

Need for Rhythm Studies in Anthroposophic and Goethean Science

By: [Gunther Hildebrandt, M.D.](#)

In early 1996, at a conference held at the Goetheanum, a "group for rhythm studies" was proposed to consider the significance of rhythms in man, earth and cosmos. The background to this was a statement by Rudolf Steiner that true science would mean penetrating the rhythms in nature (GA 184,1918).

On the initiative of Prof. Gunther Hildebrandt of Marburg, Rolf Dorka of the Carl Gustav Carus Institute in Oschelbronn, Dr. Michaels Glockler from the Medical Section and Georg Glockler of the Section of Mathematics and Astronomy at the Goetheanum, chronobiologists from the fields of medicine, biology, and forestry and agriculture had a first study session at the Carus Institute in September 1996. Prof. Hildebrandt's introductory lecture is given below. Individual members of the group then presented their research relating to biorhythms. The meeting concluded with a general discussion in which it was agreed to meet regularly in future. The next meeting on 24 and 25 October 1997 was held at the Carus Institute in Oschelbronn. Reports given by the lecturers and individual members of the group on chronobiology studies are available. For further details contact Rolf Dorka, Carl Gustav Carus Institute, An Eichhof, D-75223 Niefern-Oschelbronn, Germany. Tel. +49 7733/6 84 27, fax /6 84 13.

Systematic development of chronobiology, the scientific study of rhythms, did not begin until the 1930's. An international society for biorhythm studies was established in Sweden in 1937; it was interdisciplinary from its inception (Menzel 1987). Today, several national and international agencies exist in this specialized field, and some universities have established chairs and institutes of chronobiology.

In biology and medicine, it is increasingly apparent that the time organization (time structure) of vital processes is complementary to the spatial and morphological organization of life forms. Chronobiologic research has shown that practically all biologic functions follow rhythms and show periodicity. The duration of periods for different functions covers a wide spectrum ranging from rhythms with periods of about 1/1000 sec to others that take years.

In certain areas, biologic functions are demonstrably connected with geophysic and cosmic environmental conditions, in other parts of the spectrum, rhythmic functions show an autonomous internal order.

The mechanisms that determine environmental conditions (time setting effects) are the subject of intensive and successful investigations. Work on the inner ordering principles of and interactions among rhythmic time structures has been less extensive. However, considerable efforts have been made to establish the mechanism of the organism's internal clocks in their molecular biologic aspects, and these have received

more attention in chronobiologic research. Practical applications of knowledge gained in various areas of chronobiology have become increasingly more important, especially in clinical medicine, preventive industrial medicine, ecology, pest control, and so on. Special fields such as chronotherapy, chronopharmacology, chronotoxicology, chronohygiene and others have been identified (for literature review, see Hildebrandt 1981). There is some justification in asking if the science taking its orientation from Anthroposophy and Goetheanism can and should add anything to the work done in chronobiology and chronomedicine, which have already gained general acceptance.

Rudolf Steiner spoke about cosmic and human rhythms in his lectures. The subject was even discussed in the lectures he gave to building workers. Steiner had begun to work with this theme in the first decade of this Century, distinctly prior to the chronobiology work done in conventional science. Should one consider his concern and efforts in this direction to be merely those of a forerunner, or did his work offer specifically anthroposophical and Goethean approaches and challenges for a rhythm research with potential for the future?

It is possible to identify at least five aspects in Steiner's statements on the subject that indicate a special anthroposophic approach in rhythm research. As we consider these below, (Steiner's words will be referred to in given cases).

Outstanding significance of rhythm research

It is well known that when a student asked Steiner, "What is life?" the answer was: "Study the rhythms!" In his lectures, he put it like this: "Rhythm is implanted in matter by the spirit, man has rhythm as a legacy of his spiritual origins." (Berlin, 21 Dec. 1908). "And the whole of human nature would become dear to us exactly through these rhythms, through the mysterious internal arrangements." (Berlin, 12 Jan. 1909)

The following formulations, given in 1918, are unequivocal and indicate the direction to follow: "You only have rhythmic processes in nature, none that go on *ad infinitum*; you only have something that rhythmically returns to itself again... If people ever give up looking for things immediately apparent to the senses and make this the basis of our natural world, they will discover something very different. They will find rhythms everywhere in nature, rhythmic arrangements... The whole of life is rhythmic. True science will be to penetrate the rhythms in nature." (12 Oct. 1918)

At the Rhythm in Cosmos, Earth and Man conference, organized by the Medical Section and the Astronomy Section at the Goetheanum early in 1996, these formulations led to the creation of an anthroposophically-oriented study group for rhythm research to bring together groups of scientists working in different places to share their views and research.

