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Biorhythms in *Homo sapiens* from Paleolithic to modern times

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Abstract
Biorhythms are present in all organic life and probably evolve very slowly. The suggestion is made in this paper that there has probably not been much change in the biorhythms of Paleolithic Man and modern peoples. Therefore, through an understanding of the biorhythms of modern peoples, we can extrapolate that similar patterns would have been present in earlier members of *Homo sapiens*. This provides us with new possibilities in reconstructing the behavioral patterns of our near ancestors. In addition, the biological similarity between Paleolithic peoples and modern peoples would lead us to search for some of the causes of modern illnesses in disrupted biorhythmical patterns that have come about relatively recently in our evolutionary history, because of overwhelmingly large changes in our everyday environment.

Key words: Paleolithic, biorhythms, *Homo sapiens*

Biorhythmical patterns are found in all organic life (Sollberger 1965). The origin of these biological oscillations seems to be a combination of random development in the evolutionary history of the organism, as well as development of biorhythms in direct correlation with events that occur rhythmically in the environment of the organism, including those of a cosmic scale. Although we cannot excavate these biological patterns as archaeologists do artifacts, we assume that biorhythms found in modern humans were present in a generally similar form in earlier members of our species existing in Paleolithic times, and even before. This paper will look at the significance of the biorhythmic relationship between Man and his environment in Paleolithic and in modern times.

A persistent problem in the study of the biology of people of prehistoric times is that we must use our understanding of modern human biology as a standard for studying prehistoric human biology. For example, rates of growth and development in modern humans is usually used as the standard of expected growth and development in Paleolithic peoples, and in even the earliest hominids, the australopithecines. Although some scientists may have questioned this assumption, it was not until Bromage and Dean's work that a method was found to ascertain growth rates of early fossil hominids. Bromage (1985) analyzed the fossil hominid *Australopithecus africanus* and concluded that the Taung child, estimated by modern human standards at 6 years of age, was 3.3 years of age when studied by the technique of facial remodelling and dental perikymata counting with the scanning electron microscope. Bromage & Dean (1985) have applied this procedure to other fossil hominids and have suggested that growth rates of early hominids differed from those of modern humans. Here is a case demonstrating that modern human standards may not be correct when applied to earlier hominid forms who, in this case, were maturing at a faster rate than modern Man, and at a rate more similar to the chimpanzee.

Growth rates and indeed, life span, are species specific characteristics. Although a kind of biorhythm, growth is more tied in with genetic

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coding. There is a fetal rate of growth, a child's rate of growth, the adolescent growth spurt at puberty, full adult growth, and aging of the adult. All of these have timings characteristic of a species, and have evolved in the organism as it has adapted within a given environment. Although growth can be affected by the environment, the pattern of growth, development and aging is a genetic feature of a species.

Other examples of biological rhythms in humans would seem to show a greater degree of similarity between present and past populations. Partly this is because scientists have tied in astronomical events with biorhythms, and the cosmic patterns change extremely slowly compared with organic evolutionary changes. In other words, in an evolutionary lineage the age of the human species, astronomical influences will be very similar now as they were in prehistoric times. *Homo sapiens* as a species is believed to have existed at least 100,000 years ago (Trinkaus 1989; Bar-Yosef & Vandermeersch 1993; Thorne & Wolpoff 1992). The hominid lineage itself has been around for 4 million years. On a cosmic scale, these periods of time represent a miniscule amount of time for major changes to have occurred. On an evolutionary scale, 100,000 years is a very short species life span, of course, relative to what changes were occurring in the environment (see Simpson 1963).

Consider the three major astronomical events that affect earth and organisms on earth: the annual cycle of the earth rotating around the sun, the monthly cycle of the moon rotating around the earth, and the daily rotation of the earth on its own axis. The cyclic occurrence of these events leads us to expect to find some predictable patterns in human biorhythms throughout their evolutionary history, at least within the life span of the species (for purposes here we are using 100,000 years). The biology of humans is intimately related to their having evolved on Earth. Being aware of processes that affect our planet Earth can give us greater insight into understanding certain patterns that have evolved in the biological structure of humans.

Based on his research in the timing of biological clocks, Winfree (1987, 5) states "we've felt the sky brighten and darken again and again while the planet relentlessly rotated: a trillion cycles of brightness and dark, of warmth and chill, never missing a beat, always felt deep in the chemical essence of what we are. We are well adapted to the pervasive monotony of sunrise and sunset, to the steady tone of a planet tirelessly spinning....What would a trillion cycles sound like? Like high C for 400 years. Little wonder then that we've grown used to it, that we harmonize deeply with the unending note".

