

Hypothesis: Folklore perpetuated expression of moon-associated bipolar disorders in anecdotally exaggerated werewolf guise

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ABSTRACT

We hypothesize that Moon-associated signals, recently linked to rapid cycling bipolar disorder, may have triggered extremely rare instances of extreme manic and aggressive behaviour that may be compatible with the folklore of the werewolf. Very limited literature on instances of clinical lycanthropy or violent/manic/madness behaviour in association with the Moon may be due to very rare lycanthropic psychosis and not knowing which signal(s) could determine Moon-mood associations. Mechanistically, lunar effects related to bipolar disorder, mood changes, and psychosis could involve either, or a combination, of the following: (i) some as of yet non-measurable signal or undefined geoelectric/geomagnetic receptor or higher sensitivity in some humans, (ii) Moonlight affecting sleep and/or circadian rhythm, (iii) perinatal imprinting of susceptibility, (iv) lunar-periodic growth, and subsequent consumption, of or exposure to psychotropic agents. Importantly, remarkable recent studies (2018) suggest that links between some Moon cycles and bipolar disorder are conceivable. Further observations suggest a role for periodic changes in lunar distances in combination with the Earth and Sun positions. Targeted research could use insight from astrophysicists. If causal links between Moon signals and mood were corroborated, sufferers may benefit from improved disease understanding. Herein, we systematically review the literature and synthesize the evidence for and against the hypothesis. The werewolf myth could become another instance of folklore popularizing biological variation worthy of investigation such as the book characters created by the psychiatrist Hoffmann in 1845 as a Christmas present for his son; namely, 'Struwpeter' and 'Zappel-Philipp' (shock-headed Peter and fidgety-Philipp): Their conspicuous characteristics have since been linked to genetic uncombable hair syndrome and ADHD, respectively. Overall, rather than dismissing (seemingly) trivial and uncertain concepts as 'just folklore', scientists should grapple with the roots, causes, and significance of traditions and tales, including the werewolf legend.

*"It is the very error of the Moon;
She comes more nearer the earth than she was wont,
And makes men mad."*
-Shakespeare's Othello (1603).

Introduction

Folklore may have predictive power to identify promising research avenues as it builds on hypotheses which have survived "tests" by numerous individuals across generations. In particular, environmental associations observed to correlate with ill-health, despite often placed in a supernatural context, may contain grains of truth. A werewolf, from folklore, is a human who has shape-shifted into a wolf-human hybrid, usually in the period leading up to or during the full Moon. The creature has been considered rabid and cannibalistic, hanging around

graveyards, sometimes painted as melancholic, and the infliction is passed on through being bitten. Such a description highlights important exposures that can be investigated such as association with lunar cycles. Indeed, Moon-madness associations, which may play a role in the etiology of the werewolf concept, stem from antiquity.

Clinical lycanthropy, a form of reverse inter-metamorphosis involving belief of transformation into a non-human animal and animal-like behaviour, is associated with bipolar disorder [1]. Recent supporting evidence for lunar associations with rapid-cycling bipolar disorder provides an empirical platform to investigate werewolf phenomena from a biological point of view [2]. Wehr (2018) examined longitudinal records of 17 patients with rapid-cycling bipolar disorder – a disease wherein abrupt switches from depression to mania now appear conceivably associated with lunar cycles [2]. Furthermore, the apparent lunar-mood associations potentially affected the patients'

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circadian systems as evinced by lunar-periodic augmentation of the body temperature rhythm [2]. In theory, abrupt switching caused by a lunar “zeitgeber” (from German, ‘time-cue’) [3,4] may have triggered rare instances of extreme manic and aggressive behaviour which gave rise to the folklore of werewolves.

Hypothesis

Epistemologically, lunar effects on behaviour may extend beyond folklore into the biological realm. Moreover, lunar period synchrony with mood cycles may have implications for the causation, course, diagnosis, treatment, and prevention of disease [5], including those comorbid with werewolf- or animal-like behaviours. We hypothesize that folklore may have perpetuated expressions of moon-associated bipolar disorder in anecdotally exaggerated werewolf guise.