Rhythm studies give complete pictures

Anthroposophically-oriented rhythm research calls for a Goethean approach. Steiner asked us to "gain a complete picture of the whole human being... I would say that the course of the day is one such complete picture. It may sound odd when one hears it for the first time, but in some respect the course of the day sums up a number of natural laws that are around us, making them into a whole. Processes simply occur in

our environment and in us in the course of the day that, if considered in isolation, divide up into all kinds of physical and chemical processes and so on. We may say that the course of the day is a kind of time organism that includes a number of natural processes which we are also able to study in isolation. The course of the year is another, greater whole... To avoid having the kind of abstract relationship to his natural environment that comes with the definition of physical and chemical experiments... a person should have the organism presented to him which is the course of the day and the organism which is the course of the year." (29 Dec. 1922)

Clearly, the kind of picture gained in rhythm studies is not limited to the rhythm of the day or the year. In principle, it can be found for every rhythmic process. As this is particularly important from a methodological point of view for our group, a concrete example of finding a complete picture is shown below. It is the daily rhythm of the human temperature organization.

Fig. 1 shows the familiar daily changes in core body temperature in its upper part and the diurnal changes in cutaneous circulation in different parts of the body; essentially these correspond to the skin temperature.

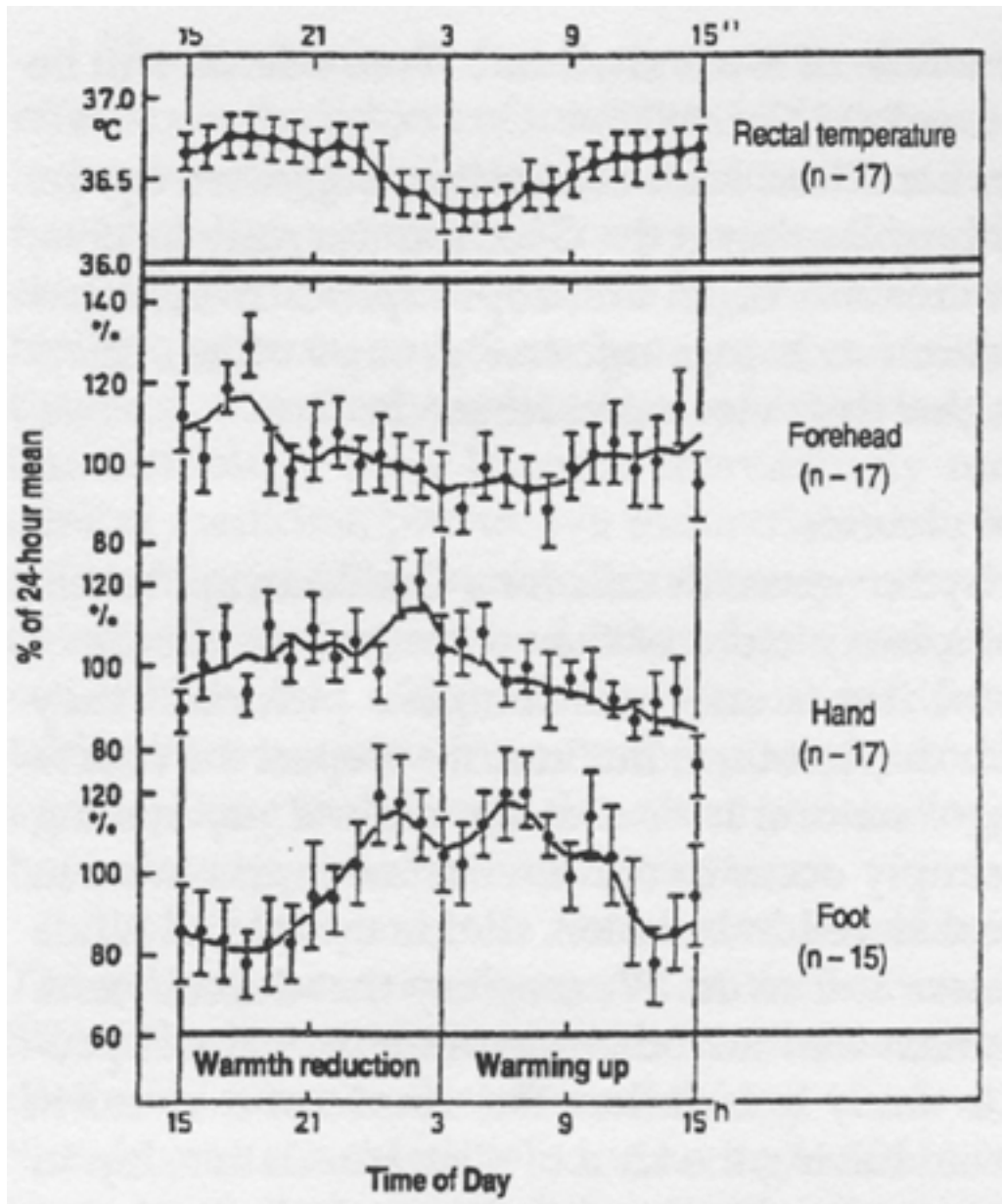


Fig. 1. Mean daily changes in cutaneous circulation on forehead, hand and foot of 17 subjects monitored at hourly intervals under the same resting conditions in an air-conditioned chamber and compared to the rectal temperature. The curves for hourly mean values were smoothed once by means of moving averages of three. The bars indicate the median error range for the mean values (after Damm et al. 1974).

Two fundamentally different constellations of these parameters may be seen. In the afternoon half of the biological day (c. 3 p.m.-3 a.m.), the organism shows a tendency to lose heat, with the core temperature going down and cutaneous circulation in the extremities (hand, foot) increased to give off more heat. In the before-noon half (c. 3 a.m.-3 p.m.), the core temperature rises, with circulation in the extremities

decreasing so that less heat is given off (warming up). The extremities are the main effectors in physical temperature regulation, apart from anything else for geometric reasons (large surfaces, small volume), whereas cutaneous circulation in the head region (more spherical) is congruous with the core temperature.

