# THE FULL MOON'S INFLUENCE ON SELECTED CRIMINAL BEHAVIOR AND CALLS FOR POLICE SERVICE IN YOUNGSTOWN, OHIO

by

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ABSTRACT

THE FULL MOON'S INFLUENCE ON SELECTED CRIMINAL BEHAVIOR AND CALLS FOR POLICE SERVICE IN YOUNGSTOWN, OHIO

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This thesis reviewed literature related to the moon's influence on criminal behavior and identified five causal theories which postulated a lunar influence on humans. The study's design attempted to show that moonlight, as opposed to gravity, somehow affects criminal behavior and, therefore, calls for police service in Youngstown, Ohio at night. The methodology consisted of comparing the amount of crime in the selected crime categories (assault, homicide, burglary/breaking and entering, auto theft, robbery) and calls for police service during full moon nights (moonlight present) with the amount of crime in the selected crime categories and calls for police service during new moon nights (no moonlight). Further examination of the moonlight issue consisted of comparing the amount of crime in the selected crime categories and calls for police service during clear full moon nights (moonlight present) with the amount of crime in the selected crime categories and calls for police service during cloudy full moon nights (no moonlight or reduced moonlight). Finally, the methodology considered the intervening variable of days of the week to determine if any particular weekday or weekend combination influenced the amount of crime in the selected crime categories and

calls for police service during full moon and new moon. Each of the aforementioned full moon/new moon comparisons was restated in the form of a null hypothesis and subjected to the chi-square nominal level test of significance. The research failed to reject each of the three null hypotheses since the data were not significantly different from what would be expected by chance at the .05 level of significance. Therefore, based upon the study's methodology, the data did not support the belief that crime increases on full moon nights. The thesis concluded by addressing the implications of lunar research for police management along with the implications for future criminal justice related lunar research.

# ACKNOWLEDGEMENTS

My sincere thanks to Dr. James Conser, Thesis Committee Chairman, for his guidance and suggestions during my research and throughout the writing of this thesis.

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# CHAPTER I

## THE PROBLEM

Finding the cause of criminal behavior remains one of the most intriguing problems facing the criminal justice system. There is little consensus whether crime is a result of biological, psychological, sociological, or other mishaps. Perhaps, more accurately, it is a combination of a number of factors. Certainly it is difficult to isolate such factors since they occur simultaneously, each impacting on the other. Theories for explaining criminal behavior are based upon the vast amount of differences genetically, psychologically, socially, culturally, environmentally, and geographically among humans.

The physical environment's impact on crime has drawn much attention and research on factors such as weather (barometric pressure, temperature, humidity, precipitation), climate, seasons, air pollutants and lunar phases.

> The physical environment has been discredited historically as a determinant of human behavior. This disrepute was created by the excess of some environmental deterministsin several disciplines who drew absurdly tight links between climate, for example, and various aspects of human conduct. . . . Certainly, the time is ripe for a reappraisal of the role of the physical environment, which has been generally ignored in what has been to some extent an over-reaction to environmental determinism.[1]

In their 1979 study of factors influencing criminal behavior, Feldman and Jarmon found certain environmental factors positively

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[1]K. D. Harries, Crime and the Environment (Springfield, Illinois: Charles C. Thomas Publisher, 1980), p. 18.

correlated with crime. According to the researchers:

> We are not trying to claim that the variables that proved to be of statistical significance in our analysis are the factors that cause crime (people were assaulting one another long before automobiles were emitting ozone). We are simply postulating that these factors may play an important part in precipitating anti-social behavior.[2]

The influence of the moon on the Earth and its inhibitants has been the subject of an abundant amount of historic literature, myth and folklore. As early as the 6th Century, B.C., Greek philosophers began suggesting that the moon, sun, and planets were not gods, but physical bodies, thus setting the stage for later Greek astronomers who began measuring and describing the moon's physical aspects, motions, and relationships with the sun and the planets.[3] Scientific studies have determined the moon's effect on the planet Earth through such phenomena as water tides, earth tides, and atmospheric tides. Further, studies have been conducted which correlated the moon's phases to observable habits of marine life, land animals, and plant life.[4] The knowledge obtained by that research has caused many modern thinkers to speculate that the moon may influence human beings in similar ways.

Although the accumulated scientific research about the influence of the moon on human behavior in general, and criminal behavior in particular, has yielded inconsistent results and methodological

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[2]H. S. Feldman and R. G. Jarmon, "Factors Influencing Criminal Behavior in Newark: A Local Study in Forensic Psychiatry," Journal of Forensic Sciences, 1979, Vol. 24, No. 1, p. 239.

[3]David Wallechinsky and Irving Wallace, The People's Almanac #2 (New York: William Morrow and Company, Inc., 1978), p. 580.

[4]See REFERENCES for a brief listing of studies.

deficiencies, enough evidence of a relationship between the moon and human biology (anatomy and physiology) and behavior has been presented to warrant continuing study and research.[5]

Studies have found many different types of data peaks and clusters in relation to the lunar phases and offer a variety of explanationsfor the results. Despite the differing methodologies and studies that found no correlations (or correlations near, but not of statistical significance; or significance in only one or two years of the total number of years reviewed), the vast majority of research seems to be saying the same thing: that there is a lunar effect.

## Applicable Theories and Purpose of the Study

Based on a review of the literature, this research has identified at least five causal theories which have been offered for explaining a lunar influence on human behavior: (1) Biological Tides (Gravitational Theory), (2) Positive Ions, (3) Psycho-Social, (4) Moonlight (Biological and Illumination Aspects), and (5) Remnants of Tidal Rhythms. Development of each of these causal theories is explored in Chapter II's review of the literature.

Under the Biological Tides or Gravitational Theory the lunar phases of full moon and new moon are similar because maximum gravitational forces occur at these two moon positions. However, some of the studies reviewed showed increased abnormal and criminal behavior

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[5]See REFERENCES for a brief listing of studies.

at full moon, but not at new moon.[6] The major purpose of this study is to attempt to account for such differences.

Although they are similar periods of maximum gravitational pull, full and new moons lie on opposite ends of an illumination continuum. The full moon reflects sunlight back to the Earth at night, while during new moon the night sky is empty and dark because the new moon travels across the horizon during daylight hours with its dark side facing the Earth (i.e., no reflected sunlight). This study examines the variable of moonlight (versus no moonlight) at night as a determinant of selected criminal behavior and calls for police service.

Based on the aforementioned causal theories, moonlight may affect human behavior in several ways. Under Moonlight and Positive Ion Theories the moonlight may effect the human physiology, resulting in abnormal behavior. Further, the illumination aspect of the moonlight may affect criminal behavior similar to research that has been done linking street and security lighting to crime. The methodology utilized by this study is also compatible with a Psycho-Social Causal Theory approach in that the data will reflect periods when the moon is visible (full moon on a clear night) versus when it is not visible (full moon on a cloudy night and new moon).

All lunar researchers agree that much more work needs to be done to fully understand how the moon may influence human behavior. Another purpose of this study is to help test and retest causal theories in different ways in hopes of eliminating weak methodologies and theories.

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[6] See REFERENCES for a brief lisitng of studies.

## Research Hypothesis

This study hypothesizes that the amount and type of selected night crime and calls for police service in Youngstown, Ohio will be influenced by the presence and absence of light generated by the moon. Such information can be useful for police management in the areas of personnel deployment and crime prevention techniques.

## Overview of Thesis

The thesis is divided into five chapters. Chapter One, The Problem, outlines the need, purpose and hypothesis of the study.

In Chapter Two, a comprehensive review of the literature is presented covering folklore, history, relationship to other disciplines, the moon's effect on the Earth, detailed explanations of causal theories, and review of the studies pertaining specifically to the moon's influence on criminal behavior.

Chapter Three contains the design of the study, including methodology, limitations, delimitations, and statistical measures.

Chapter Four contains an analysis of the data and findings while Chapter Five concludes with a summary, including implications for police management based on all information reviewed.

# CHAPTER II

## REVIEW OF THE LITERATURE

A review of the pertinent literature is divided into several sections, beginning with the relationship of the topic to history and other cultures. Subsequent sections deal with the moon's effect on the Earth, man's biological clocks, detailed explanations of causal theories, and a comprehensive review of the literature pertaining specifically to the moon's influence on criminal behavior.

### Lunar Relation to History and other Cultures

The belief in the moon's power to influence the Earth and its inhabitants has been the subject of an abundant amount of legend, myth, and folklore. Many different cultures throughout the world have at one time or another associated the moon with agriculture, fertility, religion, life, and death.

"The early Sumerian and Semitic peoples called the moon Sin, leader of the sky-gods, who fathered Shamash, the sun. Sin gave and sustained life, ordered time, and drove away darkness and evil doers."[7]

All of western Asia once used the moon crescent as a charm to increase flocks and herds, crops, and more importantly children, who were considered the only insurance against poverty and

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[7]Wallechinsky and Wallace, p. 579.

destitution in one's old age. "Today the Catholic women of Italy would tell you that the Mother who is 'Moon of our Church' is Mother Mary. . . ."[8] Women of southern Italy still wear the moon crescent as a charm or amulet to secure the Moon Mother's help in childbirth.

The people of India, China, Mongolia, Arabia, Syria, Ancient Greece and Rome, and the Celtic people of northern and western Europe incorporate the beliefs about the moon into the center of their religious structure.[9] Today the island country of Sri Lanka (once called Ceylon) celebrates one of the most impressive of all religious festivals, the Perehera, only on the full moon in August.[10]

In 325 A.D. the Council of Nicaea, the first ecumenical synod ever assembled, decided the formula for determining the date for celebrating the Christian holiday of Easter.

> The historical Nicaean decree formulated that Easter should fall on the Sunday immediately following the first full moon that occurs after the first day of spring--the vernal equinox--and always after the start of the Hebrew Passover. . . .
> The original reason for including the stipulation of the full moon was in part to assure safety to the pilgrims with a bright night sky as they traveled to Jerusalem to celebrate the Resurrection.[11]

The actual date of Easter varies from year to year since its determination depends both on a solar year (present day Gregorian calendar) and the lunar phases, the two of which are not synchronized.

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[8] Esther M. Harding, Woman's Mysteries Ancient and Modern (New York: Harper and Row, 1976), p. 25.

[9] Ibid., p. 20.

[10] ABC, "20/20," 8 November 1984, "Signs of the Moon," Audrey Glunts Producer, Roger Caras Correspondent, Show #441, Transcript p. 12.

[11] Ted Pedas, "Moon determines the date for Easter," The Youngstown Vindicator, Youngstown, Ohio, April 7, 1985.

The Chinese utilized a lunar calendar up until the 1911 Revolution, when the traditional Chinese lunar calendar was officially replaced by the Gregorian calendar. However, celebration of traditional festivals, which are an important part of the Chinese culture, is determined by the lunar calendar. For example, the Spring Festival, China's only three-day holiday, is celebrated on the first day of the old lunar calendar, and is referred to in the west as the "Chinese New Year."[12]

The list of cultures believing in the moon's power is lengthy. Included are the Indians of North and South America, the primitive tribes of Australia and Polynesia, and the aboriginal people of Asia. In ancient Africa, rites of planting, circumcision, and fertility were all governed by the moon. Civilizations in Greenland believed that seeds lacked any power in themselves to grow absent the fertility of the moon.[13] Even today the Indians in the southwest United States plant and harvest their crops by the full moon because they know the crops are protected and aided by the "spirits" of the moon. According to Teles Goodmorning, a Taos Pueblo Indian, "The full moon the best time to plant corn. And that way, somehow the moon is affect the seed and it grow up real quick."[14]

The earliest known structures for studying the moon can be found in Egypt, for the famous pyramids had been built primarily as

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[12] China, ABC (Beijing, China: New World Press, n.d.), p. 206.

[13] Harding, p. 20.

[14] ABC, "20/20," p. 12.

lunar observatories, not as tombs. Later, an ancient civilization in the British Isles constructed a lunar observatory called Stonehenge.[15]

In the 1960s Astrology became popular as many people looked to the stars for answers which eluded them on earth. Astrology's basic premise is that people and events are influenced by the position of the sun, moon, and planets. Since 1971 close to one thousand works on astrology have been published,[16] and people are able to read their horoscopes in numerous newspapers and magazines, including sophisticated publications such as "Town & Country." Pursuing a new field known as Cosmobiology, two French Psychologists studied the astrological data of 16,000 people and found a correlation between personality types and the position of certain planets at the time of their birth. Psychologist Michel Gauquelin reports, "We found the strongest effect with Mars, Jupiter, Saturn, Venus and also with the moon."[17]

Astrology currently plays a vital role on the island country of Sri Lanka in the Indian Ocean (right off the tip of India). There important events are planned only after consulting with an astrologer.[18]

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[15] Ibid.

[16] See REFERENCES for a brief listing of Astrology works.

[17] ABC, "20/20," p. 12; See: Michel Gauquelin, "Genetic Sensitivity to External Factors During the Daily Cycle of the Deliveries," Journal of Interdisciplinary Cycle Research, 1971, 2(2), 227-232.

[18] ABC, "20/20," p. 14.

## The Moon's Effect on Earth

The Earth makes one revolution around the sun a year, which is one cause of the change in seasons. At the same time it is revolving around the sun, the Earth is also rotating on its axis. It takes 24 hours for the Earth to make one complete turn and this, of course, causes daytime (the side of the Earth that is facing the sun) and nighttime (the side of the Earth that is turned away from the sun). In much the same way, the moon revolves around the Earth and rotates on its axis. If we track its movement against the stars, the moon will revolve around the earth in 27 days, 7 hours, 43 minutes, and 11.5 seconds. This period of time is known as a sidereal month. Because the Earth is simultaneously revolving around the sun, it takes about two more days of travel to bring the moon in line with the Earth and the sun again as a new moon. This additional time period, known as the synodic month (29 days, 12 hours, 44 minutes, and 2.8 seconds) includes all the light phases the moon passes through (new moon, first quarter, full moon, last quarter).[19]

> If the synodic month were an exact fraction of a year, the phases of the moon would repeat from year to year on the same day of each month, and there would be complete harmony between the lunar and calendar months. Unfortunately, it is not so. The year consists of about 12 7/19 lunar months, which advance the lunar phases by eleven days each year. After nineteen years the accumulated difference amounts to seven complete lunar months, so that the lunar phases again fall on the same dates they did nineteen years before.[20]

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[19] Fred L. Whipple, Earth, Moon, and Planets (Cambridge, Massachusetts: Harvard University Press, 1968), p. 92.

[20] George Gamow, The Moon (New York: Henry Schuman, 1953), p. 29.

With regards to rotation, the moon rotates on its axis at about the same average rate it revolves around the Earth. Thus, we always see roughly the same hemisphere of the moon's surface and are unable to view the opposite hemisphere. Because of a slight elongation in its orbit, the moon turns slightly to the right and left (librations) during each revolution around the Earth, thus enabling us to see about 59 percent of the moon's total surface at one time or another.[21]

The unaided eye is able to follow the night-to-night changes in the moon's phases. Beginning at new moon (the dark side of the moon is facing the Earth) the fraction of the illuminated face visible from Earth (caused by parallel rays of reflected sunlight) increases until the face is entirely lit (full moon). Gradually the lighted surface decreases each day until the moon is entirely dark again (new moon), where the cycle begins again to repeat itself. When the moon is half lit, and will become a full moon in one week, it is called the first quarter. When the fully lit surface decreases to half again (one week prior to new moon), it is called the last quarter (See Illustration 1).

> When the moon comes directly between the Earth and the sun, all or part of the moon's shadow falls on the Earth, totally or partially eclipsing the sun. This doesn't happen at every new moon because the moon's orbit is tilted from the Earth and its shadow often misses the Earth completely. At full moon the Earth's shadow may fall on the moon, producing a total or partial lunar eclipse.[22]

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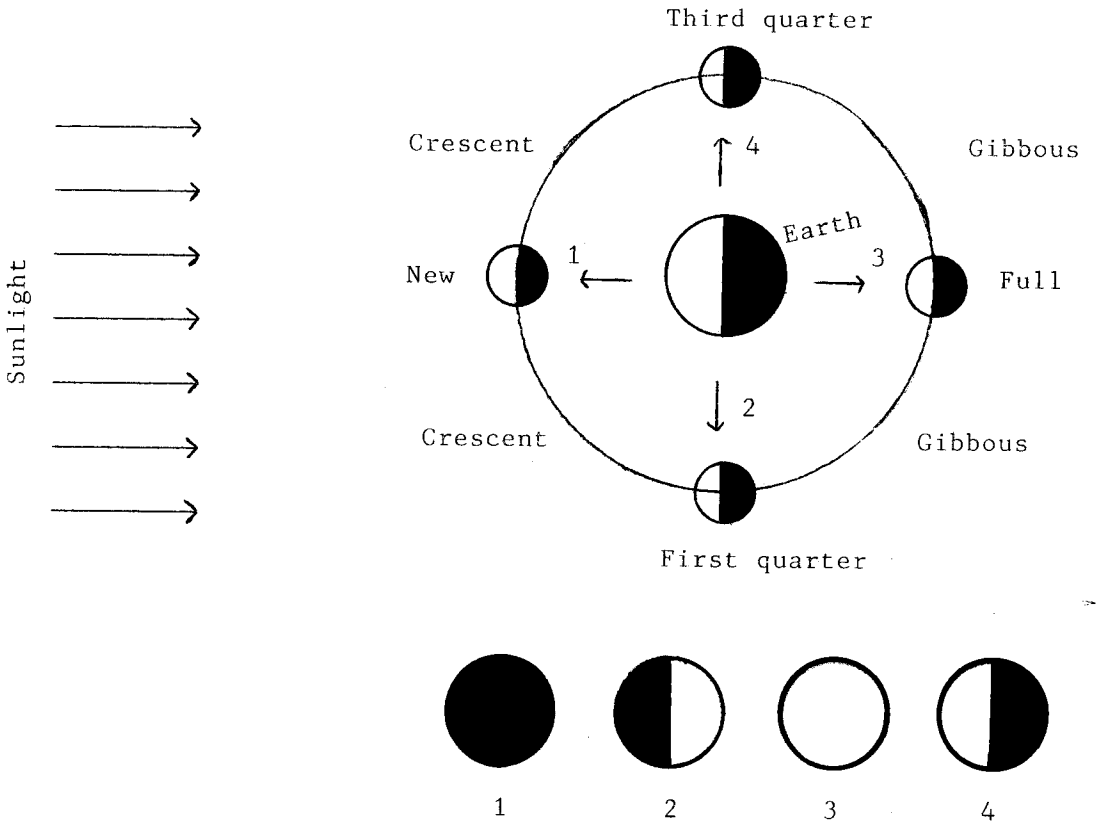
[21] Ibid., p. 28.

[22] Wallechinsky and Wallace, p. 580.

ILLUSTRATION 1

PHASES OF THE MOON AS SEEN FROM THE EARTH DURING ONE SYNODIC MONTH




Source: Whipple, p. 92.

The full moon rises in the east about the same time that the sun sets, makes its way across the night sky, then disappears over the horizon about the same time that the sun is beginning to rise again. The new moon rises and sets with the sun and is, therefore, "in the sky" during daylight hours. On new moon nights (between sunset and sunrise) the moon would be on the opposite side of the Earth. During first quarter, the moon rises around noon, follows the sun across the sky, and sets in the west around midnight. When the moon is in the last quarter it rises in the east around midnight, precedes the rising sun across the sky, then sets in the west around noon.