Evaluation of hypothesis

Our objective was to contribute to answering whether Moon-associated signals may trigger extremely rare instances of extreme manic and aggressive behaviour that may be compatible with the folklore of the werewolf. A systematic literature search of the PubMed database was conducted on 24th July 2017 for experimental, field, and epidemiological studies, reviews, and reports concerning lunar signalling, bipolar disorder, mania, increased violent or aggressive behaviour, and werewolf-like psychosis. Various relevant search terms were combined using Boolean operators (Table 1). Returned studies were filtered by title, abstract, and main text content and findings (Fig. 1). We further searched the bibliographies of relevant literature and supplemented the returned literature where appropriate (Fig. 1). Inclusion and exclusion criteria are presented in Table 1.

Our literature search returned 395 articles of which 18 were deemed relevant after applying filtering criteria (Fig. 1). The number of inaccessible texts totalled 17. A further 2 articles were included after citation searching (Fig. 1). Lunar links with lycanthropy and associated behaviour are put forward in Table 2.

Discussion

Literature synthesis

Our systematic search returned no shortage of literature on lycanthropy or accounts of historical Moon-madness associations. However, only one study notes a lycanthropy episode during a full Moon [6]. Following this, we considered lunar and werewolf-like behaviour (bipolar disorder, switches in aggression or mania associated with lunar periods etc.).

Numerous scientists accept that the light effects of the full Moon, especially in more ancient times, could have affected the human sleep-wake cycle – perturbments of which can trigger bouts of mania in susceptible individuals [7–11]. In regards to environmental conditions, McCrae concluded that the light of a full moon was more powerful in the past [12]. Asylums for people suffering from psychiatric conspicuity and disease preserved stark natural contrasts in light due to their favoured rural settings. More recently, however, it would appear that most scientists consider lunar effects to be a myth [8,13]. With most of

traditional asylums closed, today’s urban environments expose most patients to artificial lighting obscuring moonlight and awareness of lunar cycles. Moreover, tranquilising medication likely dulls the peaks and troughs of symptoms and sensitivity to natural stimuli [12].

Nonetheless, the number of recent reviews on the topic suggests that lunar-madness folklore is enduring despite supportive scientific evidence to the contrary [8–10]. Could observational tests of lunar madness be prone to detection bias? Periodic moon-lit night differences may be hidden by electric lighting and bipolar disorder patients may be better treated, masking potential biological impacts of the Moon. In line with such artefact, Simon (1998) notes that there may be more subjects who “act out” who are not brought to the attention of researchers or psychiatric administrators [14]. We put forward further suggestions below.

Lycanthropy is, for the most part, considered as a psychosis developing from more common mental illness triggers such as drug use, alcoholism, and abuse during susceptible periods, and/or co-morbid with other mental illnesses such as bipolar disorders and schizophrenias [6,15–17]. The single study noting a lycanthropy episode during a full Moon could simply be meaningless coincidence [6]. Many studies have considered associations of violent, aggressive, or miss-behaviour with phases of the Moon in different populations but supporting evidence is limited [7,13,14,18–21]. Of note, considering individual rather than bulk data, Wehr’s approach with rapid-cycling bipolar patients took a different methodological tact to the epidemiological testing of behavioural changes that came before [2]. Furthermore, the studies by Wehr are the only ones that focus on rapid-cycling bipolar disorder [2,22]. Overall, however, without knowing the specific lunar signal that may trigger affective episodes in susceptible individuals, if any, it is difficult to determine if the studies that came before those by Wehr turned up nothing of significance, statistical or biological, due to observational error.

