Chronoastrobiology: proposal, nine conferences, heliogeomagnetics, transyears, near-weeks, near-decades, phylogenetic and ontogenetic memories


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Abstract

“Chronoastrobiology: are we at the threshold of a new science? Is there a critical mass for scientific research?” A simple photograph of the planet earth from outer space was one of the greatest contributions of space exploration. It drove home in a glance that human survival depends upon the wobbly dynamics in a thin and fragile skin of water and gas that covers a small globe in a mostly cold and vast universe. This image raised the stakes in understanding our place in that universe, in finding out where we came from and in choosing a path for survival.

Since that landmark photograph was taken, new astronomical and biomedical information and growing computer power have been revealing that organic life, including human life, is and has been connected to invisible (non-photic) forces in that vast universe in some surprising ways.

Every cell in our body is bathed in an external and internal environment of fluctuating magnetism. It is becoming clear that the fluctuations are primarily caused by an intimate and systematic interplay between forces within the bowels of the earth -- which the great physician and father of magnetism William Gilbert called a ‘small magnet’ -- and the thermonuclear turbulence within the sun, an enormously larger magnet than the earth, acting upon organisms, which are minuscule magnets.

It follows and is also increasingly apparent that these external fluctuations in magnetic fields can affect virtually every circuit in the biological machinery to a lesser or greater degree, depending both on the particular biological system and on the particular properties of the magnetic fluctuations.

The development of high technology instruments and computer power, already used to visualize the human heart and brain, is furthermore making it obvious that there is a statistically predictable time structure to the fluctuations in the sun's thermonuclear turbulence and thus to its magnetic interactions with the earth's own magnetic field and hence a time structure to the magnetic fields in organisms.

Likewise in humans, and in at least those other species that have been studied, computer power has enabled us to discover statistically defined endogenous physiological rhythms and further direct effects that are associated with these invisible geo- and heliomagnetic cycles.

Thus, what once might have been dismissed as noise in both magnetic and physiological data does in fact have structure. And we may be at the threshold of understanding the biological and medical meaning and consequences of these patterns and biological-astronomical linkages as well.

Structures in time are called chronomes; their mapping in us and around us is called chronomics. The scientific study of chronomes is chronobiology. And the scientific study of all aspects of biology related to the cosmos has been called astrobiology. Hence we may dub the new study of time structures in biology with regard to influences from cosmo- helio- and geomagnetic rhythms chronoastrobiology.

It has, of course, been understood for centuries that the movements of the earth in relation to the sun produce seasonal and daily cycles in light energy and that these have had profound effects on the evolution of life. It is now emerging that rhythmic events generated from within the sun itself, as a large turbulent magnet in its own right, can have direct effects upon life on earth.

Moreover, comparative studies of diverse species indicate that there have also been ancient evolutionary effects shaping the endogenous chronomic physiological characteristics of life. Thus the rhythms of the sun can affect us not only directly, but also indirectly through the chronomic patterns that solar magnetic rhythms have created within our physiology in the remote past.

For example, we can document the direct exogenous effects of given specific solar wind events upon human blood pressure and heart rate. We also have evidence of endogenous internal rhythms in blood pressure and heart rate that are close to but not identical to the period length of rhythms in the solar wind. These were installed genetically by natural selection at some time in the distant geological past.

This interpretive model of the data makes the prediction that the internal and external influences on heart rate and blood pressure can reinforce or cancel each other out at different times. A study of extensive clinical and physiological data shows that the interpretive model is robust and that internal and external effects are indeed augmentative at a statistically significant level.

Chronoastrobiological studies are contributing to basic science – that is, our understanding is being expanded as we recognize heretofore unelaborated linkages of life to the complex dynamics of the sun, and even to heretofore unelaborated evolutionary phenomena. Once, one might have thought of solar storms as mere transient ‘perturbations’ to biology, with no lasting importance. Now we are on the brink of understanding that solar turbulences have played a role in shaping endogenous physiological chronomes. There is even documentation for correlations between solar magnetic cycles and psychological swings, eras of belligerence and of certain expressions of sacred or religious feelings.

Chronoastrobiology can surely contribute to practical applications as well as to basic science. It can help develop refinements in our ability to live safely in outer space, where for example at the distance of the moon the magnetic influences of the sun will have an effect upon humans unshielded by the earth's native magnetic field. We should be better able to understand these influences as physiological and mechanical challenges, and to improve our estimations of the effects of exposure.

Chronoastrobiology moreover holds great promise in broadening our perspectives and powers in medicine and public health right here upon the surface of the earth. Even the potential relevance of chronoastrobiology for practical environmental and agricultural challenges cannot be ruled out at this early stage in our understanding of the apparently ubiquitous effects of magnetism and hence perhaps of solar magnetism on life.

The evidence already mentioned that fluctuations in solar magnetism can influence gross clinical phenomena such as rates of strokes and heart attacks, and related cardiovascular variables such as blood pressure and heart rate, should illustrate the point that the door is open to broad studies of clinical implications.

The medical value of better understanding magnetic fluctuations as sources of variability in human physiology falls into several categories:
1) The design of improved analytical and experimental controls in medical research. Epidemiological analyses require that the multiple sources causing variability in physiological functions and clinical phenomena be identified and understood as thoroughly as possible, in order to estimate systematic alterations of any one variable.

2) Preventive medicine and the individual patients’ care. There are no flat ‘baselines’, only reference chronomes. Magnetic fluctuations can be shown statistically to exacerbate health problems in some cases. The next step should be to determine whether vulnerable individuals can be identified by individual monitoring. Such vulnerable patients may then discover that they have the option to avoid circumstances associated with anxiety during solar storms, and/or pay special attention to their medication or other treatments. Prehabilitation by self-help can hopefully complement and eventually replace much costly rehabilitation.

3) Basic understanding of human physiological mechanisms. The chronomic organization of physiology implies a much more subtle dynamic integration of functions than is generally appreciated.

All three categories of medical value in turn pertain to the challenges for space science of exploring and colonizing the solar system. The earth’s native magnetic field acts like an enormous umbrella that offers considerable protection on the surface from harsh solar winds of charged particles and magnetic fluxes. The umbrella becomes weaker with distance from the earth and will offer little protection for humans, other animals, and plants in colonies on the surface of the moon or beyond.

Thus it is important before more distant colonization is planned or implemented to better understand those magnetism-related biological—solar interactions that now can be studied conveniently on earth.

Thorough lifelong maps of chronomes should be generated and made available to the scientific world. Individual workers should not have to rediscover cycles and rhythms, which can be a confusing source of variation when ignored. By contrast, once mapped, the endpoints of a spectral element in chronomes can serve everybody, for instance for the detection of an elevation of vascular disease risk.

Chronomic cartography from birth to death is a task for governments to implement, thereby serving the interests of transdisciplinary science and the general public alike. Governments have supported the systematic gathering of physical data for nearly two centuries on earth in order to serve exploration, trade, and battle on land and on the seas, and indeed agriculture. These government functions have been augmented enormously with satellite technology in more recent decades.

The biological comparison with regard to government support and chronomic needs would be the mapping of the human genome. The complete sequences of DNA might have eventually become available due simply to countless individual laboratories publishing piecemeal results in scattered journals. But there would have been enormous redundancy and confusion in assembling and piecing the information together. The waste of time and money involved in the redundancy and confusion would have been considerable. A coordinated effort to systematically gather the information and develop a system for cataloguing it was considerably more rational.

The exchanges that have taken place over four years of scientific meetings on this topic have confirmed the great scientific promise and potential practical value of chronomic lines of research, and also the need for larger and organized, sooner rather than later, life-span-covering physiologic monitoring initiatives.

Geologists are concerned that the earth’s magnetic field is waning or even collapsing, and if this trend continues it might be as much as centuries before this umbrella protection from solar winds is gone. Yet it is possible that generations in the near or far future might look back and be grateful that our generation was looking ahead to their welfare so that they could know what to expect and would have time to prepare for their safety. © 2004 Elsevier SAS. All rights reserved.

Keywords: Chronome; Chronomics; Chronobiology; Astrobiology; Chronoastrobiology

1. Summary

The term ‘chronoastrobiology’ is derived from ‘chronome’ (time structure) and ‘astrobiology’ (reciprocal implications of biology and space studies). It was the title of a proposal for the development of a chronoastrobiology research initiative on 8 February 1999 by Franz Halberg, Germaine Cornelissen, and Othild Schwartzkopff of the University of Minnesota in Minneapolis; Daniel C. Holley of San Jose State University, California; and, within the US National Aeronautics and Space Administration (NASA), by Charles M. Winget of the Ames Research Center, Moffett Field, California (Appendix 1).

Developments in the five years since 1999 are discussed here. Progress is reflected in 387 published titles from the University of Minnesota and many more by others, and nine international conferences. This discussion will make special reference to the historical context in Russia, where non-photonic ‘heliobiologic’ effects have been widely documented and accepted.

Chronoastrobiology extends to a concern for life’s origins and eras before our own and their evolutionary effects on the temporal organization of psycho-physiological functions in today’s living organisms.

To be sure, the discipline seeks practical as well as basic knowledge. It strives to optimize psychophysiology for life on earth and elsewhere, with focus on disease prevention, or ‘prehabilitation’, as well as rehabilitation. It is sensitive to the challenges of extraterrestrial colonization and to the fact that maintaining good health in space in the absence of hospitals may require special understanding of the interactions between human physiology and cosmic forces that occur largely in an otherwise neglected so-called normal range.

An illustrative, now 38-year glimpse of the new kinds of physiological information obtained from longitudinal monitoring follows in Appendix 2.
Results document the need for government-supported systematic psychophysiological lifelong monitoring. This need has been endorsed by an international meeting in a unanimous resolution (Appendix 3), after an earlier endorsement by the Russian Academy of Medical Sciences and a series of international meetings, starting with the International Union of Physiological Sciences.

Chronoastrobiology and its parents, chronobiology and chronemics, are here to stay; they might produce an understanding of where we came from, of what we can now do for prehabilitation to forestall the need for rehabilitation, and of how we can thus get safely to where we wish to go in space. This challenge has been under-appreciated in the US by contrast to endeavors abroad.