> The Earth's atmosphere has a surprising effect upon observations of the rising or setting moon. Light rays are bent by the atmosphere to such an extent that the entire moon (or sun) can be seen before it has risen and after it has set. The refraction of the light coming from empty space into the atmosphere is just about 0.5 degree, the apparent diameter of the moon. Thus, when the moon's upper limb would be just out of sight were there atmosphere, the entire moon is apparently lifted into view. At greater heights the refraction is less, and it decreases to zero overhead.[23]

The gravitational pull of the moon (and partially that of the sun) acts upon the Earth and its ocean and sea waters to produce tides. The gravitational pull distorts the Earth by stretching it into a shape similar to a symmetric egg (See Illustration 2).

> One may understand this symmetric elongation by considering that the lunar hemisphere of the Earth is pulled away from the center, and that the center is pulled away from the opposite hemisphere. When the Earth is stretched along the line joining it to the Moon, the circumference perpendicular to this line is naturally compressed. . . .

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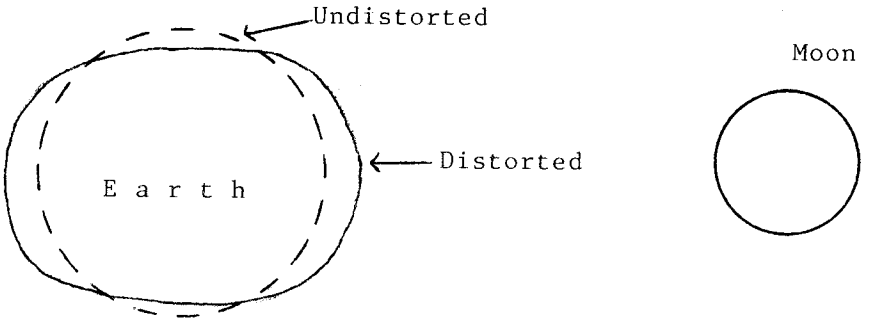
[23]Whipple, p. 94.

ILLUSTRATION 2

THE MOON'S GRAVITATIONAL PULL ELONGATES THE EARTH
ALONG THEIR LINE OF CENTERS

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Source: Whipple, p. 97.

> . . . experiments showed that the entire Earth yields immediately to the tide-raising forces, in so far as its rigidity will allow, and that it immediately returns to its original shape when they are removed. Thus the Earth is not only more rigid than steel; it is also more elastic.[24]

Studies that used careful measures of tides concluded that of the gravitational pull that is exerted by the moon, 70 percent of this pull affects the oceans and surface waters, while the remaining 30 percent acts upon the main body of the Earth to produce land tides.[25] "Water is most attracted toward the moon at the point where the moon is directly overhead; on the opposite side of the Earth, the moon attracts the ocean bed away from the ocean, causing a second high tide."[26] Further, ". . . . since gravitational forces decrease with distance, the pull exerted on the moonlit half of the Earth will be stronger than the pull on the moonless half."[27]

Because the Earth rotates faster than the moon moves through the sky, two tidal waves (changing shape of ocean surfaces) run around the Earth every six hours in the form of alternating low and high tides.[28] More precisely, the alternating rise and fall of the oceans and seas surface occurs twice in each period of 24 hours and 50 minutes (lunar day).[29] Because of the friction against the ocean

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[24] Ibid., pp. 96-97.

[25] Ibid., p. 97.

[26] Wallechinsky and Wallace, p. 580.

[27] Gamow, p. 56.

[28] Gamow, p. 57.

[29] A lunar day is defined as the amount of time it takes the Earth to turn so that any spot on Earth is directly beneath the moon again.

bottom, the differing contours of the ocean bed, and the fact that continents are between the waters, actual high tide may follow the maximum tide raising meridian by an hour or more.[30] Because of the moon's revolution around the Earth, the tides occur about 50 minutes later each day.[31]

The sun's gravitational pull produces tides in exactly the same manner as the moon, but because the sun is much further away from the Earth, its gravitational force is slightly less than one-half of that of the moon.[32] While the lunar frontal elongation points to the moon, the solar frontal elongation points toward the sun; however, these two phenomena are not usually synchronized. But twice a month, at full moon and new moon, the sun and moon align with the Earth causing their tidal forces to add together (maximum gravitational pull) resulting in exceptionally high tides and exceptionally low tides (spring tides).[33] At full moon, the alignment causes a gravitational tug of war on the Earth by the sun and the moon, since the Earth is between both gravity producing bodies (See Illustration 3).

During the moon's first and last quarter, solar high tides coincide with lunar low tides and vice versa, so that they

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[30]Gamow, p. 57.

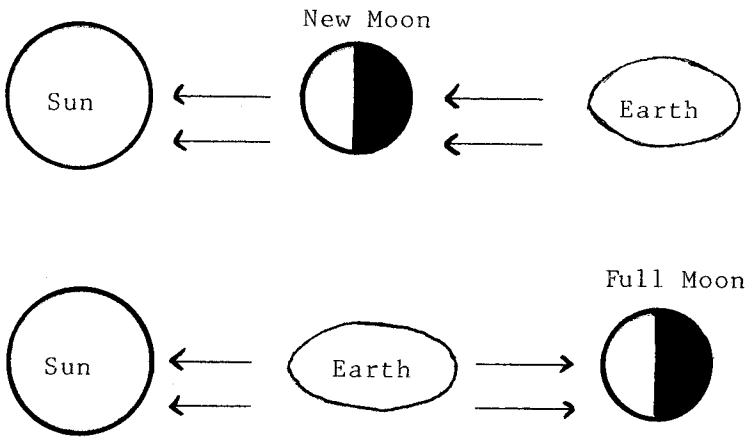
[31]Whipple, p. 98.

[32]Gamow, p. 54.

[33]Ibid., p. 57.

ILLUSTRATION 3

MAXIMUM GRAVITATIONAL PULL




The arrows show the direction that the earth is being pulled by the two gravity producing bodies.

considerably negate each other.[34] During these first and last quarter neap tides, the range from high tide to low tide is reduced to less than half the value of spring tides.[35]

> Still another factor enters into the production of the tides. When the moon is nearest to the Earth, at perigee, its tide-raising force is greater than when it is farthest away, at apogee. The range in the lunar part of the tide changes by about 30% because of this change in distance. . . .
>
> . . . Once a year, generally, the new moon occurs at a time when the moon is near perigee, while about 6 months later the full moon occurs at this position. The resultant spring tides at these two times of year are especially high, because of the increased size of the lunar tides. The dates of these maximum spring tides are progressively later by more than a month from one year to the next, because the direction of perigee is always moving forward around the moon's orbit, with a period of nearly 9 years.[36]

The varying amount of the lunar tide, along with the varying summation of lunar and solar tides, accounts for the large changes in the ranges of the ocean tides.

As was mentioned before, 30 percent of the moon's gravitational forces act upon the solid body of the Earth to create land tides. Each day the Earth's surface is twice deformed a distance of plus or minus 12 inches.[37] Precise studies have been able to show that the city of Moscow rises and falls an estimated 20 inches twice each day[38] and that ". . . . the moon plays the Earth's

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[34]Gamow, p. 57.

[35]Whipple, p. 97.

[36]Ibid., p. 98.

[37]Gamow, p. 59.

[38]Collie Small, "A Full Moon Can Beam Disaster," Boston Herald American, December 13, 1978, cited by Paul Katzeff, Full Moons (Secaucus, New Jersey: Citadel Press, 1981), p. 102.

surface like an accordion, pushing and pulling Europe and North America together and apart so that sometimes the Empire State Building is 63 feet closer to the Eiffel Tower than usual."[39] This movement, however, is not detectable to human beings as they go about their daily activities.

In addition to ocean tides and land tides, research has shown that similar "tides" occur in the Earth's atmosphere. "High tide is when the moon is directly overhead ('upper transit') or on the opposite side of the Earth ('lower transit')."[40] The highest atmospheric tides occur at any location during lower transit. Tides in the atmosphere are measured as air pressure, and depending on geographic location, the moon's gravity can raise the barometer .001 inches a day.[41] In the tropics, the barometer can rise three times as much as it does in the middle latitudes because of the moon's gravitational influence.[42]

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[39]Clark Timmins, Planting by the Moon (Chicago: Aries Press, 1939), cited by Katzeff, p. 102.

[40]William Kiser, Thomas Carpenter, and Glen Brier, "The Atmospheric Tides at Wake Island," Monthly Weather Review, 1963, 91, cited by Katzeff, p. 97.

[41]Joseph Proudman and Gordon Groves, "Tides," Encyclopedia Britannica, vol. 22 (Chicago: Encyclopedia Britannica, 1965), cited by Katzeff, p. 98.

[42]Peter Knight, "Atmosphere (Earth)," Van Nostrand's Scientific Encyclopedia, ed. Douglas M. Considine, 5th ed. (New York: Van Nostrand Reinhold, 1976), cited by Katzeff, p. 98; For more discussion and citations on ocean, land, and atmospheric tides, see Katzeff, pp. 87-102.

## Man's Biological Clocks

Human activities flow to a variety of yearly, monthly, weekly, daily, and near daily rhythms, similar to that of plants and animals. While the sun is commonly thought to be the 24 hour clock that regulates these activities, research has shown that some of man's activities more accurately conform to daily (24 hours 50 minutes) and monthly (synodic-29 days, 12 hours; sidereal-27 days, 7 hours) lunar cycles.

Humans have at least two major types of interior timing systems, or "clocks," each cycling approximately 25 hours. One body clock is set by the light-dark cycle of each day. The light of the day signals the brain that it is time to awaken from sleep. The second clock regulates body temperature, raising it during the daytime and dropping it at night. The temperature clock is set by periods of sleep and activity, and since many people follow the standard routine of activity during the day and sleep at night, the two biological clocks normally run harmoniously.[43] Because lunar and solar rhythms affect man simultaneously, it is necessary to disrupt the status quo to observe the lunar phenomena at work.

Stanford University Scientists in 1977 were confronted with a blind man who had been experiencing for several years insomnia and daytime sleepiness. Prior trips by the man to doctors and psychiatrists proved futile, as neither drugs nor hypnosis could cure his problem. The scientists began to monitor the man's biological

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[43] Parade Magazine, September 16, 1984.

and psychological functions, for example, temperature, secretion of certain vital hormones, urinary electrolyte excretion, alertness, and ability to perform certain tasks. Their results revealed that these biological and psychological functions were occurring on a time cycle of 24.9 hours, more closely imitating a lunar day rather than a solar day. Moreover, the researchers were able to find a correlation between the man's sleep onset and low tide. The man's insomnia disappeared during the time that his lifestyle conformed to the 24.9 hour cycle.[44]

German researcher Jurgen Aschoff kept a man in a soundproof underground bunker (minus clocks and natural light) for a period of 24 days. The man began going to sleep later each night and was soon living a 25.04 hour "day," once again, closely resembling a lunar day.[45] Studies of people isolated in caves and deserts again confirmed that lifestyles seem to be regulated by a lunar, as opposed to a solar, clock.[46]

For his 1972, 1973, and 1978 studies Arnold Lieber devised a "lunar phase interval scale" based on a time period of 29.53 days (synodic month) to analyze data against moon phases.

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[44]L. E. M. Miles, D. M. Raynal, and M. A. Wilson, "Blind Man Living in Normal Society Has Circadian Rhythms of 24.9 Hours," Science, 1977, 198, cited by Katzeff, pp. 204-205.

[45]Jurgen Aschoff, "Human Circadian Rhythms in Activity, Body Temperature and Other Functions," Life Sciences and Space Research, vol. 5 A. H. Brown and F. G. Favorite, eds. (Amsterdam: North Holland Publishing Co., 1967), cited by Katzeff, p. 205.

[46]Gay G. Luce, ed., Biological Rhythms in Psychiatry and Medicine (Public Health Service Publication #2088; Washington: U.S. Government Printing Office, 1970), cited by Katzeff, p. 206.

> The periodicities exhibited here occur within the context of a lunar time frame and are not identifiable when studying the behaviors within the context of clock or calendar time (which depends upon the sun for its frame of reference). . . . The basis for much moon lore becomes clear when one considers that virtually all ancient civilizations utilized a lunar calendar. Ancient scientists were often astute observers; they correlated the relative positions of the sun, moon and Earth with various terrestrial phenomena. Many of the correlations with which they were familiar were lost when Christian clerics opted to change to a solar calendar. Some of these lost relationships apparently reappear when we study behavior using a lunar time frame.[47]

## Causal Theories for a Lunar Influence on Human Behavior

Based on a review of the literature, this research has identified at least five causal theories which have been offered over time for explaining a lunar influence on human behavior: (1) Biological Tides (Gravitational Theory), (2) Positive Ions, (3) Psycho-Social, (4) Moonlight (Biological and Illuminataion Aspects), and (5) Remnants of Tidal Rhythms.

### Biological Tides (Gravitational Theory)

A biological tide theory for a lunar influence reasons that the human body and its fluids respond to the moon's gravitational forces, similar to the Earth's oceans, lands, and atmosphere. (Remember that maximum gravitational forces occur at full moon, new moon, and perigee.) These physiological changes in the human body are thought to cause behavioral and emotional changes.

> If one considers the human organism as a microcosm comprised of essentially the same elements as and in similar proportions to those of the Earth's surface (approximately 80 percent water

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[47] Arnold L. Lieber, "Human Aggression and the Lunar Synodic Cycle," Journal of Clinical Psychiatry, 1978, 39, p. 387.

> and 20 percent organic and inorganic minerals), one could speculate that the gravitational forces of the moon might exert a similar influence upon the water mass of the human microcosm. One of us (A. L. L.), drawing on evidence from various medical and non medical scientific disciplines, theorizes that the moon, via the effects of its gravitational forces on the human organism, causes cyclic changes in water flow among the fluid compartments of the body (intracellular, extracellular, intravascular, and intraluminal), as well as changes in total body water, resulting in what might be termed "biological tides." These changes, together with associated electrolyte and hormonal shifts, may set the stage for differential thresholds of neural triggering and/or altered levels of neuromuscular irritability, thus giving rise to "normal" variations in emotional tone and, in certain constitutionally predisposed individuals, to more or less severe emotional disturbance.[48]

Depending on individual receptivity, "normal variations in emotional tone" might be expressed through irritability or sluggishness, social tension, and disharmony. Persons with unstable personalities, mood disorders and/or those already under stress may experience more bizarre results. If such persons are prone to violence, they may be compelled into uncontrollable behavior.[49]

Clinical studies have provided evidence that two groups of "constitutionally predisposed individuals to more or less severe emotional disturbance" are "manic-depressives" and women who are beginning menstruation.[50]

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[48] Arnold L. Lieber and Carolyn R. Sherin, "Homicides and the Lunar Cycle: Toward a Theory of Lunar Influence on Human Emotional Disturbance," American Journal of Psychiatry, 1972, 129, p. 69.

[49] Arnold L. Lieber, Lunar Effect-Biological Tides and Human Emotions (Garden City, New York: Doubleday, 1978).

[50] See: Raphael Kerry, and Goronwy Owen, "Lithium Carbonate as a Mood and Total Body Water Stabilizer," Archives of General Psychiatry, 1970, 22, pp. 301-303; Michael H. Stone, "Madness and the Moon Revisited," Psychiatric Annals, 1976, 6(4), pp. 47-60.

> . . . manic-depressives suffer from disruptions in their reservoirs of body water, and that one key to medication for the psychosis also happens to stabilize levels of body water and the firing of nerve synapses, which may be roughly thought of as the nervous system's spark plugs. . . .
>
> . . . When too much water accumulates, the result can be a sensation of bloating, tension and depression. The premenstrual disturbance experienced by so many women is merely one example of this, and the alarming tendency of women to attempt suicide more often during the onset of menstruation is a sad confirmation.[51]

Biological tide theorists believe that the moon's gravitational forces could easily push such constitutionally predisposed individuals "over the edge" by disrupting the hormonal, electrolyte, and body water balances, thus accounting for an ample amount of abnormal human behavior.[52]

Finally, biological tide theorists argue that much of the historic moon folklore has been discovered to have a scientific basis in recent studies.

There are several weaknesses associated with a biological tide explanation of a lunar effect:

1. If gravity is the influencing factor, why have periods of apogee and perigee not made a difference in some of the studies conducted?

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[51] Katzeff, pp. 239, 238; The average menstrual cycle happens to be the same length as the synodic lunar month cycle (29.53 days), while pregnancy in humans is 266 days, precisely nine lunar months.

[52] A recent study of Developmental Psychologist Editha D. Nottelmann and colleagues of the National Institute of Mental Health and the National Institute of Child Health and Human Development found a correlation between levels of hormones "responsible for the physical aspects of pubertal development" and behavior and adjustment problems in adolescents. See: Lee Siegel, "Misbehavior during puberty linked to levels of hormones," Youngstown Vindicator, May 28, 1985, p. 21; Also see: Biology, Crime and Ethics: A Study of Biological Explanations of Criminal Behavior, by Marsh and Katz, Anderson Publishing Company, P.O. Box 1576, Cincinnati, Ohio 45201.

2. Many studies find peaks at full moon, but not at new moon (a similar period of maximum gravitational pull).

3. Studies have also found peaks at first quarter, last quarter and before the maximum tide raising effect has occurred.[53]

4. Biological tide theorists speak in terms of "constitutionally predisposed individuals." What other factors are involved in making someone "predisposed" and how do we isolate and identify these factors in humans?

5. How do we measure "normal variations in emotional tone" (irritability, sluggishness, social tension, disharmony, bad moods), as these behaviors may not be serious enough to be labeled psychiatric or criminal, or require a phone call to police and/or "hot lines?"

## Positive Ions

Another type of biological explanation for the moon's influence on human behavior is drawn from theories for the full moon's correlation with the occurrence of earthquakes, hurricanes, typhoons, electrical storms, and heavy rainstorms.[54] Scientific measurements show that the air contains large amounts of positive ions just before

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[53]Explanations are available for peaks occurring after the maximum tide raising effect has occurred, for example, "lag time." See: Roger Dean Osborn, "The Moon and the Mental Hospital: An Investigation of one Area of Folklore," Journal of Psychiatric Nursing and Mental Health Services, 1968, 6, pp. 88-93; Alex Pokorny, "Moon Phases and Mental Hospital Admissions," Journal of Psychiatric Nursing and Mental Health Services, 1968, 6, pp. 325-327; Sheldon Blackman and Don Catalina, "The Moon and the Emergency Room," Perceptual and Motor Skills, 1973, 37, pp. 624-626. Lag time explanations cannot, however, explain why peaks would occur before maximum gravitational pull.

[54]See REFERENCES for a brief listing of studies; On Friday May 31, 1985, a series of severe tornadoes, identified as the nation's worst since April 1974, devistated four counties in northeast Ohio and western Pennsylvania killing over 70 persons, injuring hundreds, and causing hundreds of millions of dollars in damage. The tornadoes were unique for several reasons: (1) ferocity, (2) the large number of them and (3) the weather systems that spawn such tornadoes are more typical of February, not May. The twisters hit just 3 days prior to the actual date of the full moon, June 3.

earthquakes and electrical storms occur. It is believed that the moon directly increases positive ions by reflecting ultraviolet radiation and x-rays from the sun back to the Earth, resulting in ionization. Another possible explanation (or one that occurs simultaneously with the first) is that the moon may become electrostatically charged, deflecting ions from the sun to the Earth. In any event, both explanations' maximum effects occur during full moon. Accumulations of positive and negative ions in the air is believed to affect human emotions by altering the body's physiology.[55]

Disturbances in the Earth's magnetic field, and the electric field that surrounds every living thing have been shown to be affected by lunar rhythms.[56] Studies have shown that humans and animals are able to detect changes in the Earth's magnetic field, even slight changes, and it is believed that magnetic fields and electromagnetic radiation can influence human emotions by altering the body's physiology.[57] Changes in the amount of electricity in the Earth's atmosphere is partially caused by lunar induced fluctuations in ionization. Leonard Ravitz was able to show that build ups of charged

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[55]Leonard J. Ravitz, "Electrocyclic Phenomena and Emotional States," Journal of Clinical and Experimental Psychopathology, 1952, 13(2); Robert Holzer, "Electricity, Atmospheric," Encyclopaedia Britannica, vol. 8 (Chicago: Encyclopaedia Britannica, 1956); E. K. Biggs, "Lunar and Planetary Influences on Geomagnetic Disturbances," Journal of Geophysical research, 1963, 68(13) cited by Katzeff, p. 242.

