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CHAPTER 23

Rhythm and Energy: Linkages Between the Individual and His Environment

Energy and rhythm are fundaments of human existence; they are in fact fundaments of the universe. What kind of human energy is most honored varies from one culture to another. It might be spiritual force, creativity, the stylized energy of fencing or the Japanese martial arts, simply activity, or perhaps even spontaneous violence. In the immensely complex process by which all the rhythms of life and universe are orchestrated, one question is which of them relates how to which of the different kinds of human energy? We do not yet know all the answers to this question. The most crucial areas for future research lie in the field of human physiology, especially of the brain, which is the pacemaker for other body rhythms, and in variations of physiological reaction in different geographic and cultural contexts.

Among the most important "givens" for human life are the rhythms of the physical environment: the earth's circle around the sun, its daily rotation, the cycles of the moon; the seasons, light and dark, heat and cold, fluctuations in humidity; sunspots, air pressure, sound and light waves, electromagnetic fields, gravity. These and many other natural phenomena are rhythmic and obviously affect our body rhythms. Nature has us in her grip. Human behavior is different in summer than in winter, in hot climates than in cold. We behave in strange ways when the moon is full.[1] Gay Gaer Luce has speculated: ". . . since the brain is at least as sensitive as a compass, it is likely that we react to large magnetic disturbances."[2] Russian scientist A. P. Dubrov has stated more forceably that magnetic fields generated by the sun play a great role in changing the permeability of biological membranes, especially those in neural cells.[3] A. S. Presman has said that the rapid variations of geomagnetic fields, and particularly magnetic storms, are a leading component of influence upon the dynamics of increase of coronary-vascular incidents.[4] B. Rao of India has shown the influence of solar and geomagnetic disturbances on the number of traffic accidents.[5] As Luce states: "The speed of the transactions of the neurons in our brains and bodies must be calibrated to the rhythms of the physical world we perceive. Our brains must respond at a certain rate to hear the sounds of certain frequencies."[6] Negative selectivity is also important in placing us in our environment; that is, our place is in part defined by the light and sound waves we are not calibrated to receive. We surely do not understand how all the body's periodicities,

especially the ones of long duration, are affected by the periodicities of the larger universe. Nor how social rhythms are affected, especially by geographic variations. When men begin to live for protracted periods on space platforms, perhaps then we will have the opportunity for comparative observations with scientific controls.

The relation of body rhythms to external natural rhythms does not go unmediated. Men can manipulate weather, build artificial environments, manufacture light and heat, and create a context of artifacts and human demands so insistent as to distract the attention of our bodies from our more natural environment and calibrate us instead to our man-made context. There is also the mediation of emotion-laden concepts and symbols about God and Nature. Those who believe in an anthropomorphic God of will and fiat and a Nature to be conquered must surely have their body energies mobilized differently from those who believe in a gentle Confucian Heaven or a Nature that is solace. Cultures vary in their prescriptions for subjugation to nature, harmony with it, or mastery over it, and therefore in their emphasis on being, self-actualization through activity, or doing.[7]

The way we think about human energy is culturally variable: it is conditioned by the social system we live in, and affects it. Images of human energy in a particular culture have often been based on metaphors borrowed from that society's primary energy source. For example, the Freudian concept of libido resembles the imagery of coal-fueled steampower: the idea that it comes from below the surface, that it is finite, that it must be harnessed.[8] Carl Jung's concept of human psychic energy borrows from the imagery of electricity: that it flows, that it can be canalized.[9] The current American debate over whether nuclear or solar energy should be emphasized is not just a dispute about practical sources of heat and fuel; it is a debate about metaphors that affect our concepts of human energy and hence affect how our society and culture relate to Nature. The difference between fossil fuel and nuclear energy is a difference between energy man can control and use as a surrogate and energy that might get out of control and consume us. It is also a difference between energy that can be tapped by private individuals or relatively small business enterprises and energy that can be mobilized only by large-scale capital and organization. Solar energy suggests pre-industrial metaphors. Once equipment is in place, solar energy is free, gentle, and lends itself to individualism, like wind power. As a metaphor for human energy, it comes closer to the kind of energy defined by the people who practice transcendental meditation or zen.

Ideas, values and symbols mediate our collective and individual stance toward the universe. So do clocks and calendars, which vary in their nature in different societies. Clocks are like money in that they are simply whatever a given society agrees they shall be.

