2018;23:923-931.

5. Nurnberger JI, Adkins S, Lahiri DK, Mayeda A, Hu K, Lewy A, Miller A, Bowman ES, Miller MJ, Rau L, Smiley C, Davis-Singh D. Melatonin suppression by light in euthymic bipolar and unipolar patients. Arch Gen Psychiatry. 2000;57:572-579.



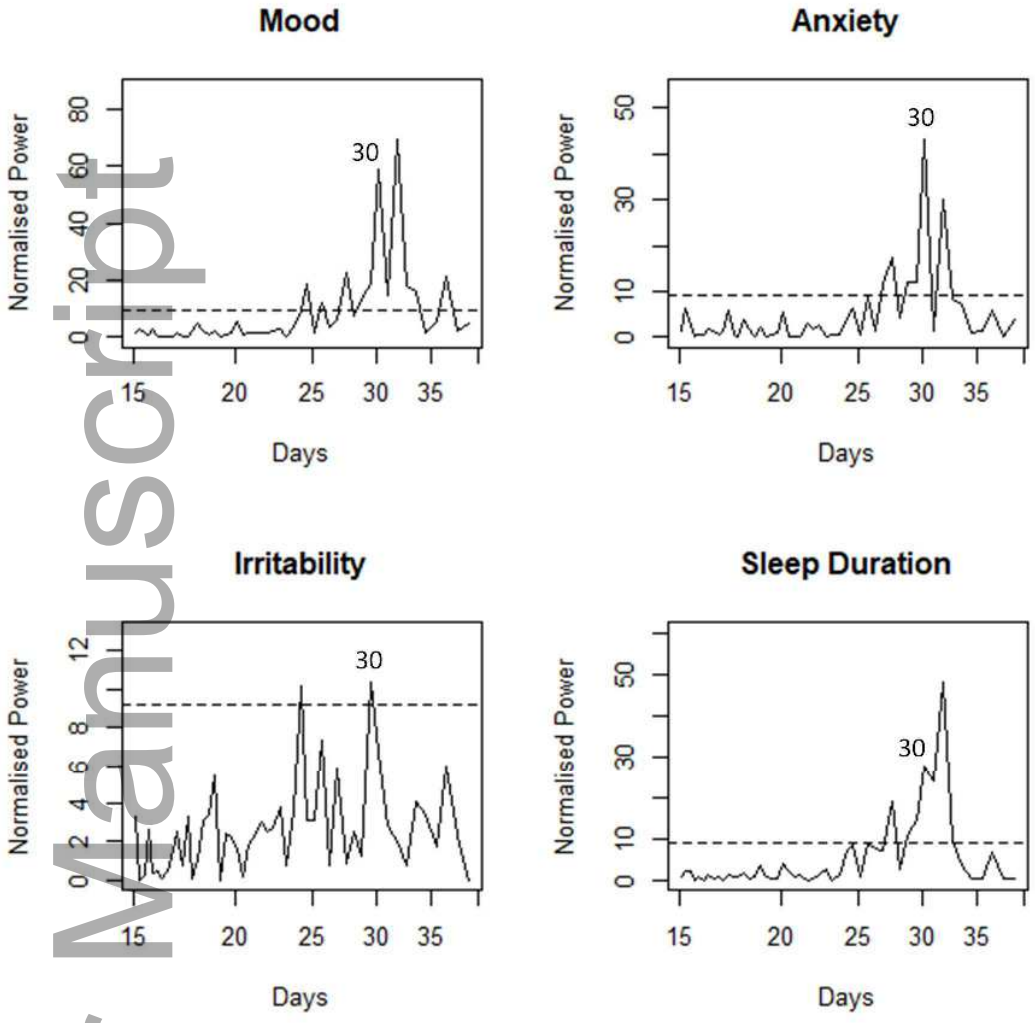


Figure 2. The periodograms of overall mood, anxiety, irritability and sleep duration. The dashed line represents the statistical significant threshold of alpha = 0.01. Mood, anxiety, irritability and sleep duration all displayed a statistically significant periodicity at 30 days.