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IS A BIRTH-MONTH-DEPENDENCE OF HUMAN LONGEVITY INFLUENCED BY HALF-YEARLY CHANGES IN GEOMAGNETICS?

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Introduction

About-daily and about-yearly variations in organisms are commonly viewed as evolutionary adaptations to changes in the proximate environmental temperature and illumination. There is now ample evidence that a much broader time structure (chronome), long known to characterize the environment, is built into biological variables, from the level of an ecological niche revealed by demographic statistics to that of molecular genetics. While a molecular basis has been established for circadian rhythms, indirect evidence for some endogenicity had long been available by the persistence of rhythms with a period differing from the environmental cycle under constant conditions (free-running) (1, 2). Natural environmental factors have also been shown to play a critical role, notably in terms of synchronizing built-in rhythms (1-3). As reviewed elsewhere (4), non-photic as well as photic effects of the sun may play a role in shaping the element of multifrequency rhythms currently, and may have done so in the past, resulting in even broader chronomes with added elements of chaos and trends (4, 5). Non-photic signatures include, with the biological week (5), the about 10.5-year solar activity cycle, the about 21.0-year Hale bipolarity variation, and a prominent about half-year rhythm peaking at the equinoxes. This natural physical half-year characterizes various indices of geomagnetic activity (6-15) and may relate to the tilt angle of the earth's dipole axis toward and away from the sun, which reportedly is not constant according to Robert L. McPherron. It is particularly prominent when analyzed in K_p (5, 16, 17) by the population-mean cosinor method (18, 19).

Methods

In response to a recent article reviewing non-photic solar influences on biota, in the context of intersecting anti-aging and chronoastrobiological issues (4), researchers at the Center on Aging at the University of Chicago kindly brought to our attention their work on the effect of birth month on human longevity (20). In checking for confounding factors in studies on possible trade-offs between human longevity and biological fertility, Gavrilov and Gavrilova unexpectedly found that the month of birth is a predictor for the life expectancy of adult women (30 years and older): women born in May and December tend to live about 3 years longer on the average by comparison with women born in August. Their data are expressed as a difference from the August value, used as reference. They are based on the point estimates of the differential intercept coefficients obtained after adjusting for other variables (such as calendar year of birth, maternal and paternal lifespan, maternal and paternal age at birth, birth order, nationality, cause of death, and loss of mother, father, or both before age 20).

These data were taken off the published graph (20), to be re-analyzed by cosinor (18, 19) in the light of prior association of geomagnetic activity with anthropometry notably at birth (21-24) and at the time of conscription (25, 26) and thus with growth, previously related to light acting via melatonin (26) and/or vasopressin (27). Trial periods of one year and harmonics thereof were considered. More specifically, cosine curves were fitted by least-squares to the data, and the hypothesis of a zero amplitude (no-rhythm) was tested. Components in non-harmonic relation with the year, or any infra-annual component were not investigated because the data, representing cohorts born in 1800-1880, had been stacked over an idealized 1-year span. Data on the antipodal index of geomagnetic activity, aa, available only since 1868 were retrieved from the internet for the span 1868-1880 and similarly stacked as monthly means over an idealized one-year span. A phase difference between aa and lifespan was examined by parameter test (28).

Results

Both geomagnetic activity and human longevity are characterized by a highly statistically significant ($P<0.001$) half-year component accounting for over 80% of the variance, as illustrated in Figure 1. The lifespan data lag behind the antipodal geomagnetic aa index by 2 months, as shown by cross-correlation analysis, Figure 2. The phase difference between lifespan and aa is statistically validated (P<0.001). Half-year changes are also documented for length at birth of babies from South Africa (21), Germany (22), Spain (23), and Denmark (24). In the latter data and similar time series from Minnesota and Russia available longitudinally over spans covering up to 112 years, the demonstration of about 10.5 and/or about 21.0-year components (4, 25), signatures of the Schwabe and Hale solar activity cycles, lends further evidence for an influence of non-photic physical environmental (solar?) factors.

A similarity of periodicities between the natural environmental (aa) and the biological (longevity) variables constitutes no more than a hint of putative associations. The result is strengthened by similar findings in other studies, involving longitudinal data series lending themselves better to additional analyses by superposed epochs, cross-spectral coherence, and remove-and-replace approaches (25, 29). In particular, body length at birth in Russia is cross-spectrally coherent with the geomagnetic activity index K_p. Cross-spectral coherence with K_p is also found at a frequency of about 2 cycles per year in our re-analyses of data on adult height from Weber et al. (26), who examined 507,125 male Austrian recruits at 18 years of age, and which show a dependence on the month of birth. Weber et al. postulated an effect of seasonably changing light, accounted for by photic effects upon melatonin, without commenting on a 10-year cyclic aspect of their data that they reported.