Let us look at examples of different biorhythms. The annual cosmic pattern results in seasonal differences that occur regularly from year to year. It is known that children grow more in seasons when the amount of daily sunlight increases (e.g. see Sollberger 1965). The increased amount of seasonal daily sunlight also affects mating and copulatory patterns which, even in humans, are more intense and frequent during these times (Heape 1900; Ploss et al. 1935). "Spring fever" occurs during this season, and is correlated with increased amount of daily sunlight which affects blood pressure.

Menstrual cycles in women have a similar number of days as have lunar cycles. That is, once a month (and a month is roughly equivalent to the time it takes for the moon to complete a rotation around the earth - 29.5 days), a female will be reproductively fertile. The remainder of the 29 or so days, she is building up a nutritive membrane in the uterus for reception of a fertilized egg, or lacking this event, preparing to shed the lining of the uterus resulting in excreted blood, called the menstrual blood, through the vagina. Other higher primates also have menstrual cycles, varying in length from 24-35 days in Old World monkeys, and from 31-37 days in gorillas and chimpanzees (Robinson & Goy 1986). An approximate lunar cycle is characteristic of the oestrus cycle in New World monkeys and prosimians, but menstruation is lacking (ibid.).

Somewhat more data is available on circadian or daily biological rhythms. A 24-hour day (a lunar day = 24.8 hours) can be divided into sunrise, morning, midday, afternoon, sunset, evening and nighttime. At any of the times, for example at midday, there is less intra-individual variation during any day of the week than there is in the individual from day to day. Humans, and all except one of the higher primates (*Dourocouli* or the owl monkey of South America), are diurnal. The organs of the human body carry out different biological functions depending on the particular time period of the 24 hour day. Especially notable is the internal body temperature pattern. The average normal body temperature is 37° C or 98.6° F, but this temperature varies on a regular cycle throughout the 24-hour day, as Conroy & Mills (1970) and others have shown. At sunrise, the temperature is below this average but during mid- to late morning it has risen and may be above 37° C. After lunch there is a post-prandial drop and by later in the afternoon the temperature rises again. It may remain high until mid-evening when it begins again to drop. At about 4 a.m. it reaches its lowest. It is interesting to note that a large number of natural deaths occurs at the point that the body temperature is lowest, that is, between 4 and 6 a.m. (Palmer 1976).

Organ function varies during the day (see Conroy & Mills 1970). Kidney electrolyte concentrations are higher in the morning, as is liver activity. Another interesting phenomenon is time of birth. Data shows that the greatest number of human births occur late at night and before sunrise. The suggested reason for this is that, in a hunting or nomadic or otherwise actively mobile social group, both mother and newborn are safer in their nighttime environment where they sleep such as a nest or shelter, than in midday when they are likely to be out on the open land and more susceptible to predation. Presumably, those females with a biological tendency toward nocturnal birthing have had a better survival rate (along with their offspring) due to natural selection, than those giving birth at other times.

Both mental and physical performance vary depending on the time of day. Both have been found to peak about midday, although some studies have shown mental skills tend to peak earlier than motor skills, i.e. late morning compared to early afternoon (Conroy & Mills 1970). Pain thresholds have also been found to vary during the day with a higher tolerance for pain in early afternoon (Palmer 1976; Conroy & Mills 1970). There are mood difference patterns during the day as well, with anxiety being greatest in the morning, alertness at midday, and sociability in the evening (Palmer 1976).

Dubrov (1989, p. 6) has brought to our attention that there are individual differences in biorhythms and reactivity, or "chronotypes" and he states: "There is a biological regularity which permits the existence of organisms with varying, sometimes contrasting, forms of diurnal rhythms and responses to the same irritants". Surely this flexibility in organisms acts to provide the possibility for new routes in evolutionary adaptation.

Other biorhythms do not show clear-cut relationships with cosmic events, but rather seem to be more a characteristic of the species, having evolved in relation to the species body size, metabolic rate and growth patterns. Heartbeat rate, referred to as ultradian by Sollberger (1965) varies in mammals from 20 to 1000 beats per minute, as recorded in the bat and elephant respectively. Adult humans have a rate of 35-100 with 70 being an average human heartbeat rate. Another "ultradian" rhythm is the brain wave pattern that can be measured by EEG's in cycles/second. There is not just one pattern for brainwaves, but several, depending on body activity (Strughold 1965; Wallace & Benson 1972).

The final type of biorhythm referred to as "infradian" has to do with predictable time periods for the production of body components such as red blood cells which take 5 days to mature from hematoblasts, blood platelets which need 7 days to form, and the life span of red erythrocytes which is about 120 days (Le Gros Clark 1965).