The findings in hand underscore the need to improve a bioscience and health care system based on evaluating data from spot-checks by eyeballing. The alternative is a time series-based, computer-analyzed time structure unfolding and quantifying everyday physiology, rather than leaving it obscured by the misleading notion of a homeostatic thermostat-like set-point in the fiction of an unresolvable ‘normal’ range of variation.

Focus upon the detection and treatment of risk elevation related to magnetic fluctuations is particularly needed for travel in extraterrestrial space; it also promises immediate spinoffs for people living on the earth’s surface, generally from cost-effective prehabilitation to replace rehabilitation as soon and as far as possible.

2. Exogenous rhythms: only conditioned reflexes?

Russia currently offers, as it has for the past century, a favorable intellectual climate for the study of time structures, chronomes, both in our environments and in our bodies (see conference report [1]; and other conferences [2–8]). This is hardly surprising. Early in the 20th century, Ivan Petrovich Pavlov (1849–1936), for generations Russia’s most celebrated biocientist, was alert to record the time of day at each step of some of the now-classic studies in Russian and world science. Pavlov’s conditioned reflex paradigm was misused by the Stalinist regime’s Lysenkoism to suppress other science. Yet on both sides of the iron curtain, conditioned reflexes were usually invoked to account for biological rhythms in classical physiology and psychology — in the West up to 1949 [9] and in the East [10] for much longer.

Eventually the conditioned reflex model “impressed from without and persisting from within” [9] was replaced by an appreciation for built-in endogenous rhythmicity, at first for circadians when it became clear by 1950 that circadian rhythms were inborn in inbred strains of mice [11]. These are more than a phenomenon reacquired by each individual, whether reflexive, imprinted or ‘learned’. Lighting and other environmental cycles rather than generating periodicity de novo synchronize the organism’s endogenous rhythms (such as in newborn human infants) with daily activity and nightly quiet [9]. Thus in human twins as well [11] as in earlier forms of life such as unicells and bacteria 11,12, the about 24-hour circadian cycle was found to have been genetically coded.

3. Exogenous rhythms: a heliobiological echo without explicit evolutionary aspects

Pioneering Russian chronobiologists went far beyond circadians to focus on circadecadal (about-ten year) changes, and they deserve to be widely known beyond their homeland where they were revered: Alexander Leonidovich Chizhevsky found an about 10-year cycle in 100 years of statistics on the incidence of cholera and described life on earth as “an echo of the sun”. Chizhevsky was deservedly offered a Nobel Prize in 1939 but was forced to turn it down by the Stalinist government, and was even imprisoned from 1942 to 1958 [13–15].

Nikolai Dmitrievich Kondratiev, the founder of the Moscow Conjuncture Institute, detected economic cycles of about 50 years [16]. “Kondratiev organized (the Conjuncture Institute) in October 1920, at a time when the creation of centers for business cycle analysis was an international phenomenon” (albeit without estimates of the uncertainty of the cycles’characteristics). A group of economists associated with Kondratiev proposed, as an alternative to Stalin’s forced industrialization policy, a market-led program … Kondratiev … hoped that the Conjuncture Institute would

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1. It has been joined by other nations, as documented by two symposia in Brno, Czech Republic [2,3], one in Munich, Germany [4], and four in the last four years in Tokyo, Japan [5–8] and more already held and anticipated further this year.

2. Political and personal aspects relating to pioneers in a budding scientific discipline discussed herein and elsewhere by invitation may appear to be irrelevant to the heading of this and the following paragraphs as well as of a few others. Their inclusion indicates a change in the views of the senior author, who for most of his active lifetime has separated the topics of the history of business and political cycles on the one hand and spirituality on the other hand from his professional biomedical endeavors. In view of the cyclic notion of ‘Never again’, at 85 years of age, he feels that it will be important to make cycles in politics, economics, bioterrorism and ethics in particular a concern of interdisciplinary science, if some of the transdisciplinary problems are to be approached by science, simply because other methods have failed. Science cannot try to contribute to society if it remains divorced from politics, economics and, in particular, ethics, all intertwined by complex intermodulations, yet all characterized by variability, the focus of chronomics. By noting this, the senior author finds that his concerns were shared by other physiologists, but, in the case of the coiner of "homeostasis", among others involved in bioethics, without an attempt to extract from cycles information on underlying mechanisms. Prior approaches to cycles in turn have often disregarded their wobbliness, that requires estimates of their uncertainties, resulting in part from multifrequency intermodulations that await mapping.
demonstrate to the (Stalinist) leadership the inadequacy of their understanding of the Soviet economy. Instead, the institute was closed permanently in 1930, when he was arrested. In September 1938, he was sentenced to death” [17].

The politics of ‘state vs science’, including Lysenkoism aside, already before glasnost visitors could find various sites in the former USSR that were rhythm-conscious. Physicists cooperated closely with biologists and the top administrators were open to a budding Western chronobiology to complement extensive Soviet studies summarized and popularized by Alexander Petrovich Dubrov [18,19].

4. A controversy resolved by data covering several solar cycles

The already-noted offer of a Nobel Prize pre-World War II notwithstanding, post-war Russian heliobiology, concerned with determining the effects of the sun, was greeted skeptically in the USA even post-war. Two large studies in the US on solar activity and mortality, and a search for the association between magnetic disturbances and mortality [20,21], reported no solar effect, perhaps since the observation span was too short, assessing less than one _10.5-year solar cycle and hence not permitting proper (chronomic) analysis, i.e. of any influence of cycles that are one or several decades in length and that may also differ in terms of geographic/geomagnetic locations [22–27]. Feinleib, Sturrock, Rogot and Lipa had thoroughly analyzed their results that were at variance with the evidence reported in part earlier and later (Fig. 1a; see [24]), in similar and other contexts elsewhere ([13–16,18,22–27]; see Fig. 1b). Lipa et al. ([21]; cf. [20]) rightly left open the question whether the lack of an effect in their studies was related to the circadecadal solar cycle stage or number. Thus by implication, they allowed for the roles of variability in time (read periodicity), as well as in space (e.g. geomagnetic/geographic latitude [28,29]). Subsequently, the analysis of data from Minnesota collected during 29 years, covering several solar cycles, indeed revealed an excess of 220 myocardial infarctions/year during years of solar maximum, if one averages over the entire time span (Fig. 1c).

5. Unresolved secular variation awaits mapping

Differences with solar cycle number, e.g. among consecutive _10.5-year cycles in Wolf’s relative sunspot number have indeed been found in the case of mortality and/or morbidity from myocardial infarctions in Minnesota ([26,27]; see Fig. 1c). Geographic/geomagnetic differences may also play a role ([26,27]; and Fig. 1b). Much ‘secular’ (read unaccounted-for) variation may also be associated with solar cycle stages and/or, in any event, with patterns remaining to be mapped. Cases illustrating changes within a solar cycle from its minimum to its ascending stage are reported when effects in the minimum could not be confirmed in the ascending stage. Thus for human neonatal blood pressure, a difference in the circadian amplitude between babies with a positive versus a negative family history of vascular disease (that was statistically significant in the solar minimum) could not be confirmed subsequently and prompted us to start focusing on the cosmos [30]. Likewise, adult human circulating melatonin showed at middle latitude a half-yearly modulation by night only during the solar minimum.
6. Partly built-in non-photic cycles?

The evidence of the past 5 years' conferences [1–8] bears on the question of whether we resonate (only) concurrently in response to subtle factors that prevail at a given time (exogenous rhythm), as Frank A. Brown Jr put it originally, but not subsequently, when he coined the term ‘autophasing’ [32]; or again as an immediate physiological ‘reverberation’ to exogenous factors, i.e. as a mere echo of our sun and of the cycles in our cosmos, as Chizhevsky put it earlier [13–15,33]; or as reactive and, to that extent, exogenous periodicities, as Gunther Hildebrandt put it originally, but not later [34]. In all of these instances, the very early champions of the exogenicity of circadian rhythms switched to the acceptance of some degree of endogenicity. While citing the foregoing ‘phrases’ used by important pioneers in the field, we wish to qualify their stand and ours [11] by adding that almost certainly all scholars in the field increasingly realized that organisms are open systems, and that the debate on exogenous vs endogenous is primarily one of emphasis on the relative importance of one or the other aspect and approach.

The historical plea to recognize the extent of endogenicity (for a review, see [11]) is in keeping with the now general recognition of some built-in part played by the organism with respect to circadians. Evidence is accumulating to consider more than a concurrent or slightly delayed echo (physiological reverberation?) for rhythms other than circadian as well [35]. There is a spectrum of coded built-in cycles with components in us that were heretofore unknown or not mentioned in physiology textbooks; their periods near-match cycles around us ([25]; cf. [7,8,11]); they become manifest after exposure to single stimuli, which carry no information as to period, as documented best for circaseptans [25,26].
7. Exophased endocycling

In a model of exophased endocycling, the phase is exogenous and the period partly endogenous, in keeping with a demonstrated ‘free-run’ of endogenous circadians and circaseptans. For these rhythms, many replications of a cycle can be more readily tested than in the case of yet longer cycles. For the cycles with long periods, the nonoverlapping 95% confidence intervals (CIs) for near-matching external and internal cycles (with a length of, e.g. years or decades) strongly suggests some degree of endogenicity [36]. The use of exophased endocycling emphasizes by ‘exophasing’ rather than ‘autophasing’, that a number of rhythms appear to be ‘induced’ by a single stimulus, which has led to calling them ‘exogenous’. But the fact that a single stimulus carries no information about any period is a hint of endogenicity. This line of evidence, along with free-running, was emphasized by others in the early days of circadians [11] and by us for circaseptans and other non-photic cycles that act as triggers.

