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ACTUALIZACION POR TEMAS

Moon cycle effects on humans: myth or reality?

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Figura 1. Celestial Pap, Remedios Varo (1908-1963), Private Collection, Mexico City.

Summary

For centuries, it has been of popular belief that the moon cycle influences human physiology and behavior. This is an idea

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which can be most suitably explained by chronobiology, given that the organisms behavioral patterns are the result of the interaction between their endogenous temporal programs which are the cause of biological rhythms and their tuning to external stimuli, both environmental and social. However, non-natural effects, such as city noise and electric light, among others, may mask such interactions. Research on this subject has looked for the causal relation between moon cycles and physiological factors, such as: admissions to psychiatric hospitals, mental trauma, abnormal behaviour, criminal activity, suicidal attempts and homicide. Nevertheless, this has been slanted to epidemiological studies with extensive population samples, obtaining contradictory results, most likely due to the statistical analyses used. The relation between moon cycles and sleep-awake phases in human beings has not been studied exhaustively and, therefore, has not provided convincing

results. On the other hand, there are systematic studies using methods that are more robust in non-human animal species, purporting strong evidence concerning the activity rhythm alteration in relation to the moon phase. Therefore, to distinguish the factors that are probably masking the moon cycles effects on human life, it is necessary to carry out studies with more systematic recording methods and observations.

Key words: Lunar cycles, humans, primates, behaviour.

Resumen

Durante siglos se ha mantenido la creencia popular de que el ciclo lunar influye en los factores fisiológicos y conductuales de los seres humanos. Esta idea podría explicarse por la cronobiología, pues esta perspectiva sugiere que los patrones conductuales de los organismos son el resultado de la interacción entre el programa temporal endógeno, que genera los ritmos biológicos, y las modificaciones causadas por los estímulos externos, como los ambientales y los sociales. Sin embargo, tales interacciones pueden ser enmascaradas por efectos no naturales, como la luz eléctrica y los ruidos de la ciudad, entre otros. Diversas investigaciones han buscado la relación causal entre el ciclo lunar y los factores fisiológicos: las admisiones a los hospitales psiquiátricos, los traumas mentales, la conducta anormal, la actividad criminal, los intentos de homicidio y el suicidio, etc. No obstante los estudios han tenido un carácter epidemiológico, con extensas muestras poblacionales, y han obtenido resultados contradictorios debido, principalmente, a la manipulación estadística de los datos. Las relaciones entre el ciclo lunar y el periodo de sueño-vigilia de los seres humanos ha sido poco estudiado y no ofrece resultados convincentes. Por otro lado, los estudios sistemáticos en los que se han usado métodos robustos, en los animales han proporcionado fuertes evidencias acerca de la alteración de los ritmos de reposo-actividad, en relación con las fases del ciclo lunar. Proponemos que se hagan estudios comparados en los seres humanos, con métodos confiables de registro y de observación sistemática que aporten datos más objetivos, capaces de distinguir los factores que probablemente estén enmascarando los efectos del ciclo lunar en la vida humana.

Palabras clave: Ciclos lunares, humanos, primates, conducta.

Amica silentia lunae
(The friendly silences of the quiet moon)
Virgilio, La Eneida, II, 255

The moon's face is red,
it means that from the spoken it will speak
Indios zuñi

Introduction

The organisms' behaviour throughout a 24-hour period results from the interaction between the endogenous programming and the modifications caused by external stimuli, both environmental and social (Bartnes and Goldman, 1989; Moore-Ede *et al*, 1982; De Castro, 1978, 1987). This putting in phase endogenous rhythms with environmental cues was termed *Zeitgeber* by Aschoff (1957), and is of great interest for the behavioral sciences (i.e. the date of birth of schizophrenic patients, Pérez-Rincón, 1991).

Even though research on annual, monthly, weekly and daily rhythms have been done, it is still a source of curiosity as to how the moon cycle (29.5 days) might affect human physiology and behaviour.

Since immemorial times, such a notion has been of human concern being both of intellectual interest and a cultural legacy which has been found to be deeply rooted in popular beliefs (an extensive revision can be found in Martinez, 1970). Nevertheless, now at the end of the 20th Century and the beginning of the new millenium, we cannot categorically assert that such a belief is superstitious, unreal, mistaken, religious or pragmatic, even though scientists have disdained its importance, considering it merely as folk psychology. Moreover, systematic studies have been plagued with procedural mistakes, leading to the discreditation of the subject.