These basic aspects of the daily rhythm in the human temperature organism have been known for more than 50 years and widely investigated, yet no reference has been made to them in the anthroposophical literature (Penter 1996).

To gain a complete picture of rhythmic daily changes in the human temperature organism we have to include many other functional parameters. While these are more or less directly in complex relationship with the temperature changes, they do all fit into the rhythmic changes with the two polar functional trends of 'warming up' and 'warmth reduction'. Table 1 gives some examples. A careful review of existing chronobiologic literature will certainly help in developing complete pictures of a wide range of rhythms.

	Warming up ergophase (c. 3 a.m. - 3. p.m.)	Warmth reduction trophophase (c. 3 p.m. - 3. a.m.)
Ideal core temperature	+	-
Regulating Prevalence of behavior behavior regulation	-	+
Core temp. deviation from ideal (load error)	+	-
Sense of comfort/discomfort	-	+
Physical Autonomous sensitivity regulation to heat stimuli	-	+(dissipating
Autonomous sensitivity heat) to cold stimuli	+	-
Autonomous thermo indifference zone	+	-
Consensual vasodilatation	-	+
Consensual vasoconstriction	+	-
Diuresis	+	-
Hydremia	-	+
Liability to sweat	-	+
Insensible release of water from skin	-	+
Acral heat transmission	-	+
Acral skin circulation	-	+
Acral skin temperature	-	+
Chemical Efficacy of regulation muscle work (heat Long-term ability to perform	-	+ production)
Muscular circulation on effort	+	-
Muscular circulation at rest	+	-
Reactivity of energy metabolism		
Muscle tone, cold tremor	+	-
Spec. dynamic action	+	-
Basal metabolism	(+)	(-)

Table 1. Diurnal phase trends for thermoregulation in man (after Hildebrandt 1984).

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Rhythmic system — time organism — time body

To my knowledge, Steiner was the first to speak of a rhythmic system that included all the rhythmic processes in the organism: "The second system I then distinguished was the human rhythmic system. This includes everything at the functional level which is subject to rhythm. In the first place, this would, of course, be the respiratory system in conjunction with the blood circulation system and then also, in a wider sense, the rhythm that plays a major role for human beings (at least in essence, for individuals may break it in many ways) which is the day and night rhythm, sleeping and waking, and also any other rhythmic processes, including food intake, and so on." (28 Oct. 1922, Stuttgart)

This complex time organism (time body, time form) was seen as part of the etheric organization (ether body). In modern chronobiology and chronomedicine, the fact that organisms have a broad spectrum of rhythmic functions, which are in a regular functional relationship has only been considered in passing. Even the polarities in the time organism, which are of eminent importance for understanding time organization, have so far attracted little attention, let alone understanding.

