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PART II.

TRANSDISCIPLINARY BIOLOGICAL-HELIOGEOPHYSICAL RELATIONS AT WEEKLY, HALF-YEARLY AND SCHWABE- AND HALE-CYCLE FREQUENCIES

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A b s t r a c t

Magnetic storms trigger myocardial infarctions with mechanisms relating to heart rate variability. Solar cycle-to-solar cycle differences and solar cycle stage dependence shown herein may resolve prior controversy and serve to advocate coordinated worldwide systematically aligned biological and physical monitoring.

K e y w o r d s

Biological cycles, Chronomes, heart rate variability, Magnetic storms, Myocardial infarctions

INTRODUCTION

A dynamic physical environmental feature may be manifested in organisms as living fossils, providing information of interest to physicists. Like circadian and circannual rhythms, other bioperiodicities may also be associated with positive adjustment value and timing according to them can make the difference between survival and death. This point is here documented for a circadecennian rhythm in human myocardial infarctions. Evidence from spectra and from cross-spectral coherence, the latter less unspecific than product-moment correlations, is strengthened in some cases (such as

myocardial infarctions or microbial sectoring) by superposed epoch analysis, and by other remove-and-replace approaches. Some results are further safeguarded by pseudoepochs that are equivalent to blanks in chemistry. These methods reveal biomedical associations of non-photic solar activity, triggering magnetic storms in space that are known to displace the flux of galactic cosmic rays. Storms and/or cosmic rays, directly or via other natural physical environmental factors, trigger fatal myocardial infarctions on earth, by mechanisms involving heart rate variability, among other physiological endpoints. Anthropometric, including morphological variables, influenced by helio- and geomagnetics, are neonatal body weight, body length and head circumference, insofar as they undergo cycles of similar length, as does non-photic solar activity, and, as a further hint, they also show cross-spectral coherence with geomagnetic indices. Problems at the interface of meteorology or geophysics with biology are often approached by ignoring rhythms, allowing these rhythms (if unassessed) to inflate a noise term. When assessed, the rhythms do more than deflate the noise term; by their characteristics, they reveal the critical, since predictable and important element of the broader time structures, chronomes, representing the physical and/or biological dynamics, consisting of rhythms, chaos and trends *(1, 2).*

MATERIALS AND METHODS

Rather than focusing on one or a few anticipated rhythms, such as about 24-hour or about-yearly changes, when the data are dense and long enough in any one variable, it seems best to examine the whole chronome (chaos and trends as well as rhythms). For the rhythmic element of these structures, the spectrum that is assessable with the available density and length of an observation span, may reveal new candidate components that in their turn can be examined in other series to see whether they are confirmed. If so, they constitute validated prior evidence that justifies their anticipation in physics or biology *(1, 2, 3, 4).*

We examine interplanetary and geomagnetic disturbance indices; Bz, the north-south component of the interplanetary magnetic field; aa and Kp, based on 2 (antipodal in the two hemispheres) and 13 ground-based stations, respectively, on the one hand and biological data on the other hand, in the light of associations based on evidence of widely different weights. The similarity of periods can be a hint. Product-moment correlations are less specific than cross-spectral coherences which constitute more solid evidence when they describe relations at one or several specific frequencies (away from spectral peaks, to avoid artifacts). Evidence from superposed epochs, combined with the subtraction and addition of a factor (remove-and-replace), ranks even higher in the context of cosmo-helio-geo-biological interactions that cannot be readily reproduced experimentally in the laboratory.

RESULTS

New to most physicists, and also to biologists alike, except for those in Brno, where the team from Medical Faculty *(5)* contributed pertinent original data, is that the biosphere has a built-in weekly dimension encountered widely, which is apparent early in life in vastly different species.