In Antiquity, philosophers such as Plutarch, Hippocrates, Aristotle, Pliny and referred to the relation between the moon and madness. Paracelsus (1493-1541) writings make use of the word "lunatic" to describe the different states of madness: "The influence of the moon is cold, and insane people have been called lunatics; they suffer because the moon damages the action of the brain, and they are stimulated by sexual passion, dreams and hallucinations".

Most of the time, moon cycles seem related to evil or tragic events. The Koran, the Muslims' sacred book, calls our attention to the danger of the moon phases, especially the new moon, which elicits epilepsy (Douglas and Kelly, 1942). In the Bible (1984), both the Old and the New Testament take into account the risks regarding the moon-mind relation in madness. Matthew (17:15) uses the word *lunatic* when referring to epileptics.

It is worth remembering the so called "Lunatics Group", i.e., The Lunar Society of Birmingham, which was named so because it used to meet on every single full moon night in order to discuss art, science and literature. This group played an important role in the Industrial Revolution at the end of the 18th Century (Ritchie-Calder, 1982).

In English literature, *Othello*, from Shakespeare (1991), says that Desemona's death was the moon's mistake. Among Latin-American writers, Rulfo (1955) imputes certain hallucinations of some of the characters of *Pedro Páramo* to the presence of moonlight. Nowadays, we find Mutis (1990) who in his work *Amirbar*, attributes the high fevers and death of a certain individual to the fact that he had consumed *guarapo** prepared under a full moon.

The astrological role of the moon can be found in almost every classical culture in the world: Babylonian, Phoenician, Greek and Roman, as well as in most actual traditional cultures. Some aboriginal populations in Brazil, as well as the Bedouins, consider that moonlight can be dangerous during sleep, as it can elicit aggressive behavior on the following day. The Eskimos and the Polynesians have attributed the masculine sex to the moon (Oliven, 1943). Among pre-Hispanic cultures, the Mayas related the moon to mental disorders (Villa, 1987). The Aztecs, Incas and Quechuas viewed the

* *Guarapo*: Traditional beverage made from fermented pineapple skin, a highly alcoholic concoction.

moon as an evil goddess (Martinez, 1970). Even in traditional music, the moon is known as a common source of inspiration and romance; remember all the well-liked *Claire de Lune* tunes of many romantic and impressionist composers.

Since the 18th Century, a widespread assumption is that the moon cycle affects the menstrual period. However, systematic research carried out in the 20th Century has yielded controversial results. Gunn *et al* (1937) did not find any relationship between the moon cycle and menstruation; but Law (1986) did observe a positive correlation between menstruation onset and a full moon. Studies about birth frequencies report similar results (McDonalds, 1966) with births increasing during full moon. On the other hand, Osley *et al* (1973) recorded day by day all births occurring in New York City within a three year period, accounting a total of 500,000 events, and then correlated them to the moon cycle. The birth rate during a full moon was not significantly different from other phases. Nevertheless, in their discussion they mention that the influence of the moon could be more evident in social groups that do not use electricity, where the moon is the main source of night light. Martens *et al* (1988) revised 21 studies about birth frequencies and moon cycles and found works reporting both positive and negative correlations. They make a severe criticism of the methodology used in these studies; such as using a large population sample with minimal control of geophysics, nutritional and social variables which could be influencing the results, besides the statistical manipulation of the data. Trap *et al* (1989) studied 1516 pregnant women, finding no correlation between the breaking of the fetal membrane, labor and the moon phase. However, it is important to point out that these studies were done in urban environments, with no comparisons with the countryside, where activity and rest respond mainly to the natural course of light and darkness.

Regarding food ingestion, De Castro and Pearcey (1995) reported a causal relation between the amount of food ingested and the moon phase, suggesting that changes in the quantity of food can be produced by an internal biological rhythm synchronized to the moon cycle, while there is a decrease in alcohol consumption during full moon in comparison with new moon.

A research concerning road accidents (Templer *et al*, 1982) showed a relation with the full moon period. However, subsequent studies have been unable to replicate this positive correlation, attributing it to a non-adequate statistical analysis (Kelly and Rotton, 1983ab; Kelly *et al*, 1990a; Laverty *et al*, 1992; Alonso, 1993). Moreover, Kelly *et al* (1990b), and Templer *et al* (1983) did not find any relation either with disasters or emergency calls to the police.