[56]See REFERENCES for a brief listing of studies.

[57]See: Luce; Howard Friedman, Robert Becker and Charles Bachman, "Geomagnetic Parameters and Psychiatric Hospital Admissions," Nature, 1963, 200, 626-628; Howard Friedman, Robert Becker and Charles Bachman, "Psychiatric Ward Behavior and Geophysical Parameters," Nature, 1965, 205, 1050-1052.

atoms in the human body (electric potential) followed a lunar cycle. Seventeen men and women were ranked psychologically as severely maladjusted, moderately maladjusted and reasonably well adjusted. All subjects showed higher peaks of electric potential (measured in volts) at full and new moon. Smaller peaks sometimes occurred just before or just after first and last quarter. Whenever the peaks occurred, the more seriously disturbed the subject was, the higher his voltage reading was. Ravitz was able to replicate his study a year later using 100 test subjects.[58]

Dr. Ralph Morris, Professor of Pharmacology at the University of Illinois has also studied man's relationship with the moon's phases with data covering some 20 years. Dr. Morris states:

> There is little doubt in my mind that the moon has an effect on the response of man and other mammals to both the safety and the efficacy of drugs. . . . The week of full moon, a person is more likely to overdose on heroin.[59]

Dr. Morris believes that humans radiate an energy field that the moon disrupts. This disruption results in increased ions or electric particles within our energy fields. He stated, "So as you increase positive ions and/or increase the concentration of ions--total concentration--you will cause aggressive, assertive, antagonistic type of behavior."[60]

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[58]Ravitz, "Electrocyclic Phenomena"; Leonard J. Ravitz, "Electrodynamic Field Theory in Psychiatry," Southern Medical Journal, 1953, 46(7), cited by Katzeff, pp. 263-264.

[59]ABC, "20/20," p. 13.

[60]Ibid.

## Psycho-Social

Cultures all over the world for most of human history have associated the moon with an abundant amount of legend and superstition, and many of these beliefs have persisted into modern times. The moon has been associated with such things as agricultural planting and growth, fertility (for the successful birth and healthy growth of human and animal offspring), religion (as a deity, and in occults and witchcraft), decay, death, lunacy, and lycanthropy.[61]

There is something magical and mystical about the moon that people do not seem to feel about the sun. "In an old Persian story, a wise man is asked which is more useful, the sun or the moon. 'The moon' he answers, 'because the sun shines in the daytime, when it's light out anyway.'"[62] According to world myth and folklore, people have visioned many different images from the irregular bright (ancient battered highlands) and dark (more recent frozen-lava lowlands) markings of the moon. The images concocted include a woman weaving, a girl with a basket on her back, a woman pounding tapa cloth, an elephant jumping off a cliff, a rabbit, and the most common image by far, the man in the moon. Further, the moon's waxing and waning (observable monthly cycles of increasing then decreasing light phases) has been considered a metaphor of death and rebirth.[63]

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[61] For more discussion of moon folklore and mythology, See Katzeff, Chapters 1-9, pp. xi-84.

[62] Carl Sagan, "The Man in the Moon," Parade Magazine, June 2, 1985, p. 14.

[63] Ibid.; Joe Murray, "Big Rabbit on the Moon," Youngstown Vindicator, p. 20.

The moon and the calendar are very important to well over 20,000 persons currently practicing witchcraft in the United States. During each full moon witches hold religious ceremonies while on every Friday the thirteenth they gather for celebration. On Friday July 13, 1984, witches everywhere held extra-special festivities, for it was one of the rare occasions when the full moon fell on Friday the thirteenth. According to Gavin Frost, head of the school of Wicca in New Bern, North Carolina, which mails literature to witches:

> Witchcraft is the old religion. So when the Christians came on being the new religion, they said we were devil worshipers, because the god of the old religion is always the devil of the new religion, . . .
>
> . . . witchcraft is not based on devil worship, as many people believe but, rather, on the worship of gods and goddesses established centuries ago. . . .
>
> . . . We don't believe in blood sacrifices and things of that nature, . . .[64]

Of the many classic horror films made in the 1930s to 1950s, one of the most popular is a series of films about the continuing sad story of a man named Lawrence Talbot, who on every full moon at midnight turned into a werewolf, instinctively seeking to kill, a consequence of having been bit by a wolf. To complicate matters, a werewolf ". . . could only be killed by a silver bullet or by a stick covered with silver."[65] Consider the following ancient Gypsy proverb, well remembered in "The Wolfman," Universal Studios, 1941: "Even a man

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[64]"Calendar, Moon Aid Witchcraft," AP, Vineland, NJ, Youngstown Vindicator, July 13, 1984.

[65]Alan G. Frank, Horror Movies, Octopus Books Limited, (Hong Kong: Mandarin Publishers Limited, 1974), p. 97.

who is pure in heart and says his prayers by night, can become a wolf when the wolfbane blooms and the autumn moon is bright."[66]

Aristotle believed that the moon resembled the human brain, and that the brain changed with the moon's phases. Aristotle's contention led to the idea that the moon could somehow affect the mind, resulting in words such as lunatic, lunacy, and moonstruck.[67] The Holy Bible recounts the story of Jesus casting the devil out of a "lunatick"[sic] in Matt. 17:14-18:

> And when they were come to the multitude, there came to him a certain man, kneeling down to him, and saying,
>
> Lord, have mercy on my son: for he is lunatick, and sore vexed: for ofttimes he falleth into the fire, and oft into the water.
>
> And I brought him to thy disciples, and they could not cure him.
>
> Then Jesus answered and said, O faithless and perverse generation, how long shall I be with you? how long shall I suffer you? bring him hither to me.
>
> And Jesus rebuked the devil; and he departed out of him: and the child was cured from that very hour.[68]

According to Bauer and Hornick, one of the first official codified usages of the term "lunatic" was recorded in the eighteenth century, in the following legal definition by Blackstone:

> A lunatic, or non compos mentis, is one who hath . . . lost the use of his reason and who hath lucid intervals, sometimes enjoying his senses and sometimes not, and that frequently depending upon the changes of the moon.[69]

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[66] Ibid.

[67] Wallechinsky and Wallace, p. 580.

[68] Matt. 17:14-18.

[69] Stephen F. Bauer and Edward J. Hornick, "Lunar Effect on Mental Illness: The Relationship of Moon Phase to Psychiatric Emergencies," American Journal of Psychiatry, 1968, vol. 125, p. 696.

Today's professionals who deal with human emotions and trauma, such as police personnel, medical and hospital personnel, and the mental health specialists, are quick to point out that their activities seem to increase or become more bizarre in nature during full moons.

> Police Sgt. Bill Garrison, Dade County Florida: During a night of a full moon, we, at least in looking back through statistical information, that we seem to do more hostage rescue or barricaded subjects during a full moon. . . .
>
> Toni Salazar, nurse: I've been in nursing, in O.B. nursing, for about 30 years, and I definitely think the moon has something to do with all the births that we have, because when I'm coming to work and I see a full moon, I think, "Oh, you'd better rest up, 'cause you're going to be busy tonight."
>
> Joan Van Ongevalle, nurse: The doctors always complain, "There must be a full moon," and that's their favorite line, you know. And you phone them up and you say, "Guess what, five women have just come through the door, and we don't have a sale on today, you know, two for one." "Must be a full moon."[70]

Nor is this belief restricted to the above professional occupations. People from all walks of life, ethnic backgrounds and socioeconomic status believe that the moon somehow causes people to behave in unusual ways. There is a club in Key Biscayne, Florida, near Miami, called "The Howlers" who gather once a month to party and howl at the full moon.

> MAN, member The Howlers: You know what the full moon does to werewolves? It turns them into animals. You know what it does to me? It turns me into a beast!
>
> 2nd MAN: I'm tougher, meaner and nastier, so if it has an effect on me, I know it has an effect on the public, 'cause I'm a nice guy.[71]

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[70] ABC, "20/20," p. 13.

[71] Ibid., p. 12.

Moon folklore and the effect of a self-fulfilling prophecy may be partially to blame for the above mentioned attitudes. Observers may be more conscious of normal amounts of abnormal behavior and emotional instability. Viewing a full moon may make certain people act "crazy," because they believe that is the way they are supposed to act. Thus, the moon may also create a power of suggestion to those supposedly "affected." In a 1960 report, Dr. Edson Andrews suggested that the full moon may influence people who are on the psychiatric brink.[72] Indeed, many psychiatrists believe that the sight of the full moon may serve as the object that unconsciously triggers psychotic behavior in emotionally disturbed persons.

A full moon also has a very romantic connotation. Countless songs have been written associating love with the moon and lovers continue to believe that the full moon helps make them feel the way they do. Recent scientific research has begun to reinforce the moon's romantic perception.

> If births do indeed occur more often at full moons, then there should be evidence that humans make love more often at full moons, too, and the reason is simple. Not only is the average menstrual cycle the same length--29.53 days--as the synodic lunar month, but the average gestation period is also nine months. If birth is at full moon, then conception probably was too, nine months earlier.[73]

Evidence has also been provided that men experience monthly physiological and emotional cycles similar to those accompanying women's menstruation period, which as previously stated, corresponds to the

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[72] Edson Andrews, "Moon Talk: The Cyclic Periodicity of Post-operative Hemmorrhage," Journal of the Florida Medical Association, 1960, 46(11), cited by Katzeff, p. 190.

[73] John D. Palmer, "The Many Clocks of Man," Cycles, 1971, 22(2), cited by Katzeff, p. 156.

synodic lunar month. Some studies have shown that male sexual desires and drives seem to be correlated with the lunar phases, especially the full moon.[74]

Under the Biological Tides and Positive Ion Theories it was shown how biological changes within the human body are thought to affect human behavior. The Psycho-Social theorists attempt to show how the human mind (psychology) can affect the body's physiology.

It is conservatively estimated that a minimum of 2 percent of all medical patients have a condition known as hypochondriasis.[75] Hypochondriacs are ". . . people who have no significant physical disease but are convinced they do. . . . the most common single diagnosis made in general medical practice is 'nonsickness.'"[76] Yet millions of these persons suffer aches and pains similar to "legitimately" ill patients. Most everyone experiences minor hypochondria now and then. If we get sick we may fear that we have some serious disease, thus compounding the initial problem via anxiety. Further, medical doctors acknowledge that patients' mental attitudes can slow or speed recovery and even mean the difference between life and death.

Most people are familiar with the fact that nervous, tense, or anxious feelings can cause headaches, stomachaches, fainting, perspiration, blushing, queasiness, and fatigue. According to Dr. John Bulette, Chairman of the Department of Psychiatry at Abington Hospital in

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[74]See REFERENCES "Human Biology."

[75]Lawrence Galton, "You're Not Sick," Parade Magazine, June 2, 1985, p. 19.

[76]Ibid.

Pennsylvania, "The physiological impact of anxiety is pretty clear. It causes metabolic demands on organ systems. The heart and the organs that support the cardiovascular system have to work harder."[77]

The power of the mind over the body also becomes apparent when considering the following: false pregnancies, phobias, biofeedback, stress, polygraph machines, nervous breakdowns, placebo drugs, and hypnosis.

A number of studies have, however, yielded results that cannot be explained merely from a Psycho-Social theory. Examples include research showing parallel increases in the studied behavior at new moon, experiments conducted with blind people, and studies where people have been isolated from all natural light (as in caves). Further, much of the historic moon folklore has been discovered to have a scientific basis, for example the studies which correlate the moon's phases to observable habits of marine life, land animals, plant life and human biology.[78]

## Moonlight

A fourth body of theory has been proposed in an attempt to fill the gap left by the theories presented thus far, and possibly provide an explanation as to why many studies find clusters during full moons but not at new moons (both are phases of maximum

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[77]Tom Naughton, "Why You're Tired and What to do About It," Family Safety and Health, Summer 1985, vol. 44, no. 2, pp. 26-27.

[78]See REFERENCES for a brief listing of studies.

gravitational pull). There are two ways in which moonlight might affect human behavior in general and criminal behavior in particular. One is from a biological standpoint, while the other is from an illumination standpoint.

## Biological

Proponents of a moonlight theory postulate that gravity is not the sole factor in certain lunar correlations. Experiments with plants and animals provide evidence that moonlight, not gravity, regulates sexual and other activity among them.[79]

Edmond M. Dewan hypothesized that moonlight caused the release of enzymes and hormones in the female human body important for the start of the ovulation cycle. Dewan used artificial light from lightbulbs to simulate moonlight and was able to successfully alter women's unpredictable menstrual cycles to regular ones.[80] Similar experiments have resulted in regularity for women's menstrual cycles.[81]

Dr. Alain Reinberg and others conducted an experiment where a female was isolated in an underground cave with a very small amount of

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[79] See REFERENCES for a brief listing of studies.

[80] Edmond M. Dewan, "On the Possibility of a Perfect Method of Birth Control by Periodic Light Stimulation," American Journal of Obstetrics and Gynecology, 1967, 99, cited by Katzeff, pp. 225-226.

[81] Anne K. Rush, Moon, Moon (Berkeley, CA: Moon Books, 1976); Nancy Passmore, The 1977 Lunar Calendar (Boston: Luna Press, 1976); Ursula Cowgill, et al., "An Apparent Lunar Periodicity in the Sexual Cycle of Certain Prosimians," Proceedings of the National Academy of Sciences, 1962, 48.

illumination for three months. Before going underground the woman had lived a normal 24 hour day schedule and had a regular 29 day menstrual cycle. Once underground, her lifestyle began to follow a 24.6 hour day (similar to a lunar day) and a 25.7 day menstrual cycle. When she returned above ground her daily and menstrual cycles returned to 24 hours and 29 days respectively.[82] Again, it appears that sunlight and moonlight (as opposed to gravity) were responsible for the change.

Katzeff quotes Gay G. Luce (editor of Biological Rhythms In Psychiatry and Medicine) on how the moon's light initiates ovulation:

> The ovulatory cycle starts when light makes the hypothalamus produce more "follicle stimulating hormone releasing factor" (FSHRF). FSHRF then prompts the pituitary gland, which is the size of a pea in humans and located beneath the brain, to secrete more "follicle stimulating hormone," or FSH. FSH induces development of the small follicles of the ovary, in which eggs develop, and secretion of estrogen by the ovaries. "FSH is followed by another pituitary hormone, known as luteinizing hormone, LH, which makes possible the final maturation of the ovum and its release through the rupture of the follicle. The ruptured follicle then becomes transformed into the yellow body--corpus luteum--that secretes progesterone to complete preparation of the uterus for the coming ovum, and to develop the environment for the implantation of the fertilized egg."[83]

According to Katzeff:

> The reason that the moon, which reflects so much less light than the sun casts, may be important to this cycle is that the time of day seems to be as important as the light itself. The critical time is before dawn, when the moon may indeed be the biggest show in the sky.[84]

Further research has shown that the pineal gland, located within the brain and believed to act as a brake on the pituitary

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[82] Luce cited by Katzeff, p. 227.

[83] Luce quoted by Katzeff, p. 231.

[84] Katzeff, p. 231.

production of sexual ripening hormones, is reduced by exposure to light.[85] "Moreover, recent studies suggest that the pineal gland plays a key villainous role in manic-depression, . . ."[86]

In addition to the ovulation studies and citations which show statistically significant number of births occurring at full moon, several studies have shown that significant numbers of successful births occur during the night time period, a time when the moon's light is present.[87]

Further development of moonlight theories have centered on such things as light polarization, light wavelengths, and the abiliity of moonlight to stimulate muscle action.[88]

If moonlight can cause physiological changes in humans, it is possible that these physiological changes can affect human behavior, similar to biological tide and positive ion theories. Some research in the area of lighting has suggested that dim light (similar to the light generated by a full moon) may increase antisocial and/or criminal behavior.

> Studies at Wright State University have indicated that lighting can have an important effect on social behavior. Tests showed that a dimly lit setting markedly increased

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[85] Luce cited by Katzeff, pp. 232-233.

[86] Katzeff, p. 233.

[87] See REFERENCES for a brief listing of studies.

[88] Ibid.

> feelings of aggression and hostility between two interacting individuals, and that this effect is heightened when the subjects are in close proximity.[89]

Illumination

There is a second way moonlight might affect human criminal behavior, "The Moon is so large and so close to us that it reflects sufficient sunlight at its full phase to light up the night satisfactorily for many practical purposes of life."[90] Unfortunately, one possible "practical purpose" of this night light may be for the perpetration of crimes such as burglary, breaking and entering, and auto thefts. Philip P. Purpura compared crimes during "full-moon time spans" with crimes occurring during "non-full-moon time spans" and found that although there were no significant differences, the crime of breaking and entering showed the biggest non-significant difference, occurring more frequently during the full-moon time span. Purpura speculated that the dim light from the moon may provide a person optimal opportunity to perpetrate a crime such as breaking and entering.[91]

The Library of Congress once reported that night crimes occurred 12 times more frequently than daytime acts of violence,

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[89] John E. Gibson, "When People Become Angry," Family Weekly, October 16, 1977, quoted in Philip P. Purpura, "Police Activity and the Full Moon," Journal of Police Science and Administration, 1979, vol. 7, no. 3, p. 353.

[90] Whipple, p. 91.

[91] Purpura, pp. 350-353.

while a study conducted by the Joint Committee of the Illuminating Society and the Institute for Traffic Engineers found that 75 to 90 percent of certain criminal offenses were committed at night.[92]

The use of artificial lighting at night to prevent and deter criminal activity is a widely studied and controversial topic. Areas of controversy include questions of: (1) Light versus no light, (2) Light intensity (bright light versus dim light), and (3) The strategic placement of the lights. Of particular interest for security purposes then, would be the following locations of night lighting: (1) Houses, interior and exterior, (2) Businesses, interior and exterior, and (3) Streetlighting.

Proponents of night security lighting argue that light denies camouflage, thus making detection and identification of perpetrators more likely. Improper lighting techniques however, such as dim lighting and improper placement of the lights would defeat this principle by (1) providing enough light to successfully move around in the dark and perpetrate the crime with little or no aid from a flashlight, and (2) by providing shadows. Therefore, while lighting that is bright and strategically placed may deter criminal activity, dim lighting (similar to moonlight) and/or poor placement of the lighting may provide a person the opportunity to commit a crime.[93]

It is noted that not all scholars and studies agree with the concept of lighting as a means of crime prevention. Opponents include

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[92] J. M. Siemon and L. Vardell, "Bright Answer to the Crime and Energy Question," The Police Chief, June 1974, p. 53.

[93] See REFERENCES for a brief listing of studies.

Astronomers concerned with "light pollution," which prevents them from studying the stars at night.[94] Although some research has shown that night lighting has little or no impact on crime, many studies acknowledge that people seem to feel safer when the nightlights (especially the streetlights) are on.[95]

One weakness of a moonlight causal theory is that some studies show parallel increases in the studied behavior at new moon (i.e., no moonlight).

### Remnants of Tidal Rhythms

Dr. Isaac Asimov has proposed a fifth causal theory for a lunar influence on living things.

> . . . The only logical method of showing that the moon produces effects of any kind is to try to relate it to a kind of tidal rhythm in living things, including the human being, because we were descended from tidal creatures a few hundred million years ago, and there may be a vestigial remnant of such tidal rhythms in us.[96]

According to Dr. Asimov, it is not the tides within our bodies, but rather the memories of such tidal rhythms that influence one's behavior.

## The Lunar Correlation with Criminal Behavior

It can be argued that if the moon does induce "abnormal" human behavior it should be reflected, to a certain extent, in the

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[94] Ibid.