There is a regularity or rhythmicity in how the body functions (e.g. see Dubrov 1989). Some of the rhythmicity such as ultradian and infradian patterns, seems to be part of the genetic code, having evolved as the species itself did, through natural evolutionary processes. Other biorhythms such as seasonally faster growth rates, ovulation and menstrual cycles, mating peaks, time of birth, daily body temperature curve and organ activity appear to take their cues from the outside environment including showing correlations with astronomical events. Of course all of these patterns have also evolved through interaction between organism and environment.

How far back in the human evolutionary record can we expect to find biorhythms that are simmilar to those of modern Man? One approach to answering this question is through the study of skeletal remains of prehistoric populations. If we equate similar skeletal morphology to similar biology, then as long as a skeleton can be identified as *Homo sapiens*, we might expect its biorhythms to be like those of modern Man. (Probably the biorhythm pattern is quite a bit older than the species as defined here, but using species life span seems to be a reasonable basis for estimating at least minimal duration of human biorhythms.) Through this approach we may judge the life span of the species *Homo sapiens* to be in the order of at least 100,000. Bar-Yosef & Vandermeersch (1993), for example refer to the "evident presence of morphologically modern humans in the Levant some 100,000 years ago".

Should we make a distinction when we are dealing with a separate hominid genus such as *Australopithecus* that existed 2-3 mya ? The findings of Bromage and Dean suggest this genus had different rates of maturation; how much would other biological processes differ? This is certainly an important issue in human evolutionary studies, but one which is out of the scope of the present paper.

For purposes of this paper, I am suggesting here that those populations belonging to *Homo sapiens*, based on skeletal similarity, would probably possess similar biorhythms. If we make this assumption, what further inferences can we deduce? In other words, what is the significance of recognizing that Paleolithic peoples had biorhythms like modern peoples? One important consideration here is that this could provide us with information about biological behavior that is not preserved in the fossil or archaeological record. It might enable us to make certain predictions about prehistoric behavior.

For example, with some knowledge of the early human paleoenvironment, we might be able to predict which seasons were most likely to be mating or birthing seasons, based on the amount of increased sunlight influencing the greater likelihood to mate. This deduction could give us information about migration patterns of a population in that people might be less likely to migrate especially during these birthing periods. We might also be able to make statements about other daily patterns of people which could provide us with information on their social structure, e.g. through using modern biorhythm studies on circadian variations in variables such a mental and motor performance, pain threshold and moods, we might be able to reconstruct behavior patterns in Paleolithic peoples.

Another result of tracing biorhythms back in prehistory is that it provides us with information about our own modern day biological nature. If these patterns have been a part of our evolutionary heritage for a relatively long period, they have obviously become entrenched in our biology. Recognizing this can give us greater insights into our own biological nature. The continuity of the biorhythm patterns from prehistoric to historic and present peoples could provide us with insight on modern day problems. An evolutionary pattern that has been part of our species for 100,000 years or more will not be easily altered in the short time represented by the historical period of 6,000 to 8,000 years, or in even the shorter time represented by the "industrial revolution" when life styles began changing drastically compared to prehistorical ones. Since some of the most overwhelming changes to human life style have come about in the 20th century, such as the automobile, airplane and computer, this allows for even less evolutionary time for change. One hundred years out of 100,000 years is 0.1 % of species life span time, a mere drop of water in a bucket.

Indeed, some biorhythms have been detected because of maladaptions and problems that people experience when normal patterns are disrupted or altered. These changes in regular patterns may occur through: (1) certain social habits such as shift working that varies the diurnal/nocturnal rhythm, living indoors in an artificial environment different from outside, mobility patterns, etc.; (2) drugs ingested, and (3) use of technology not known until very recent times, e.g. fast modes of travel especially by airplane east and west through different time zones resulting in circadian dysrhythmia. Motion illness is also related to travel modes and speeds greater than a human by itself can make. Various means of "word processing" including computers alter our mental and physical activity patterns, and machines that have been devised for improving our health such as those utilizing electricity, magnetism and radiation may be responsible for deleteriously affecting our biorhythms.

To some extent, social factors and drug use could apply to people in prehistoric times. However, the social factors referred to above are particular to recent times. The technological aids that modern peoples have are an entirely new aspect of human adaptation that have existed only in very recent times. For most of our 100,000 years as a species, people did not "live indoors", they did not travel faster than their own feet could carry them (there may be a few cases of early domestication of animals for transport), they did not spend hours during the day sitting on a chair at a desk, staring at a machine with a screen where they could make symbols for communicating with someone at either a shortly later time or instantaneously, and to a number of different parts of the world. This concept is still mind-boggling to most people not brought up in the generation of computers.

Our ancestors, up to 10,000 or 20,000 years ago, had a technology based primarily on tools that they could make from their environment through utilizing stone, bone, teeth, horn, wood. We know the technological level of prehistoric peoples through archaeological studies of their artifacts. Their tool industries have been well defined back in time to about 2 million years.