These correlations remain controversial in the realm of behavioral science. We must remember that in medical science, Galeno attributed the happening of epileptic attacks to the moon cycles (Douglas and Kelly, 1942). Psychiatrists such as Daquin, in France, and Koster, in Germany, asserted that the influence of the moon upon mental disorders was undeniable. This is why several hospitals took special precautions during full moon, regarding it as a stimulus for violent behavior.

More detailed reviews on this subject are in Kelly (1942) and Oliven (1943).

Porkony (1964) studied offensive behaviors such as suicide and homicide in Texas between 1959 and 1961, taking into account sex, race, and the position of the moon towards the earth, without finding any causal relation with the moon cycle. In a later study, Porkony (1968) made a list of 4937 admissions to a psychiatric hospital, finding annual and weekly differences, but no relation to the moon cycle. He also observed that suicides occurred throughout the week, while admissions to hospitalization took place mainly during the weekends. In a study regarding admissions to emergency rooms in hospitals, Blackman and Catalina (1973) found a positive correlation with the presence of full moon. Yet, Bauer *et al* (1968) did not find any relation between the use of the emergency room in a psychiatric hospital and the moon cycle. Nevertheless, in a letter to the editor of the American Journal of Psychiatry, referring to previous studies, Lilienfeld (1969) pointed out that other factors ought to be taken in account, such as the energy fields or the planets' movement, among others, given that their correlation could provide more information about the factors that influence behavioral changes. Coates *et al* (1989) did not find any relation between moon cycle and admissions to hospitals for mental disorder either; similar results were obtained by Lester *et al* (1969) regarding suicide and the moon phase. In Australia, however, Taylor and Diespecker (1972) reported increased suicidal attempts by women during crescent moon. Dannel (1974) did not find any influence of the moon in 3033 suicide cases. Tasso and Miller (1976) carried out a study regarding the moon's effect on nine criminal behavioral categories, finding a significant correlation with 8 of them, excepting suicide.

The occurrence of different mental disorders, studied by several authors, provided the same controversial results (a review can be found in Rotton and Kelly, 1985). In such review, these authors found no positive correlation regarding psychiatric disturbances, admissions to hospitals and homicide with moon phases. Shapiro *et al* (1970) did not find any correlation between the moon cycle and the onset of acute psychiatric disorders. Culver *et al* (1988) made an extensive review of a series of publications which had the moonlight effects among their hypotheses; the conclusion invalidated such influence upon human behavior. Nevertheless, analyzing their study in detail, we can find some imprecise data that seem to be an error of consideration.

Templer and Veleber (1980) performed a meta-analysis obtained from different studies concerning abnormal behavior and the moon cycle, using two different statistical analyses. With the first one, they found that the behaviour considered abnormal was more evident during the full moon and third quartered periods, while in the second analysis the abnormal behavior was more frequent during the new and the full moon. This is an example of mistaken statistical assumptions when working with large data in retrospective studies. The preceding studies leave a doubt margin regarding objectivity. Ossenkopp and Ossenkopp (1973) described a causal relation between self-destructive behaviour and the presence of the waning moon. Lieber and Sherin

(1972), based on a 15 year data of homicide in Dade, Florida, found a positive correlation between homicides and the new and the full moon phases. However, in the same study these authors, using data taken during 13 years in Cuyahoga, Ohio, did not find a similar relation. In a new study, Lieber (1973) did confirm the influence of the full moon upon homicides. Chapman (1961) performed research including 3231 psychiatric patients without finding any positive correlation between moon phases and the number of admissions to emergency wards, the increased agitation of 98 schizophrenics or the 489 incidents that occurred to 39 parietic people. Cohen-Mansfield *et al* (1989) studied 24 elderly people's restlessness in relation to a full moon, finding no causality. Nonetheless, they observed that the highest frequencies of such behavior occurred mostly during the phase of darkness, between the last quarter and the new moon. Regarding aggressive behavior in hospitalized women with mental retardation, Hicks-Caskey and Potter (1991) reported a high causal relation with the full moon. Binkley *et al* (1990), in a study of the moon cycle effects on the activity and the sleep periods of four individuals who moved from different time zones—one traveled from the USA to Finland and back, the second stayed in the USA, the third flew from the USA to Italy and back to the USA, and from Phoenix to Japan and back to Phoenix, and the last one flew from the USA to Spain and back to the USA—found no influence of the moon phases on sleep patterns. Nevertheless, the authors considered that exposure to artificial light at night might have had a masking effect over moonlight. Later, Binkley (1992), using actigraphy to measure the activity rhythms of a woman for a whole year, in order to determine whether these were annual, monthly, weekly or lunar, found no changes regarding the last variable.