Bevington (2018) suggests multivariate lunar-associated pathways, potentially including local electromagnetic field changes, which is the most likely signal of lunar periodicity to animals displaying lunar periodicity in the absence of Moon-light [23]. The author describes how the Moon periodically crosses the magneto-tail caused by solar wind passing the Earth, thereby augmenting the Earth’s magnetosphere. The precise trajectory of the Moon, which varies, in combination with other factors such as distance of the Moon from the Earth, differences between light radiation effects on the Moon’s atmosphere relative to its position to the Earth, the lunar wake affecting solar wind passing the Earth (i.e. new Moon vs. full Moon), weather conditions on Earth, the Earth’s daily changing electromagnetic intensity, and even distance to bodies of water likely influences this augmentation [23]. That many lunar periodicities have been associated with rapid-cycling bipolar disorder [2,22], including periodicities related to orbital distance, may explain why effects that focus on e.g. a specific phase such as the full Moon are not always observable in potentially susceptible individuals [10,23,24]. Moreover, that lunar wake effects are more highly focussed on a particular area of the Earth may explain conflicting results [23]. Indeed, the author reviews other instances of augmented physiology in humans related to geoelectric and geomagnetic perturbations. Halberg and colleagues go so far as to suggest non-photic cycles coding in genomes, similar to circadian biology [25].

According to Metzger (2015), an entire epidemic of kynanthropy (dog instead of wolf) madness has been described in antiquity literature in addition to cases of kynanthropy in culturally, linguistically, and

Table 1
Search String & Study Criteria.

Search String	((werewolf OR “were-wolf” OR wolf OR lycan* OR “inter-metamorphosis” OR lycorex*) AND (“Moon”[Mesh] OR “Chronobiology Discipline”[Mesh] OR “Chronobiology Phenomena”[Mesh] OR “Chronobiology Disorders”[Mesh] OR “Sleep Disorders, Circadian Rhythm”[Mesh] OR “Circadian Clocks”[Mesh] OR “Circadian Rhythm”[Mesh] OR Moon OR lunar OR circadian)) OR ((mania OR manic OR bipolar OR depress* OR mood OR aggression OR loon OR lunatic OR rabid) AND (“Moon”[Mesh] OR Moon OR lunar)) OR (lycanthrop*) NOT (Moon[Author] OR Wolf[Author])
Inclusion Criteria	Demonstrated association or biologically plausible links between lunar periodicities and werewolf-like behaviour or lycanthropy
Exclusion Criteria	Werewolf proteins; Epilepsy; Road traffic accidents; non-English language

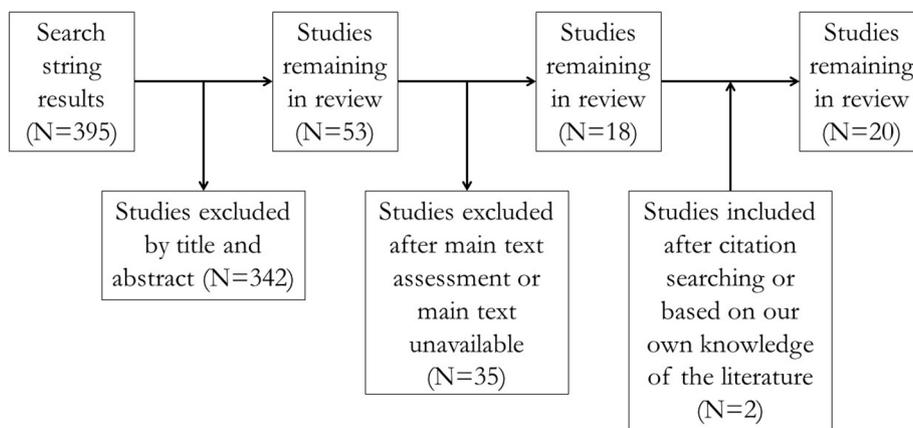


Fig. 1. PRISMA flow diagram.

geographically, very different populations [26,27]. That epidemics of lycanthropy are described more than once in historical texts is somewhat fascinating (what might cause such an epidemic?) [17,26]. Metzger further describes the antediluvian concept of celestial sphere positioning at birth affecting health and disease in later life [26]. This may not be an antiquated notion. If the position of the Moon has

potential to affect susceptible populations [2,22], would this not be possible during a potentially more susceptible perinatal time window? Imprinting effects of environmental periodicities around the time of birth and later life ill-health have been previously put forward with supporting scientific rationale [28]. Moreover, combining the antiquated celestial body positioning-lycanthropy notion described by

Table 2
Lunar-lycanthropy links.