[95] Ibid.

[96] ABC, "20/20," p. 14.

occurrence of crime, criminal behavior, and aggressive behavior. Consider the following victims: Jesus Christ, crucified under a full moon; Julius Caesar, stabbed to death under a full moon; and Abraham Lincoln, assassinated three days before the full moon. The following dignitaries were assassinated during the full-moon phase: Alexander II, Russia; Leon Trotsky, Russian war minister; Count Folke Berndotte, United Nations Palestine mediator; Abdul Iban Hussein, King of Jordan; Francisco Madero, President of Mexico; Engelbert Dollfuss, Austrian chancellor; Rafael Trujillo Molina, Dominican dictator.[97]

Tragedies such as the My Lai Massacre (Vietnam War) and the "World's worst sports-oriented disaster" (Lima, Peru), where 328 people were killed after a referee's call caused the fans to riot, also occurred on full moon nights.[98] More recently, New York's "Son of Sam" murderer struck on eight nights between July 29, 1976 and July 31, 1978. Five of those nights were during (or in one case, right before) the full or new moon phases. Also, the full moon day of September 22, 1975 was when Sarah Jane Moore unsuccessfully attempted to assassinate President Gerald Ford, firing one shot before being overpowered by police and citizens.[99]

In 1963, during an international meeting on forensic immunology, medicine, pathology, and toxicology at the London University, Edmund A. Jannino, a former County Medical Examiner in Massachusetts, lectured about two of history's infamous murder sprees,

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[97]Small cited by Katzeff, p. 178.

[98]Ibid.

[99]Katzeff, pp. 175, 179.

Jack the Ripper and the Boston Strangler. Jannino made reference to a study of two schizophrenic twins by Leonard Ravitz which found that the subjects' voltage readings were highest during full and new moons. As the one brother's mental health improved, his voltage readings simultaneously declined (but still peaked at new and full moon)., which supported Ravitz's earlier findings that mentally healthier patients have lower voltage readings.[100]

> The hunt for a logical explanation for the illogical acts of a homicidal mind can be frustrating, Jannino said. Perhaps the tides of bodily electricity are the only predictable, logical action involved. Jannino was making no premature jump onto any theory's bandwagon, mind you; merely thinking out loud in a structured way. . . .[101]

"One of the most intriguing things about Ravitz's work is that it may forecast how the moon can be used for medical and psychiatric diagnosis."[102]

## The Studies

Alex Pokorny matched homicides that occurred in 1959, 1960, and 1961 in the State of Texas with moon phases, apogee and perigee. Pokorny obtained the dates of each of the four moon phases (new moon, first quarter, full moon, and last quarter) and the dates of each

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[100] See: Leonard J. Ravitz, "Comparative Clinical and Electrocyclic Observations on Twin Brothers Concordant as to Schizophrenia," Journal of Nervous and Mental Disease, 1955, 121, pp. 72-87; Ravitz, "Electrocyclic Phenomena"; Ravitz, "Electrodynamic Field Theory."

[101] Edmund Jannino, "Jack the Ripper, 1962 version," International Meeting in Forensic Immunology, Medicine, Pathology and Toxicology, 3rd, London, 1963, Discussion Papers, cited by Katzeff, p. 266.

[102] Katzeff, p. 265.

homicide. No significant relationships were found. Data grouped by apogee and perigee also did not produce any significant relationships. Pokorny then rearranged his data so that the quarters were combined to create one fortnight around full moon and one fortnight around new moon. Once again, no significant relationships were found. Grouping data by race, sex, and fortnights around apogee and perigee also failed to produce any relationship.[103]

Lieber and Sherin theorized that the moon's influence on humans is biological or physical in nature, similar to the moon's gravitational effect on tides. Using homicide rates (representative of "human emotional disturbance") from Dade County, Florida (1956-1970) and Cuyahoga County, Ohio (1958-1970), the researchers expected to find peaks around new and full moons (maximum tidal effect) and also at coincidences of new and/or full moon with lunar perigee (again, a maximum tidal effect). The time of injury (month, day, year, and hour) for each homicide was used as a data base, eliminating cases where the exact date of injury were unknown, and assigning the hour 12:00 noon to cases where the day of injury was known, but not the precise hour. Lieber and Sherin devised a "lunar phase interval scale" based on a time period of 29.53 days (synodic month). The 29.53 day period was then divided into equal time intervals into which the homicide dates (converted into a number of minutes) were placed. It was then determined which intervals represented which moon phases and which dates represented apogee, perigee and coincidences of new/full moon with perigee to within 24

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[103]Alex D. Pokorny, "Moon Phases, Suicide, and Homicide," American Journal of Psychiatry, 1964, vol. 121, pp. 66-67.

hours. Time windows of 24, 48, and 72 hours before and after each phase were also examined.

Homicides in Dade County, Florida significantly peaked at full moon and showed a trough leading up to new moon. Homicides again significantly peaked just after new moon. The study also found a significantly greater number of homicides within the 24 hours before and after full moon, and 48 hours after new moon. When considering apogee and perigee, and coincidences of perigee with new and full moon however, no significant differences were found.

In the Cuyahoga County, Ohio sample, the homicides showed similar clusters as Dade County, except that they were all shifted to the right and did not quite reach significance. Cases approached significance 48 hours after new moon, and 72 hours after full moon. Again, no significant differences were found relative to apogee and perigee.

Lieber and Sherin believed that geographic location (more specifically, distance from the equator) is an important variable and may be responsible for the delay in the Cuyahoga County data. As evidence, the authors cite a study of hamster activities in Evanston, Illinois, by F. A. Brown and Y. H. Park that showed a lunar periodicity strikingly similar to Cuyahoga County. Cuyahoga County and Evanston, Illinois fall on almost the exact same geographical latitude.

Although the quantitative data of apogee and perigee cycles did not support their "Biological Tides" Theory of a lunar influence, Lieber and Sherin suggested that the maximum gravitational forces of perigee and coincidences of perigee with new and full moon produced a qualitative difference in the acts of violence used to carry out each

homicide, in that they seemed more "bizarre" or "ruthless" in nature. The authors also noted at these times that victims may have somewhat provoked the crime by their irrational actions. The authors note that these observations are quite subjective though, and difficult to quantify. Further, Lieber and Sherin cite a study by T. H. Carpenter, R. L. Holle and others that showed a lunar influence on hurricane formations. While the timing of the storm formations was strictly a function of the synodic cycle, apogee and perigee seemed to affect the size of the peaks that occurred in relation with the synodic cycle.[104]

As a result of his 1972 research findings of a ". . . bimodal periodicity of homicide frequency in relation to the lunar synodic cycle, with significant peaks occurring around new and full moon."[105] Arnold Lieber sought to further test his theory of a lunar tidal effect on human behavior (Biological Tides). Lieber hypothesized that if his theory was correct, he ". . . should be able to demonstrate significant clustering of homicides relative to the daily tidal cycle."[106] The homicides in Dade County, Florida during 1969 and 1970 (excluding those where the exact time of injury was unknown) were plotted according to the daily lunar period into which each fell. The results showed that the homicides significantly clustered around upper lunar transits (lunar noon, the moon is highest in the sky) and

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[104]Lieber and Sherin, "Homicides and the Lunar Cycle," pp. 69-74.

[105]Arnold Lieber, "Lunar Effect on Homicides: A Confirmation," International Journal of Chronobiology, 1973, 1(4), p. 338.

[106]Ibid.

lower lunar transits (lunar midnight, the moon is lowest beneath the horizon). Upper and lower lunar transits are times of daily maximum gravitational force. The least number of homicides occurred at moonrise and moonset, times of daily minimum gravitational force.

Lieber concluded that the results of his 1972 and 1973 studies lend credence to a Biological Tides Theory of causation for a lunar influence on human behavior.[107]

Doris Ann Stahl studied selected crimes in two representative New York City police precincts (the 32nd and 110th, each representing contrasting population segments) in relation to the days of new moon, first quarter, full moon and last quarter during 1971 and 1972. Intervening variables of weather (clear, rainy, hazy, and cloudy days) and days of the week to determine what types of weather prevailed for each phase, and if Fridays and Saturdays coincided with higher criminal activity as is widely accepted, were also calculated.

> The crimes of rape and arson did not increase on the days of the full moon as was expected. However, with regard to robberies, assaults and motor vehicle thefts an increase was shown. The days of the week along with the weather for the days under study was evenly distributed and there was no predominance of any special day or climate. . . .[108]
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> . . .
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> The aided and accident cases reported in the 110th precinct were gathered according to the four phases of the moon, and the aided cases were added to the accident cases for each date. The average number of cases for clear days occurring on the first quarter was computed. The same was done for cloudy, rainy, and

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[107] Ibid., p. 339.

[108] Doris Ann Stahl, The Revelance of Hard But Unusual Data Upon Commanding Officers In Their Utilization of Manpower. Thesis for MPA #396, John Jay College of Criminal Justice, 1974, pp. 6-7.

> hazy days occurring on the first quarter. This procedure was repeated for full moon, last quarter, and new moon days. . . . Forty-four aided and accident cases occurred on clear days of the full moon, with thirty-nine cases appearing for clear days of the new moon. It again appears there is a definite increase on the days of the full moon.[109]

Pokorny and Jachimczyk, skeptical of any lunar influence, set out to confirm Lieber's findings by studying homicides over a 14 year period (1957-1970) in Harris County, Texas, which includes Houston. Critical of Lieber's methodology and conclusions, the authors slightly altered the methodology for their study. Instead of using time of injury (as Lieber did), Pokorny and Jachimczyk used time of death, discarding those cases where the hour of death was unknown. The authors utilized Lieber's "lunar phase intervals" and additionally tabulated the homicides by hour of the day and day of the week.

The results of the study showed that the distribution curve of homicides in reference to lunar phase intervals in the Harris County sample were smoother than Lieber's Dade and Cuyahoga County samples. "The distribution of homicide deaths from our sample does not resemble that found in Dade County or Cuyahoga County, either by graphic superimposition or by use of coefficients of correlation."[110]

Pokorny and Jachimczyk's data showed that homicides peaked on Saturday nights, with 53 percent of homicide deaths occurring within the 56 hours from 6:00 p.m. on Friday through 12:00 a.m. on Monday, exactly one third of the week. With regards to hours during the day,

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[109] Ibid., pp. 33-34.

[110] Alex D. Pokorny, and Joseph Jachimczyk, "The Questionable Relationship Between Homicides and the Lunar Cycle," American Journal of Psychiatry, 1974, 131, 7, p. 829.

a peak occurred in the three hours before midnight. Further, 63 percent of the homicide deaths occurred during the hours of 8:00 p.m. and 2:00 a.m., approximately one fourth of the day.[111]

Arnold Lieber responded to, and criticized Pokorny and Jachimczyk's 1974 study and conclusions in a letter to the editor of the American Journal of Psychiatry. Lieber defended the use of time of injury as opposed to time of death because it better measures the occurrence of a violent event.

> . . . Pokorny and Jachimczyk's use of time of death is not justified by their supposition that 85 percent of Houston's homicide victims die within one hour after injury.
>
> A 15 percent error that is always in the same direction (death is always later than injury) would certainly affect the frequency distribution in these data.[112]

To further prove his point, Lieber retested the Cuyahoga County data and over 8,000 New York City homicides using time of death.

> Overall chi-square tests on each sample showed no significant variation among lunar phase intervals from the frequency expected by chance. In other words, when measured according to lunar time, violent injuries show a lunar periodicity, but deaths are distributed randomly throughout the lunar cycle.[113]

Lieber also criticized Pokorny and Jachimczyk's statistical approach, and suggests, in a round-about way, that the authors did not fully understand the statistical measures they used.

An extensive evaluation project of the rape crises network in Spokane, Washington was conducted between 1975 and 1976. One low

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[111] Ibid., pp. 827-829.

[112] Arnold L. Lieber, M.D., "On the Moon Again," (letter to the editor), American Journal of Psychiatry, 1975, 132(6), p. 669.

[113] Ibid.

priority aspect (but of particular interest to project director JoAnn Ray) involved plotting rapes against the lunar phases. Ray divided the lunar phase calendar into eight segments of four days each, then plotted 132 rapes in 1976 against it, finding definite clusters. The highest number of rapes occurred during the period between new moon and first quarter (21). The second highest number (18) occurred during the new moon phase, and the lowest number (11) occurred during the full moon phase. Ray pointed out two obvious limitations of her sub-study of rape: the sample was too small and contained only rapes that had been reported.[114]

Tasso and Miller examined 34,318 criminal offenses in nine different categories over a one year period (1969) in Hamilton County, (Cincinnati) Ohio. The offenses were grouped according to the "full-moon phase" (three days before and after the actual day of the full moon) and the "non-full-moon phase" (all other days of the year). Crimes of rape, robbery and assault, burglary, larceny and theft, auto theft, offenses against family and children, drunkenness, and disorderly conduct occurred significantly more often during the full-moon phase.

> Noteworthy is the finding that offenses against family and children which involve interpersonal relationships resulted in the highest value of chi-square ($x^2$=122.00), whereas auto thefts which are offenses involving material objects resulted in the lowest value of chi-square.[115]

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[114] JoAnn Ray, Rape Crises Network, Spokane Washington, 1975-1976, Year Two Evaluation, 1976, pp. 150-152; See Chapter III for a discussion of crime statistics.

[115] Jodi Tasso and Dlizabeth Miller, "The Effects of the Full Moon on Human Behavior," Journal of Psychology, 1976, 93, p. 83.

Homicide was the only crime category that was not significant during the full-moon phase.[116]

Arnold Lieber conducted a follow-up study of his 1972 and 1973 efforts, this time looking at the relationship between the lunar synodic cycle and five types of aggressive and/or violent human behavior. One aggressive human behavior examined was the crime of aggravated assaults in Dade County, Florida between 1969 and 1973. Aggravated assaults include serious physical injuries to victims by means such as gunshots, stabbings, and wounds caused by blunt instruments. Lieber considered aggravated assaults similar to homicide, except that the victim survived the crime. Data on the type and time of injury (month, day, year, and hour) were gathered. Lieber eliminated from the data cases where the exact hour of injury was unknown. Lieber used the same lunar phase interval method described in his 1972 study. Aggravated assaults were distributed among 30 lunar phase intervals based on their occurrence with the moon phases. Data were subject to time window analysis (similar to the 1972 study) if an overall chi-square test indicated a frequency significantly different from expected values for a particular lunar phase. This procedure results in a clustering of cases around any of the four moon phases.

The results of the study showed a primary nonsignificant peak in aggravated assaults just before new moon and three significant peaks clustering around full moon. When subject to time window

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[116]Ibid., pp. 81-83.

analysis, a statistically significant number of cases clustered around the full moon.

> The periodicity of aggravated assaults plotted against the synodic cycle is remarkably similar to that for suicides. The positive correlation between the frequency distributions of these two behaviors indicates that their frequencies do indeed tend to parallel one another throughout the lunar cycle. These findings suggest that there may be behavioral and/or psychodynamic characteristics common to both aggravated assaults and suicides.[117]

Lieber again noted that the results of such studies are expected to vary from one geographical location (latitude and longitude) to another.[118]

An extensive study of available rape data was conducted in the metropolitan area of Kansas City for the years 1971 and 1975. Among the numerous variables examined were moon phases and days of the week. Dates of rape occurrences were compared to the corresponding phase of the moon and the results showed that no significant relationships were found, as the cases were fairly evenly distributed among each moon phase. The study also found ". . . a somewhat higher incidence on Saturday, with a higher incidence on both Saturday and Sunday in Kansas City, Kansas.[119]

H. S. Feldman and R. G. Jarmon conducted a two-part study which examined the effect of certain environmental variables on criminal behavior in Newark, New Jersey. Part 1 examined 26 variables

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[117] Arnold L. Lieber, "Human Aggression," p. 390.

[118] Ibid., pp. 385-392.

[119] Dr. Constance Osgood, Julie Edgerton, Linda Phelps, et al., Ecology of Rape, Kansas City Metropolitan Area (Summary Report of the Rape Data Bank), Prepared by Institute for Community Studies for Metropolitan Organization to Counter Sexual Assault, March 1978, p. 13.

which included day of the week, total crimes reported for each day, homicides, assaults, welfare and social security checks reception days, moon phases, various air pollutants and weather (temperature, dew point, precipitation, and barometric pressure) from June 1971 through May 1972. The authors ran an correlation matrix where ". . . if two factors had a correlation coefficient of 0.11 there would be a 95% chance that the two variables were related. Two variables with a coefficient of 0.14 would have a 99% chance."[120] Of interest to this study was the finding that precipitation showed a high inverse correlation with total crimes and with assaults.

Part 2 of the study addressed homicide rates over a 15 year period in Newark as compared to the following five moon phases: full moon; the first, second, and third days after the full moon; and new moon. The authors found that homicides showed a slight increase during the first full day following a full moon.

A few of the other findings of the Feldman and Jarmon study were:

1. Homicides and assaults were up on weekends (highest on Saturdays) and ebbed on Tuesdays and Wednesdays.
2. Total crimes are actually lower on Saturdays than the daily average (223 versus 240), yet assaults and homicides are up by more than 50% (9.3 versus 6.3, and 0.68 versus 0.40).
3. Total crimes, homicides, and assaults showed a questionable increase on the third day following the full moon.

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[120] Feldman and Jarmon, p. 235.

4. Assault rates were up 19% over the monthly average in days of the full moon (7.5 versus 6.3) for the period 1 January 1971 through 31 May 1972 (approximately 3000 assaults tabulated).121

Philip P. Purpura set out to determine if any relationship existed between lunar phases and police activity (types and amounts of calls for police service). He studied activity in three medium sized police agencies in South Carolina between 1975 and 1976. Various methods of recording police statistics required that each agency be studied from different types of records. Purpura looked at dispatcher logs, deputy incident reports, and weekly summary reports of officer incident reports.

Purpura defined a "full moon time span" (FMTS) as the day of the week in which the full moon occurred (for example, Saturday) and the overlapping of shifts from the day before and the day after the full moon day (Friday and Sunday). This FMTS was compared to a "non-full moon time span" (NFMTS), which comprised the other three non-full moon Saturdays of the month, including the overlapping shifts of Friday and Sunday. Purpura tabulated his data by first adding up the number of months when a specific type of call for police service was greater during either time span. Domestics, robberies, and breaking and enterings were three crimes where the FMTS months outnumbered the NFMTS months.

Purpura next examined the average number of calls for police service per month during FMTS and NFMTS. For domestics, assaults, disorderly conduct, fights, drunks, robberies, breaking and enterings, larcenies, and shoplifting, no significant differences were found.

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[121] Ibid., pp. 236, 238.

However, domestics, robberies and breaking and enterings were again found to be slightly higher in numbers during FMTS in this data tabulation. Breaking and enterings showed the biggest difference in the average number of calls for police service per month with 3.05 occurring during the FMTS and 2.56 during the NFMTS. One of Purpura's conclusions was that moonlight may provide enough dim light to perpetrate crimes such as breaking and enterings, and suggested that the studying of weather conditions with full moons, more specifically, full moons on clear nights, may reveal higher crime rates.[122]

## Moon Madness as a Defense in Criminal Trials

The lunar effect is known to have been used as a successful defense in criminal court on at least three different occasions. Herman Heppel in 1938 (Brooklyn, New York) was charged with stealing an auto and crashing it into a bus, and several related traffic offenses in an attempt to avoid arrest. Although Heppel was found to be sane, County Court Judge William O'Dwyer allowed him to plead guilty to petty larceny based on testimony that he suffered mentally when the moon was full.[123]

Charles Hyde in 1953 (Cornwall, England) was charged with breaking into a home. Hyde's barrister argued in his defense that the full moon had caused his criminal actions. The court accepted the moon defense and Hyde was placed on probation. One year later, Hyde

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[122] Ibid., pp. 350-353; The idea for this study's methodology cam from Purpura's suggestion.