8. Illustrative examples of ‘single stimulus induction’ or rather ‘manifestation’ after a single stimulus

A kidney transplant is followed by rejection episodes at about 7-day intervals, as removal of a kidney induces a wave of DNA-labelling and mitotic peaks at 7-day intervals. Human birth is associated with many amplified population cycles such as the biological near-week, month, half-year, transyear and decade, presumably all coded by natural selection as cycles of non-photic origin. The use of endocycling thus refers to the particular cycle length as a built-in feature, yet it is also eminently suited for resonance. Endocycling complementing exophasing, i.e., internal mechanisms contributing to a cycle’s length, are not always stated but probably implied in the short phrases cited by pioneers who originally assumed that even circadians were purely reactive, as in the case of Frank Brown before he coined the term ‘autophasing’.

9. Non-photic/photic amplitude ratios

Pertinent evidence for endocycling includes chronostatistical studies reported in the published proceedings of eight conferences [1–8]. Further evidence of endogenous chronomic components stems from the shift in the course of ontogeny [25] and phylogeny [26] of the ratio of the amplitudes (A) of the biological signatures of certain non-photic cycles vs the signature of the photic cycle with the nearest period length. Illustrative amplitude ratios are the A of the week vs that of the day or the As of the transyear (e.g. of _1.3 years) or of the _10.5 or _21-year vs the A at the calendar year [37]. The genetic coding in life of photic cycles such as the alternation of day with night is more prominent in Escherichia coli and in cyanobacteria than the coding of a near-week or circaseptan component, which is not detected in air bacteria and staphylococci [11,12].

By contrast, there is a transient prominence early in ontogeny of the biological near-week over the circadian rhythms in certain variables of a unicell [11], crayfish [38], rat [39], pig [40] and human baby [11]. Some relatively early forms of life such as Acetabularia have coded non-photic unseen cycles around us, and traces of this coding appear early and consistently in the ontogeny of non-human animals and of human newborns. These non-photic schedules may have been the major ones that life was exposed to at the bottom of the sea or in the interior of the earth with no known cycles of light and darkness, or in some other cosmic location in the possible event of panspermia. This theory holds that reproductive bodies exist throughout the universe and develop wherever the environment is favorable. Hence, the proposition that life could have come from other entities in the universe...
verse cannot be ruled out. We can assume, however, that life may have developed before photosensitive pigments did, and it certainly came about before eyes developed.

10. Biological mimicry of longer than yearly oscillations found in satellite data

In 1994, John D. Richardson, at the Massachusetts Institute of Technology in Cambridge, USA, found oscillations with a period of about 1.3 years in the changing speed of the solar wind, i.e. the particles ejected into space by the sun [41]. In 2000, Kalevi Mursula and Bertalan Zieger further reported a change in the same speed measurements, as a function of Schwabe's circadecadal cycle in sunspots from about 1.3 to 1.6 years [42]. By now, a longer series has become available as Omni2 (http://nssdc.gsfc.nasa.gov/omniweb/ow.html) which combines data from several satellites, displayed in both the time (Fig. 2a) and frequency (Figs 2b and 2c) domains. The naked eye would miss these oscillations without a model like that included in (Fig. 2c).

A peak in the periodogram of Fig. 2c reveals a component with an about 1.3-year period, as well as an ~1.054-year periodicity, each with a 95% CI that does not overlap the precise calendar year. Gliding spectral windows in Fig. 2d, with time on the abscissa and frequency on the ordinate, show as contour maps during the 1970s, first a component with a period of 1.3 years which gradually lengthens until it is of about 1.6-year length by 1978. Thereafter, this component disappears, to reappear only before the end of the millennium. Still in the early 1970s, there is also a component of about 1.0-year length. A very prominent 1.3-year is apparent only in the late 1980s and early 1990s. The transyearly components in the global spectral windows of Figs 2b and 2c are indeed wobbly components and not spectral lines or even consistent bands.

Solar wind data have been recorded only during the past several decades. Hence, it seemed worthwhile in Figs 2e and 2f to gauge another kind of solar activity during a different prior timespan, as the Wolf numbers after filtering shows that for spans of 60 years a transyear can be present after it had been undetected (with the resolution used) for even longer time spans.

Any artifactual damping possibly resulting from combining solar wind speed data from different satellites remains unvaluated. These and other qualifications notwithstanding, it is noteworthy that in life on earth a relatively very small change outside us in the solar wind, unseen except for
aurorae, can be prominent at certain ages [36]. To many biological time series, the qualification of artifacts from combining time series from different satellites in different locations does not apply. The dynamically changing patterns of some physical variables such as solar wind speed (Fig. 2d) and Wolf’s relative sunspot numbers (Fig. 2e) qu-
lify the wobbly nature of the unseen transyears around us. With this qualification, in any time series, we define a transyear as a spectral component resolved with a 95% CI between 1 and 2 years, overlapping neither of these lengths of time. Such a component of biological time series— a mimicry in length of the changes in the speed of the solar wind— can override in us the effect of the seasons at middle latitudes [36, 37, 43–46].

As to biological time series, there are also qualifications such as changes in diagnostic criteria of morbidity and/or of treatment and/or of monitoring instrumentation. Table 1 shows the problem resulting from gaps in the data. Sooner rather than later, systematic equidistant biological monitoring, following the precedent set in physics, will be mandatory.

When the solar wind data obtained from satellites that now cover several decades are aligned with biological data we learn that the human transyear may be genetically coded. One line of evidence stems from non-overlapping 95% CIs of near-matching periods in and around us, a criterion that had earlier led to the recognition of the built-in nature of circadians [11]. The precedent of the biological week as a counterpart of a weak near-weekly component in terrestrial magnetism, found by biologists [25], originally led to the proposition of reciprocal natural environmental and biological periods [25].

That natural cycles in magnetism [25] have human-made socio-techno-environmental counterparts is now documented for the case of the week [47], confirmed [48] and recognized as a putative gauge of global magnetic pollution [49].
That circadians have entered our genes early in phylogeny, even at the stage of bacterial evolution, is now amply recognized, after having been disputed for decades by opinion leaders in the field who depended on eye-balling of data and classical rather than time series statistics ([11,12]; cf. [50–53]). If non-photic cycles are also coded in genomes, this would be much more than a mere echo of solar events. The next task is to explore the genetics of these non-photic periodicities at the molecular level; this is, of course, most readily considered in the homeland of Chizhevsky and of Vladimir Ivanovich Vernadsky [54].

### Table 1

<table>
<thead>
<tr>
<th>Series N</th>
<th>Data series (units)</th>
<th>ATY/AY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17-KS (daily) (mg/24 h)</td>
<td>1.21</td>
</tr>
<tr>
<td>2</td>
<td>Urine volume (daily) (ml)</td>
<td>0.61</td>
</tr>
<tr>
<td>3</td>
<td>Kp (daily) (AU)</td>
<td>1.40</td>
</tr>
<tr>
<td>4</td>
<td>Wolf N (daily) (AU)</td>
<td>28.7</td>
</tr>
<tr>
<td>5</td>
<td>Kp (matching dates) (AU)</td>
<td>1.28</td>
</tr>
<tr>
<td>6</td>
<td>Wolf N (matching dates) (AU)</td>
<td>0.93</td>
</tr>
</tbody>
</table>

* Covering (with gaps) 15 years; N data: 3719; N days: 5476; AU: arbitrary units. For 17-KS, the transyear has a ratio larger than unity, as do the environmental cycles, when all available data are analyzed. Gaps reduce the ratio, a methodologic hint to seek data that are dense and equidistant. Whether the difference in ratio between the urine volumes (in which the 17-KS were determined) and the 17-KS themselves, indicating that the operation of time keeping steroidal mechanisms is subject to subtle environmental influences, is a topic in need of long-term research on the degree of reproducibility of these results.

Fig. 2f. A least squares periodogram with trial periods between 2.0 and 0.5 years was computed with harmonic increments=0.05. For approximations at every trial period, several statistical parameters were estimated, including the coefficient of determination (i.e. the percentage rhythm). A global spectral window of WN residuals is shown on the right, with peaks corresponding to bands around 1–1.3 yr and around 0.8–0.6 yr. These bands are not sharp, suggesting that the spectral components are not stable (non-stationary). A gliding spectral window confirms this hypothesis and is plotted as a contour map (surface chart prepared with Microsoft Excel software). There is no obvious consistent variation as a function of time in the gliding spectral window (left) of components seen in a global spectral window (right). A 1.3-year component, as shown in black shading, is prominent at one time, less prominent in gray at other times, or may not be resolved at still other times. Differences in prominence with shading coming and going are also seen around the trial period of 1 year rather than at precisely 1 year. Thus, among many other components, all transient with the resolution used, we find that the sunspots, like the solar wind and geomagnetism, have some near-years that are not exactly yearly, and also have some components of about 1.3-years, all time-varying if not transient. © Halberg.

11. A broad scope of chronomics in Russia

Many individuals in the former Soviet Union, not mentioned in this paper, are critical for the discipline and have contributed to reference [1] or to papers cited herein. Against this background, the current mentors of the field of chronobiology in Russia are Feodor Ivanovich Komarov, Vice-President of the Academy of Medical Sciences, the author of a classic text in the field [55], with a second
volume recently published, and Academician Yuri Alexandrovich Romanov, who focuses on spatio-temporal diversity. The latter topic has been the lifelong interest of George Silvestrovich Katinas [56], who found circasemiseptans in the laboratory after transplantation. Katinas documented the prominence of extra-circadians in the population density of endotheliocytes, including circasemiseptans in wound healing broadly as a feature of temporo-spatial diversity. Vsevolod Ivanovich Medvedev is another opinion leader in the Academy of Sciences; Victoria Pavlovna Karp co-wrote a book with Katinas on the methodology of rhythm analysis; Mikhail Arkadyevich Blank of St. Petersburg is identified with oncochronotherapy. Blank extended rhythmometry based on the behavior of mitoses first to other variables, doing so by extending focus from circadians to circasemiseptan and circasemiseptan aspects [57] and mapped about 24-hour cycles in the bone marrow and tumor mitoses of laboratory animals [58] and cancer patients [59], demonstrating that mitoses in a number of malignant tumors are in near antiphase with those in the bone marrow, one of the targets of side effects from anti-cancer drugs.