The Mohammedan, Chinese, and Jewish ritual calendars vary from year to year in their beginning dates, because of problems of intercalating the lunar calendar and solar year. The number of seasons in a year varies for different peoples, influenced by when flora and fauna are available for food. Some have five or six seasons, rather than our four or others' two.[10] Some ancient cultures had a ten-day week; on Madagascar, the Tanala have a two-day week.[11] Ancient Mexico had a five-day week; so do some peoples in India and the East Indies.[12] The Romans had three eight-day periods in each month, and counted the days backward from the Ides, Calends, and the Nones of each month, which made time seem to stream forward to key points, like our calendars that say eight days to Christmas.[13]

According to Doob, speakers of the Luganda language in Africa are compelled by their grammar to note whether an event occurs within or before the 24-hour period immediately preceding the time at which the event is described.[14] In Europe many old clocks had no minute hands until the 16th century and the 24-hour day did not stabilize in all regions until the 20th century.[15] Now, clocks are calibrated to finer and finer units. Some societies have no clear and comparable units of time; their time is discontinuous. As Whorf pointed out, the Hopi language has no tenses, though it distinguishes events of long and short duration. In the Hopi culture, time is cumulative, not linear, and therefore not described in spatial metaphors as it is in English. The rising of the sun is for the Hopi not the sign of a new day, but of the return of yesterday in slightly different form.[16] The Balinese calendar was formerly punctual rather than durational, a device for classifying discrete self-sufficient days appearing and reappearing in endlessly repeated cycles, each a particular manifestation of the fixed order of things.[17] Differences such as these surely create differences in the synchronization of body time to nature.

Our body rhythms can be affected by how a society marks a lifetime's major changes: birth, puberty, entries into various aspects of adult life, retirement, death. Body rhythms and energy are also affected by other space-time patterns of social structure and processes: whether we live in an agricultural or industrial or post-industrial society; whether society's focus is primarily toward the past, the present or the future; what its demographic and ecological dispersals and aggregations are; the spans of its political jurisdiction, military control and economic transactions; the speed of its exchanges.

The essence of human ecology is the relation of time to space. The size of a human settlement affects its time budgets. So does the amount of space it occupies.[18] The greater the space of a society's interdependence, the more necessity for pluralisms in space and time to reinforce differences in social function. The broader the space the interdependence covers, the more need for homogeneity of common time markers in order to coordinate activities over space.

The spatial and temporal boundaries and structure of a whole society (including communication and transportation patterns, division of labor, systems of cities, and geopolitics, as well as concepts of various sorts) are important as frames within which society's rhythms are contained.

All of social life is rhythmic. The timing of our meals and sleeping follows a daily round. Other activities may have longer-range periodicities: business cycles, cycles in crops, interest rates, money supply, prices, central bank discount rates, real estate and construction activity, patent filings, stock market activity, and so forth. Epidemiology, crime, birth and death rates, migration patterns, and women's fashions, as well as a number of other noneconomic areas of human behavior, show cyclical patterns too.[19]

Then, as Doob has said, "The modal temporal perspective of society reflects and affects a modal philosophy of values pertaining to other behavior."[20] The rhythms of the arts of any particular society and culture help to reinforce or alleviate other social rhythms. Like the kindergarten band or the martial drill at boot camp, they seem to help us adjust to the order of the society we live in. Sometimes they help us resist it or prepare us for change.

In the 18th century, for example, when members of the American upper class on the southern Atlantic seaboard came together for dancing, they opened the event with a stately and formal minuet, a dance developed for European royal courts. But then they turned to more lively and individualistic jigs and reels.[21] One might have foreshadowed the American revolution by looking at the contrast between these dances.

By the 1840s Americans danced the polka; a little later, the waltz.[22] Both were unlike the minuet because the dancers were paired and moved freely over the floor—at a time when American farm couples were migrating freely in great numbers to the West and when American society was emphasizing laissez-faire and individualism. Nineteenth-century American music was becoming more vocal than instrumental during the period of shift from auditory to visual emphasis Marshall McLuhan has noted. Suddenly there were many new songs for school children, new church hymns, ballads for social causes, the songs of Stephen Foster, the Civil War's "Marching Through Georgia," "Dixie," or "Battle Hymn of the Republic." Instruments were played to sound like the human voice. Orchestral music became more like vocal music, like a chorale.[23] The significance of this emphasis on music like the human voice was that the human voice expresses human needs, desires, and will. Whatever the words might say, music in the 19th century was becoming more assertion than acceptance.