[123] Timmins, cited by Katzeff, p. 175.

left England (just before full moon) breaking his probation, and was placed on probation a second time. A short time later, Hyde was arrested for breaking into his brother-in-law's home (the night after new moon) and was sentenced to eighteen months in prison.[124]

In 1963 a Birmingham, England court found Alan Dennis Witcomb guilty of murder, but also declared him insane based on his sister's testimony that Witcomb often made statements that the moon did "strange things" to him.[125]

## Summary and Discussion

This chapter reviewed the pertinent literature by dividing it into several sections, the first of which discussed the topic of the moon in myth and various cultural settings. Subsequent sections addressed the moon's effect on the Earth, man's biological clocks, detailed explanations of causal theories, and a comprehensive review of the literature pertaining specifically to the moon's influence on criminal behavior.

Scientific research has shown that the moon and sun affect the Earth's waters, land, and atmosphere through gravitational pull. Maximum gravitational pull occurs when the sun and moon align with the Earth (full and new moon), and when the moon reaches perigee (is nearest to the Earth).

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[124]John Cottrell, "Moon Madness: Does It Really Exist?" Science Digest, October, 1969, cited by Katzeff, p. xi.

[125]Ibid., p. 175.

Meticulous studies have revealed that humans have interior timing systems, or "biological clocks," that seem to cycle in harmony with lunar time periods (lunar day, 24 hours 50 minutes; lunar sideral month, 27 days 7 hours; lunar synodic month, 29 days 12 hours) as opposed to solar time periods.

Five causal theories for explaining a lunar influence over human behavior were identified: Biological Tides, Positive Ions, Psycho-Social, Moonlight, and Remnants of Tidal Rhythms.

A Biological Tides approach reasoned that the human body and its fluids respond to the moon's gravitational forces, similar to the earth's waters, lands, and atmosphere. The resulting physiological changes cause the abnormal human behavior. Weaknesses of this approach came from the studies that found peaks in the studied behavior at full moon, but not at new moon (a similar period of maximum gravitational pull).

A second proposed causal theory held that accumulations of positive and negative ions in the air affect human emotions by altering the body's physiology. Under this approach, the full moon is believed to increase the amount of positive ions in the air via reflected sunlight.

Psycho-Social theorists showed how the human mind (psychology) affects the body's physiology. Because of the abundant amount of moon folklore, legend, and superstition, and the knowledge of the different ways in which the mind can influence the body, it is believed that the mere knowledge of a full moon can trigger people into abnormal behavior. A Psycho-Social theory was unable, however, to account for data peaks at new moon (no moonlight). Further, much

of the historic moon folklore has been discovered to have a scientific basis.

The Moonlight causal theory tried to provide an explanation as to why some studies found peaks in the studied behavior at full moon, but not at new moon (both phases of maximum gravitational pull). There were two ways moonlight was shown to affect human behavior in general, and criminal behavior in particular. One was from a biological standpoint, while the other was from an illumination standpoint.

A number of studies were able to show that the moon's light (reflected sunlight, as opposed to gravity) regulated plants', animals', and humans' physiological activities. Moonlight theorists reasoned that if moonlight causes physiological changes in humans, it is possible that these physiological changes affect human behavior, similar to Biological Tide and Positive Ion theories.

The light of a full moon may also impact on criminal behavior in particular, based on some security night lighting research which reasoned that dim light (similar to moonlight) may provide a person the opportunity to perpetrate a crime.

Moonlight theories in general were unable to account for peaks in the studied behavior at new moon, when the dark side of the moon faces the Earth.

A fifth causal theory proposed that memories of tidal rhythms (as opposed to tides within the body) influence ones behavior.

Searching for a causal theory of the moon's effect is similar to searching for causal theories as to what causes crime, what motivates human behavior, or what causes mental illness. There is

little consensus whether such things are results of biological, psychological, or sociological mishaps. Perhaps, more accurately, it is a combination of a number of factors. Certainly it is difficult to isolate such factors since they occur simultaneously, each impacting on the other. For example, there exists a relationship between physical (biological) addiction to narcotics, alcohol, and cigarette smoking and a psychological dependency (addiction) to the same. One may also ask if the mind influences (affects) the body (psycho-social theory), or the body influences (affects) the mind (biological theories), or both? Psychiatrists acknowledge the body/mind relationship by prescribing drugs that alter moods and behavior in their "treatments," while medical doctors acknowledge that the patient's mental attitudes can slow or speed recovery, and may mean the difference between life and death.

Twelve studies were reviewed which attempted to link lunar phases with criminal behavior. Six studies found positive correlations between the two.[126] Five studies found no correlations, or at best, questionable ones.[127] One study's results were divided depending on how the data were grouped.[128]

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[126]Lieber and Sherin, "Homicides and the Lunar Cycle"; Lieber, "Lunar Effect on Homicides"; Stahl; Lieber, "On the Moon Again"; Tasso and Miller; Lieber, "Human Aggression."

[127]Pokorny, "Moon Phases, Suicide, and Homicide"; Pokorny and Jachimczyk, "The Questionable Relationship"; Ray; Osgood, Edgerton, and Phelps; Purpura.

[128]Feldman and Jarmon

Because of the wide range of differing methodologies and differing definitions of key terms, several questions arise when attempting to compare lunar research studies:

1. Can studies with dissimilar methodologies be compared?
2. Which methodology should be used (i.e., How do we best measure a lunar influence?)?
3. How well can intervening variables be controlled or isolated, for example, weather, seasons, day of the week, citizen crime areas, high crime areas, social makeup of population areas, and police presence/absence?
4. How much do these intervening variables contribute to or taint lunar research?

According to Lieber, "The validity of any scientific study depends on the accuracy and appropriateness of 1) the variable being measured and 2) the tools used in the measurement."[129]

Methodologies for lunar research are ultimately based on a particular causal theory. For example, Arnold Lieber, who coined the term "biological tides," utilizes a methodology that considers all moon phases, every day of the year and every hour of the day, adjusted to lunar time. This method allows a clustering of data around the moon phases, results showing peaks "just before" and/or "just after" the exact date of the particular moon phase, and explanations such as "lag time" and "geographic location." Other causal theories (Positive Ions, Psycho-Social, and Moonlight) may utilize different methodologies because they are particularly interested in moonlight. While new and full moon phases are similar under a Biological Tide Theory (increased gravitational influence), they are opposites in

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[129]Lieber, "On the Moon Again," p. 669.

theories studying moonlight (full moon, moonlight present; new moon, moonlight not present).

The present study is interested in the full moon's (moonlight) influence on selected criminal behavior and calls for police service, but is not dependent on any particular causal theory.

# CHAPTER III

## DESIGN OF THE STUDY

Designing a methodology to study lunar influence on criminal behavior depends upon the particular causal theory adhered to as discussed in Chapter II. A review of past research also reveals that differing methodologies have been constructed based upon the same causal theory. This study attempted to show that moonlight affects criminal behavior and calls for police service in Youngstown, Ohio at night. The following methodology is compatible with Positive Ion, Moonlight, and Psycho-Social causal theories.

### Sample

A lunar influence on humans should be reflected, to a certain extent, in the occurrence of criminal behavior, as measured by crime statistics. The criminal behavior under consideration for the study was drawn from the records of written reports maintained by the Youngstown[130] (Ohio) Police Department during the years 1981, 1982, and 1983. The following crime categories were selected for study: crimes against persons (homicides, misdemeanor and felony assaults)

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[130]Youngstown, Ohio: Latitude N. 41° 16' Longitude W. 80° 40'.

and crimes against property (burglary/breaking and entering, auto thefts, robbery[131]).

In considering the above crime categories, the following variables were not considered:

1. Whether or not an arrest was made.
2. Whether or not the original crime reported was reduced or dropped, either through the detective division, the prosecutor's office, through plea bargaining, or by the victim refusing to prosecute (testify).
3. Whether or not a conviction was obtained.
4. Whether or not the case was solved, cleared, closed, pending, or unfounded.

Such variables (except for the call being unfounded) do not change the fact that a crime incident occurred and the police were notified.

## Reliability of Crime Statistics

It has been argued that the official means of counting crime does not reflect an accurate picture of the reality of the situation. Consider the following problems with official crime statistics:

1. The definition and elements of a crime may vary from jurisdiction to jurisdiction.
2. Victims of crime may choose, for one reason or another, not to report the crime to the police.

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[131]The FBI Uniform Crime Reporting (UCR) System classifies robbery as a crime against property. It should be noted however, that many criminal justice practitioners believe robbery should be classified as a crime against person. Although robbery involves a theft offense of property, it also contains the element of force or threat of force against a person. It is also noted that the UCR system was developed in 1939 and is the nation's official crime statistics gathering system.

3. Victims may wait several hours, days, or weeks before reporting the crime, resulting in the report being filed on the date reported, not the date occurred.

4. Complaints of crime to the police may be subject to errors that result from the complainants mistakes and/or lies.

5. The police can use their discretion and not make an official report so that the crime incident is not counted.

6. Police may report a more or less serious offense depending on the elements necessary for the offense. For example, the stealing of a lawnmower from a garage may be reported as either a theft offense, or a breaking and entering.

7. Sometimes a single occurrence may consist of an offender(s) violating several laws affecting more than one victim. For example, a person may rob a grocery store, rob five of the customers who happen to be inside the store, shoot the responding police officer, then steal the car of a citizen who is driving down the street to make his getaway. There are differing opinions and policies as to how many crimes to count and how many charges to file against the offender(s).

8. The police may allow their informants to commit some crime (or be free from arrest and/or prosecution) in exchange for information against more serious offenders.

Alternate crime counting methods such as counts made through direct observation, private policing, unobtrusive (indirect) measures, surveys of victims, and self-reports, although not without their problems and limitations, have attempted to fill some of the gaps created by official statistics.

> With some discrepancies, these optional study methods do not drastically revise official tallies. Some of these observations open our eyes to new forms of criminal enterprise, but they do not change markedly the maps of criminal conduct from official data.
>
> A fair conclusion to be drawn from a comparison of different measures of crime is that, where the unofficial tallies of crime disagree with the official statistics, no one knows which is the more valid. On the other hand, where the official and unofficial

> tabulations agree, one is more confident of the facts with which explanations of criminality are built.[132]

One noteable discrepancy between official statistics and unofficial tallies occurs in National Crime Victimization studies. A fair conclusion drawn from numerous victimization studies across the country is that ". . . for all crimes, about twice as many offenses are committed as are reported to the police."[133] This, along with other evidence, suggests that there is much more crime occurring in our society than those entered into the official statistics books. This factor will undoubtedly influence this study and other studies' findings. However, it is unknown in what direction the crime that never makes the official statistics would take; that is, support the hypotheses or not.

The total number of calls for police service (police activity log) was examined for three reasons. First, it takes into consideration the large numbers of calls for police service that are handled without the making of an arrest or the writing of a formal police report (i.e., police discretion). During busy periods police may tend to write fewer reports, preferring to handle calls more informally. Second, it may be a gauge for lunar influences more subtle in nature (i.e., irritability, and bad moods). Third, the log of total calls for police service may help fill some of the gap created by the limitations of crime statistics as previously discussed.

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[132] Gwynn Nettler, Explaining Crime (New York: McGraw-Hill Book Company, 1984), p. 50.

[133] Ibid., p. 71.

The number of calls for police service was gathered from logs maintained by the police department, which reflects incidents such as fights, all disturbances of the peace, domestic disputes, all reports and investigations (including crime categories not selected for this study), various juvenile problems, various non-criminal complaints, and calls initiated by officers, as in the stopping of an automobile for a traffic violation.[134]

## Measures or Instrumentation

### Full Moon versus New Moon

The full and new moons are similar in that they are both phases of maximum gravitational pull. At the same time they are opposites in that the full moon reflects sunlight back to the Earth at night, while during new moon the night sky is empty and dark because the moon is "in the sky" during daylight hours with its dark side facing the Earth (i.e., no reflected sunlight). The methodology isolates moonlight as a variable by comparing full moon night crime and calls for police service with new moon night crime and calls for police service.

"Night" is referred to in the study as the time period between sunset and sunrise, which is roughly the same time that the full moon rises and sets.[135] The exact times of sunset and sunrise (adjusted

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[134] See Appendix A for yearly total of crimes committed in the selected categories.

[135] On some dates the moon may rise an hour or so prior to sunset. The sun may also rise before the moon has set. Because this study is most interested in nighttime, and in order to be consistent, the time between sunset and sunrise was utilized.

for Daylight Savings Time when necessary) in Youngstown was obtained from the National Weather Service located at the Youngstown Municipal Airport.

The exact dates of each full and new moon for the years 1981, 1982, and 1983 were obtained from two astronomy handbooks.[136] There is roughly one full moon and one new moon per month. A part of the date before and after the date of the full moon (and new moon) will be examined for the following reasons:

1. By strict definition, the moon is only "full" (when the Earth, the sun, and the moon are exactly aligned) for a matter of minutes because of the non-stop revolution and rotation of both bodies. For our position on Earth, the exact "full" moon position may actually occur during our daylight period when the moon is on the opposite side of the Earth and not visible to us. However, when nighttime arrives and the moon rises on our side of the Earth, it appears totally full, even though it has already slowly begun to decrease in size (i.e, the amount of sunlight reflected).[137]

2. The moon appears to be full to the lay observer on the date before and after the date of the full moon, even though it technically is not.

3. When looking at night time periods (between sunset and sunrise), a change of calandar date occurs after the midnight hour.

4. Since full and new moons fall on different days of the week from month to month, including part of the day before and the day after helps satisfy randomness of the days of the week.

Charts were prepared to record data in the following manner:

July 5, 1982 time of sunset to July 6, 1982 time of sunrise.
July 6, 1982 time of sunset to July 7, 1982 time of sunrise.

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[136] The Astronomical Almanac for the Year 1981, (Washington, D.C.: U.S. Government Printing Office); Roy L. Bishop, ed., The Observers Handbook, (Canada: University of Toronto Press), 1982, 1983.

[137] See Katzeff, p. 291, footnote 25 for further discussion.

In the above example, July 6 is the date of the full or new moon. Although three calendar dates were used (July 5, 6, 7) only "night" crime (between sunset and sunrise) was counted. Since the entire 72 hour time span is not counted in the crime tabulation, terminology such as "three-day period" or "three-date period" is not used. Instead the term "night cycle" is used to describe the time periods under consideration, which takes into account the change of date after midnight. Using the same dates as the previous example, July 5 sunset to July 6 sunrise would equal one night cycle. July 6 sunset to July 7 sunrise would again equal one night cycle. Therefore, two "night cycles" will be examined for each full and new moon that occurred in 1981, 1982, and 1983.[138]

## Cloudy Full Moon versus Clear Full Moon

Cloudy and clear weather data were obtained to further examine the issue of light. On a cloudy night the amount of moonlight is either substantially reduced or totally eliminated. If moonlight does have an effect on human behavior, one would expect cloudiness to have an impact on such effects.

Cloudy and clear data were obtained from the National Weather Service (located at the Youngstown Municipal Airport). Meteorologists

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[138]Two night cycles (as opposed to three--one night before and one night after the night of the new/full moon) is utilized because almanacs, calendars and astronomy books list a single date as the time occurrence of a lunar phase. A two night period can be thought of as an even division on each side of the calendar date of the new/full moon as follows: July 5--night before the full moon date (sunset to midnight); July 6--full moon date; July 7--morning after the full moon date (midnight to sunrise); See Appendix B.

make cloud cover readings every hour by visual observation of the sky and record the readings in tenths based upon the following two scales: (1) Aviation Scale: Clear=0; Scattered=1/10 to 5/10; Broken=6/10 to 9/10 (interrupted glimpses of the moon); Overcast=10/10 (not likely to see the moon). (2) Climatology Scale: Clear=0 to 3/10; Partly Cloudy=4/10 to 7/10; Cloudy=8/10 to 10/10. The study used the following scale, derived by combining the aviation and climatology scales: Clear=0 to 5/10; Cloudy=6/10 to 10/10.

Night cycle periods were divided into cloudy and clear depending on the majority reading for the night and/or obvious patterns of cloudiness and clearness. There were some hours in 1981 during the months of May, June, July, and August when no cloud cover readings were made because of staffing problems. The crime occurring during these times will not be considered when comparing clear full moon nights with cloudy full moon nights. The crime during these periods will, however, be considered when comparing full moon with new moon and when considering the intervening variable of days of the week.[139]

The following procedure was used to measure the amount of crime during cloudy and clear periods: If both cycle time periods were completely cloudy, then "cloudy" received one "unit." If both night cycle time periods were completely clear, then "clear" received one "unit." If the night cycles were divided so that part of the cycle was clear and part of the cycle was cloudy, "cloudy" and "clear" were

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[139]See Appendix C for sample cloud cover readings.

credited with ½ unit each, since the actual breakdown of hours showed them almost equally divided.[140]

Cloudy time periods far outnumbered clear time periods as follows: 21½ units for cloudy; 11½ units for clear. To compare crime during cloudy and clear periods, the total number of crimes (and calls for police service) during the cloudy unit periods was added, then divided by the total number of units (21½). The same procedure was then used for clear, using 11½ units. Thus, the number arrived at will be the average number of crimes (calls for police service) per unit period.

### Full Moon versus New Moon by Days of the Week

The study also considered the days of the week during full and new moon as an intervening variable to determining if any particular weekday or weekend combination influenced the selected crime categories or calls for police service when comparing each lunar phase. The following weekday combinations were examined: Sunday/Tuesday night; Tuesday/Wednesday night; Wednesday/Thursday night. A weekend was defined as a Friday/Saturday night cycle. For example:

> Fri. Aug. 14 sunset to Sat. Aug. 15 sunrise would equal Fri. night.
> Sat. Aug. 15 sunset to Sun. Aug. 16 sunrise would equal Sat. night.

Friday night will include the a.m. hours of Saturday morning (i.e., after midnight), and Saturday night will include the a.m. hours of Sunday morning. Weekday combinations were similarly computed. The

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[140] Total number of two-night cycles during full moon=37; Completely cloudy=16; Completely clear=6; Part cloudy, part clear=11; Evenly divided, i.e., equal number of hours for cloudy and clear=9.

total number of crimes and calls for police service during each combination was divided by the actual number of two-night cycles,[141] thus arriving at the average number of night crimes for each two-night combination.

## Statistical Hypotheses

The research hypothesis stated in Chapter I was evaluated based on acceptance or rejection of the following null hypotheses:

1. There is no significant difference in the amount of crime in the selected categories and calls for police service during full moon nights (moonlight present) and new moon nights (no moonlight).
2. There is no significant difference between the amount of crime in the selected categories and calls for police service during clear full moon nights (moonlight present) and cloudy full moon nights (no moonlight or reduced moonlight).
3. There is no significant difference between the amount of crime in the selected categories and calls for police service during full moon nights and new moon nights when compared using various weekday combinations.