Since the origin of *Homo sapiens*, only a small percentage of the species life span has been spent with technology and living styles of the kind that we know from the historic records of less than 10,000 years ago. During the rest of the species life span, humans made their own tools primarily from stone which is why this time period is referred to as the Age of Paleolithic man.

In general body structure and probably in basic patterns of response to environmental cues, we have undergone very little significant evolutionary change since our ancestors became anatomically modern humans by 100,000 years ago. This suggests that *we are operating in modern times with a body that is basically adapted to life in Paleolithic times*. However, life in modern society is very different from the life of our earlier ancestors, yet we are still biologically the same species. Is our basic human biological heritage in a state of disharmony with our modern environments?

Here are a few examples of how human biology today, in many peoples, has gotten out of synchronization with its environment:

(1) Circadian patterns: When human beings began living indoors on a regular basis, and began using technological aids that "co-cooned" them from the outside, they altered their diurnal/-noctural rhythms. One way this happened was to increase the number of "daylight" hours through the use of artificial light by which they could perform activities. Certain variables in the weather such as extremes of heat, cold, humidity could also be removed from affecting a person though the use of technological aids to modify these variables. Sleep patterns could also be altered by indoor "cocoon" living, and this is most evidenced by shift working (Aschoff 1978). However, studies have shown that the physiological processes of the body must follow a pattern of biological rhythms and that for normal bodily functioning, it is essential that the body do so. Therefore, removing the body from its external environmental cues does not remove it from the necessity of having a rhythmical pattern of biological functioning. Studies of astronauts have also shown that their sleep patterns follow a more or less 24 hour rhythm as on earth, although the reduction in gravitation pressure appears to result in their needing less sleep (Strughold 1962, 1965).

When humans designed machines for fast travel across time zones, they also created a new problem for their biorhythms. In earlier times, a human could not travel great distances over a short period of time, and had never experienced the problem of circadian dysrhythmia until the 20th century with the invention of automobiles and airplanes. "Jet lag" or transmeridian dyschronism (Halberg 1969) originated during this century and is indeed one of the newest biorhythmical adaptations that humans have experienced. Daily organ functioning is keyed to a pattern and disruptions in this schedule can result in diarrhea, nausea, and general confusion in eating, excretory, activity and sleeping patterns, as many travellers have experienced.

Modern life styles involving, for example, a great deal of sitting and desk work have also effected a reduction in physical activity. Being physically active has been a necessary part of human survival for most of their existence as a lineage. Being inactive has not been successful for a healthy biology. This is evidenced in a variety of problems which are a consequence of lack of physical activity. Obesity and its related problems is one of the major results of this.

(2) Infradian rhythms are those seen in different systems of the body including the blood, the cells of the body and the various organs. If this system is unbalanced, as can happen when biorhythms are generally affected, a variety of pathologies may occur. One might be related to cancer which, as a malignant tumor, is defined as a "new growth of cells or tissues characterized by autonomy, i.e. independent of the laws of growth of the host. It is progressive, or unknown cause". Possibly one *cause* is symptomatic of modern living where biological periodicity has been placed into an unbalanced state. Where the body's normal biological rhythms are out of balance with cues from the environment, the result may be arhythmia of dividing cells.

(3) Modern day problems in the reproductive system may be viewed as examples of disharmony in lunar or monthly cycles. It is quite possible that problems with menstruation and premenstrual syndrome, even menopause, may be associated with dysrhythmia that is caused by certain modern day living practices that "cocoon" off the female from natural external environmental cues and reduce the amount of physical activity

necessary for the body to function normally, in the sense that it did in their prehistoric ancestors. Confirmation of this possibility could come from comparative studies of women living in modern society and who are more dependent on artificial technology in everyday living, contrasted with women who live in conditions which would have been more like those of our earlier ancestors. The small amount of data that does exist tends to confirm this suggestion.

These examples both illustrate as well as suggest that certain modern pathologies may be explainable through being out of synchronization with a biology that has existed and was adaptive for humans for well over 100,000 years. The rapid mental and social evolution of the recent past has proceeded faster than the biology of the body has been able to evolve and adapt. Perhaps it is a case of mosaic evolution where one part of the body's biology has outpaced other parts, yet cannot survive without coming to terms with the more conservative biological functioning of those other parts.

Our evolutionary future lies not *only* in altering our body with various "high-technological" and other biological improvisations for its improved efficiency, but *also* by improving on our use of an already successful blueprint by reading it with a greater sense of awareness. Through recognition of our dependence on environmental cues and understanding our own innate rhythmic responses, we can then operate in our body with greater efficiency. This is surely one of our new challenges in human evolution - applying knowledge of the patterns we have inherited from our prehistoric biology to adapt most successfully in the environment that we have at present created for ourselves.

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