Fig. 2 shows a spectrum of periods for the rhythmic functions of a human being. A hierarchic structure exists insofar as the rhythmic processes get more and more complex as the period increases, progressing from cellular, tissue and organ rhythms to rhythmic variations involving whole systems (circulation, digestion) and changes in the whole organism (e.g. diurnal, monthly and annual rhythms) that involve all functions. Monthly and annual rhythm as fertility and population rhythms go beyond the individual organism.

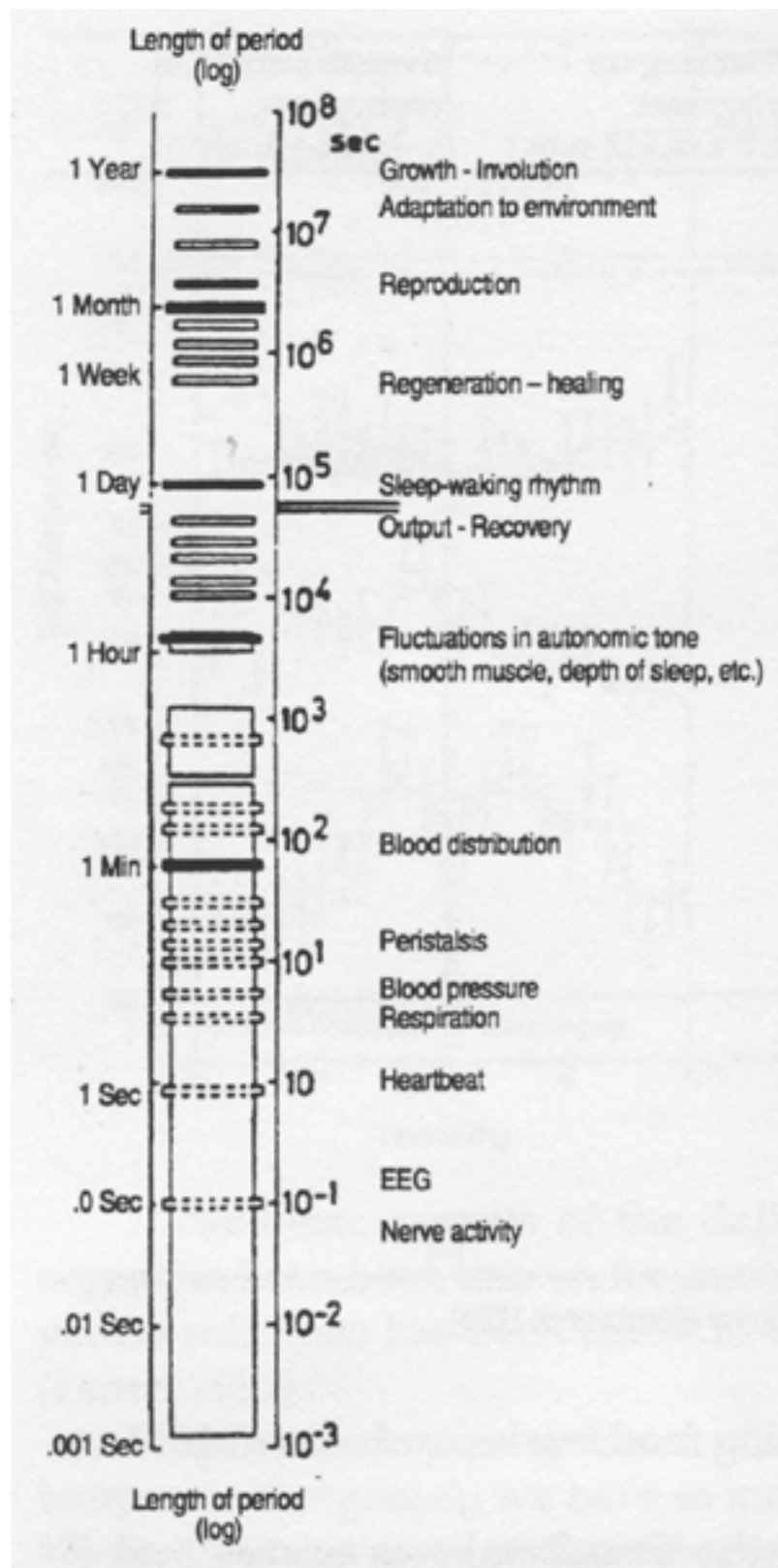


Fig 2. Preferred periods (frequency bands) of human rhythmic functions. The stable frequency bands of spontaneous rhythms have been emphasized. The

double horizontal line separates environmentally-determined, long-wave (infradian) and purely automatic (ultradian) rhythms (after Hildebrandt 1975, adapted).