When American society became individualized, this helped break up old mercantile and status patterns. But it was not long before the individual units were restructured into new and different kinds of large institutions. Human will came to be expressed primarily through such organizations. Institutional changes

in music paralleled the industrial revolution. At a time when major technological changes were being made in industry, new musical instruments were developed and old ones changed, often from wood to metal, or they were given more precise metal parts—for example, the cylinder flute introduced in 1846. Beginning with Beethoven, brasses and horns were given more prominent places in musical compositions. By 1830 at American political rallies brass instruments had replaced the fife and drums; from the late 1830s to the end of the 1860s the oom-pah-pah of brass bands marked the beat of important urban celebrations.[24] Orchestras became increasingly large and complex over the same decades. Similar changes were taking place in industry. In the 17th and 18th centuries, concertmasters took over gradually from harpsichordists, but their role was still coordinative rather than interpretive and executive. In the 19th century the conductor became a time-counter and timekeeper in an era when the timeclock was also appearing for industrial work. As Henry Pleasants has said, in *The Agony of Modern Music,* when emphasis in performance changed from self-evident execution to speculative interpretation, the essential expressive quality of melodic interval was not in the notes but in the space between the notes and the manner by which one gets from one note to another.[25] At this point, the conductor became necessary and important, just as the manager was becoming important in industry.

Much post-Civil War 19th-century music put heavy emphasis on commandeering individuals into a collective order oriented to striving. But once the voice of human will had been thoroughly institutionalized in music, the voice of the vulnerable individual became lost. The beat was too domineering and the space between the notes did not allow enough latitude. In 20th-century music the individual voice sometimes reasserted itself. In the early 20th century, both in Europe and the U.S., orchestras became smaller again. Black music out of the fields, cathouses, and churches developed through the boogie woogie and blues into jazz. In both serious and popular music, syncopation appeared, misplaced accents, tonal distortions.[26] Serious music and dance often deliberately negated the old striding rhythms—for example, through use of the 12-tone row. But often the arts expressed a new kind of acceptance. In the musical compositions of John Cage or the choreography of Eric Hawkins the emphasis was on randomness and on the abandonment of human will in favor of tuning in to the accidents and silences of the rhythms in the physical world.[27] Later, electronic music tuned in more thoroughly. Although this music seemed to indicate submission to the universe, rather than the social order, perhaps this was because so much else did link the individual to the social order. As John-Raphael Staude has commented, computer programs may be the music of our times.

Cultural changes in rhythm have been expressed not only in music and dance but also in the so-called static arts. A house by Frank Lloyd Wright had

rhythms different from those of a Victorian house. The rhythms in a painting by Jackson Pollock were different from those in a 19th-century portrait by John Singer Sargent.

Taken as a whole, arts and letters have differed from era to era in their characteristic rhythms. For example, many 18th-century American artists and thinkers, constantly reminded that seasons came and went and came again and that ships went out to sea and returned again, assumed that time was also cyclical; and so, in many ways before the Enlightenment took hold, the rhythm of 18th-century American and Western European forms was one of balance and non-progression. This idea of balance appeared even in the Constitution and later in the idea that the free play of forces of capitalistic enterprise will always return to equilibrium. With the Enlightenment, there came a tension between the older balanced forms and new emotional pressures (related to new class pressures). In the 18th century the tension was described as a conflict between reason and emotion; in the 19th-century arts it was displayed as a contrast between classicism and romanticism, as the 18th-century will to moderation was being pressured by the unshaped, unformed emotional forces that represented a will to escape, to expand, or to aspire. During the 19th century, these tensions resolved themselves into greater emphasis on linear time, replacing the older concept of cyclical time, and the paradigmatic rhythms became triadic in a dynamic based on conflict and resolution. New rhythms arose out of this conflict and resolution and were thought to be progressive, moving toward climax (like moving toward heaven and trying to capture it). We see this in 19th-century music and novels, but also in 19th-century thought such as that of Hegel, Marx, or Compte. (To be sure, triadic forms had appeared in other times and places, but their rhythm and meaning might not be the same. For example, the old religious spatial triad of heaven, earth, and hell embodied a different orientation to time than 19th-century secular temporal triads.) Recent novels or social theories are less apt to take triadic form.[28]

It should be noted that temporal orientations vary not only from culture to culture and era to era, but also among different groups within a specific society and period—among ethnic subcultures, for example. Economic position also makes a difference. An old-money upper class may look backward in time. Present-day American elites are drawn from the kind of people who plan for and conquer the future. If a person has hope and self-confidence, he might forego present pleasures for future ones. In contrast, if the individual thinks the future will be bad, he may contract his temporal orientation. When future prospects are really bleak, the process of temporal integration of past, present, and future may disintegrate.[29] Oscar Lewis has claimed that the tendency of the poor to think only of the present is an adaptation to poverty.[30] Others have said

it is one aspect of the poor's self-indulgence that keeps them from making a future for themselves. Edward Banfield, for example, has argued that the poor are poor because of their present-orientation.[31] Cottle and Klineberg contend that the working-class individual is often deeply imbedded in a network of friends and relatives within a system of mutual rights and obligations, and that this is what ties him down to the present rather than marshaling his energies toward future goals.[32] Since "drive" requires physical energy, we have probably not given enough attention to the influence of dietary habits on the temporal orientation of the poor.