Blank’s results on chronotherapy constitute steps to introduce tumor marker rhythm-guided chronotherapy [60], which should be effective when host markers of myelotoxicity are not used and vice versa, whenever a major side effect and the effectiveness of therapy are in antiphase. Recently, in a thesis by his wife Olga Alexeevna Blank, an effect of extremes in terrestrial magnetism, both storms and magnetic calm, reportedly interacts with the extent of thrombopenia and leukopenia in clinical radiotherapy [61]. Basic data on susceptibility rhythms to anticancer drugs had been contributed earlier in their laboratories in Moscow by Mikhail Viktorovich Berezkin [62] and Tatyana Pavlovna Ryabikh, whose great credit is again the extension of focus to infradians, a step toward chronomes [63–68].

Rina Mikhailovna Zaslavskaya, also of Moscow and the author of several books ([69,70]; cf. [71]), introduced time-microscopic chronocardiology with the help of Mikhail M. Teibloom, in a long series of publications. She has compared timed with conventional treatment and found, with a lower dose, faster and greater efficacy with fewer side effects from her cost-effective chronotherapy. Chronocardiology is independently a field of major contributions by Nubar Levon Aslanyan in Yerevan, Armenia [72], who is now focusing on the circulation during pregnancy. Aslanyan has also written a comprehensive book on the worldwide history of chronobiology [73]. The ontogeny of circadians has been of interest to Gennady Dmitrievich Gubin, now in Tyumen, and that of about 7-day rhythms to his son Denis Gennadyevich Gubin [74,75].

Elena Vasilievna Syutkina, of the Institute of Pediatrics of the Russian Academy of Medical Sciences, again in close cooperation with physicist Anatoly Viktorovich Masalov [35], deserves credit for picking up where Chizhevsky left off. Syutkina's over-decade-long studies suggest that not only the biological day and year, but also the biological week, decade and transyear, somewhat longer than the calendar year, can all be detected in the human newborn; they may be built into the gene pool of the population [76–88]. Her studies covering more than a decade make her the undisputed worldwide leader of chrononeonatology. Among many other contributions, she showed that the effect of exposure to betamimetic drugs in utero lasts into adolescence, as demonstrated by chronobiologically assessed results from blood pressure monitoring and an enlarged left ventricular mass index [83]. With her, the study of neonatal rhythms has become a topic of chronobiology, a partly genetic, partly inferential statistical branch of physiological clinical science in its own right. Chronomics, the cartography of time structures, had started on the same basis [11].

12. Two meetings in Moscow and one in nearby Pushchino within two months

Many topics on cycles of anthropogenic and social as well as physiological and clinical processes and their temporal variations were discussed from March 1–3, 2004 [1], at the Russian People's Friendship University (RPFU) in Moscow; from April 6–9, 2004, in a workshop in Pushchino on “Biological effects of solar activity”, organized by the late Alexander Konradov of the Institute for Biochemical Physics in Moscow and Boris Vladimirsky of the Crimean Astrophysical Observatory in Bakhchisarai, Ukraine; and from April 22–24, 2004, at a meeting in Moscow on “Pathophysiology in contemporary medicine”, again at RPFU. At the March meeting, about 200 scientists, mostly from different regions of the former USSR, celebrated the 80th birthday of Professor Karl Hecht of Berlin, Germany [89]. At this meeting, Hecht introduced ‘Quisi’, an instrument for the home monitoring of the EEG for sleep studies. This meeting was organized by one of us, Sergey Mikhailovich Chibisov (SMC), Professor of Physiopathology at the RPFU, and Breus ([90–93]; cf. [94]), of the Space Research Institute in Moscow, the latter a solar scientist who in a series of endeavors with physicians, had, like Chizhevsky [13–15,95], long argued that magnetic storms are bad for human health ([90–93]; cf. [25–27]). It was timely for Breus and SMC to conceive of a meeting that constituted a further, much needed bridge between physics and biomedicine. Cities can lose their electrical power when the sun is ‘angry’, i.e. produces a magnetic storm that eventually has consequences in the form of blackouts on earth. Breus has suggested, supported by analyses of western scientists, that blackouts can also extend to the human heart and brain, and possibly other tissues ([90–93]; cf. [94]).

In a book co-authored by Breus, Roman Markovich Baeovsky – the leading Russian cardiologist in space medicine – K.V. Schebushov and SMC [92], SMC demonstrated electron-microscopically that magnetic storms drastically alter the structure of the myocardium in addition to shifting the phase of circadian rhythms in systolic and diastolic blood pressure in rabbit hearts, as reported elsewhere ([92,94]; he
reports distended mitochondria, broken myofibrils and an increase in the amount of lipid; cf. [46,92]). Breus had also published a book on the general topic of solar effects on biota with Semen Isakovitch Rappoprt, containing references to many Western studies [93]. The evidence concerning magnetic storms and myocardial infarctions has now been further analyzed by time-varying coherence and phase-synchronization [96], a further step in the footsteps of what Chizhevsky [95] cited poetically from two 19th-century French scientists, Jean-Baptiste André Dumas and Jean-Baptiste Dieudonne Boussingault, who compared humans with fishes, except that humans ‘swim’ in the atmosphere while fishes swim in water. We are indeed in continuous touch with the atmosphere and with influences upon it.

The sun and other cosmic entities all affect our open systems’physiology, psychology and pathology: at the meeting he implemented, SMC documented this by securing in inferential statistical terms, i.e. by time-microscopy [1,46,94], the drastic pathophysiological changes he had reported earlier from his experimental laboratory by electron-microscopy [92]. SMC also obtained data (eventually under conditions to be standardized for environmental temperature, lighting and magnetic fields) to ask whether and, if so, to what extent the transyears (which we do not see) may be more important than the year (which we do see) by fitting to his data a 1-year and a 1.3-year cosine curve [46]. In three variables out of four, the transyear had the numerically larger amplitude. But in 29 years of mortality from myocardial infarctions in Minnesota, the transyear, albeit present and statistically significant, contributes much less than the year to the overall variability. These results are noted only to point to the need for longer time series; they support the advocacy of continued studies in laboratory animal chambers controlled not only for lighting, temperature and ad libitum feeding with shielding from noise and aggression, but preferably also controlled for and compensated for changes in magnetic fields.

SMC’s data on rabbits were complemented by data on hundreds of human babies provided by Syyutkina [76], whose team had earlier shown a correlation between the period lengths of about 7-day rhythms, the circaseptans, of blood pressure and heart rate, on the one hand, and the circaseptans in local geomagnetic activity on the other hand ([86]; cf. [91]). In blood pressure and heart rate data of babies, a transyear could be shown to dominate over the seasons. In a data pool from a population of several hundred babies studied, largely with serial independence, as to babies for more than a decade, a component of about 1.3-year length, distinctly different from a precise year, had the larger extent of change (or double amplitude), as compared with the double amplitude at a trial period of precisely 1 year. The biological about 1.3-year changes have been recorded only for the past few decades, while there are satellites to carry instruments for measurements of changes in the speed of the solar wind. We may try to reconstruct how the solar wind behaved in the remote past by seeking in phylogeny, starting relatively early in prokaryotes such as air bacteria and staphylococci [37] and early in human ontogeny, a comparison of the relative prominence.

For certain variables and at certain ages, a transyear (e.g. an about 1.3-year) can be more prominent than the yearly change from summer to winter. This is found for oxygen evolution in Acetabularia, in the circulation of human babies and in the elderly, perhaps because the latter are less synchronized with their socioecological yearly cycles. Cycles such as the year and one or several transyears may have competed throughout evolution and may have become stronger at the time when Acetabularia developed, perhaps 500 million years ago. In the limited data covering a decade or longer, the relative prominence in this eukaryotic unicell of a transyear is greater in Acetabularia than in bacteria. We are dealing, however, with different variables, namely with oxygen evolution in the eukaryote and with sectoring, a probable mutation, in air bacteria, including staphylococci.

As reported in Pushchino [37], the presence of the transyear in bacteria suggests that almost certainly this feature was acquired not too long after the beginning of life on earth. (Time series on Archaea as yet are unavailable for us, but would be extremely desirable!) In bacterial series, the transyear’s amplitude was smaller than that of the biological (calendar) year in five of eight series, in one series the transyear’s amplitude is only slightly greater and in three series a cis-year (slightly shorter than a year) was found, again only slightly greater in amplitude than the 1-year fit, as summarized in Fig 3. This figure also shows that in a eukaryotic (nucleated) single cell, Acetabularia, the transyear’s amplitude is bigger than that of the year in terms of its extent of change. This finding applies to time series that consist of changes (from serially independent studies, each assigned to the calendar date of its midpoint) of circadian MESORs, amplitudes or acrophases.

What we see in the unicell, we can also see in a particularly interesting variable related to biological timekeeping in humans, such that in 15 years of data on the excretion of certain steroidal hormonal metabolites. In this case overall, there is no consistent precise yearly component and just a number of transyearly components, each statistically significantly longer than 1 year, as reported in Moscow ([1,45]; see Fig. 4a). By contrast to the steroidal behavior in the volumes of urines in which the hormonal metabolites were determined, the 1-year component is most prominent, with a numerically higher amplitude than that of the transyear, Table 1. We must not generalize, however, as can be seen from Fig. 4b, which shows that the behavior of heart rate contrasts with that of blood pressure. Blood pressure shows a prominent yearly component whereas heart rate shows transyears gaining in prominence with age and on the average a cisyear, which after the age of 40 years becomes a transyear.