The internal structure of the time organism shows a division into two (double horizontal line). The range of long-wave rhythms involves processes that have corresponding rhythmic time sequences in the geophysical and cosmic environment and can have a regulative (synchronizing) effect on biologic rhythms.

The part of the spectrum where waves are shorter (below the double horizontal line) is limited to purely endogenous rhythms that have no direct relationship to environmental time systems and represent the autonomic part of the time organism in life forms.

Plants, animals and humans have different areas of emphasis in the total spectrum of rhythmic processes. With plants, emphasis is on the annual rhythm (annual plant type) and longer periods of planetary rhythms in the cosmos. In the animal world, and especially among marine animals, lunar rhythms, including the tides, are particularly marked; while among higher animals and in humans, the emphasis is on diurnal rhythms. This phylogenetic developmental tendency with functional rhythms of higher frequency increasingly more developed is apparent in the growing prevalence of rhythmic nerve functions.

The genetically-determined provision of rhythm spectra ('chronomes') taking specific forms relates to the following words by Steiner: "We can divide the animal world into genera on the basis of rhythms, depending on how the rhythms of the astral bodies relate to those of the ether bodies." (21 Dec. 1908, Berlin, and 20 July 1923, Dornach). No data are so far available on this.

A particularly important aspect is Steiner's repeated references to the way the autonomic rhythms in the spectrum are related in humans. This applies, above all, to the relative frequencies of functions. The best known references are those to relationship of the frequencies of the pulse and respiratory rhythms, reflecting an inner equilibrium between the higher and lower aspects of the human being. The data now available have confirmed and, in many ways, extended this characteristic.

Fig. 3 shows empirically-recorded frequency distributions between different circulatory and respiratory rhythms in man. The peaks, marked preferred frequencies or statistical frequency norms, are all in simple, harmonious, whole-figure relationships with one another, with the relationship between pulse and respiratory frequencies, which is considered normal, just a section of this whole musically-organized part of the rhythmic system.

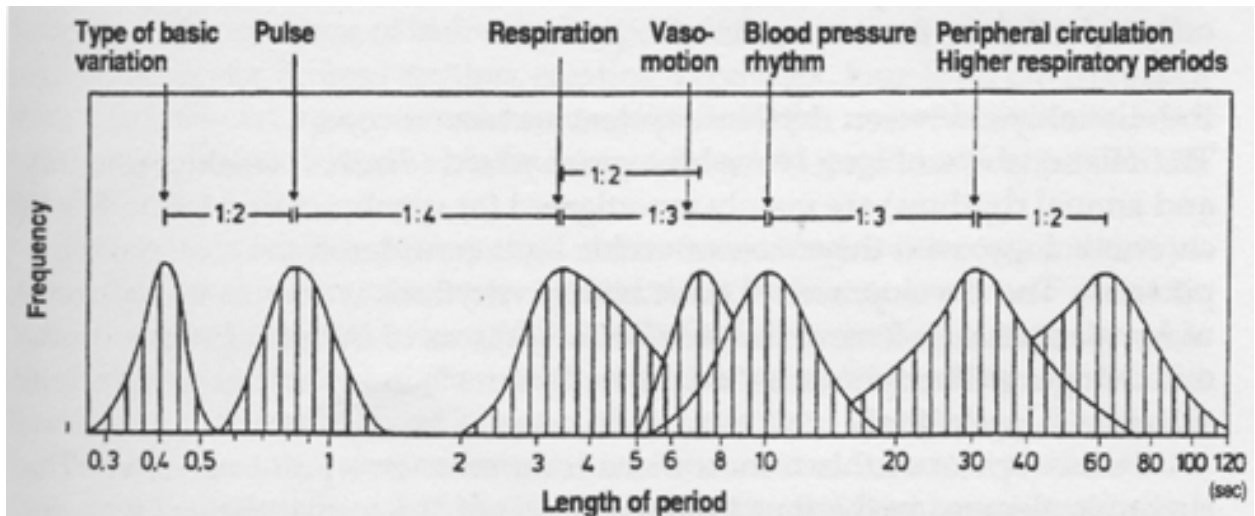


Fig 3. Frequency distribution of periods for different circulatory and respiratory rhythms in relatively large groups of people. The relative proportions given apply to peak incidences of rhythmic functions (after Hildebrandt 1967, with additions).