## Analysis

Charts were prepared to record crime data against the variables (full moon/new moon; cloudy full moon/clear full moon; full moon/new moon by days of the week) and the differing time elements (i.e., sunset/sunrise; changes in cloud cover). A crime incident was counted if the reported occurrence time fell within the considered

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[141] The actual number of two-night cycles for each combination was as follows: Full Moon: Fri/Sat=4; Sun/Mon=5; Mon/Tue=6; Tue/Wed=5; Wed/Thur=5. New Moon: Fri/Sat=4; Sun/Mon=7; Mon/Tue=5; Tue/Wed=6; Wed/Thur=5. Thur/Fri and Sat/Sun combinations were not considered since each contain half a weekend day. Such combinations totaled 12 in full moon and 10 in new moon.

date/time period; the reported discovery time fell within the considered date/time period; and for property crimes, if the time of potential occurrence fell closely within the considered date/time period.[142]

The chi-square nominal-level test of significance for "k" independent samples was used to accept or reject the three aforementioned null hypotheses. Appendix D contains the sampling distribution chart for chi-square that was consulted. A .05 level of significance was necessary to reject each null hypothesis. The .05 level was chosen as a matter of convention and because it is frequently used in social research. Finally, a one-tailed critical region test was used, and a coefficient of contingency measure of association plus Guttman's coefficient of predictability, lambda, was computed if the resulting chi-square discrepancy was significant (that is, the observations differed from what would ordinarily be expected by chance at the .05 level of significance).[143]

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[142]Unless the property crime was reported to the police as a crime in progress either by a witness or an alarm company (recorded in reports as time occurred), the exact time of occurrence would be unknown, which is why the time of potential occurrence was used. This became less of a problem when considering crimes against persons, since victims can usually relate the approximate time of the incident. There was no problem when examining calls for police service since department complaint cards are mechanically stamped by a time clock when the complaint is received.

[143]The following Statistics Text was refered to: Dean J. Champion, Basic Statistics for Social Research, (Scranton, Pennsylvania: Chandler Publishing Company, 1970).

## General Delimitations

Because the methodology was designed to examine moonlight, as opposed to gravity, as a variable, first quarter and last quarter moon phases were not considered. The study focused narrowly on the issue of moonlight versus no moonlight by looking at the exact date of the full moon and new moon, along with part of the day before and after. Full moon and new moon are the extremes of the light issue and as calendar days are added before and after the exact date of the full and new moon the light is decreasing (full moon) and increasing (new moon), until the moonlight is equal in first quarter and last quarter. Finally, it would be meaningless to compare the results of this study to crime totals for the entire year because the study does not consider the entire full and new phases (each phase lasting about one week) and daylight incidents of crime.

## Summary

A lunar influence on humans should be reflected, to a certain extent, in the occurrence of criminal behavior, as measured by crime statistics. The methodology described in Chapter III was selected to determine whether moonlight was somehow associated with criminal behavior and calls for police service in Youngstown, Ohio at night. This was accomplished by comparing the amount of crime in the selected crime categories (crimes against persons/crimes against property) and calls for police service during full moon (moonlight present) with the amount of crime in the selected crime categories and calls for police service during new moon (no moonlight). Since the

full moon roughly rises when the sun sets, and sets when the sun rises, the study is only concerned with night crime. Further examination of the moonlight issue will be accomplished by distinguishing between clear and full moon nights (moonlight present) and cloudy full moon nights (no moonlight or reduced moonlight). The study considers the days of the week during full and new moon as an intervening variable to determine if any particular weekday or weekend combination influences the selected crime categories or calls for police service when compared with each lunar phase. The methodology was designed to focus narrowly on moonlight (versus no moonlight) as opposed to gravity and does not consider the lunar phases of first quarter and last quarter. The chi-square nominal-level test of significance will be used to accept or reject each null hypothesis. A .05 level of significance will be necessary to reject each null hypothesis. A one-tailed critical region test will be used, and a coefficient of contingency measure of association plus Guttman's coefficient of predictability, lambda will be computed if the resulting chi-square discrepancy is significant.

# CHAPTER IV

## ANALYSIS OF RESULTS

The individual crime categories selected for study were combined into crimes against property and crimes against persons in order to achieve larger frequencies, which are necessary to make the chi-square statistic more accurate and meaningful.[144]

### Null Hypothesis #1

There is no significant difference in the amount of crime in the selected categories and calls for police service during full moon nights (moonlight present) and new moon nights (no moonlight).

### Findings

Crimes against property numbered 571 during full moon nights and 603 during new moon nights. Crimes against persons numbered 140 during full moon nights and 120 during new moon nights. Calls for police service numbered 7067 during full moon nights and 6854 during new moon nights. Based on these data, a 2 x 3 table (See Table 1) was generated and chi-square calculated (See Appendix F). Since the chi-square value obtained (3.03) was less than the critical value of the chi-square chart (4.60), it was concluded that the observed difference in the amount of crime and calls for police service during full moon nights and new moon nights was not

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[144] See Appendix E for individual crime category breakdowns.

TABLE 1

FULL MOON VERSUS NEW MOON

TOTAL NIGHT INCIDENTS 1981, 1982, AND 1983

| | FULL MOON | NEW MOON | TOTAL |
|---|---|---|---|
| CRIMES AGAINST PROPERTY | 571 (594.7) | 603 (579.3) | 1174 |
| CRIMES AGAINST PERSONS | 140 (131.7) | 120 (128.3) | 260 |
| CALLS FOR POLICE SERVICE | 7069 (7051.6) | 6854 (6869.4) | 13,921 |
| TOTAL | 7778 | 7577 | 15,355 |

Expected frequencies shown in parentheses

significant at the .05 level of significance. The data, therefore, failed to support a rejection of null hypothesis #1.

## Null Hypothesis #2

There is no significant difference between the amount of crime in the selected categories and calls for police service during clear full moon nights (moonlight present) and cloudy full moon nights (no moonlight or reduced moonlight).

### Findings

Crimes against property averaged 17.5 on cloudy full moon nights and 12.5 on clear full moon nights. Crimes against persons averaged 4.3 on cloudy full moon nights and 2.9 on clear full moon nights. Calls for police service averaged 196 on cloudy full moon nights and 185.8 on clear full moon nights. Based on these data, a 2 x 3 table (See Table 2) was generated and chi-square calculated (See Appendix G). Since the chi-square value obtained (0.74) was less than the critical value of the chi-square chart (4.60), it was concluded that the observed difference in the amount of crime and calls for police service during cloudy full moon nights and clear full moon nights was not significant at the .05 level of significance. Thus, null hypothesis #2 was unable to be rejected.

## Null Hypothesis #3

There is no significant difference between the amount of crime in the selected categories and calls for police service during full moon nights and new moon nights when compared using various weekday combinations.

TABLE 2

CLOUDY FULL MOON VERSUS CLEAR FULL MOON

AVERAGE NUMBER OF FULL MOON NIGHT INCIDENTS
PER UNIT PERIOD 1981, 1982 AND 1983

| | CLOUDY FULL MOON | CLEAR FULL MOON | TOTAL |
|---|---|---|---|
| CRIMES AGAINST PROPERTY | 17.5 (15.6) | 12.5 (14.4) | 30 |
| CRIMES AGAINST PERSONS | 4.3 (3.7) | 2.9 (3.5) | 7.2 |
| CALLS FOR POLICE SERVICE | 196 (198.5) | 185.5 (183.3) | 381.8 |
| TOTAL | 217.8 | 201.2 | 419 |

Expected frequencies shown in parentheses

## Findings

Three 2 x 5 tables (See Table 3) were constructed and chi-square was calculated (See Appendix H) for comparing full and new moon night incidents using various weekday combinations.

In the crimes against property category, the chi-square value obtained (0.12) was less than the critical value of the chi-square chart (7.77). Therefore, it was concluded that, when compared against various weekday combinations, the observed difference in the amount of property crimes during full moon nights and new moon nights was not significant at the .05 level of significance.

In the calls for police service category, the chi-square value obtained (5.04) was less than the critical value of the chi-square chart (7.77). It was concluded that, when compared against various weekday combinations, the observed difference in the amount of calls for police service during full moon nights and new moon nights was not significant at the .05 level of significance.

Chi-square for crimes against persons could not meaningfully be calculated since eight out of the ten cells' expected frequencies were under five. ". . . The smaller one sample, the more distorted the $x^2$ value is likely to be. Distortion is introduced when any expected frequency is less than 5".[145] "When the expected frequency in any cell in a table is less than 5, the resulting $x^2$ value becomes an overestimate of the probability that the observed frequencies are significantly different from chance.[146]

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[145] Champion, p. 136.

[146] Ibid., p. 155.

TABLE 3

FULL MOON VERSUS NEW MOON BY DAYS OF THE WEEK

AVERAGE NUMBER OF NIGHT INCIDENTS FOR WEEKEND AND NON-WEEKEND COMBINATIONS, 1981, 1982, AND 1983

| | | FRI/SAT | SUN/MON | MON/TUE | TUE/WED | WED/THUR | TOTAL |
|---|---|---|---|---|---|---|---|
| FULL MOON | PROPERTY CRIMES | 13.5 (13.3) | 14.8 (14.6) | 16.5 (16.2) | 16.6 (16.4) | 14 (14.9) | 75.4 |
| | PERSONS CRIMES | 5 (5.3) | 1.6 (2.2) | 3.7 (3.3) | 4.8 (4) | 3.8 (4.1) | 18.9 |
| | SERVICE CALLS | 240.5 (222) | 168 (167.1) | 186.8 (188.7) | 178.8 (184.9) | 174.6 (186) | 948.7 |
| NEW MOON | PROPERTY CRIMES | 14.3 (14.5) | 15.7 (15.9) | 17.2 (17.5) | 17.5 (17.7) | 17 (16.1) | 81.7 |
| | PERSONS CRIMES | 5.5 (5.2) | 2.7 (2.1) | 2.8 (3.2) | 3 (3.8) | 4.2 (3.9) | 18.2 |
| | SERVICE CALLS | 194 (212.5) | 159 (159.9) | 182.6 (180.7) | 183 (176.9) | 189.4 (178) | 908 |
| TOTAL | PROPERTY CRIMES | 27.8 | 30.5 | 33.7 | 34.1 | 31 | 157.1 |
| | PERSONS CRIMES | 10.5 | 4.3 | 6.5 | 7.8 | 8 | 37.1 |
| | SERVICE CALLS | 434.5 | 327 | 369.4 | 361.8 | 364 | 1856.7 |

Expected frequencies shown in parentheses

The data were manipulated to include crimes against persons in the chi-square calculations by combining all night incidents (i.e., crimes against property, crimes against persons, and calls for police service) during full and new moons and comparing the totals using the weekday combinations (See Table 4). Chi-square was then calculated for the combined night incidents (See Appendix I). Since the chi-square value obtained (4.78) was less than the critical value of the chi-square chart (7.77), it was concluded that, when compared against various weekday combinations, the observed difference in the amount of the combined night incidents during full moon and new moon was not significant at the .05 level of significance.

Based on the three aforementioned chi-square calculations, the data did not support a rejection of null hypothesis #3.

## Discussion

### Full Moon vs New Moon (Hypothesis #1)

The data comparing full moon with new moon revealed crimes against property as the only category where new moon night incidents outnumber full moon night incidents. Although not a significant difference, the finding that crimes against persons were higher during full moon paralleled Tasso and Miller's 1976 study results that showed some ten different crime classifications occurred significantly more often during the full moon phase.[147]

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[147] Tasso and Miller defined a "full moon phase" as three days before and after the actual day of the full moon. All other days of the year were labeled the "non-full moon phase."

TABLE 4

FULL MOON VERSUS NEW MOON BY DAYS OF THE WEEK

COMBINED NIGHT INCIDENTS (PROPERTY CRIMES/ PERSONS CRIMES/SERVICE CALLS)
FOR 1981, 1982, AND 1983

| | FRI/SAT | SUN/MON | MON/TUE | TUE/WED | WED/THUR | TOTAL |
|---|---|---|---|---|---|---|
| FULL MOON | 259 | 184.4 | 207 | 200.2 | 192.4 | 1043 |
| | (240.4) | (184) | (208.3) | (205.3) | (205) | |
| NEW MOON | 213.8 | 177.4 | 202.6 | 203.5 | 210.6 | 1007.9 |
| | (232.4) | (177.8) | (201.3) | (198.4) | (198) | |
| TOTAL | 472.8 | 361.8 | 409.6 | 403.7 | 403 | 2050.9 |

Expected frequencies shown in parentheses

> Noteworthy is the finding that offenses against family and children which involve interpersonal relationships resulted in the highest value of chi-square ($x^2$=122.00), whereas auto thefts which are offenses involving material objects resulted in the lowest value of chi-square.[148]

Further, the number of calls for police service showed the biggest difference between full moon (7067) and new moon (6854).

Two possible explanations exist for the observed increase of full moon incidents (although not significant) in moving from crimes against property to crimes against persons to calls for police service. The first explanation involves the mathematical law of large numbers, that is, increasing the sample size causes the sampling distribution to tend toward the normal.[149] The problem with this explanation when applied to the present study, however, is that the total number of crimes against property (1174) far outnumber the total number of crimes against persons (260). As an alternate explanation the researcher suggests that the number of calls for police service statistic serves as law enforcement's best measure of "weird" or "strange" behavior. Perhaps calls for police service is an appropriate gauge for lunar influences more subtle in nature (i.e., irritability, and bad moods) as the calls for police service statistic reflects the numerous non-criminal complaints that police officers handle daily. Besides, Youngstown police logs contain all of the crime incidents that have been written into reports, plus all other calls handled informally without the writing of a report even though

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[148]Tasso and Miller, p. 83.

[149]Champion, p. 89.

a technical violation of the law may have occurred (which reflects the use of police discretion).

One disadvantage of the number of calls for police service in Youngstown evolves from the manner in which the statistic is gathered. A complaint card must be filled out by the desk personnel and a cruiser or police officer must be assigned to investigate the complaint in order for a call for police service to receive a "number" for statistical purposes. Complaints that are handled over the phone or determined (for whatever reason) not worthy of further police intervention are not included in the statistic. The researcher believes that an additional statistic worthy of evaluation would be the total number of phone calls received during various time periods, which would accurately reflect the number of "weird" or "strange" people who often call the police department for service.

## Clear Full Moon vs Cloudy Full Moon (Hypothesis #2)

The results obtained when comparing clear full moon nights with cloudy full moon nights fail to support the research hypothesis that moonlight influences crime. Cloudy full moon night incidents outnumber clear full moon night incidents in every category (crimes against property, crimes against persons, and calls for police service). It must be noted that when calculating the chi-square statistic for cloudy and clear data, two cells have expected frequencies that are less than five. Champion suggests using Fisher's exact test for a 2 x 3 table when <u>any</u> expected cell frequency is less than five. However, a recalculation is not necessary because expected frequencies under five result in an <u>overestimate</u> of the way

things really are, and the results are not significant at the .05 level even with the overestimate.

### Full Moon vs New Moon by Days of the Week (Hypothesis #3)

Full moon and new moon data were compared against various weekday combinations to determine if the intervening variable (days of the week) affected the full/new moon data. Chi-square was calculated for property crimes and calls for police service. Chi-square could not meaningfully be calculated for crimes against persons because most of the cells' expected frequencies were under five.

The researcher considered two alternatives for enlarging the crimes against persons data: (1) Collapsing the 2 x 5 table into a 2 x 2 table comparing full moon and new moon against weekdays and weekends. However, two weaknesses accompany this approach. First, collapsing data causes information loss (i.e., which day combinations have a greater affect on the data). Second, collapsing the data into a 2 x 2 table would result in the cell frequencies being an average of the average. (2) Crimes against persons can be included in chi-square calculations by combining them with crimes against property and calls for police service. The result is a 2 x 5 table comparing full moon combined night incidents and new moon combined night incidents using the various weekday combinations.

### Summary

Chi-square was calculated to test three statistical null hypotheses. Null hypothesis #1 stated that there is no significant

difference in the amount of crime in the selected categories and calls for police service during full moon nights (moonlight present) and new moon nights (no moonlight). Data generated from null hypothesis #1 were not significantly different from what would be expected by chance at the .05 level of significance (chi-square obtained 3.03 versus chi-square needed for significance 4.60). Therefore, the research failed to reject null hypothesis #1.

Null hypothesis #2 stated that there is no significant difference between the amount of crime in the selected categories and calls for police service during clear full moon nights (moonlight present) and cloudy full moon nights (no moonlight or reduced moonlight). Data generated from null hypothesis #2 were not significantly different from what would be expected by chance at the .05 level of significance (chi-square obtained was 0.74 versus chi-square needed for significance which is 4.60). Therefore, null hypothesis #2 could not be rejected.

Null hypothesis #3 stated that there is no significant difference between the amount of crime in the selected categories and calls for police service during full moon nights and new moon nights when compared using various weekday combinations. Data generated from null hypothesis #3 were not significantly different from what would be expected by chance at the .05 level of significance as follows: (1) Property Crimes: chi-square obtained, 0.12; chi-square needed for significance, 7.77, (2) Persons Crimes: chi-square could not meaningfully be calculated since eight out of the ten cells' expected frequencies were under five, (3) Calls for Police Service: chi-square obtained, 5.04; chi-square needed for signif-

icance, 7.77, and (4) Combined Night Incidents (crimes against property, crimes against persons and calls for police service): chi-square obtained, 4.78; chi-square needed for significance, 7.77. Therefore, the research failed to support a rejection of null hypothesis #3.

Although not significant, full moon night incidents outnumbered new moon night incidents in two of the three categories (calls for police service and crimes against persons). Further, the largest observed difference between full moon and new moon was in the calls for police service category, with full moon calls numbering 7067 and new moon calls numbering 6854. It is possible that calls for police service may be law enforcement's most accurate means to show that the moon somehow causes people to act strange or aggressive.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

The physical environment's impact on crime has been the focus of much attention and research in areas such as weather (barometric pressure, temperature, humidity, preciptiation), climate, seasons, air pollutants, and lunar phases. This thesis addressed the scientific research accumulated on the moon's influence on crimianl behavior. Based on a review of the literature, and an understanding of how the moon affects the planet Earth, at least five causal theories were identified for explaing lunar influences on humans: (1) Biological Tides (Gravitational Theory), (2) Positive Ions, (3) Psycho-Social, (4) Moonlight (Biological and Illumination Aspects), and (5) Remnants of Tidal Rhythms. A number of differing methodologies have been designed by researchers to study the moon's impact on human behavior in general and criminal behavior in particular.

This study addressed the issue of whether moonlight (as opposed to gravity) somehow affects the amount of criminal behavior and calls for police service in Youngstown, Ohio at night. The methodology, compatible with Positive Ion, Moonlight and Psycho-Social causal theories, consisted of comparing the amount of crime in the selected crime categories (crimes against persons: misdemeanor and felony assaults, homicides; crimes against property: burglary, breaking and entering, auto theft, robbery; and calls for police

service during full moon nights (moonlight present) with the amount of crime in the selected crime categories and calls for police service during new moon nights (no moonlight). This information was restated in the form of a null hypothesis and subjected to the chi-square nominal level test of significance. Further examination of the moonlight issue consisted of comparing the amount of crime in the selected crime categories and calls for police service during clear full moon nights (moonlight present) with the amount of crime in the selected crime categories and calls for police service during cloudy full moon nights (no moonlight or reduced moonlight). This information was restated in the form of a null hypothesis and subjected to the chi-square nominal level test of significance. The methodology also considered the intervening variable of days of the week to determine if any particular weekday or weekend combination influenced the amount of crime in the selected crime categories and calls for police service during full moon and new moon. This information was restated in the form of a null hypothesis and subjected to the chi-square nominal level test of significance. The research failed to reject each of the three null hypotheses tested since the data were not significantly different from what would be expected by chance at the .05 level of significance.

The results of this study can be added to the myriad of results of past research. Twelve studies were reviewed which attempted to link the lunar phases with criminal behavior. Six

studies found positive correlations between the two;[150] five studies found no correlations, or at best, questionable ones;[151] and one study's results were divided depending on how the data were grouped.[152]

The data comparing full moon with new moon showed crimes against property as the only category where new moon night incidents outnumbered full moon night incidents. Although not a significant difference, the finding that crimes against persons were higher during full moon parallels Tasso and Miller's 1976 study results that showed some ten different crime classifications occurring significantly more often during the full moon phase.