In most cultures, time-orientation is different for male and female. Until recently in the U.S. the man was expected to transcend his childhood, while the woman was expected to establish continuity between past and future. Cultural patterns conspired to make girls more passive toward time and less developed in ego.[33]

One of the most systemic models of how time relates to social grouping is that of Victoria Gioscia, who distinguishes between metachronic people, who tend to be ahead of social time, and anachronic ones who run behind; epichronic responses that rise "above" a given temporal social process, as in elation, mysticism or martial law, and catachronic ones, states of depression that sink below a given social temporal process; and degrees of rate tolerance that range from hyperchronic to hypochronic. Anxiety, alienation, and anomie are reactions against or responses to the "normal" temporal process, which is imposed by one dominant social group upon others who might prefer a different temporal mode.[34] Marcuse said in *Eros and Civilization,* "The flux of time is society's most natural ally in maintaining law and order, conformity, and the institutions that relegate freedom to a perpetual utopia . . ." The ability to forget leads to forgiveness. "Against this surrender to time, the restoration of remembrance to its rights as a vehicle of liberation, is one of the noblest tasks of thought."[35]

Membership in the great orchestra of external rhythms is to a considerable extent involuntary. Much of the linkage is through body rhythms, which in turn are closely correlated to the production of human energy. The most fundamental energy unit in the human body is adenosine triphosophate (ATP) of which glucose is the raw material. When a cell requires energy, its enzymes break up the bonds holding the larger molecule of ATP together in a process known as hydrolysis, water is formed and one of the phosphates is stripped away to form adenosine diphosphate. In this process, energy is released.

Chemical messengers moving through tissue fluids play an important role in coordinating body processes. Adrenocortical hormones help regulate metabolism and energy supplies, and influence the transmission of nerve impulses.[36] Protein and potassium then are among the main conductors of the intercellular

communication that is part of the sensory and memory process.[37] A hormone from the pituitary gland is also important in the process of carbohydrate metabolism. Its release must be timed to match and counterbalance levels of insulin and vice versa. Modern scientific knowledge about the role of hormones in the body and especially in relation to metabolism has come relatively recently and is incomplete, but we do know that the endocrinological-neurological system is profoundly interconnected with energy production and release in a process which is rhythmic and correlated with other body rhythms.[38]

Experts have even more to learn about the nature and effects of the great pluralism of rhythms that relate to the production and use of human energy. Body temperature, pulse, respiration, blood pressure, levels of protein in the blood, calcaemia levels, hemoglobin levels, lymphocyte count, adrenal secretions, liver functions, the kinds and levels of chemicals in urine, hunger, thirst, excretion, as well as sleep, all have rhythmic patterns.[39] Each day as DNA synthesis increases and drops, there is a ten-to-one difference between the amount of synthesis at the peak and at the trough.[40] Cell division reaches its peak in certain tissues and organs at various times of day or night.[41] Vigilance, acuity, subjective fatigue, mood, keenness of hearing, sense of time and possibly pain tolerance change in daily rhythm.[42]

According to Luce, secretion of adrenal hormones follows a definite circadian 24-hour rhythm, with the amount in the blood declining from midday to midnight and rising just before waking time in the morning. This rhythm is not present at birth but develops some time after the age of three.[43] Various other processes are correlated with the rhythms of adrenal secretions. Histamines, which affect the brain and possibly help to promote wakefulness, are at their peak in the hours of sleep when adrenal corticosteroid levels are at their lowest. The growth hormone is also at its peak of release during the time of deepest sleep.[44] On the other hand, the liver, which stores glycogen so as to regulate blood-sugar supplies around the clock, has used up much of its glycogen by 3 to 6 A.M. when adrenal secretions are rising.[45] Testosterone is 35 to 40 percent higher in early morning than at midnight.[46] Triglyceride (fatty acid) levels are at their peak when adrenal-cortical hormones are high.[47] The level of amino acids in the blood rises during the day as adrenal hormones are at their peak. Sodium and potassium are excreted mostly around midday and afternoon.[48] The peaks of body temperature, urine flow, heart rate and potassium excretion usually occur within the same four-hour span.[49] Ranges in body temperature seem to be closely correlated with metabolic changes: temperature and metabolism decline at night, regardless of meals or activity.[50]