The data represented in the figure merely show the characteristic in statistical cumulation. They were obtained from people who were resting but awake in the daytime. If one studies the frequency relationship between cardiac and respiratory rhythm further, into the night, using the pulse/respiration rate, the normal 4:1 quotient becomes more precise during sleep (normalization) independent of the daytime changes which show considerable individual variation (Fig. 4). This is independent of the deviation seen in the day and independent of the individual frequency level of the pulse rate.

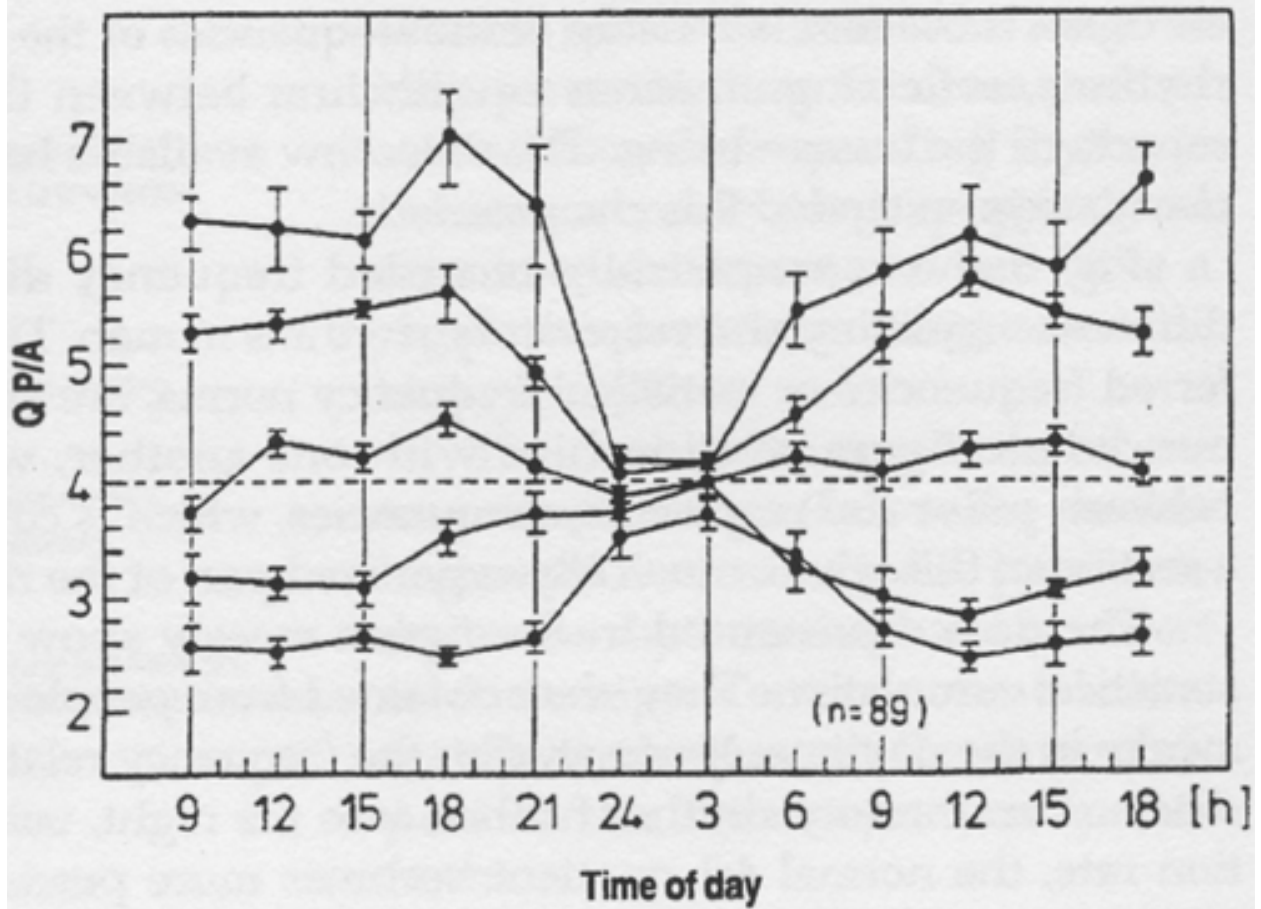


Fig. 4. Mean daily patterns of pulse-respiration frequency quotients (Q P/A) of a total of 89 healthy subjects divided into five groups according to their mean 24-hour readings. The cross bars indicate the mean error range for the mean values. Note nighttime normalization between midnight and 3 am which occurs irrespective of the direction taken by daytime variations (based on data provided by Pollmann, from Hildebrandt 1994).