Why should we worry about transyears vs years? The two phenomena, transyears, a brand-new finding in biomedicine
can amplify each other when they are in phase, i.e. when the explored as photoperiodism, can coexist (Fig. 4c) and if so [36,43,44], and the match of the calendar year, extensively S156

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**Fig. 3.** A spectral component with 95% confidence intervals (CI) between 1 and 2 years, overlapping neither of those lengths, called a transyear, is present early in phylogeny, in a unicellular eukaryotic alga's oxygen production and in 'air bacterial' and staphylococcal sectoring, i.e. in probable genetic microbial changes [37]. There are differences in relative prominence, however. The ratio of the amplitude of the transyear over that of the precise year is the gauge. This ratio is above unity in the one unicell studied from this viewpoint (*Acetabularia*). By this gauge, a transyear dominates over the biological equivalent of a calendar year, whether one analyzes a time series consisting of circadian MESORs (chronome-adjusted means), circadian amplitudes or acrophases. In a large mix of 'air bacteria', there is a near-(trans) year. This transyear in air bacteria is very close to the exact 1-year length, even though there is no overlap of the year by the CI of this transyear. For most staphylococcal cultures, the amplitude at a calendar year is larger than that at a transyear; hence the ratio is smaller than unity, except for colo-

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**Table 1**

<table>
<thead>
<tr>
<th>Period (years)</th>
<th>A/Y (dimensionless, log scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>1.1</td>
<td>0.7</td>
</tr>
<tr>
<td>1.3</td>
<td>0.9</td>
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<tr>
<td>1.5</td>
<td>1.2</td>
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<tr>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>1.9</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* Greater prominence of TY in *Acetabularia* and some (not all) prokaryotes. TY defined as (one or several) spectral peak(s), each showing a 95% confidence interval lying between (and not overlapping) precisely 1 and 2 years. Some spectral component(s) in the TY range may represent modulations of 1 cycle in 1-3 Y by an ~5-year cycle.

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**Fig. 4.** Initiations or exacerbations of disease, even sudden death, and remissions of disease may conceivably relate to such interaction between two or more near-matching but distinct periodic mechanisms in the circulation or in variables influencing the circulation for which heart rate and blood pressure may be markers if they are not etiologically involved. It will be important to seek mechanisms with periods that are close in length but sufficiently different to augment each other or cancel each other out, as seems possible for the components in Fig. 4a (lower quarter, left). We have seen a beat ([36,43,44]; see Fig. 4e) and we can expect, and what is critical, we can test for more and for their consequences, once longitudinal series are continuously collected, an urgent task.

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13. The about-weekly, decadal and a broader spectrum of cycles and sampling designs

The story of the competition between the transyear and year is similar to that between the week and near-week. Both the near-week and the transyear are built in, as shown in a variety of ways, including close but different lengths as suggested, if not established, by non-overlapping uncertainties (95% CIs) of the objectively determined cycle lengths. The analysis of long serial data on populations and individuals has shown about 10.5- and/or 21-, and/or 50-year and even 500-year cycles. All of these cycles may be found as different components in the same variable, such as hormonal metabolites, blood pressure or heart rate measured around the clock for up to one or several decades. Any beating consisting of cancellations and augmentations cannot be detected in cross-sectional studies, where many people are studied for short times, with sampling designs that ignore the rhythms relying on imaginary baselines. For chromonic maps, in turn, that are pertinent to any study, there is a need to study at least some individuals longitudinally for decades or preferably for lifespans.

A consensus of the meeting in Moscow [1] concerned the need for government institutions to take charge of the monitoring by especially devoted subjects to enable them to continue systematic monitoring preferably for their lifetime, and to enable others or their families to start monitoring preferably from birth or at whatever age volunteers become available. As put by a journal editor, we need not be 'flying blind' [97], not knowing what happens today in terms of external–internal interactions. We monitor space weather but do not yet use it because biological effects are not popularized or believed to be insignificant and controversial. Spot-check medicine has not yet realized that hypertension, and probably many other symptoms, constitute an intermittent condition, even under treatment (Fig. 5), and any effect of magnetism [25] sounds far-fetched.
Taking a 24-hour ambulatory profile is still a spotcheck; from the viewpoint of a 24-hour rhythm it is equivalent to taking an ECG for one second. A still greater limitation applies to the assessment from 7-day records of a circaseptan rhythm, since in human adults the circaseptan amplitude is much smaller than the circadian. For diagnosis and therapy, we need series of a length that allows the assessment of infradians that can modulate circadians, the more so now that drugs for individualized treatment have been developed and become available. Individualized chronotherapy can be based on different drugs, whether we wish to lower an excessive amplitude of blood pressure or raise the variability of heart rate, when it is too low, as discussed elsewhere.

At the March 1–3 meeting [1], Rina Mikhailovna Zaslavskaya contributed a clinical therapeutic highlight: She had reported earlier, with Komarov, that melatonin can lower blood pressure in patients resistant to conventional antihypertensive therapy. Dr. Zaslavskaya has now extended her findings to patients with other problems involving the circulation, including patients with heart failure and angina [98,99]. Reportedly, her patients derived therapeutic benefit from melatonin as it lowered the number of anginal attacks and the number of occasions when nitroglycerine was used, and improved the ECG. An association between melatonin and the blood circulation was noted earlier by Lennart Wetterberg in an international broader-than the Japanese/USA study of various endocrine indicators of disease risks [100].

A basic clinical report by Malinovskaya et al. [101] reported that the response to changes in the terrestrial magnetic field of seven healthy volunteers 18–39 years of age, as compared with that of 42 patients 53–76 years of age, was different when gauged by melatonin in 24-hour urines. Along a scale from ‘calm’ through ‘disturbed’ to ‘stormy’, melatonin excretion of the elderly patients was higher during a calm magnetic span than during a disturbed or stormy span. In the younger group, melatonin excretion was lower for both extremes vs. the disturbed, presumably usual geomagnetic index. An age effect will also have to be considered [102].

Constantin A. Shemerovsky, a scholar following in the steps of Pavlov in the latter’s city of St. Petersburg, interested in particular in the rhythms of intestinal motility, has

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Fig. 4a. Transyears in both a 15-year series of the daily excretion of steroidal hormones (left) and in the urine volume in which these hormonal metabolites were determined (right). Note in urine volume the precise 1-year spike with a much smaller peak corresponding to a transyear. Also note an about-half-yearly component that is not of precisely one-half year length. By contrast, in 17-ketosteroids, there is no half-year or precise year, only 3 transyears, one a near-year, another of about 1.3 years, and a third at about 1.6 years. The time course of the transyears awaits scrutiny by a gliding spectral window. The difference between the two variables may perhaps correspond to a greater degree of endogenicity in the behavior of 17-ketosteroids as compared to that of the volume of urine. An effect of terrestrial magnetism may underlie near-transyears, while heliomagnetics contribute more to ~1.3 and ~1.6 years. © Halberg.
communicated plans for another meeting next year. While in the West solar physicists are practically absent at medical meetings, this year’s meeting in Moscow involved solar physicists to a considerable extent but that can still be improved upon (Table 2). It is good to see substantial cooperation on chronomes in an integrative context in a country devoted to the study of non-photic as well as photic cycles, with many enthusiastic scientists active in it, with leaders like Dean Frolov of RPFU, who organized the meeting [1]. One outcome of this meeting could be the purchase of monitors for use by university medical students serving as test pilots for the transyear. It was a pleasure for BIOCOS, thanks to support by the A&D Company, to have been able to offer, in Russia or elsewhere, every interested person willing to collect data locally or on himself/herself according to a protocol of the individual’s choice (including monitoring for personal health), a great (85%) price reduction for the purchase of ambulatorily functioning monitors, so that we do not fly blind, notably in the country of Chizhevsky, Vernadsky and Kondratiev.

Major scholars who could have made contributions were unfortunately missing [103–110], as was one of us, GSK, who had been sent to the USA on a 6-month visit by the USSR in 1971, and who has made Minnesota his academic home for the past 6 years and has implemented longitudinal mapping on himself. In half-hourly systolic blood pressure measurements over 6 years of GSK, the 95% CI of the transyear does not overlap the 95% CI of the concurrently matched solar wind speed’s transyear [36,43]. These findings are in keeping with the assumption that the non-photic transyear may have been built into our evolving genome, as in the case of the circadian rhythm related to the much more prominent photic and thermic environmental day. 

Table 2
Cooperation among physicians and/or other biologists with physicists has begun in Russia; currently at 10.4%*: it requires transdisciplinary intensification, as does the use of inferential statistical methods by physicians, biologists and physicists alike

<table>
<thead>
<tr>
<th>Presented by:</th>
<th>No. of abstracts</th>
<th>Percentage</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians</td>
<td>114</td>
<td>54.1</td>
<td>81.1</td>
</tr>
<tr>
<td>Biologists</td>
<td>49</td>
<td>23.2</td>
<td></td>
</tr>
<tr>
<td>Physicians and biologists</td>
<td>8</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>18</td>
<td>8.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Physicians and biologists</td>
<td>7</td>
<td>3.3</td>
<td>10.4</td>
</tr>
<tr>
<td>Physicians and biologists</td>
<td>11</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>Physicians, physicians</td>
<td>4</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Inferential statistical</td>
<td>36</td>
<td>17.1</td>
<td></td>
</tr>
</tbody>
</table>

* 211 abstracts were used to classify participants at the 2nd International Symposium on “Problems of Rhythms in the Natural Sciences” in Moscow (March 1-3, 2004). Those dealing with geology, geophysics, mathematics and engineering were classified as ‘physicists’; abstracts from pedagogical universities and colleges, devoted to symptoms or treatment of various diseases, were classified as presentations by ‘physicians’; physiologists and pathologists were classified as ‘biologists’ rather than as ‘physicists’.

In *Les origines humaines* (‘Human Origins’), Edouard le Roy distinguished two stages in evolution: one starting with the origin of life, the other starting with ‘hominization’, the appearance of humans [111], who with their language created what we call civilization or culture, if not yet a chronobiology. Vernadsky used le Roy’s concept of the noosphere, i.e., the sphere of the human mind as an achievement from the emergence of hominization. Russian scientific endeavors aligned this noosphere with the broader

14. Transdisciplinary atlas of the human noosphere

In *Les origines humaines* (‘Human Origins’), Edouard le Roy distinguished two stages in evolution: one starting with the origin of life, the other starting with ‘hominization’, the appearance of humans [111], who with their language created what we call civilization or culture, if not yet a chronobiology. Vernadsky used le Roy’s concept of the noosphere, i.e., the sphere of the human mind as an achievement from the emergence of hominization. Russian scientific endeavors aligned this noosphere with the broader
biosphere, embracing all living matter on the yet broader earthly lithosphere, hydrosphere and atmosphere, and the still broader mineralosphere of the cosmos. The actually nine (cf. [1–8] and [37]) meetings here distilled, notably [4], seek the inclusion, by a scientific approach, of something even more critical than the mind, i.e. of an ethosphere [11,112–114].