Different specific areas of the brain have different cycles of brain waves.[51] The brain is the greatest energy consumer in the body, with glucose as its main energy source. Even in sleep it consumes 25 percent of the energy used by the

body. Circadian rhythm, linked to metabolic changes, modulates the frequency and amplitude of brain wave patterns.[52]

Luce concludes that we are constructed out of time as surely as we are constructed out of bones and flesh, and that many of our most serious ailments may be primarily ailments of desynchronization, disturbance of the very delicate timing that makes all our rhythms coordinate closely with one another. Adult diabetes may be brought on by the desynchronizing effects of stress or trauma or erratic schedules.[53] Desynchronization may also produce cancer and may be a main factor in some mental diseases.[54]

Certainly, people with mental problems have different rhythms and a different time sense than normal people. The psychopath may not feel that time is passing at all. It follows that attempts to cure various bodily breakdowns should be more keenly sensitive to the role of body rhythms and to their coordination—an insight yet to pervade medical practice.

Human circadian (i.e. daily) rhythms are prima facie evidence that the body is tuned to the rhythms in the physical universe. The more interesting issue is precisely how body rhythms are modified by social and cultural rhythms. As Pittendrigh has written, the human body is an autonomous oscillator which can be entrained by another periodic system; so is the individual cell. Free-running rhythms can be captured into entrainment by either a temperature or a light cycle and perhaps also by sounds. When the frequency of the driving rhythm is close to the organism's "natural" frequency, the latter assumes the frequency of the driver.[55] In a sense, all of social life is a periodic system or a pluralism of such systems.[56] The detailed question is just how social and cultural rhythmic entrainment affects body processes. What difference does it make to the individual body what kind of music is prevalent or the form dances take, or what kind of expression of physical energy society encourages?

Curt Sachs once argued that the rhythms of the world's music fell into three categories: striding rhythms, like the rhythms of our muscles; breathing rhythms; and polyrhythms which imitate the simultaneous pluralisms of the many rhythms of our bodies. He says striding rhythms characterized western music during the industrial revolution, breathing rhythms characterize eastern music, and polyrhythms are typically African.[57] Whether we can accept his categorization or not, we do know that musical rhythms have underscored major cultural differences, even within a single country at different stages. Perhaps variations in cultural responses to nature's rhythms and in individual links to social rhythms work through differences in physiological emphasis that determine which one of the body's rhythms shall be the conductor of the body's rhythmic band.

In the 1930s, John Martin published a little book called *The Modern Dance,* attempting to explain how music and dance rhythms relate to the individual's

psychology and how they help link the individual to society. Martin pointed out that rhythmic accents set up expectancies because they occur in regularly recurring groups. To get your attention the artist must provide something not too different from your experience but also not too close. He condenses and eliminates to bring his material within the scope of your unit of perception. Accents, which are the basic beat, express some common denominator of human experience. The more crucial and universal the reference, the more potent the beat. Tempo varies according to the number of events per unit of time and their rate of occurrence. Moods of quietness, heaviness, excitement or grandeur are conveyed by the number of beats to the measure and which beat is accented. Regularity or irregularity of stress, short or long pauses, slow or fast tempo convey different moods. In the space between the beats, the individual psyche and body time are brought into coordination with the common elements the beat signifies.[58] As Gisele Brilet has said, "If silence is an escape in the direction of future possibility, it is also a taking into custody of the past."[59] What we need to know is how the human body responds in physiological detail in the space between the notes, in the intervals between the beats, and how the individual's self-image and his cognitive set toward the world help to vary his response.

Time sense affects the occasions and focus of energy release. The experience of time through rhythms helps the individual define his personal identity. His sense of identity plays a part in selecting the rhythms to which he will attend. As Erik Erickson has shown, self-image changes at different stages in personal development;[60] and as Jean Piaget has shown, self-image is correlated with the cognitive schemata (especially ideas of time) through which the individual screens his perception of the world and therefore his susceptibility to the imprints of different kinds of rhythms.[61]

When a newborn infant is in a state of primal unity with his mother, he is in a state of timelessness. A child's awareness of time comes with the process of distinguishing himself from his environment (mother), breaking free from unity with primal context, which happens when his needs are not always gratified immediately, so that he has to endure tension, but when there is some regularity in self/other contacts and in relief from his tension. Attending and expecting involve a self-reference. Through awareness of time and through rhythm, the sense of self develops. The "I" develops as a continuity construct for the discontinuous "me."[62]