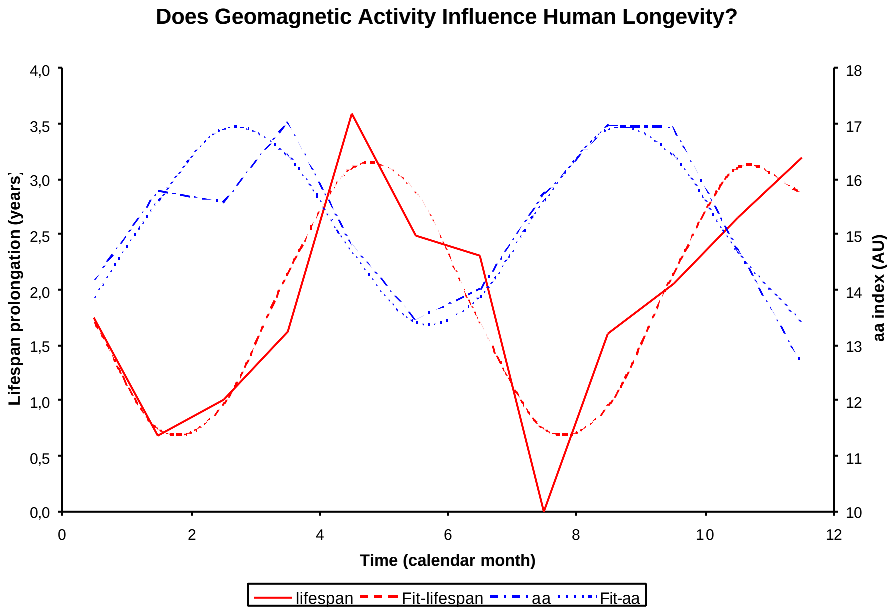

Figure 1. Human longevity studied by Gavrilov and Gavrilova (20) in adult women (30 years and older), in cohorts born in 1800-1880, expressed as a difference for the August value, used as reference, are plotted vs. the month of birth. For comparison, data from the geomagnetic index aa (1868-1880) are plotted after stacking over an idealized 1-year span.

Discussion

Putative hypothalamic-pineal mechanisms come to mind in accounting for these associations. A half-year component was documented to characterize vasopressin (27). The pineal, in turn, is reportedly capable of responding to variations of the order of a few nT induced by the solar wind via the magnetosphere (30). Of particular importance is the report by Lerchl et al. (31) that both the synthesis and the release of pineal melatonin in vitro are significantly reduced (P<0.001) by exposure to extremely low frequency Ca^{++}-cyclotron resonance, presumably caused by the enzyme N-acetyltransferase. Melatonin, in turn, is implicated in growth. Serum growth hormone concentrations have been reported to increase fivefold after melatonin administration in clinically healthy men (32). Melatonin secretion is also known to increase during pregnancy (33), and is thought to be implicated with cortisol in mechanisms underlying intrauterine growth retardation (34). Whereas no differences in circulating maternal melatonin were found in terms of circadian rhythm characteristics, a half-year component was present only for IUGR. Circulating estriol in maternal blood, which has a fetal origin, shows a marked difference between healthy and IUGR groups at a half-year, as well as along the 24-hour scale. Circulating melatonin itself has been shown to be latitude dependent (35). Furthermore, it undergoes a half-year variation by night occasionally at middle latitudes, and even at noon at higher latitudes (36-38), where magnetic disturbances induced by the solar wind tend to be more pronounced (39). A reduced nocturnal excretion of a melatonin metabolite (6-hydroxymelatonin sulfate) has also been observed in humans exposed to fluctuating magnetic fields (40-42).