Spectroanalytical investigations on sleeping subjects have shown that this whole-figure 4:1 relationship is also seen with other rhythmic functions. It is evidently an important precondition for nighttime regeneration of the organism (lit. review, see Hildebrandt 1994).

Apart from frequency relations, the autonomic order of rhythmic functions is also maintained by phase relationships. Steiner spoke of "... points of coincidence (phase superimposition points) that could be found for all kinds of human vital phenomena." (12 Jan. 1909, Berlin)

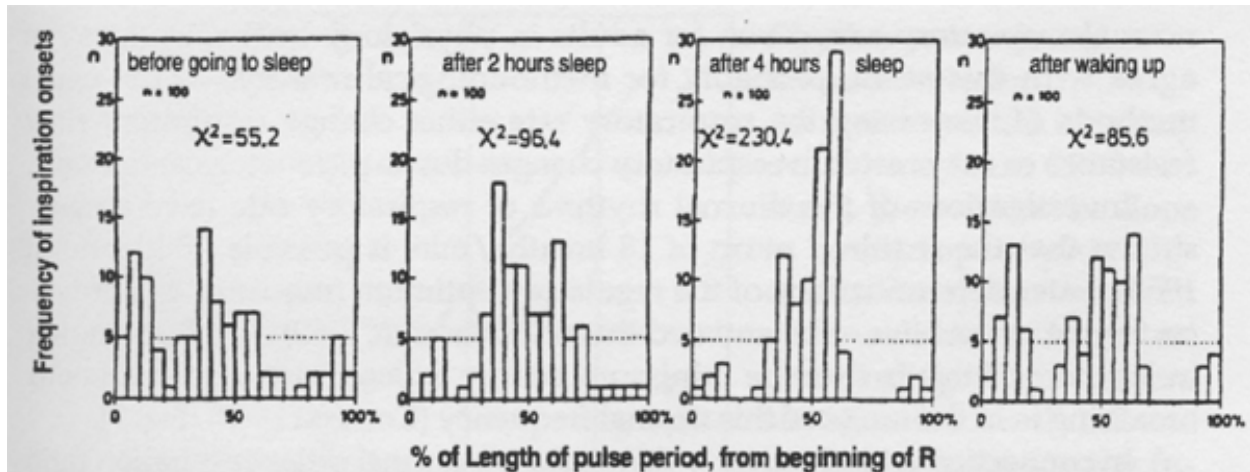


Fig. 5. Frequency distribution of 100 inhalation onsets each plotted against cardiac cycle. This was determined between R and R in the ECG and divided into 20 classes of 5% of the cardiac cycle period each. Healthy subject, before, during and after nighttime sleep Chi-squared equals the extent to which distribution deviates from equal distribution over the 20 classes (dotted horizontal line). (After Storch 1967).

Fig. 5 shows frequency distributions of 100 inspiration onsets each plotted against the cardiac cycle which was divided into classes of 5% each of the cycle period. This was recorded before, during and after nighttime sleep. In the waking state, inspiration onsets were more or less distributed at random over the cardiac rhythm, but during nighttime sleep they concentrated increasingly on a particular section of the cardiac cycle. Many instances of such phase coupling between rhythmic functions have been established, above all between autonomic and motor rhythms. Further investigation of such relationships and the practical application of insights in diagnosis and treatment are no doubt an important area for future work in anthroposophically-oriented rhythm research.

Relationships between rhythmic system and macrocosm

The relationships of long-wave biologic rhythms (diurnal, weekly, monthly and annual rhythms) are mainly investigated for synchronizing influences in chronobiology, with the effects of visible light considered to be of major importance. The development of these biologic rhythms is seen as the outcome of an adaptation process which enables organisms to initiate effective rhythmic changes at the right time ("adaptive rhythms") independent of the actual situation (e.g. weather).

Steiner spoke of this from a more comprehensive point of view: "The rhythmic element in the four bodies (aspects of the human being) was implanted in man over long, long periods, with the hierarchies bringing it about that the different bodies can influence one another... And we would recognize the rhythm of our human aspects in the movements of the heavenly bodies, which make a complete system." (20 July 1923, Dornach)

Steiner specifically related the individual rhythms of the four aspects of the human being to environmental rhythms as follows (20 July 1923, Dornach)

Long-wave rhythms modulate more short-wave rhythms in any time organism. The time relationships between the aspects of the human being would thus be as shown in Fig. 6 relative to the total spectrum of rhythmic functions. The rhythms of individual aspects interpenetrate completely in the region below the diurnal rhythm, creating a complex, four level environment that is influenced by cosmic elements. Within it, the more short-wave autonomic time structures are able to form a threefold organization (see Hildebrandt 1994).