A special round table at the March 1–3 meeting [1] was held against the background of an atlas of temporal variations in natural, anthropogenic and social processes already published under the sponsorship of the Russian Federation for Basic Science and the State Scientific Program on Global Changes of Environment and Climate [113]. Azarj G. Gamburtsev advocated the extension of this ambitious
Fig. 4d. Beating between 1.0- and 1.3-year components leads to reinforced and cancelled oscillations alternately as a function of time. © Halberg.

Fig. 5. Even in the absence of changes in treatment, systolic MESOR-hypertension and circadian hyperamplitude-tension, as gauged by the MESOR (top) and double amplitude (bottom) of systolic blood pressure, respectively, are time-varying phenomena. The dots corresponding to 1-day intervals of data collected half-hourly are sometimes above and sometimes below a reference value developed from peers of the same gender and age. Such variable behavior, even in the absence of changes in treatment, strongly suggests the need to develop inexpensive tools to continually assess and interpret blood pressure behavior so as to adjust treatment as necessary. © Halberg.
accomplishment into an international endeavor, which could include health care topics for the individual but could also emphasize diseases of society by focusing on crime and terrorism. Thus, it would be concerned with mapping cycles in data on ‘good and bad’ customs and habits (= ethos), in an ethosphere including spirituality and morality (Fig. 6). By invitation of the participants at the round table, one of us (FH) was asked to outline methodological specifications, whereby to examine how chronobiology and chronomics could institute international mapping of the cyclic and other dynamics involved in the health and diseases of societies as well as of individuals. Mapping from birth to death, yet to be set up, should include ontogenetic and phylogenetic ‘memories’, to eventually serve in dealing with the optimization of ethics.

Chronobiology seeks the mechanisms underlying quasi-reciprocal cycles or rhythms found in and around us. Some seem obvious, like the light-involving, i.e. the photic and thermic environmental vs the biological day and superficially the (again) i.e. photic and thermic seasons vs the biological calendar year. The latter must now be qualified by the transyears. Indeed, unseen, non-photonic but assessable cycles are primordial insofar as they are prominent early in life and may be vestiges in us, yet functioning, among others, as ontogenetic and phylogenetic ‘memories’. The non-photonic cycles include, among many others, about half-weekly, about weekly, about half-yearly, trans-yearly (i.e. slightly longer than a year), about decadal, about didecadal, about quindecadal and even longer about multi-decadal cycles of populations. We here propose that their relative importance for a given variable, species, sex, age and other qualification be gauged by amplitude ratios, as illustrated in an abstract manner in Fig. 7 for the case of the week.

The known spectral element of cycles and rhythms covers in frequency 10 orders of magnitude in a human individual and is still broader in populations. Many of the rhythms and/or cycles that underlie life are synchronized; can be phase-shifted by ‘switches’, i.e. by light–dark and feed–starve cycles; and are influenced by (resonate with) presumably built-in non-photonic cycles that can, like magnetic storms, transiently override all other synchronizers for the case of magnetic storms [46]. Special focus on mapping
intermodulations of the reciprocal (in the sense of near-matching) internal and external infradian cycles in religious motivation vs crimes and atrocities with ultradian rhythms of the heart, the brain and the endocrines is overdue [114]. The finding of reciprocal cycles around and in us (omnis rhythmus, omnis cyclus e cosmo) [181] may prompt the alignment and scrutiny, among others, of interactions among cyclic physical environmental factors and cyclic or other changes in spirituality. Thereby, we anticipate finding an understanding of any physiologic bases of spirituality and thus, perhaps, the possibility to predict and prevent diseases of society, such as crimes and atrocities (Fig. 6).

15. Conclusion

A scientific optimization is needed and may become possible in endeavors inquiring into where we come from, into where we want to safely go, and most importantly, how we go about life in everyday physiology and psychology, including crime, bioterrorism, and accordingly ethics. An approach here advocated examines pertinent cycles of behavior in us and their visible and invisible counterparts around us, as these relate to many others, also to spirituality. As motivational cycles become in part measurable [114] and are found to be manipulable by physical environmental factors, an optimization may become possible. If so, we may conclude that to the extent that ontogenetic and phylogenetetic memories makes us understand where we come from, they may also help us construct a better future not only in extraterrestrial space, the task of a chronoastrobiology initiative, but also on Gilbert's terrella.

16. Epilogue and dedication

This paper is dedicated by the senior author to his many co-authors in this first 'white paper' and to even more in his bibliography on his website. In particular, FH is indebted to Miroslav Mikulecky, Emeritus Professor and Head Emeritus of the Department of Medicine and Professor of Statistics (a much better combination of disciplines by comparison with combinations of medicine with business [sic] administration, now common in the USA), at Comenius University in Bratislava, Slovakia. Miroslav has organized a series of three meetings on the cosmos and biology [103–105], preceding the conferences here 'distilled', yet laying a foundation for them (so that this position proper is based on 12 meetings rather than nine); to Lucien Baillaud, of Herbiers Universitaire de Clermont-Ferrand, France [108–110], who cautiously carried Mikulecky's message concerning chronoastrobiology to French scholars of rhythms; and to the late Alexander A. Konradov, who before his death on 18 May, 2004, wanted to focus on time-varying multifrequency phase synchronizations and on time-varying coherences [96] within living matter and among organisms and their environments; to Suitbert Ertel, who did not shy away from testing links between current science and astrology; and to Hans W. Wendt, Emeritus Professor of Psychology at Macalester College (St. Paul, Minnesota), whose references, hints and occasional computations are very greatly appreciated.

Baillaud's reflections concerning accepted and controversial lunar cycles, meteorology and agriculture, pertinent to, but beyond the scope of this paper, remind us that Hyde Clarke, in the Railway Register in 1838 [115], first described a cycle in economics that coincided with a cycle in solar activity, in the same year in which Schwabe [116] published data revealing a clear cyclicity in sunspots, but as yet did not dare to write about periodicity until he had assembled several additional years of data by 1844 [117]. Biology must also focus on other cycles such as those reported by Pales and Mikulecky of about 500–600 years in human cultural growth [118]. It is only a hint to find a cycle characterizing famous physicians [118] to correspond (in length only) to one of tree ring width [119], and to another in international battles [36], all with overlapping 95% confidence intervals.
The postulate that, just like physical growth, cultural growth does not appear continuously but occurs in wavelike creative outbursts [118], prompted Emil Pales and Miroslav Mikulecky to analyze three sets of famous physicians, 44 of Greek and Roman, 18 of Chinese and eight of Indian origin, living between 700 BC and 1400 AD, tabulated as numbers per century (or half a century for the Greco-Roman data). By periodogram and cosinor, Pales and Mikulecky reported a cycle of about 500 years for the periodic emergence of great physicians in the histories of these three regions widely separated geographically. We confirm the findings of Pales and Mikulecky by linear–nonlinear rhythmometry, for the emergence of great physicians (Fig. 8a) and for the emergence of great historians and poets (Fig. 8b), while to be

Fig. 8a. About 500-year cycles in the emergence of famous physicians are visible to the naked eye, and seem to be synchronized in three completely different regions. © Halberg.

Fig. 8b. About 500-year cycles are also apparent in the emergence of famous historians and poets. © Halberg.
rigorous, the cosinor, of course, requires the prediction of the period of an anticipated cycle.

Whenever a solar origin is postulated in physics, economics, agriculture or psychophysiology, the postulate of quasi-reciprocal cycles in and around us [26] can be helpful, and indeed some solar rhythms exhibit cycle lengths found in biology and vice versa. But the physicists' records of aurorae and sunspots are not long enough to look for cycles half a millennium in length. It seemed of interest therefore to look again for a proxy marker of solar activity in tree ring widths that cover the past 2000 years or more, as others had done before us. We had analyzed 11 sequoias and had found a period of 534 years as the most prominent feature (Fig. 8c). In data taken from a published graph [120], an about 500-year cycle was also found to characterize the coloring of stalagmites, possibly reflecting changes in earth's subsurface temperature.

The average period from a nonlinear analysis of famous physicians from three different areas in our hands was 505.6, with 95% CIs from 462 to 549 years. The average period of famous physicians, historians and poets, and of similar cycles in the Wheeler index of international battles [121], tree ring widths and stalagmite coloring was 518.6 years (Fig. 8d). An acrophase chart at this average period is provided in Fig. 8e. The results cautiously encourage us to consider extrapolating backward by the dynamic (read: cyclic) biology of living matter today, to times for which there is no dynamic physical and only a dead fossil record. In so doing, physics could avail itself of biomedicine. Historically, physicists remember the physician William. Gilbert

Fig. 8c. Indirect proxy-approximations of solar activity via the effects of climate upon the growth of trees during spans when no other human dynamic indices exist. A cycle with a period of over 500 years here shown was obtained in the course of studies reported earlier [119]. A similar cycle was also found, among others, in the spectrum of international battles (in log-transformed data) with a period of 499 years and a 95% CI extending from 459 to 539 years, as also found in human creative cultural growth by Pales and Mikulecky [118]. © Halberg.

Fig. 8d. Chart of about 500-year cycles in the emergence of prominent personalities and in their environment.
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Fig. 8e. Acrophase chart of about 500-year cycles shown in Figure 8d, estimated at average period. © Halberg.