> Noteworthy is the finding that offenses against family and children which involve interpersonal relationships resulted in the highest value of chi-square ($x^2$=122.00), whereas auto thefts which are offenses involving material objects resulted in the lowest value of chi-square.[153]

Further, the number of calls for police service showed the biggest difference between full moon and new moon. The results suggested that calls for police is an appropriate gauge for lunar influences more subtle in nature and serves as law enforcement's best means to show that the moon somehow causes people to act strange or aggressive. The researcher also tends to agree with Feldman and Jarmon's 1979 study conclusion:

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[150]Lieber and Sherin, "Homicides and the Lunar Cycle"; Lieber, "Lunar Effect on Homicides"; Stahl; Lieber, "On the Moon Again"; Tasso and Miller; Lieber, "Human Aggression."

[151]Pokorny, "Moon Phases, Suicide, and Homicide"; Pokorny and Jachimiczyk, "The Questionable Relationship"; Ray; Osgood, Edgerton, and Phelps; Purpura.

[152]Feldman and Jarmon.

[153]Tasso and Miller, p. 83.

> We are not trying to claim that the [environmental] variables that proved to be of statistical significance in our analysis are the factors that cause crime (people were assaulting one another long before automobiles were emitting ozone). We are simply postulating that these factors may play an important part in precipitating antisocial behavior.[154]

## Implications of Lunar Research For Police Management

Criminal justice practitioners continue to search for methods for predicting violent and criminal human behavior. The assignment and deployment of police personnel and allocation of resources is based in part on variables such as specific crime problems and high crime areas, therefore, such predictability would be useful. While these variables are readily accepted by police administrators as obvious factors affecting crime, some research has provided evidence that the physical environment also plays an important role in precipitating antisocial behavior. This study analyzed one environmental variable, lunar phases. In his 1978 study, Arnold Lieber explained how lunar research might be put to practical use:

> The clustering characteristics of these behaviors might be of practical use to police, fire-rescue and hospital personnel. However, it must be emphasized that these characteristics are expected to differ from one geographical location to another. Once a retrospective cluster analysis is generated for any given city, this information might then be used to embark on crime prevention programs, to enable a more efficient utilization of human resources by police, fire-rescue and hospital agencies and to undertake programs of public education which could help safeguard life and limb. . . .
>
> . . . . the tendency of certain violent behaviors to cluster around moon phases may provide a rational basis for local programs in preventive psychiatry and criminology.[155]

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[154] Feldman and Jarmon, p. 239.

[155] Arnold L. Lieber, "Human Aggression," pp. 390-391.

Doris Stahl set out, in her 1974 master's thesis, to determine to what degree police administrators would accept and make use of unusual data in reallocating personnel. Sixty (out of one hundred) New York City police administrators representing all of the city's precincts responded to her questionnaire for the purpose of determining their attitudes toward crime and the full moon.

> When asked if they believed that lunar changes caused abnormal behavior, 11 said yes, 15 said no and 8 had no opinion.
>
> They were asked if they altered their patrol routine to comply with the cycles of the moon and 1 man said yes, while 33 said no. . . .
>
> The last question on the initial questionnaire asked the administrators if they would be willing to reschedule their men or discuss the necessity of doing so with persons in charge if hard uncontestible data were shown them demonstrating a definite (more than 10%) increase in crime on nights of the full moon. Twenty-eight said yes, 1 said no and 5 answered maybe.[156]

The police administrators were then given Lieber and Sherin's 1972 study results linking homicide rates to the phases of the moon (see discussion in Chapter II).

> . . . the administrators were asked if they considered this research significant for the police department. Twenty-two said yes and 11 responded with no. They were also asked if they would be willing to use this data for administrative decisions: 22 said yes and 12 said no.[157]

Stahl then revealed to the administrators the results of her study of the 32nd and 110th precincts in their city (New York) which demonstrated a correlation between certain criminal behavior and the full moon (see discussion in Chapter II).

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[156] Stahl, pp. 36-37.

[157] Ibid., pp. 37-38.

> The administrators were asked if they considered these findings significant enough to warrant any alteration of current manpower allocations. Their responses to this question (9) was "yes," 12 men, "no," 17 men and "no opinion," 5 men.[158]

Stahl concluded her questionnaire by asking: "If you have never previously considered the moon influential in criminal behavior, have the previous facts altered your appraisal of the matter?"[159] The administrators responded to her question as follows: Thirteen said yes; four replied they were more curious; twelve said no; and six claimed that they already believed in the phenomenon. Stahl concluded by saying:

> When these administrators, who were only too willing to express affirmation to the suggestions of the hard but unusual data, were confronted with the decision to make changes based on the data, most of the men proved not to be the true innovators they initially suggested they were.[160]

Casual conversations with two of this researcher's colleagues revealed personnel adjustments on full moon nights. Director of Florida Corrections Louie Wainwright recalls more police officers assigned to duty on full moon nights when he was a police officer in Gainsville, Florida, approximately 25 years ago. Until recently, additional police were scheduled for duty at Massachusetts General Hospital in Boston, according to Security Supervisor John Hughes, on the nights of the full moon.

Police management will undoubtedly become more dependent on scientific and social research to assist them in personnel deployment

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[158] Ibid., pp. 38-39.

[159] Ibid., p. 39.

[160] Ibid., pp. 42-43.

and implementation of crime prevention techniques as police work strives toward professionalism. This study is one example of the many types of research that will need to be consulted for future management decisions. Of course the problem that research is often contradictory and/or non-conclusive (as this thesis has shown) remains as a challenge for the future. Police managers will want to conduct studies within their own jurisdictions to determine if a lunar impact on crime exists, and if so, evaluate how they can best allocate their resources to compensate. This study implied that additional manpower (sworn and non-sworn) may be needed on full moon nights, not because of increased "crime" per se, but for adequately processing the increased volume of complaints (calls for police service).

## Implications for Future Research

One purpose of this study was to account for the data differences found by some studies between full moon and new moon, which are both phases of maximum gravitational pull. The study focused narrowly on the issue of moonlight versus no moonlight by looking at the exact date of the full moon and new moon, along with part of the date before and after. One could speculate that more data may be necessary for differences to manifest themselves. Using the same methodology outlined in this thesis, four nights before and after the night of the full/new moon should be sufficient, keeping in mind that the amount of moonlight is decreasing (full moon) and increasing (new moon) as calendar dates are added.

Also appealing to future research are the contributions to the topic by Arnold Lieber. Lieber believes that the gravitational

pull of the moon causes biological tides within the human body, thus accounting for emotional and behavioral changes. Indeed, Lieber's studies have been able to find significant correlations where other studies have failed.

> . . . the fact that innate human behaviors (aggressive and sexual) apparently resonate with a predictable cosmic cycle lends credence to the concept that man exists in dynamic equalibrium with him geophysical environment and, in turn, with his universe.[161]

A major concern for future police related lunar research lies in the appropriateness of the sample. This research implies that the total number of calls for police service statistic (as opposed to specific crime category classifications) serves as law enforcement's best measure of "weird" or "strange" behavior and is an appropriate gauge for lunar influences more subtle in nature. Calls for police service is an accurate reflection of irritability or sluggishness, bad moods, social tension, disharmony and aggressiveness. Youngstown Police Department calls for service statistic reflects all police activity: criminal, non-criminal, service related and peacekeeping. A major advantage of using calls for police service as opposed to specific crime classifications lies in accounting for technical criminal occurrences that are handled informally, perhaps without the writing of a report (i.e., widely used police discretion). The Youngstown Police calls for police service log includes criminal incidents written into reports plus all other calls handled informally making it a comprehensive statistic. Written reports of crime occurrences alone do not account for police discretion. Finally,

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[161] Arnold L. Lieber, "Human Aggression," p. 391.

using calls for police service helps to overcome some of the deficiencies and limitations of official crime statistics as discussed in Chapter III.

As discussed in Chapter IV, attention should also be given to the total number of phone calls received at police departments during various time periods to account for complaints handled over the phone or determined (for whatever reason) not worthy of further police intervention.

Future lunar researchers will be faced with at least two fundamental problems: (1) evaluating the multitude of causal theories, and (2) deciding which of the differing methodologies best measures lunar influence on humans.[162] Answers to these dilemmas will undoubtedly provide invaluable insight to an unusual and fascinating phenomena.

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[162] See "Summary and Discussion" in Chapter II.

# APPENDIX A

## Total Number of Crimes in Youngstown, Ohio

Total Number of Crimes in Youngstown, Ohio

| CATEGORY | 1981 | 1982 | 1983 |
|---|---|---|---|
| Burglary/B & E | 3579 | 2898 | 3030 |
| Auto Theft | 599 | 693 | 1329 |
| Homicide | 34 | 26 | 20 |
| Robbery | 748 | 549 | 478 |
| Assaults (Misdemeanor/Felony) | 890 | 1133 | 913 |
| Calls For Police Service | 68,664 | 74,638 | 67,849 |

# APPENDIX B

## Full Moon and New Moon Dates

*Full Moon Date

| DATE | SUNSET | SUNRISE |
|---|---|---|
| Mon. Jan. 19, 81 | 1723 | |
| *Tue. Jan. 20, 81 | 1724 | 0744 |
| Wed. Jan. 21, 81 | | 0743 |
| Tue. Feb. 17, 81 | 1759 | |
| *Wed. Feb. 18, 81 | 1800 | 0714 |
| Thur Feb. 19, 81 | | 0712 |
| Thur Mar. 19, 81 | 1833 | |
| *Fri. Mar. 20, 81 | 1835 | 0627 |
| Sat. Mar. 21, 81 | | 0625 |
| Sat. Apr. 18, 81 | 1906 | |
| *Sun. Apr. 19, 81 | 1907 | 0538 |
| Mon. Apr. 20, 81 | | 0536 |
| Sun. May. 17, 81 | 2036 | |
| *Mon. May. 18, 81 | 2037 | 0602 |
| Tue. May. 19, 81 | | 0601 |
| Tue. Jun. 16, 81 | 2058 | |
| *Wed. Jun. 17, 81 | 2058 | 0549 |
| Thur Jun. 18, 81 | | 0549 |
| Wed. Jul. 15, 81 | 2054 | |
| *Thur Jul. 16, 81 | 2054 | 0603 |
| Fri. Jul. 17, 81 | | 0604 |
| Fri. Aug. 14, 81 | 2023 | |
| *Sat. Aug. 15, 81 | 2022 | 0631 |
| Sun. Aug. 16, 81 | | 0632 |
| Sat. Sep. 12, 81 | 1938 | |
| *Sun. Sep. 13, 81 | 1936 | 0701 |
| Mon. Sep. 14, 81 | | 0702 |
| Mon. Oct. 12, 81 | 1847 | |
| *Tue. Oct. 13, 81 | 1845 | 0732 |
| Wed. Oct. 14, 81 | | 0733 |
| Tue. Nov. 10. 81 | 1708 | |
| *Wed. Nov. 11, 81 | 1707 | 0706 |
| Thur Nov. 12, 81 | | 0707 |
| Thur Dec. 10, 81 | 1654 | |
| *Fri. Dec. 11, 81 | 1654 | 0738 |
| Sat. Dec. 12, 81 | | 0739 |

*Full Moon Date

| DATE | SUNSET | SUNRISE |
|---|---|---|
| Fri. Jan. 8, 82 | 1711 | |
| *Sat. Jan. 9, 82 | 1712 | 0748 |
| Sun. Jan. 10, 82 | | 0748 |
| Sun. Feb. 7, 82 | 1746 | |
| *Mon. Feb. 8, 82 | 1748 | 0727 |
| Tue. Feb. 9, 82 | | 0725 |
| Mon. Mar. 8, 82 | 1821 | |
| *Tue. Mar. 9, 82 | 1822 | 0645 |
| Wed. Mar. 10, 82 | | 0643 |
| Wed. Apr. 7, 82 | 1854 | |
| *Thur Apr. 8, 82 | 1855 | 0555 |
| Fri. Apr. 9, 82 | | 0553 |
| Thur May. 6, 82 | 2025 | |
| *Fri. May. 7, 82 | 2026 | 0613 |
| Sat. May. 8, 82 | | 0612 |
| Sat. Jun. 5, 82 | 2052 | |
| *Sun. Jun. 6, 82 | 2053 | 0550 |
| Mon. Jun. 7, 82 | | 0550 |
| Mon. Jul. 5, 82 | 2059 | |
| *Tue. Jul. 6, 82 | 2058 | 0556 |
| Wed. Jul. 7, 82 | | 0556 |
| Tue. Aug. 3, 82 | 2037 | |
| *Wed. Aug. 4, 82 | 2036 | 0620 |
| Thur Aug. 5, 82 | | 0621 |
| Thur Sep. 2, 82 | 1954 | |
| *Fri. Sep. 3, 82 | 1953 | 0651 |
| Sat. Sep. 4, 82 | | 0652 |
| Fri. Oct. 1, 82 | 1905 | |
| *Sat. Oct. 2, 82 | 1903 | 0720 |
| Sun. Oct. 3, 82 | | 0721 |
| Sun. Oct. 31, 82 | 1720 | |
| *Mon. Nov. 1, 82 | 1718 | 0654 |
| Tue. Nov. 2, 82 | | 0655 |
| Mon. Nov. 29, 82 | 1655 | |
| *Tue. Nov. 30, 82 | 1655 | 0728 |
| Wed. Dec. 1, 82 | | 0729 |
| Wed. Dec. 29, 82 | 1702 | |
| *Thur Dec. 30, 82 | 1702 | 0748 |
| Fri. Dec. 31, 82 | | 0748 |

*Full Moon Date

| DATE | SUNSET | SUNRISE |
|---|---|---|
| Thur Jan. 27, 83 | 1733 | |
| *Fri. Jan. 28, 83 | 1734 | 0738 |
| Sat. Jan. 29, 83 | | 0737 |
| Sat. Feb. 26, 83 | 1810 | |
| *Sun. Feb. 27, 83 | 1811 | 0701 |
| Mon. Feb. 28, 83 | | 0659 |
| Sun. Mar. 27, 83 | 1842 | |
| *Mon. Mar. 28, 83 | 1843 | 0613 |
| Tue. Mar. 29, 83 | | 0611 |
| Tue. Apr. 26, 83 | 2014 | |
| *Wed. Apr. 27, 83 | 2015 | 0626 |
| Thur Apr. 28, 83 | | 0625 |
| Wed. May. 25, 83 | 2043 | |
| *Thur May. 26, 83 | 2044 | 0555 |
| Fri. May. 27, 83 | | 0555 |
| Fri. Jun. 24, 83 | 2100 | |
| *Sat. Jun. 25, 83 | 2100 | 0551 |
| Sun. Jun. 26, 83 | | 0551 |
| Sat. Jul. 23, 83 | 2049 | |
| *Sun. Jul. 24, 83 | 2048 | 0610 |
| Mon. Jul. 25, 83 | | 0611 |
| Mon. Aug. 22, 83 | 2012 | |
| *Tue. Aug. 23, 83 | 2010 | 0640 |
| Wed. Aug. 24, 83 | | 0641 |
| Wed. Sep. 21, 83 | 1922 | |
| *Thur Sep. 22, 83 | 1920 | 0710 |
| Fri. Sep. 23, 83 | | 0711 |
| Thur Oct. 20, 83 | 1835 | |
| *Fri. Oct. 21, 83 | 1833 | 0741 |
| Sat. Oct. 22, 83 | | 0742 |
| Sat. Nov. 19, 83 | 1701 | |
| *Sun. Nov. 20, 83 | 1700 | 0716 |
| Mon. Nov. 21, 83 | | 0718 |
| Sun. Dec. 18, 83 | 1655 | |
| *Mon. Dec. 19, 83 | 1656 | 0744 |
| Tue. Dec. 20, 83 | | 0744 |

*New Moon Date

| DATE | SUNSET | SUNSET |
|---|---|---|
| Mon. Jan. 5, 81 | 1708 | |
| *Tue. Jan. 6, 81 | 1709 | 0749 |
| Wed. Jan. 7, 81 | 1709 | 0749 |
| Tue. Feb. 3, 81 | 1741 | |
| *Wed. Feb. 4, 81 | 1743 | 0731 |
| Thur FEb. 5, 81 | | 0730 |
| Tue. Mar. 3, 81 | 1816 | |
| *Wed. Mar. 4, 81 | 1817 | 0653 |
| Thur Mar. 5, 81 | | 0651 |
| Fri. Apr. 3, 81 | 1850 | |
| *Sat. Apr. 4, 81 | 1851 | 0601 |
| Sun. Apr. 5, 81 | | 0600 |
| Sun. May. 3, 81 | 2022 | |
| *Mon. May. 4, 81 | 2023 | 0617 |
| Tue. May. 5, 81 | | 0615 |
| Mon. Jun. 1, 81 | 2049 | |
| *Tue. Jun. 2, 81 | 2050 | 0552 |
| Wed. Jun. 3, 81 | | 0551 |
| Tue. Jun. 30, 81 | 2100 | |
| *Wed. July 1, 81 | 2100 | 0553 |
| Thur July 2, 81 | | 0554 |
| Thur July 30, 81 | 2042 | |
| *Fri. July 31, 81 | 2041 | 0617 |
| Sat. Aug. 1, 81 | | 0617 |
| Fri. Aug. 28, 81 | 2002 | |
| *Sat. Aug. 29, 81 | 2001 | 0646 |
| Sun. Aug. 30, 81 | | 0647 |
| Sun. Sep. 27, 81 | 1912 | |
| *Mon. Sep. 28, 81 | 1910 | 0716 |
| Tue. Sep. 29, 81 | | 0717 |
| Mon. Oct. 26, 81 | 1726 | |
| *Tue. Oct. 27, 81 | 1725 | 0648 |
| Wed. Oct. 28, 81 | | 0649 |
| Wed. Nov. 25, 81 | 1657 | |
| *Thur Nov. 26, 81 | 1656 | 0723 |
| Fri. Nov. 27, 81 | | 0724 |
| Fri. Dec. 25, 81 | 1659 | |
| *Sat. Dec. 26, 81 | 1659 | 0747 |
| Sun. Dec. 27, 81 | | 0747 |

*New Moon Date

| DATE | SUNSET | SUNRISE |
|---|---|---|
| Sun. Jan. 24, 82 | 1729 | |
| *Mon. Jan. 25, 82 | 1730 | 0740 |
| Tue. Jan. 26, 82 | | 0740 |
| Mon. Feb. 22, 82 | 1805 | |
| *Tue. Feb. 23, 82 | 1806 | 0707 |
| Wed. Feb. 24, 82 | | 0705 |
| Wed. Mar. 24, 82 | 1839 | |
| *Thur Mar. 25, 82 | 1840 | 0618 |
| Fri. Mar. 26, 82 | | 0616 |
| Thur Apr. 22, 82 | 1910 | |
| *Fri. Apr. 23, 82 | 1911 | 0532 |
| Sat. Apr. 24, 82 | | 0530 |
| Sat. May. 22, 82 | 2041 | |
| *Sun. May. 23, 82 | 2042 | 0557 |
| Mon. May. 24, 82 | | 0557 |
| Sun. Jun. 20, 82 | 2059 | |
| *Mon. Jun. 21, 82 | 2059 | 0550 |
| Tue. Jun. 22, 82 | | 0550 |
| Mon. Jul. 19, 82 | 2052 | |
| *Tue. Jul. 20, 82 | 2051 | 0606 |
| Wed. Jul. 21, 82 | | 0607 |
| Wed. Aug. 18, 82 | 2018 | |
| *Thur Aug. 19, 82 | 2016 | 0636 |
| Fri. Aug. 20, 82 | | 0637 |
| Thur Sep. 16, 82 | 1931 | |
| *Fri. Sep. 17, 82 | 1929 | 0705 |
| Sat. Sep. 18, 82 | | 0706 |
| Sat. Oct. 16, 82 | 1841 | |
| *Sun. Oct. 17, 82 | 1839 | 0736 |
| Mon. Oct. 18, 82 | | 0737 |
| Sun. Nov. 14, 82 | 1705 | |
| *Mon. Nov. 15, 82 | 1704 | 0711 |
| Tue. Nov. 16, 82 | | 0712 |
| Tue. Dec. 14, 82 | 1654 | |
| *Wed. Dec. 15, 82 | 1654 | 0741 |
| Thur Dec. 16, 82 | | 0742 |