All the previous works created a controversy over the relations of the moon to physiological and behavioral parameters in human beings. Research on the link between moon phase and daily human life events has been dealt mostly from a retrospective point of view and, in general, we can see that the human being has not been considered as an ecological being. Therefore, geophysical, social and nutritional variables have been consistently left out, forgetting they are an integral part of the ecology of human behavior.

It seems that most researchers overlooked the matters regarding this issue, raised by several letters published in *Science*. In a first letter, Sinclair (1987) argued that laboratory studies focused on the reproduction of the conditions of moon light intensity have yielded positive data about the possible influence on circadian markers on a wide variety of species, including the human being. Czeisler (1987) replied that the response amplitude is related, at least in non-human species, with the light intensity, the duration and the circadian phase of administration. However, he estimates that the brightness of light affecting the circadian rhythms in humans must be more intense than moonlight, at least in those people who live in equatorial latitudes. He points out the idea that while these studies are done in people exposed to artificial light, such light will have a masking effect over the intensity of the natural course of light and darkness.

The preceding data does not imply that moonlight influence does not exist. Seemingly, what happens is that it has not been properly studied. We base this argument on studies in other animal species, which make clear that the moon cycle is involved in the circadian rhythms modulation. These studies have all been prospective and therefore they include a meticulous examination of the variables involved. For example, we can mention the studies in non-human primates such as the ones of Erkert (1974, 1976a,b) in field and laboratory conditions on the nocturnal anthropoids, *Aotus lemurinus griseimembra* and *Aotus trivirgatus*. These *Aotus* limit their activity to nightfall and dawn during the new moon period, extending it to the entire night during full moon. Bearder and Martin (1979), by means of radio-tracking monitoring of free-ranging *Galago senegalensis moholi* in the north of Transvaal, South Africa, during summer and winter, and an annual rainfall average of 610 mm, found more motor activity in males than in females during moonlight. Nash (1986) observed that frequency of vocalizations of *Galago zanzibaricus* was higher during full moon. In *Eulemur macaco macaco*, a species whose cathemeral rhythm is similar to the human infant, Calquhoun (1998) described much more night activity during full moon and more day activity during new moon. Moreover, Gursky (1999), using radio telemetry with *Tarsius* for a year and 5 months, reported a decrease of activity during full moon, as well as variations of social behavior in relation to moon phase. Likewise, empirical observations of *Pongo pygmaeus* and *Pan troglodytes* showed that some behaviors are more frequent on intense moonlight nights and there is even more foraging activity (quoted by Anderson, 1984).

The controversy in the studies in human beings and the evidence brought forth by research in non-human primates suggests that if we consider the moon's influence from an ecological perspective, comparing species and using observational and recording techniques that may provide us with more exact data, we might be able to distinguish the factors that are probably masking the effects of moon cycles over the life of human beings.

Conclusions

The works reviewed in this paper, dealing on the relation of the effects of the moon cycle on human behavior are controversial and, therefore, not conclusive, mainly due to the fact that most researchers view this notion purely as folk psychology, and thus do not perform adequate data collection and statistical analyses. Essentially, the biggest mistakes seem to make use of retrospective results or data, and to rely on correlation analyses in search of causality. On the other hand, prospective research in non-human animals yields encouraging results, suggesting that this approach should be encouraged in the research on human beings.

Table 1 shows how the previous statements applied to research on human beings can be the result of the evident absence of demographic, cultural (Walters *et al*, 1975), meteorological, geographical, nutritional and