Author(s)	Study	Link
Avery & Wehr (2018) [22]	Case Study of 35 year old male rapid-cycling bipolar patient	Mood cycle oscillated in synchrony with a lunar cycle. Nights with little or no sleep regularly occurred with peaks of the spring-neap cycles that occurred in conjunction with full Moons and new Moons. Severe reductions in sleep accompanied mania.
Wehr (2018) [2]	Case studies of 17 rapid-cycling bipolar patients	Cyclic switching between mania and depression occurred with lunar periodicity. This was also associated with augmented body temperature rhythms.
Raible et al. (2017) [10]	Review of physiology linked to lunar periodicities	Circalunar rhythms have been linked with hormone cycles, sleep, and behaviour in humans. The review includes suggestion that decreased sleep during lit nights may have been associated with mania (reduced sleep is a common parameter).
Metzger (2015) [26]	Review of lycanthropy in antiquity	Antiquity concepts hold that positioning of celestial spheres (at birth) may result in periods of lycanthropy or ‘canine madness’.
Bevington (2015) [23]	Review of physiology linked to lunar periodicities	The review suggests multivariate lunar-associated pathways, potentially including electromagnetic field changes, affecting biology.
Bostock et al. (2015) [24]	Review comparing precipitating factors for mania and partial seizures	The review concludes that lunar effects on mania are not substantiated and no clear evidence exists between menstruation phase (has a lunar period but not necessarily related to lunar phase) and mania.
Kamat et al. (2014) [7]	Epidemiology of visits to paediatric psychiatric emergency departments	There was no full Moon effect.
Riva et al. (2011) [27]	A review of linguistic and pathological links between the Moon and madness	According to the authors, the Moon and madness have been associated since pre-Christian times and their analysis has not shown evidence of a lunar psychiatric disorder link.
Calver et al. (2009) [20]	Epidemiology of violent behaviour presenting to an emergency department	The authors found that violent and acute behavioural disturbance manifested more commonly during full moon phase.
McLay et al. (2006) [18]	Epidemiology of psychiatric admission rates	There was no effect of individual lunar phases.
Iosif & Ballon (2005) [8]	Review of lunar connections to madness	The authors conclude there is no lunar connection to madness.
Benezech & Chapenoire (2005) [35]	Comment on another article	The authors suggest hypersensitivity to sunlight as a possible co-etiological factor in the belief of werewolves associated with night-time and possibly the Moon in early 15th century European literature.
Nunez et al. (2002) [19]	Epidemiology of violent behaviour seen in an emergency department	There was no effect of the fraction of visible lunar surface on individuals.
Raison et al. (1999) [9]	Review	The authors put forward sleep deprivation on moonlit nights as the historical etiology of moon-madness associations.
Parmeshwaran et al. (1999) [21]	Epidemiology of admissions to a psychiatric hospital	A full Moon association with non-affective psychosis but not mania was observed.
Owen et al. (1998) [13]	Epidemiology of increased frequency of violent and aggressive behaviour in a psychiatric hospital	There was no effect of individual lunar phases.
Parry (1998) [11]	Comment on another article	Insomnia, as a facet of mental illness, could have led individuals to be outside at night and more noticeable on nights where the Moon provided sufficient light. Hence, madness was associated with Moon.
Simon (1998) [14]	Epidemiology of aggression in a prison setting	No effect of lunar luminosity was observed.
Hicks-Caskey & Potter (1991) [36]	Epidemiology of aggressive misbehaviours in developmentally delayed, institutionalised women	The number of misbehaviours was significantly higher around the time of the full Moon.
Rosenstock & Vincent (1977) [6]	Case study of lycanthropic delusion	One mention of a lycanthropic delusion episode occurring on the night of a full-Moon.