How time, rhythm, and identity are related from that point on probably varies from culture to culture. As Altizer describes: "the Indian or Chinese mystic begins by identifying all his experiences with the rhythms governing the universe (sun and moon), but once this 'cosmication' has been achieved he turns all his efforts toward unifying the sun and moon, toward taking into himself the cosmos as a whole; he remakes in himself and for himself the primal unity . . ."[63]

Time in the usual Western social meaning of the word is an experience of the developing ego and helps to form that ego as it organizes the self for I-other relationships. The three primary aspects of time as understood in modern Western society (permanence, succession, and simultaneity) can only be synthesized and understood in time, which requires an enduring ego. The individual selects and reshapes what time he pays attention to; he also projects some aspects of time. Stabilization of time sense results from and contributes to self-stabilization. As Nathan Adler has said, "The time hypotheses of the individual serve to stabilize the environment and aid both in the reception of and protection from stimuli."[64]

Stages in the individual's capacity for cognition, stages of development of self-identity, and stages of ability in time perception influence one another, as various scholars have demonstrated. If the child develops normally in Western society, gradually, after about the age of ten, his concept of time grows more firmly linear, organized around the growing sense of self and a growing awareness of the continuity of society. During this process of psychological maturing, diverse body rhythms have become gradually stabilized and coordinated.[65] The human body and the ego are both precipitates of experience.[66] In this process, external social rhythms play a role (regular meals and bedtimes, regular holidays, etc.). Adolescent physical and psychological changes disrupt the process but new stabilizations and coordinations are required anyway, because the rhythms of adult context are different from those of childhood milieux.

There is a continual interplay between the individual's natural or acquired rhythms and those of the milieu in which he finds himself. According to Schutz and Luckmann, "Continuation of the acquisition of knowledge is above all conditioned and limited by the changes in the tension of consciousness and the rhythm of inner duration, which show themselves subjectively to be the limited aspects of corporeality, attentiveness, and 'will power.' Acts whose scope exceeds the duration of individual phases of this rhythm must be interrupted in order to be picked up again later. Certain acts which are inserted into world time (the seasons, social time, etc.) demand periods of waiting until the 'right' time has come, and must be interrupted when the 'time' is 'over' in order to be taken up again later. . . . The scope of acts in its turn refers to elements in the situation which are imposed above all on the spatial, temporal, and social structures of experience."[67]

Body rhythms do vary with age.[68] The oxygen consumption of the brain falls off rapidly between childhood and adolescence and then undergoes a gradual progressive decline.[69] Physiological clocks run faster when the metabolic rate is faster, which is one reason why time seems to pass more slowly for a child. Experimental scientists have found that increased body temperature unconsciously increases tapping rates, even while the subjects of the experiment

adhere to former conscious verbal temporal judgments. Differences in metabolic rate affect attention span—hence the adult's span of attention is longer than that of a child.[70]

Metabolic rate affects the amount of energy available for activity, and the child's energy is often expressed simply as activity. Energy expressed as violence may be triggered by adrenaline spurts so that the metabolic rate is speeded up. Stress maximizes the production of ATP so that biological time is contracted at the molecular level, correlated with changes in metabolic rate.[71] On the other hand, energy expressed as creativity seems to be highest when lower frequency brain waves are ascendant—that is, when the brain is in a relative resting state as well as when the right hemisphere of the brain, emphasizing holistic gestalt and intuitive perception, is not excessively dominated by the left hemisphere's verbal analytic mode.[72] Energy expressed in Eastern ways has another set of physiological manifestations, Barbara Brown writes: "Some introductory forms of zen and an occasional yoga sect advocate emptying the 'mind' and entering the 'no-mind' state in which there is no primary focus of attention. In sharp contrast, certain advanced zen meditations and nearly all yogic meditations involve intense concentration. These two quite different activities of mind are accompanied by quite different patterns of brain wave activity.[73] ". . . [S]tudies of advanced practitioners of yoga show significantly altered EEG patterns."[74] (The EEG is the electroencephalogram that measures brain waves.) The goal of transcendental meditation introduced into the United States by Maharishi Mahesh Yogi is to tune body rhythms to the fundamental cosmic rhythms so that the individual may tap the whole energy of Being for his own.[75] Presumably this occurs when theta brain waves are ascendant, the ones associated both with dreaming and sudden insight. Advanced research on linkages between different forms of human energy and the rhythms of the sociocultural and physical environment will probably measure the metrics of all this—the precise tempos involved. Although greater knowledge can yield greater individual self-direction, it is also possible that detailed knowledge of such metrics would make possible a vast planned choreography that could become the ultimate social control.[76]