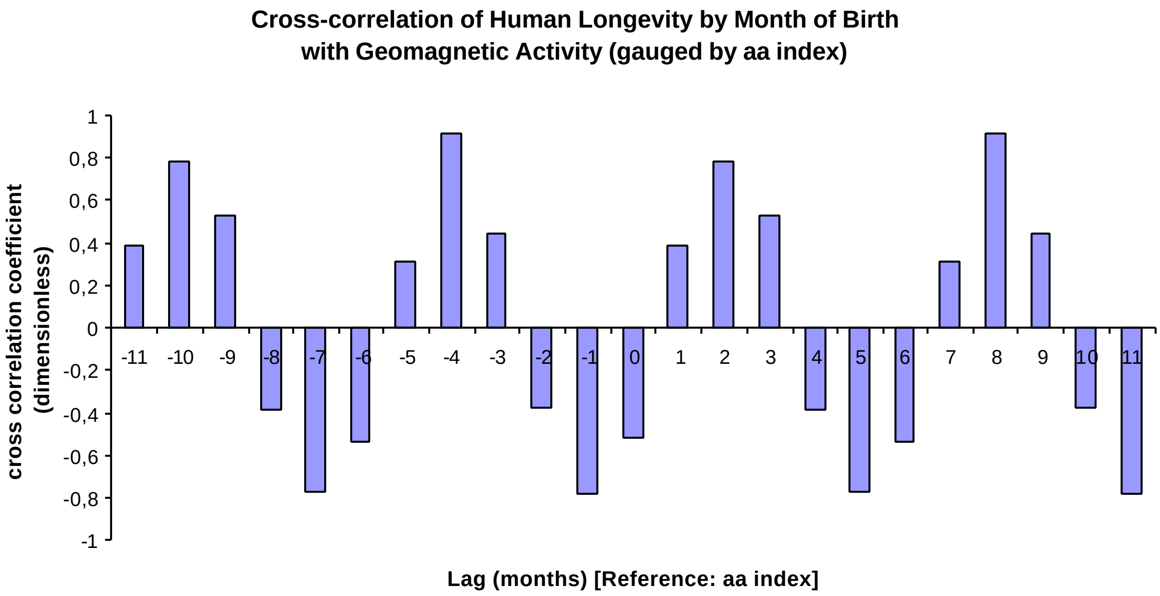

Figure 2. Cross-correlation of human longevity vs. the geomagnetic activity index aa shows a maximum at a lag of 2 months, in keeping with the possibility, quantified below, that the maximum of human longevity follows the maximum in aa two months later. A half-year periodicity characterizes the cross-correlation function, which results in maxima occurring at lags -10, -4, 2 and 8 months, and in minima at lags -7, -1, 5 and 11 months. Whereas the results indicate that human longevity and aa share a common period of six months, longevity peaking 2 months after the peak in aa, it cannot be said without further work whether the two variables are causally related. If they were, directly or by mediating variables, then it cannot be said whether the association is positive or negative. It is also not clear at which moment of the child's (embryo's or fetus's) life the effect of geomagnetics operates, if at all. With a possible causal relation and a 2-month lag, the effect may take place when the child is born. Alternative possibilities include a negative association with zero lag if the effect occurs during the second or 8th month of gestation (or a positive association taking place in the 5th gestational month). Should the original data become available in toto (instead of only as 12 monthly means), dividing the data into subsamples of varying aa exposures would allow the testing of a graded response which, should it validate an association, would lend support to geomagnetic influences on human longevity.

A melatonin-dependent circannual variability of the quality of the oocyte has been postulated by Smits et al. (43) to account for an association of fecundity with the month of birth. These authors studied a cohort of 1526 women who married between 1802 and 1931, using only women whose first marriage occurred before the age of 35 years. Childless women, as compared with fecunds, reportedly showed a birth distribution that was represented by a bimodal curve peaking in January and July (43). The question will have to be elucidated whether we deal with a vacation or a geomagnetic effect, which latter should show a latitude dependence (36-38) or probably with both, including perhaps other social effects as well. Effects of melatonin supplementation on longevity, investigated in the experimental laboratory are inconclusive (44-46). Physiological effects of exposure to geomagnetic fields appear complex (47). A systematic recording of biological signals complementing the data bases physicists are assembling on natural environmental factors would gain from analyses aimed at assessing broad interacting time structures (chronomes) (4, 5, 29).

In summary, chronobiologic aging research documented earlier that circadian rhythms (e.g., in core temperature) can involve a greater extent of change than does aging over several decades (48). Hence, if unassessed, these rhythms constitute a great confounder of aging trends. The same warning of a potential confounder applies to an about half-year change. The Gavrilovs' meta-analyzed discovery (20) strengthens the case of heliogeophysical associations with research on aging (25, 49). The similarity of periods, in us and around us, constitutes a hint, but no proof. Latitude-dependence would strengthen the case further, as in a decadal aspect of human motivation (50). The in-phase-ness of the cycles in the northern and southern hemispheres would support the global effect again, as shown earlier (25). Cross-spectral coherence studies remain to be performed in conjunction with remove-and-replace approaches wherein the sun rather than a surgeon may do the removal and replacement of one of its spectral components (51, 52). With the accumulating evidence, the story of built-in circadians, now extensively covered in journals such as Science and Nature, repeats itself in biological populations and individual components with longer than circadian periods, associated with non-photic corpuscular radiation directly or indirectly affecting the embryo and fetus, and thus influencing longevity.

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