Metzger with the physical and biological phenomena reviewed by Bevington, Halberg, and colleagues place the antiquated notion into a new light [23,25,26]. With the help of astrophysicists, predictions about greater fluctuations in mental-health for a given place on Earth with regard to the positioning of celestial bodies (augmenting the magnetosphere) could be tested for both imprinting affects at birth and for later life exacerbations of disease.

Davis and his werewolf-named colleagues, in their ‘Very Original Research’ ‘mock-u-study’, describe blood-borne hallucinogens that dramatically increase upon exposure to full Moon light. There whimsical contribution may have inadvertently pointed to a more credible concept – that some environmental hallucinogens may grow with a lunar periodicity, and are thus more likely to be consumed or for an individual to be exposed to such hallucinogens with lunar periodicity. Such an environmental factor could be one explanation of epidemics of lycanthropy or manic, aggressive, animal-like behavior [17,26].

Limitations of the review

Lunar periods have also been associated with epilepsy and schizophrenia but our intention was to focus on aggression, mania, and bipolar disorder as per recent findings and werewolf folklore descriptions [2]. Advanced treatment options in more modern times may mask lunar effects on mood. Patients suffering from depression and mania may develop coping strategies to appear less conspicuous. Phases of their depression or mania may be characterized by more or less restraint, respectively.

Perspectives

Folklore is expressive tradition and culture shared by large groups of people. For an idea to pass into folklore, it must be transmitted over generations. Thus, there must be some plausibility or grain of truth involved that can be, and is, “tested” constantly. Scientists may want to be sensitive to the following question: If folklore were true, is it conceivable that understanding the causal link may change how we treat patients or shape research questions going forward? There are empirical examples of folklore turning to scientific explanation. One instance is figures of psychiatric interest described in a children’s book from 1845. Unable to find a Christmas present for his son, the psychologist Hoffman wrote and illustrated a book with the characters ‘Struwelpeter’ and ‘Zappel-Philipp’ (shock-headed Peter and fidgety-Philipp) whose conspicuous characteristics have since been linked to genetic uncombable hair syndrome and ADHD, respectively [29–31].

Importantly, the key question is not so much about the mythical werewolf as it is about whether the moon provides health-relevant zeitgeber information or not. If yes, such demonstration could be supportive to those who “suffer” at times due to lunar signals. Explaining why this may happen could be supportive to coping mechanisms to deal with the hereto yet unexplained. Ultimately, there may be ways to block or avoid Moon-associated information externally and/or internally. While many scientists may consider much of folklore to be improbable and insignificant [“this is just folklore ...”], we agree with Horrobin: “I follow Karl Popper in seeing the virtues of improbability. If a hypothesis that most people think is probably true does turn out to be true (or rather not falsified by valid experimental testing) then little progress has been made. If a hypothesis which most think is improbable turns out to be true then a scientific revolution occurs and progress is dramatic” [32].

Conclusion with candidate lunar effects on humans

Folklore wisdom can provide science with clues as to what variables might interact with biology to affect health and disease. Indeed, more believable stories tend to contain some grains of truth (and potentially scientific-nuggets of common sense as anecdotal evidence) [33]. It is up to the scientific method to falsify such observations and even revisit

closed investigations when new observations come to light.

Lunar effects could include either, or a combination of, (i) some as of yet non-measurable signal or undefined geoelectric/ geomagnetic physiological receptor, (ii) Moon light affecting sleep and/or circadian rhythm, (iii) imprinting susceptibility at birth, (iv) lunar periodic growth of, and subsequent consumption of or exposure to, psychotropic agents.

Overall, rather than ignoring folklore, scientists may want to think what biological roots may manifest in folklore tradition and tales. Such awareness could fuel new insights and benefit causal understanding for individuals and populations in regards to the roots, causes, and significance of health and disease-associated traditions and tales, including the werewolf legend [34].

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Competing interests

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