In his book, *Cybernetics,* in 1948, Norbert Wiener claimed that the phase length of the alpha rhythm (the resting rhythm of the cortex, with a pulse rate hovering near 10 per second) was very close to the length of the perceptual moment before time changes from simultaneity to succession.[77] Our culture treats the second, which is measured by the translation between two energy levels of the isotope cesium 133, as its basic unit of time; other societies use different and usually longer basic time units,[78] units less temporally close to the natural temporal patterns of the firings of neural cells that assimilate and transmit external rhythmic sensory input. Surely timing of natural body rhythms is

crucial to the process of entrainment by external rhythms and vice versa but there are serious gaps in our knowledge of rhythmic linkage processes. One gap is the absence of comparative studies of how cultural difference affects physiology, and how the entrainment process is affected by culturally variable differences in the individual's self-image and cognitive set.[79]

The essence of time, at least as we know it, is duration.[80] Perception of duration requires attention span, which is affected by metabolism, which can be altered by hormones triggered by emotions. Our experience of duration is related to the temporal process of neural response to sensory input, a process which is both electrical and chemical and is closely correlated with metabolic process.[81] The basic unit is the neuron. In the absence of synaptic input some neural cells are silent, but others have different kinds of spontaneous rhythmic firing patterns. The mechanism of synaptic transmission of new information between cells is rhythmic.[82] (What EEG records is a statistical average of the pulsing of thousands of neurons either in a resting or more active firing pattern.) Electromyogram recordings of muscle electrical activity often reflect a basic rhythmic pattern like that of EEG-recorded alpha brain waves.[83] Triggering of rhythms other than spontaneous ones depends on the nature and intensity of the stimulus, and the receptivity of the person, which is influenced by his age, degree of habituation to the stimulus, mental and physical health, personality configuration and temporal orientation, as well as by situation, including time of day, motivation, and task involvement.[84] The temporal pattern of the stimulus must be near to but different from the normal unconscious rhythmic patterns. The space-time pattern of the original experience is then replicated in the pattern of neuron firings, though the assimilated rhythms are sometimes at harmonics or sub-harmonics of the stimulus frequency.[85] The temporal sequence of stimulation may result in the organization of a neural pattern in the brain like that of the original stimulus. Awareness then may be defined as the effect on an aggregate of neurons of its own configuration of activity.[86] Imagining or reflecting about an activity may trigger the same brain wave and muscle response as does the original stimulus.

Many of our responses to rhythms depend upon memory. There is short-term memory, which may last up to thirty seconds or up to a few hours if there is rehearsal, and which encompasses visual, auditory, olfactory and motor memory as separate but analogous and coordinated systems. There is also a long-term memory.[87] Research suggests that short-term and long-term memory are two separate systems or two separate processes and certain time intervals are required for information to be coded and stored from one to the other.[88] Theories of how the brain functions are still tentative, though currently science is leaning to the view that the brain works like a holograph, with any one part being able to produce the whole picture. Experience of temporal duration is a

cognitive memory process, a function of the information remaining in storage during a given interval rather than simply the information input during that interval. However, increasing the number or complexity of events will increase the size of storage and as storage size increases the experience of duration lengthens.[89] If too many items are presented, short-term memory decays very rapidly.[90] Coding is a function not only of the external input but also the attention, motivation, and prior cognitive set of the individual.

Scientists disagree about the nature of long-term memory. One hypothesis is that it requires synaptic growth which in turn requires an increase in brain metabolism of a special kind, with the manufacture of proteins and other macromolecules required for the membranes and the chemical transmission mechanism. Long-term learning does not occur when either cerebral protein synthesis or RNA synthesis is greatly depressed by enzyme poisons. The necessary synaptic growth takes from about 30 minutes to three hours, though 20 minutes is often the duration of initial memory consolidation and sometimes consolidation time is much shorter.[91] Experiments indicate an initial phase of information storage which does not involve protein synthesis and which is capable of mediating recall for less than three hours.[92] Brain wave frequencies vary in relation to different stages of the memory process.