Also new is that over 50,000 epileptic attacks not only have a weekly or a half-weekly, but also a half-yearly but not a yearly periodicity. Against the background of a previously known wobbly wide band between 6–8 days in the velocity changes of the solar wind and a much better defined peak in rainfall, the biological week prompted a search in Kp for a narrower band. We found a harmonic of 6.7 days, in the spectrum of a 59-year series of Kp *(8, 14),* confirmed and qualified by *Roederer (4, 12, 13)* who demonstrated differences between the ascending and descending stages of solar activity, and by *Vladimirskii et al.(6*), who further validated this component on aa covering more than a century. Both Roederer and Vladimirskii et al. found the harmonic precisely as reported for Kp by biologists, while other physicists reported an anthropogenic 7-day synchronized component in several indices of geomagnetic disturbance, one associated, e.g., with a traffic system. The about 7-day and the half-year features of time structures (chronomes) in us and around us suggest interactions of the sun with the biosphere that can be more readily analyzed than those corresponding numerically to the ~10.5-year Schwabe and 21-year Hale solar activity cycles.

The cycle length itself in biological data series can be a signature of geomagnetics and may promptly focus on heretofore ignored effects. The extent of the effect can then be compared with the role of photic effects in the amplitude ratios discussed above. The risk of drawing incomplete, if not unjustified conclusions is particularly true when one deals with very wobbly sunspot activity, notorious for variability, but standing out nonetheless as recurrent in approximately 10.5- and 21-yearly cycles. By 1843, *Samuel Heinrich Schwabe (9)* recognized the importance of about 10.5-yearly (circadecennian) periodicities in solar activity, and *George Ellery Hale (10)* did likewise for about 21-yearly (circavigintunennian) rhythms in the early 20th century.

For alignment with these latter cycles, biological data of corresponding length are also available and reveal cross-spectral coherence. Evidence along morphological, physiological and pathological lines, suggests the need for systematic international study. The spectra of biologists and physicists both include periods misinterpreted as purely societal, like the week. A near half-weekly, i.e., 81-hour modulation by Kp is seen during 267 days of isolation from society of a woman's vascular variables. Schwabe's and Hale's solar activity cycles modulate the half-year as well as the week of Kp and even of the human heart rate's weekly component. By further scrutiny, biologists can learn more about effects from solar non-photic and terrestrial cyclic and other events; physicists acquire perhaps sensitive biogalvanometers and biometeorometers, and we all learn what problems in health care can be anticipated by a space weather report and can plan countermeasures.

DISCUSSION

Most recently we found a marked disturbance of circadian rhythms and the appearance of a very large about 7-day (circaseptan) component in different endpoints of heart rate variability *(7).* Inquiring about any unusual conditions during the 7 days of ECG monitoring, we were told that none were known. Somewhat later, however, we learned that a magnetic storm occurred on certain days of the 7-day monitoring. In separating data obtained during relative magnetic quiescence from those obtained during magnetic disturbance, we found a statistically significant difference in spectral regions centered around 10.5 seconds and 46.5 seconds, but not around 3.6 seconds *(7, 8, 14, 15).* Since the latter spectral region has been associated with the parasympathetic autonomous nervous system, it was possible to postulate a role of the sympathetic activity, considered earlier by others in a different context in space *(16).* This was at first a single anecdotal case on one subject *(7, 14, 15).* Most recently, however, in 7-day ECGs recorded in Alta, Norway, at 70°N, results from 8 subjects reproduced the effect of magnetic storms observed earlier, as a result of reduced heart rate variability in spectral regions associated probably with sympathetic and certainly not in regions corresponding to parasympathetic activity *(7).*

A c k n o w l e d g e m e n t

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TRANSDISCIPLINÁRNÍ BIOLOGICKO-HELIOGEOFYZIKÁLNÍ VZTAHY PŘI TÝDENNÍCH, PŮLROČNÍCH A SCHWABEHO A HALEHO FREKVENČNÍCH CYKLECH

S o u h r n

Magnetické bouře vyvolávají infarkty myokardu prostřednictvím mechanismů vztahujících se ke změnám variability srdeční frekvence. Rozdíly mezi slunečními cykly by mohly mít vliv na monitorování biologických funkcí a fyzikálních parametrů.

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