Fig. 9. A choice to be made concerning mapping by chronomics as a governmental task by administrators worldwide, including those of the (US) National Aeronautics and Space Administration, the (US) National Institutes of Health, and the (US) National Science Foundation. In space flight, the Challenger disaster likely resulted from neglecting the acceptable range of operational environmental temperature. To avoid disasters in biology, we can use time structural (chronomic) mapping and based on reference values thus obtained, we can implement continuous surveillance of individuals and societies within the so-called ‘normal range’. For space flight, involving a relatively wide range of temperatures, a piece of equipment may be safe to use, but once a threshold temperature has been exceeded, the likelihood of problems rises sharply (middle of graph). The situation that led to the Challenger disaster is here compared with the elevation of cardiovascular disease risk. The latter is associated with: 1) a decreased heart rate variability (gauged by the standard deviation [SD] of heart rate, right), with 2) an overswinging of blood pressure (CHAT) (left), both exhibiting thresholds (nonlinear behavior), with (not shown) 3) an elevated overall pulse pressure and 4) an elevated blood pressure average (MESOR) (the latter behaves linearly so that with every increase in BP-MESOR, there is an increase in vascular disease risk). Note that on the graph the increase in hard events follows only after a threshold is exceeded, and action before that threshold is reached (before a hard event likely occurs), can be prompted and implemented only by chronomic monitoring, and analyses in the light of a gender- and age-qualified data base. The merits of chronomics constitute a particular challenge in populations at high vascular disease risk. © Halberg.
relations and time-varying coherences, with changes in prominence, at multiple frequencies] without realizing it, and I'm infinitely grateful to you for having told me so."") (Molière: Le bourgeois gentilhomme, Act II, Scene V).

With available and yet to be extended methods, an atlas of the chronomes is at least as important as the mapping of the genome (Figs 9 and 10). The cycles are the reproducible aspects of the litho-, hydro-, atmo-, mineralo-, bio-, noo- and ethospheres, and hence this aspect of chronomes is essential, not only for genomics but far beyond, as a sine qua non for the intact maintenance of life on earth. Chronome mapping has to be a nationally and internationally coordinated effort in everybody's service. It can immediately change a health care based on spot checks for disease into one of chronometrically examined time series, seeking to detect risk elevation before the fait accompli of disease.

In comparing the yield of chronomics with that of genomics, e.g. in the service of cardiovascular disease risk assessment, genomics as yet has not equaled chronomics in detecting silent risks that can be substantially lowered for a cost-effective prehabilitation. This aspect of chronastrobiology [124–126] is critical for missions in extraterrestrial space, where an avoidable stroke can jeopardize a costly mission (Fig. 9). As a spinoff from equipment designed for use in space, a chronomic grew physiological observation device is needed, notably in areas of limited resources that can be offered for cardiac surgery and other procedures that are currently in use for rehabilitation.

References

nal blood pressure and heart rate in Moscow, Russia. Scripta Med (Brno) 1996;67(Suppl. 2):85–92.


Proposition dated February 8, 1999, to the US NASA Ames Research Center for Development of a Chronoastrobiology Research Initiative

Franz Halberg, Germaine Cornélissen, Othild Schwartzkopff, D. Holley, C.M. Winget

The foregoing paper and 387 other published titles reveal progress made in the interim of 5 years, including the finding of transyears as added ontogenetic and phylogenetic memories. The distillate of meetings eventually led to the resolution in Appendix II complementing an earlier resolution by the Russian Academy of Medical Science [124, 125].

Abstract

1 We propose to use existing devices, while developing less obtrusive instrumentation, as need be, for the monitoring of psycho-physiological, notably cardiovascular variables for alignment with ongoing recording of cosmo-, helio- and atmospheric as well as geophysical variables. Precisely because some of the periods of the spectral element of time structures (chronomes) in us may be genetically anchored, they may be more synchronizable by and/or more readily resonating with external physical environmental cycles. Ontogenetic and comparative studies may contribute as ontogenetic and phylogenetic memories to locating the sites and time course of life on earth by the sequences of integration of the rhythms into our genome, possibly revealed by their relative prominence in ontogeny and phylogeny. An example is the case for the prominence of the week early in the human neonatal circulation, also in certain variables of pigs, rats, crayfish and unicells.

2 Retrospective and prospective analyses of physiological records by least squares global and cross-spectral coherence, superimposed epochs, and ‘remove and replace’ analyses will seek associations with concomitantly obtained physical data. The evidence is to be validated by the concordance of results from different statistical approaches and by their reproducibility at a given site and by the patterns revealed in comparisons across several geographic locations (at different geographic and geomagnetic latitudes), where a long history of cooperation exists among participants of a project on The Biosphere and the Cosmos, the BIO-COS project.

3 Thereby, the time structures of key physiological variables are to be mapped in humans and other selected species at different stages of development to examine by means of a comparative physiological approach the extent to which the evolution of the physiologic time structures can lead to testable hypotheses concerning the origins of life.

4 A major benefit, as a dividend from basic work will be a reference data base for the identification of disease risk syndromes. Cases in point are too large a circadian variation in blood pressure, which is associated with a 720% increase in the risk of cerebral ischemic events, and too little heart rate variability, which is associated with a 550% increase in the risk of coronary artery disease. Putative triggers, such as the exposure to a magnetic storm, are to be further examined. Countermeasures are to be designed and applied in a timely fashion at optimal rhythm stages to lower risk and maintain health.

Focus is required on extra-circadian and circadian rhythms. These are superimposed on seemingly chaotic changes. Physical changes, as events or continuous records, monitored concomitantly, will be analyzed for matches or near-matches between geophysical features and biological ones, on earth and in space, retrospectively as well as prospectively. Periodicities or other patterns found in one field will lead to exploration of their numerical counterparts in the other fields, as a first step.

Cross-spectral coherence, less unspecific than a product moment correlation, will be sought between geomagnetic pulsations and features of the electrocardiogram (and eventually of the electroencephalogram). Initially, associations already uncovered will continue to be mapped and further
explored. For instance, close examination of biology has led to the discovery of physical periodicities, as in the case of the built-in about-weekly component, which found its way into our culture and was uncovered as part of our genetic and physical environmental nature. Vice versa, a geophysical periodicity, such as the half-yearly feature of geomagnetic disturbance, has led to biological numerical matches, as in the case of the half-yearly distribution pattern of over 50,000 cases of status epilepticus. Such parallels between physiology and physics will continue to be mapped and further explored.

Each association among physiologic and physical phenomena will have to be scrutinized, whenever possible, by both archival and physiological monitoring, with a battery of analytical procedures. These range from cross-spectral coherence and superimposed epochs, to a “remove and replace” approach. The latter mimics what is done in endocrinology when a gland is removed and its product, the hormone(s), is then administered as a replacement. Similarly, physically recorded changes in the solar or extra-solar system will be examined for associations with changes in biological variables, examined in monitored physiological time series. A case in point is the presence or absence of 7-day patterns in the velocity changes of the solar wind, as they amplify or dampen, respectively, about 7-day changes in human heart rate.

Scrutiny of physiological time series recorded concomitantly with the physical variables in strategically placed locations on earth, and whenever possible in space, will allow the mapping of the relative prominence of photic (electromagnetic radiation, notably but not exclusively in the visible domain) and non-photic (corpuscular emissions, heliogeomagnetics, gravitation and other) effects from the sun and/or from beyond the solar system and their dependence upon latitude. As an example of the need for extra-circadian study, we cite the case of endothelin-1 (ET-1), the most potent vasoconstrictor in human blood. While a circadian variation was not demonstrated in ET-1, about 3.5-day and about 8-hour components were discovered as characterizing its concentration. A follow-up finding in the mouse was that the population density of endotheliocytes, the cells producing the hormone, is also characterized by the prominence of extra-circadian components of variation with frequencies similar to those noted in blood. The additional clinically relevant finding that the about 3.5-day pattern is altered in the presence of vascular disease risk is of potential usefulness for screening astronauts.

The search for physical and/or biologic mechanisms underlying these and other extra-circadian rhythms is on the agenda next, as a test case of the hypothesis that some features of our current time structure result from an internal as well as Darwinian evolution. The survival of the fittest depends upon an internal integrative rather than only on an externally adaptive evolution.

PS: The foregoing distillate of meetings including the transyear documents what has been learned in the interim, including transyears. In the interim, a monthly 14-month ECG record has become available from space, and poses the challenge of comparing, the brevity of the series notwithstanding, the amplitude ratio of the transyear to the year in extraterrestrial space, with reference data already collected on earth as a start. The provision of these data for analysis and provisions for the systematic collection of new longitudinal data on earth are challenges for national and international space agencies, including NASA headquarters. It can be postulated, but is to be validated, that while the amplitude ratios of the transyear to the year vary greatly, also as a function of age [126], all else being equal, with age- and gender-matched controls available, the transyear in space should be more prominent than it is on earth, a point that could also be checked by further monitoring of the same cosmonaut on earth.
Appendix 2

A 38-year record, albeit informative, is not yet enough: omb-to-tomb monitoring is overdue

Robert B. Sothern, George S. Katinas, Germaine Cornélissen, Franz Halberg

Time structural (chronomic) analyses of an accumulating now 37-year long series (with very few gaps), among others, of 2-7 daily blood pressure (BP) and heart rate (HR) measurements, reveal a differential behavior in the same circulation of a clinically healthy individual. An about yearly change in diastolic BP may or may not be detected by an analysis of variance and/or by cosinor, apparently as a function of solar cycle number and/or stage (Figs 1–6), but is 1-year synchronized in the span examined as a whole (Fig. 7). HR shows a different age-dependent course, not readily apparent in a chronogram (Fig. 8) or in a serial acrophase section (Fig. 9), but revealed by gliding spectral windows (Figs 10 and 11). Figs 12 and 13 lead to amplitude ratios of the transyear/calendar year components, as a mimicry of presumably built-in ‘non-photic/photic’ cycles, that may gauge aging in health. There is no short-cut to systematic long(er) and dense(r) monitoring of important physiologic functions, before the time course of human physiologic variables, as a function of growth, development and aging, can be mapped in health as a reference for detecting risk elevation and disease.

At a symposium in Seewiesen, Germany, organized decades ago by Lübbo von Lindern and Ekkehard Haen, two other opinion leaders at the time suggested that BP and HR rhythms are very similar in behavior, referring by implication to circadians. Differences, however, had been reported by that time and later between these variables and some are here recalled and more added.