As John has summarized, "the experienced constancy of the self, the apparent simultaneity of the rich texture of sensations, the continuity of purpose and meaning in life itself, must arise from statistical processes with certain invariant characteristics, arising in aggregates of millions of neurons."[93]

The ego plays a role in integrating sensorimotor, emotional, and intellectual reactions. How this integration occurs and what effect it has on body rhythms and the supply and focus of basic human energy has still to be fully understood. We do know that the hippocampus in the brain plays a primary role in endocrine control and in expansion of emotional states, and that it integrates emotions and feelings with other sensory input;[94] we also know that the rhythms of that section of the brain are particularly labile. As a stable set of concepts or constructs, the ego is an aspect of or depends upon long-term memory. Biofeedback studies have demonstrated how much cognition can affect unconscious body processes, so that heart rate, blood pressure, body temperature, muscle reaction, and brain waves can be consciously controlled. The physiological question is how the ego and the mechanisms of long-term memory direct or contain emotional responses and the more labile short-range rhythmic coordinative functions of the brain.[95] Long-range social cycles are also correlated with our span, but in ways we do not yet fully understand.

Much more research must be done on the relation between human energy and social energy if we are to understand better why some societies are more productive or creative than others. Productivity is probably the result of a suc-

cessful harnessing of body rhythms to external socially imposed rhythms. Creativity probably arises out of a long-range rhythmic pattern, not a single state, but we lack specifics as to how the pattern demonstrates itself over time.[96]

There are also questions about how social rhythms affect individual physiology. Does will to conquer the future, an important stimulant of adrenal hormones, thereby create a different chemical state than the absence of such a will? American society generates a high degree of anxiety, which may stimulate adrenaline, which is an important part of the metabolic process. But too much anxiety can be traumatic and lead to desynchronization and dysfunctionalism.[97] How does conscious time orientation affect the rhythms of individual body processes, especially those related to metabolism and the meshing of those rhythms to social rhythms? What is the aggregate effect of timing patterns on the quality of a given civilization? In a given culture, what kind of time sense and rhythms create maximum happiness and emotional well-being? Timing is essential to the grace of a dance, the efficacy of a joke, the evocativeness of celebrations,[98] and the art of leadership, as well as to general and individual psychological and physical well-being, but we have not dissected its mechanisms.

For society, the issues are ultimately ones of value choices. What kind of urban pattern, work pattern, and societal pattern is optimum? And what kind of civilization, involving what kinds of timing, should be fostered?

In the wake of the industrial revolution came a long campaign to eliminate child labor and to decrease the working day from 12 or 15 hours to 8 or less, followed by greater routinization of work within the shorter working spans. In the wake of our contemporary leisure society, some people campaign for more regular and demanding work. Apparently most of us need some external socially determined schedule as a frame of reference for our body rhythms, providing that schedule also allows for freedom. But what is freedom in rhythmic terms?

Various tests have shown that when people are given more control over their own time, as in the policy called flextime in the U.S. and *gleichzeit* in Germany, they tend to be happier and better adjusted than they are when tyrannized by the assembly line or time clock. That is, if they are expected to work a contractual number of hours in a week or month and are allowed to bunch the hours according to their own tastes and needs, they are healthier and happier and the work is done better.[99] Experiments on assembly lines have shown that more productivity results when groups of workers are allowed to vary the speed of the assembly line according to their own natural pace, or when workers are allowed more role in the total process and hence have more sense of control over the process.[100] Better coordination between external rhythms and body rhythms is probably the reason for the good results. On the other end of the scale, one reason so many men die so soon after retirement probably is that their complex bodily processes are desynchronized by the absence of firm schedules. Opinion

seems to be turning away from the Benjamin Spock school of child-rearing that says feed the baby when he cries, back toward an earlier method of fixed feeding schedules. With fixed schedules, the child's body rhythms have an orderly framework within which to adjust internal body-rhythms to one another. The issue bears not only on the way basic human energy is produced in the first place, through the metabolic process, but also whether that energy is suppressed or released, and how it is put to social use. Tacitly there is a gross national temporal aggregate just as there is a gross national product. How that time store is deployed—how much of it is put to collective use, for whom, and for what purposes—profoundly affects aggregate wealth measure in non-economic as well as economic terms.

We have only begun to apply insights pertaining to time and rhythm to our policies concerning the social and artifactual structuring of family urban life and education. And we have scarcely begun at all to apply them to a better conscious design of culture.

Major cultural changes generally entail major changes in social rhythms, which is why such cultural revolutions can be so disturbing and compelling. (Think of the social rhythm changes introduced by Mao Tse Tung or Hitler.) Spurts of social energy mark the beat of social rhythms. The individual is caught within these, but he also helps create them. They are both guides and opportunities. For the individual, the question is how his personal rhythms and personal space-time field can relate to social, economic, and cultural rhythms in a way that serves his interests best.