*New Moon Date

| DATE | SUNSET | SUNRISE |
|---|---|---|
| Thur Jan. 13, 83 | 1716 | |
| *Fri. Jan. 14, 83 | 1717 | 0747 |
| Sat. Jan. 15, 83 | | 0746 |
| Sat. Feb. 12, 83 | 1753 | |
| *Sun. Feb. 13, 83 | 1754 | 0721 |
| Mon. Feb. 14, 83 | | 0719 |
| Sun. Mar. 13, 83 | 1827 | |
| *Mon. Mar. 14, 83 | 1828 | 0637 |
| Tue. Mar. 15, 83 | | 0635 |
| Tue. Apr. 12, 83 | 1859 | |
| *Wed. Apr. 13, 83 | 1900 | 0547 |
| Thur Apr. 14, 83 | | 0545 |
| Wed. May. 11, 83 | 2030 | |
| *Thur May. 12, 83 | 2031 | 0607 |
| Fri. May. 13, 83 | | 0606 |
| Fri. Jun. 10, 83 | 2055 | |
| *Sat. Jun. 11, 83 | 2055 | 0549 |
| Sun. Jun. 12, 83 | | 0549 |
| Sat. Jul. 9, 83 | 2057 | |
| *Sun. Jul. 10, 83 | 2057 | 0558 |
| Mon. Jul. 11, 83 | | 0559 |
| Sun. Aug. 7, 83 | 2033 | |
| *Mon. Aug. 8, 83 | 2031 | 0624 |
| Tue. Aug. 9, 83 | | 0625 |
| Tue. Sep. 6, 83 | 1948 | |
| *Wed. Sep. 7, 83 | 1946 | 0655 |
| Thur Sep. 8, 83 | | 0656 |
| Wed. Oct. 5, 83 | 1858 | |
| *Thur Oct. 6, 83 | 1857 | 0724 |
| Fri. Oct. 7, 83 | | 0725 |
| Thur Nov. 3, 83 | 1716 | |
| *Fri. Nov. 4, 83 | 1715 | 0657 |
| Sat. Nov. 5, 83 | | 0658 |
| Sat. Dec. 3, 83 | 1654 | |
| *Sun. Dec. 4, 83 | 1654 | 0732 |
| Mon. Dec. 5, 83 | | 0733 |

# APPENDIX C

## Sample Cloud Cover Readings

| DATE/TIME READING MADE | | TOTAL SKY COVER IN TENTHS | |
|---|---|---|---|
| Jan. 19, 81 | 1650 | 10 | |
| " | 1750 | 10 | |
| " | 1850 | 10 | |
| " | 1950 | 10 | |
| " | 2050 | 10 | |
| " | 2150 | 10 | |
| " | 2250 | 10 | |
| " | 2350 | 10 | |
| *Jan. 20, 81 | 0050 | 7 | |
| " | 0150 | 10 | |
| " | 0250 | 10 | |
| " | 0350 | 10 | |
| " | 0450 | 10 | |
| " | 0550 | 10 | CLOUDY |
| " | 0650 | 10 | |
| " | 0750 | 10 | |
| | | | |
| " | 1750 | 10 | |
| " | 1850 | 10 | |
| " | 1950 | 10 | |
| " | 2050 | 10 | |
| " | 2150 | 10 | |
| " | 2250 | 10 | |
| " | 2350 | 10 | |
| Jan. 21, 81 | 0050 | 10 | |
| " | 0150 | 10 | |
| " | 0250 | 10 | |
| " | 0350 | 10 | |
| " | 0450 | 10 | |
| " | 0550 | 10 | |
| " | 0650 | 10 | |
| " | 0750 | 10 | |

| DATE/TIME READING MADE | | TOTAL SKY COVER IN TENTHS | |
|---|---|---|---|
| Oct. 12, 81 | 1850 | 0 | |
| " | 1950 | 0 | |
| " | 2050 | 0 | |
| " | 2150 | 0 | |
| " | 2250 | 0 | |
| " | 2350 | 0 | |
| *Oct. 13, 81 | 0050 | 0 | |
| " | 0150 | 0 | |
| " | 0250 | 0 | |
| " | 0350 | 0 | |
| " | 0450 | 0 | |
| " | 0550 | 0 | |
| " | 0650 | 0 | |
| " | 0750 | 0 | |
| | | | |
| " | 1850 | 3 | |
| " | 1950 | 3 | CLEAR |
| " | 2050 | 2 | |
| " | 2150 | 0 | |
| " | 2250 | 4 | |
| " | 2350 | 0 | |
| Oct. 14, 81 | 0050 | 0 | |
| " | 0150 | 0 | |
| " | 0250 | 0 | |
| " | 0350 | 1 | |
| " | 0450 | 0 | |
| " | 0550 | 0 | |
| " | 0650 | 2 | |
| " | 0750 | 5 | |

| DATE/TIME READING MADE | | TOTAL SKY COVER IN TENTHS | |
|---|---|---|---|
| Feb. 7, 82 | 1650 | 2 | |
| " | 1750 | 1 | |
| " | 1850 | 0 | |
| " | 1950 | 0 | |
| " | 2050 | 0 | |
| " | 2150 | 0 | |
| " | 2250 | 0 | |
| " | 2350 | 0 | |
| *Feb. 8, 82 | 0050 | 0 | CLEAR |
| " | 0150 | 0 | |
| " | 0250 | 0 | |
| " | 0350 | 0 | |
| " | 0450 | 0 | |
| " | 0550 | 2 | |
| " | 0650 | 2 | |
| " | 0750 | 7 | |
| " | 1750 | 10 | |
| " | 1850 | 10 | |
| " | 1950 | 10 | |
| " | 2050 | 10 | |
| " | 2150 | 10 | |
| " | 2250 | 10 | |
| " | 2350 | 10 | |
| Feb. 9, 82 | 0050 | 10 | |
| " | 0150 | 10 | CLOUDY |
| " | 0250 | 10 | |
| " | 0350 | 10 | |
| " | 0450 | 10 | |
| " | 0550 | 10 | |
| " | 0650 | 10 | |
| " | 0750 | 10 | |

# APPENDIX D

## Distribution of Chi-Square

# Distribution of Chi-Square

| | Probability (two-tailed)* | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *df* | .99 | .98 | .95 | .90 | .80 | .70 | .50 | .30 | .20 | .10 | .05 | .02 | .01 | .001 |
| 1 | .03157 | .03628 | .00393 | .0158 | .0642 | .148 | .455 | 1.074 | 1.642 | 2.706 | 3.841 | 5.412 | 6.635 | 10.827 |
| 2 | .0201 | .0404 | .103 | .211 | .446 | .713 | 1.386 | 2.408 | 3.219 | 4.605 | 5.991 | 7.824 | 9.210 | 13.815 |
| 3 | .115 | .185 | .352 | .584 | 1.005 | 1.424 | 2.366 | 3.665 | 4.642 | 6.251 | 7.815 | 9.837 | 11.345 | 16.268 |
| 4 | .297 | .429 | .711 | 1.064 | 1.649 | 2.195 | 3.357 | 4.878 | 5.989 | 7.779 | 9.488 | 11.668 | 13.277 | 18.465 |
| 5 | .554 | .752 | 1.145 | 1.610 | 2.343 | 3.000 | 4.351 | 6.064 | 7.289 | 9.236 | 11.070 | 13.388 | 15.086 | 20.517 |
| 6 | .872 | 1.134 | 1.635 | 2.204 | 3.070 | 3.828 | 5.348 | 7.231 | 8.558 | 10.645 | 12.592 | 15.033 | 16.812 | 22.457 |
| 7 | 1.239 | 1.564 | 2.167 | 2.833 | 3.822 | 4.671 | 6.346 | 8.383 | 9.803 | 12.017 | 14.067 | 16.622 | 18.475 | 24.322 |
| 8 | 1.646 | 2.032 | 2.733 | 3.490 | 4.594 | 5.527 | 7.344 | 9.524 | 11.030 | 13.362 | 15.507 | 18.168 | 20.090 | 26.125 |
| 9 | 2.088 | 2.532 | 3.325 | 4.168 | 5.380 | 6.393 | 8.343 | 10.656 | 12.242 | 14.684 | 16.919 | 19.679 | 21.666 | 27.877 |
| 10 | 2.558 | 3.059 | 3.940 | 4.865 | 6.179 | 7.267 | 9.342 | 11.781 | 13.442 | 15.987 | 18.307 | 21.161 | 23.209 | 29.588 |
| 11 | 3.053 | 3.609 | 4.575 | 5.578 | 6.989 | 8.148 | 10.341 | 12.899 | 14.631 | 17.275 | 19.675 | 22.618 | 24.725 | 31.264 |
| 12 | 3.571 | 4.178 | 5.226 | 6.304 | 7.807 | 9.034 | 11.340 | 14.011 | 15.812 | 18.549 | 21.026 | 24.054 | 26.217 | 32.909 |
| 13 | 4.107 | 4.765 | 5.892 | 7.042 | 8.634 | 9.926 | 12.340 | 15.119 | 16.985 | 19.812 | 22.362 | 25.472 | 27.688 | 34.528 |
| 14 | 4.660 | 5.368 | 6.571 | 7.790 | 9.467 | 10.821 | 13.339 | 16.222 | 18.151 | 21.064 | 23.685 | 26.873 | 29.141 | 36.123 |
| 15 | 5.229 | 5.985 | 7.261 | 8.547 | 10.307 | 11.721 | 14.339 | 17.322 | 19.311 | 22.307 | 24.996 | 28.259 | 30.578 | 37.697 |
| 16 | 5.812 | 6.614 | 7.962 | 9.312 | 11.152 | 12.624 | 15.338 | 18.418 | 20.465 | 23.542 | 26.296 | 29.633 | 32.000 | 39.252 |
| 17 | 6.408 | 7.255 | 8.672 | 10.085 | 12.002 | 13.531 | 16.338 | 19.511 | 21.615 | 24.769 | 27.587 | 30.995 | 33.409 | 40.790 |
| 18 | 7.015 | 7.906 | 9.390 | 10.865 | 12.857 | 14.440 | 17.338 | 20.601 | 22.760 | 25.989 | 28.869 | 32.346 | 34.805 | 42.312 |
| 19 | 7.633 | 8.567 | 10.117 | 11.651 | 13.716 | 15.352 | 18.338 | 21.689 | 23.900 | 27.204 | 30.144 | 33.687 | 36.191 | 43.820 |
| 20 | 8.260 | 9.237 | 10.851 | 12.443 | 14.578 | 16.266 | 19.337 | 22.775 | 25.038 | 28.412 | 31.410 | 35.020 | 37.566 | 45.315 |
| 21 | 8.897 | 9.915 | 11.591 | 13.240 | 15.445 | 17.182 | 20.337 | 23.858 | 26.171 | 29.615 | 32.671 | 36.343 | 38.932 | 46.797 |
| 22 | 9.542 | 10.600 | 12.338 | 14.041 | 16.314 | 18.101 | 21.337 | 24.939 | 27.301 | 30.813 | 33.924 | 37.659 | 40.289 | 48.268 |
| 23 | 10.196 | 11.293 | 13.091 | 14.848 | 17.187 | 19.021 | 22.337 | 26.018 | 28.429 | 32.007 | 35.172 | 38.968 | 41.638 | 49.728 |
| 24 | 10.856 | 11.992 | 13.848 | 15.659 | 18.062 | 19.943 | 23.337 | 27.096 | 29.553 | 33.196 | 36.415 | 40.270 | 42.980 | 51.179 |
| 25 | 11.524 | 12.697 | 14.611 | 16.473 | 18.940 | 20.867 | 24.337 | 28.172 | 30.675 | 34.382 | 37.652 | 41.566 | 44.314 | 52.620 |
| 26 | 12.198 | 13.409 | 15.379 | 17.292 | 19.820 | 21.792 | 25.336 | 29.246 | 31.795 | 35.563 | 38.885 | 42.856 | 45.642 | 54.052 |
| 27 | 12.879 | 14.125 | 16.151 | 18.114 | 20.703 | 22.719 | 26.336 | 30.319 | 32.912 | 36.741 | 40.113 | 44.140 | 46.963 | 55.476 |
| 28 | 13.565 | 14.847 | 16.928 | 18.939 | 21.588 | 23.647 | 27.336 | 31.391 | 34.027 | 37.916 | 41.337 | 45.419 | 48.278 | 56.893 |
| 29 | 14.256 | 15.574 | 17.708 | 19.768 | 22.475 | 24.577 | 28.336 | 32.461 | 35.139 | 39.087 | 42.557 | 46.693 | 49.588 | 58.302 |
| 30 | 14.953 | 16.306 | 18.493 | 20.599 | 23.364 | 25.508 | 29.336 | 33.530 | 36.250 | 40.256 | 43.773 | 47.962 | 50.892 | 59.703 |

*For one-tailed applications, simply *halve* the probability shown; that is, .10 (two-tailed) becomes .10/2, or .05, for a one-tailed probability.

Source: Champion, p. 264.

# APPENDIX E

## Individual Crime Category Breakdown

Total Night Crimes

| | FULL MOON | NEW MOON |
|---|---|---|
| BURGLARY/BREAKING AND ENTERING | 365 | 376 |
| AUTO THEFT | 137 | 161 |
| ROBBERY | 69 | 66 |
| HOMICIDES | 4 | 2 |
| ASSAULTS | 136 | 118 |

Average Number of Full Moon Night Crimes Per Unit Period

| | CLOUDY | CLEAR |
|---|---|---|
| BURGLARY/BREAKING AND ENTERING | 11.7 | 7.6 |
| AUTO THEFT | 4.2 | 2.9 |
| ROBBERY | 1.6 | 2 |
| HOMICIDES | (2)* | (1)* |
| ASSAULTS | 4.2 | 2.8 |

*Number shown is the actual number of crimes (too small to calculate an average).

Average Number of Night Crimes

| | | FRI/SAT | SUN/MON | MON/TUE | TUE/WED | WED/THUR |
|---|---|---|---|---|---|---|
| FULL MOON | BURGLARY/ B & E | 8.3 | 10.2 | 12.5 | 10.4 | 8.8 |
| | AUTO THEFT | 3.2 | 3.6 | 2.6 | 3.2 | 3.8 |
| | ROBBERY | 2 | 1 | 1.4 | 3 | 1.4 |
| | HOMICIDES | (1)* | (0)* | (0)* | (0)* | (1)* |
| | ASSAULTS | 4.7 | 1.6 | 3.7 | 4.8 | 3.6 |
| NEW MOON | BURGLARY/ B & E | 9.3 | 8.7 | 10.6 | 11.6 | 10.8 |
| | AUTO THEFT | 4.3 | 4.9 | 3.6 | 3.7 | 5 |
| | ROBBERY | 0.7 | 2.1 | 3 | 2.2 | 1.2 |
| | HOMICIDES | (1)* | (0)* | (0)* | (0)* | (0)* |
| | ASSAULTS | 5.25 | 2.7 | 2.8 | 3 | 4.2 |

*Number shown is the actual number of crimes (too small to calculate an average).

# APPENDIX F

## Chi-Square Calculations for Table 1

## Full Moon versus New Moon

$$x^2 = \frac{(571-594.7)^2}{594.7} = 0.94$$

$$x^2 = \frac{(603-579.3)^2}{593.3} = 0.97$$

$$x^2 = \frac{(140-131.7)^2}{131.7} = 0.52$$

$$x^2 = \frac{(120-128.3)^2}{128.3} = 0.54$$

$$x^2 = \frac{(7067-7051.6)^2}{7051.6} = 0.03$$

$$x^2 = \frac{(6854-6869.4)^2}{6869.4} = 0.03$$

TOTAL = 3.03

df=2 (3-1) (2-1)=2 (r-1) (c-1)=df

# APPENDIX G

## Chi-Square Calculations for Table 2

Cloudy Full Moon versus Clear Full Moon

$$x^2 = \frac{(17.5-15.6)^2}{15.6} = 0.23$$

$$x^2 = \frac{(12.5-14.4)^2}{14.4} = 0.25$$

$$x^2 = \frac{(4.3-3.7)^2}{3.7} = 0.10$$

$$x^2 = \frac{(2.9-3.5)^2}{3.5} = 0.10$$

$$x^2 = \frac{(196-198.5)^2}{198.5} = 0.03$$

$$x^2 = \frac{(185.8-183.3)^2}{183.3} = 0.03$$

TOTAL = 0.74

df=2 (3-1) (2-1)=2 (r-1) (c-1)=df

# APENDIX H

## Chi-Square Calculations for Table 3

## Property Crimes

$$x^2 = \frac{(13.5-13.3)^2}{13.3} = 0.00$$

$$x^2 = \frac{(14.8-14.6)^2}{14.6} = 0.00$$

$$x^2 = \frac{(16.5-14.6)^2}{16.2} = 0.01$$

$$x^2 = \frac{(16.6-16.4)^2}{16.4} = 0.00$$

$$x^2 = \frac{(14-14.9)^2}{14.9} = 0.05$$

$$x^2 = \frac{(14.3-14.5)^2}{14.5} = 0.00$$

$$x^2 = \frac{(15.7-15.9)^2}{15.9} = 0.00$$

$$x^2 = \frac{(17.2-17.5)^2}{17.5} = 0.01$$

$$x^2 = \frac{(17.5-17.7)^2}{17.7} = 0.00$$

$$x^2 = \frac{(17-16.1)^2}{16.1} = 0.05$$

TOTAL = 0.12

df=4 (r-1) (c-1) (2-1) (5-1)

Calls For Police Service

$$x^2 = \frac{(240.5-222)^2}{222} = 1.54$$

$$x^2 = \frac{(168-167.1)^2}{167.1} = 0.00$$

$$x^2 = \frac{(186.8-188.7)^2}{188.7} = 0.02$$

$$x^2 = \frac{(178.8-184.9)^2}{184.9} = 0.20$$

$$x^2 = \frac{(174.6-186)^2}{186} = 0.70$$

$$x^2 = \frac{(194-212.5)^2}{212.5} = 1.61$$

$$x^2 = \frac{(159-159.9)^2}{159.9} = 0.01$$

$$x^2 = \frac{(182.6-180.7)^2}{180.7} = 0.02$$

$$x^2 = \frac{(183-176.9)^2}{176.9} = 0.21$$

$$x^2 = \frac{(189.4-178)^2}{178} = 0.73$$

TOTAL = 5.04

df = 4 (r-1) (c-1) (2-1) (5-1)

# APPENDIX I

## Chi-Square Calculations for Table 4

Combined Night Incidents

$$x^2 = \frac{(259-240.4)^2}{240.4} = 1.44$$

$$x^2 = \frac{(184.4-184)^2}{184} = 0.00$$

$$x^2 = \frac{(207-208.3)^2}{208.3} = 0.01$$

$$x^2 = \frac{(200.2-205.3)^2}{205.3} = 0.13$$

$$x^2 = \frac{(192.4-205)^2}{205} = 0.77$$

$$x^2 = \frac{(213.8-232.4)^2}{232.4} = 1.49$$

$$x^2 = \frac{(177.4-177.8)^2}{177.8} = 0.00$$

$$x^2 = \frac{(202.6-201.3)^2}{201.3} = 0.01$$

$$x^2 = \frac{(203.5-198.4)^2}{198.4} = 0.13$$

$$x^2 = \frac{(210.6-198)^2}{198} = 0.80$$

TOTAL = 4.78

df=4 (r-1) (c-1) (2-1) (5-1)

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