In the laboratory, on the unrestrained rat, telemetry combined with serial sectional analysis revealed that systolic (S) BP can free-run when HR and locomotor activity are 24-hour synchronized under the controlled conditions of the laboratory (inside cover of reference [1]). In humans as well, SBP can free-run from activity and other variables [2]. The time course of aging differs for BP and HR, in terms of extracircadian/circadian amplitude ratios [3], notably in centenarians [4].

During bed rest for days, the circadian amplitude can behave differently, e.g. decrease more for HR than for BP or vice versa [5]. Throughout pregnancy, on the average, HR increases progressively while BP reaches a minimum during the second trimester [6]. Behaviors of BP and HR in relation to magnetic storms in the interplanetary field can also differ [7]. Recovery from (hip) surgery can alter a circadian SBP-rhythm selectively [8]. Herein, Figs 1–13 show further differences along the scale of years and decades, amplifying on studies reported earlier [9–12].

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CIRCANNUAL AMPLITUDE (A) OF DIASTOLIC BLOOD PRESSURE* MAY NOT BE DETECTED during SOME STAGES of SOLAR CYCLES

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\* RBS, 20.5-year old man at start of self-measurements, ~ 5 times/day on most days for 35 years.
** Duration of solar activity minima gauged by 3 consecutive lowest yearly Wolf Numbers in each cycle. No causality is implied, a communality of periods, also documented elsewhere, notwithstanding.

Fig. 1. A gilding spectral window, in a view from above, suggests the intermittency of a 1-year component in diastolic blood pressure of a clinical healthy man.
Fig. 3. Data stacked for a calendar year show dramatic differences in $P$-values, ranging from a lack of statistical significance to a $P<0.001$, apparently as a function of solar cycle number, in the ascending solar cycle stages for the diastolic blood pressure of a clinically healthy man, RBS.

Fig. 2. A side view provides another aspect of the intermittency of several spectral components, also shown in Fig. 1 for RBS.
Fig. 4. Borderline significance in solar cycle 22 contrasts with statistical significance in other solar cycles, investigated during solar maxima, for the diastolic blood pressure of a clinically healthy man, RBS.

Fig. 5. Consistently statistically significant circannual rhythms in 3 consecutive solar cycles during the descending stages of solar activity in the diastolic blood pressure of a clinically healthy man, RBS.
Fig. 6. Solar cycle number-dependent results during solar minima in the diastolic blood pressure of a clinically healthy man, RBS.

Fig. 7. Averaging, while yielding consistent statistical significance, obscures the foregoing results covering the diastolic blood pressure of a clinically healthy man, RBS.
**Fig. 8.** A chronogram of heart rate requiring time-microscopy to reveal the chronome (time structure) in the heart rate of a clinically healthy man, RBS.

**Fig. 9.** A chronobiologic serial section with 360° equated to 365.25-days shows the extent of wobble in the interval (vertical lines), as well as in the point (bold curve) estimates of the yearly acrophase of the heart rate of a clinically healthy man, RBS.
Fig. 10. A gliding spectral window of heart rate reveals changes with age with the damping of a component with a period of ~1 year, the emergence and amplification of transyears and of a half-yearly component in the heart rate of a clinically healthy man, RBS.

Fig. 11. The half-yearly component of Figure 10 is better resolved along with a transient component with a still shorter period, in the heart rate of a clinically healthy man, RBS.
Fig. 12. The change in relative prominence of the about-yearly and transyearly component shown herein for the heart rate of a clinically healthy man, RBS, are summarized as an amplitude ratio in Fig. 13.

Fig. 13. Built-in mimicry of non-photic/photic amplitude ratio changes with age from below unity to above unity in RBS, but awaits study regarding further consistency of increasing trend in RBS and of their degree of generality and may be gauges of aging.
Resolution concerning chronobiology\(^1\) and chronomics\(^2\)

Summarized by Sergei Mikhailovich Chibisov

at the 2nd Int. Symp. on “Problems of rhythms in the natural sciences”, March 3, 2004

**Medical Faculty, Russian People’s Friendship University [RPFU] in Moscow**

The symposium’s participants unanimously agreed that the study of rhythms and broader chronomes both of the cosmos and of living organisms and of their interactions has now become (in their part of the world) one of the leading biological and medical disciplines. Results of biorythmological investigations are not only of fundamental importance, but also play an extremely important applied role. Ignoring chronomedical regularities decreases the effectiveness of treatment and may even change the direction of its positive action into an undesirable effect, such as medications given to lower blood pressure that induce overswinging (CHAT, short for circadian hyper-amplitude-tension) and thus may lead to harm. By contrast, the advocated introduction of systematic and of living organisms and of their interactions has now become (in their part of the world) one of the leading biological and medical disciplines. Results of biorythmological investigations are not only of fundamental importance, but also play an extremely important applied role. Ignoring chronomedical regularities decreases the effectiveness of treatment and may even change the direction of its positive action into an undesirable effect, such as medications given to lower blood pressure that induce overswinging (CHAT, short for circadian hyper-amplitude-tension) and thus may lead to harm. By contrast, the advocated introduction of systematic chronotherapy into clinical health care. Hence, the participants at the symposium considered it necessary to: 1) continue to systematize investigation of cosmo–biospheric interrelations; 2) publish reviews and original papers in the main journals of natural sciences and medicine; 3) systematically organize symposia and conferences in the fields of chronobiology and chronomics with special reference to chronoastrobiology; 4) organize special courses, student programs, prepare textbooks and handbooks; 5) organize special international and interdisciplinary research programs; 6) actively participate in existing projects; 7) supply mass media with information provided by specialists in these problems; 8) stress the interdisciplinary character of investigations by providing a coordinated analysis of synchronous medicobiological, chemical and geo-, helio- and cosmophysical data; 9) elaborate on the fundamental results to provide practical recommendations.

Participants at the symposium unanimously supported the practical suggestions of Professor Franz Halberg (Halberg Chronobiology Center, University of Minnesota, Minneapolis, MN, USA):

1. To introduce to the medical community, research institutions, and directly to the public, the practice of psy-
cho-physiologic monitoring. Cost-effective instrumentation and reference values are in use for blood pressure and heart rate assessment by centralized analyses, currently by the BIOCOS project (corne001@umn.edu): these involve comparisons of the dynamic chronic characteristics of each time series with data from clinically healthy human peers of corresponding gender and age and are being extended to take into account geographic/geomagnetic location, ethnicity, social class and any other pertinent condition, to be sought in the person’s diary, in geo-helio- and broader cosmo-physical records as well as social conditions, to eventually be checked in the light of end-of-life outcomes. Reference values are transverse, stem- ming from previously monitored ‘clinically healthy’ subjects and are being complemented by longitudinal lifetime monitoring to verify health, eventually preferably from birth onwards until the end of life, preferably followed by autopsy. Current analytical programs determine, apart from a diagnosis of abnormality within the normal range of variation, also for how long the duration of monitoring has to be in a given case, starting with a 7-day record with the duration judged by the opportunity of continuing analyses, notably after the start of therapy.

It is desirable for immediate health care and indispensable for science that some dedicated individuals (volunteers) perform monitoring during the entire lifespan or at least from the time they volunteer to life’s end, starting with blood pressure and heart rate. Recent discoveries such as those of transyearly spectral components, beating with a spectral component with a period of a year (reinforcing and then canceling each other), have thus become possible.

2. The ongoing monitoring of the cosmos has to be thus accompanied by the monitoring of the biosphere: systematic monitoring in real time of the environment on earth and in the cosmos has to be integrated with the monitoring of the bio-, noo- and ethospheres, i.e. of living matter, of the mind and of spirituality. This monitoring deserves high priority and requires obligatory governmental support.

For analyses of the monitored results it is necessary to create specialized centers, the activity of which should be directed not only to uncover the main time structures (regularities=chronomes), but would also serve for prognosis and prophylaxis in personal and environmental health care.

Signatures

Co-chairman, Organizing Committee, Dean of Medical Faculty, RPFU; Member, IAS: Prof. V.A. Frolov; Co-organizers: Ministry of Education, Russian Federation (RF); Russian People’s Friendship University (RPFU); Russian and Azerbaijan Sections, International Academy of Sciences (IAS); Scientific program “Universities of Russia” of the Ministry of Education RF; Problem Committee “Chronobiology and chronomedicine, Russian Academy of Medical Sciences (RAMS). Chairmen, Symposium Organizing Committee: D.P. Bilibin (Rector and Professor, RPFU, Russia); V. Kofler (President, International Council for Scientific Development IAS, Member, IAS, Professor, Austria); K. Hecht (President of the East-European section of IAS, Member, IAS, Professor, Germany). Co-chairmen, Organizing Committee: V.A. Frolov (Dean of the Medical Faculty, Member, IAS, Professor, Russia); K.V. Sudakov (Co-president of Russian section of IAS, Secretary-Academician of RAMS, Member, RAMS and IAS, Professor, Russia); E.N. Chalilov (Co-president, Chairman of the Bureau of the Presidium of Azerbaijan section of IAS, Professor, Azerbaijan). Deputy chairmen: O.S. Glazachev (General Secretary of Russian section of IAS, Member, IAS, Professor, Russia); C.M. Chibisov (Member, Russian section of IAS, Professor, Russia); A.M. Mamedov (Co-president of Azerbaijan section of IAS, Member, IAS, Professor, Azerbaijan). the organizing committee included distinguished Russian and foreign scientists: RAMS members: F.I. Komarov, V.P. Kaznacheev, H.A. Agadzhanjan, V.G. Zilov, Y.A. Romanov, T.T. Berezov, V.A. Matjukhin; Professors F. Halberg (USA), G. Cornelissen (USA), S.D. Duda (Germany), K. Otsuka (Japan), G. Yamanaka (Japan), B.M. Vladimirska (Ukraine), I.V. Radys, A.G. Gamburtsev, R.M. Baevsky, E.S. Shnol, T.K. Breus, R.M. Zaslavskaya, S.I. Rapoport, V.V. Kassandrov and others.