TABLA 1
Relation between reviewed studies and considered variables

	Year	Met	Geo	Nut	Cult	Desig
<i>Study</i>	<i>HUMAN BEINGS</i>					
Chapman	1961	0	1	0	0	Retros
Pokorny	1964	0	1	0	0	Retros
McDonald	1966	1	1	0	0	Retros
Pokorny	1968	0	1	0	0	Retros
Bauer and Hornick	1968	0	1	0	0	Retros
Lester <i>et al</i>	1969	0	1	0	0	Retros
Shapiro <i>et al</i>	1970	0	1	0	0	Retros
Lieber and Sherin	1972	1	1	0	0	Retros
Taylor and Diespecker	1972	0	1	0	0	Retros
Osley <i>et al</i>	1973	0	1	0	0	Retros
Lieber	1973	1	1	0	0	Retros
Ossenkopp and Ossenkopp	1973	1	1	0	0	Retros
Blackman and Catalina	1973	1	1	0	0	Retros
Dannel	1974	1	1	0	0	Retros
Walters <i>et al</i>	1975	0	1	0	0	Retros
Tasso and Miller	1976	0	1	0	0	Retros
Templer and Veleber	1980	0	1	0	0	Retros
Templer <i>et al</i>	1982	0	1	0	0	Retros
Templer <i>et al</i>	1983	1	1	0	0	Retros
Rotton and Kelly	1985	1	1	0	0	Retros
Law	1986	0	1	0	0	Prosp
Trap <i>et al</i>	1989	1	1	0	0	Retros
Cohen-Mansfield	1989	0	0	0	0	Retros
Coates <i>et al</i>	1989	0	0	0	0	Retros
Kelly <i>et al</i>	1990	1	0	0	0	Retros
Binkley <i>et al</i>	1990	1	1	0	0	Prosp
Hicks-Caskey and Potter	1991	0	0	0	0	Retros
Laverty <i>et al</i>	1992	1	1	0	0	Retros
Binkley	1992	1	1	0	0	Prosp
Alonso	1993	1	1	0	0	Retros
De Castro and Pearcey	1995	0	0	1	0	Prosp
Owen <i>et al</i>	1998	1	1	0	0	Prosp
<i>Study</i>	<i>HUMAN BEINGS</i>					
Erkert	1974	1	1	1	0	Prosp
Erkert	1976a	1	1	1	0	Prosp
Erkert	1976b	1	1	1	0	Prosp
Bearder and Martin	1979	1	1	1	0	Prosp
Nash	1986	1	1	1	0	Prosp
Colquhoun	1998	1	1	1	0	Prosp
Gursky	1999	1	1	1	0	Pros

Note: Met = Meteorological. Geo = Geophysycal. Nut = Nutritional. Cult = Cultural. Desig = Designe. Retros = Retrospective. Prosp = Prospective. 0 = No. 1 = Yes

social variables among the ones takes in account. All these could be playing some role in masking the moon cycle effects. Even in one of Owen *et al* (1998) studies, which was characterized by prospective proposals, controlled temporal variables and robust statistical

analysis. Using a structured scale for aggression and violence designed for human psychiatric patients, they were not able to find any correlation with any of the moon phases. One possible confounding effect might be due to taking into account the full length of the moon

phase, as phase changes are continuous, not discrete. Therefore, averaging over a full phase, e.g., crescent to full moon, introduces night-to-night increases in luminosity, resulting in a masking effect. Results that are more reliable could be obtained by restricting analyses to the day, or to the 2 to 3 days of the maximum phase state. Furthermore, this study lacks a critical examination of how settings might inhibit natural effects of moonlight intensity, since they obtained their samples from urban psychiatric hospitals, where electric light is turned on during most of the night.

Seemingly, individual variability also plays an important role in this research field. Recent research has shown that people with sleep disorders related to the circadian rhythm are highly susceptible to low light intensities (Dagan and Eissenstein, 1999). Not surprisingly, the afore mentioned susceptibility might well be masked when thoroughly analyzing large samples, as the moonlight intensity is very low, going from 0.1-0.5 lux during full moon to 10^{-4} lux during new moon (Erkert, 1989). Moreover, moonlight involves distinct wavelengths, implying that exposure to the moon rays might involve two different effects: one directly through the retina and its associated paths (e.g., the suprachiasmatic nucleus), or via the somathesthetetic system, involving another set of sensory receptors, and therefore eliciting dissimilar effects (Llinás, personal communication).

Finally, human research lacks a proper evolutionary basis that would help to ground the hypotheses surrounding the relationship between moon cycle and

behavior. It seems important, given the increasing information provided by non-human primates research, to consider Robson-Brown's (1999) proposal: "... The phylogenetic context of socioecological traits is clearly important to the understanding of adaptive strategies and their transformation". We understand the importance of including the comparative method, as well as prospective studies based on the evolutionary theory, robust hypotheses, and adequate data sampling, to address a question which, to date, has provided incongruous, sometimes quite odd results that do not shed a clear light on this immemorial question.

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