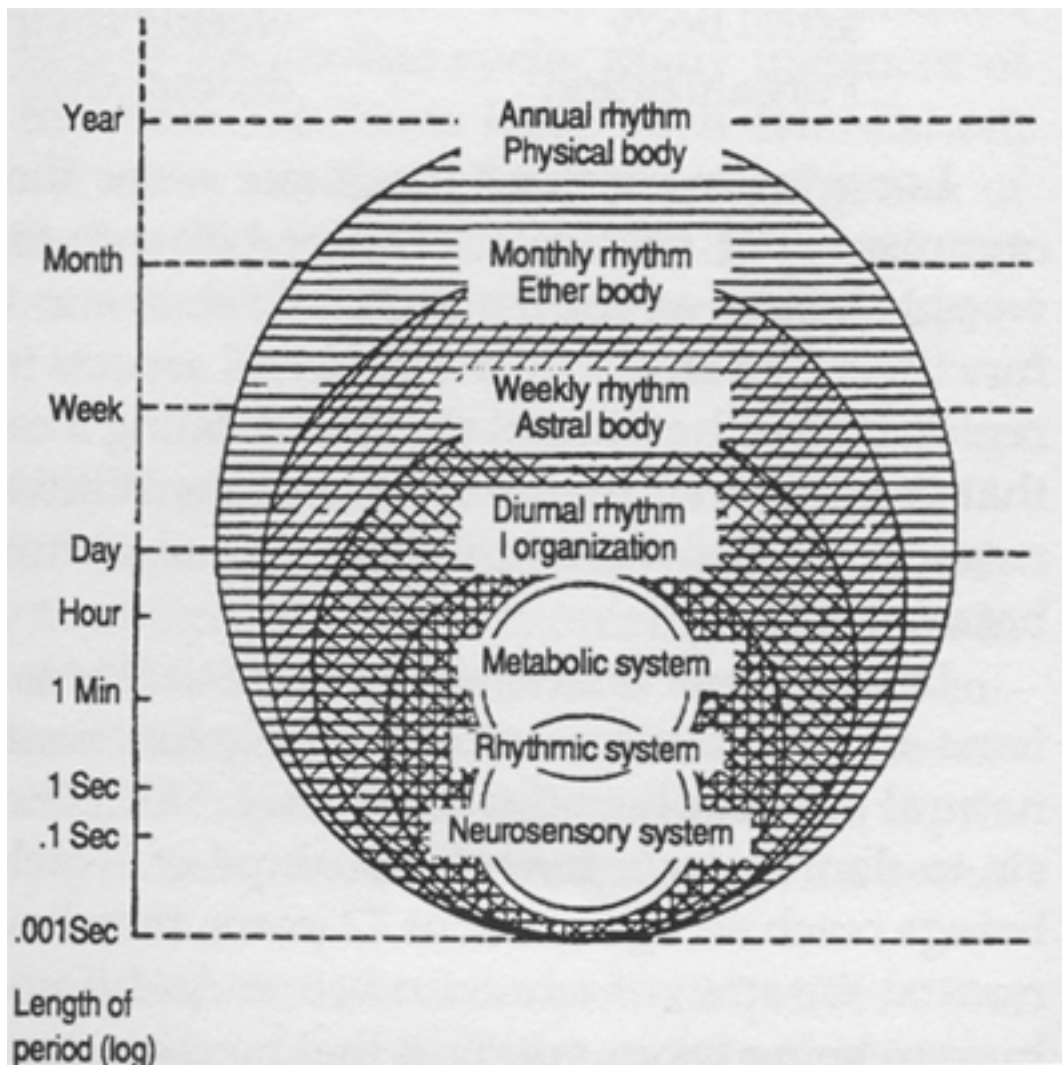


Fig. 6. Diagram to show interaction of cosmically determined long wave rhythms in men. In the region below the diurnal rhythm, all functions are influenced by all four rhythms and organize themselves in a threefold time organism (after Hildebrandt 1986).

Distinct time relationships also exist between long-wave cosmic time systems and the rhythms of autonomic functions. This was known to romantic natural philosophers (Schubert 1821,1877). Steiner gave them special emphasis to demonstrate the

relationships of which he was speaking: "If human beings reach an age of about 72 years, they have lived 25,920 days. That is the normal life span of a human being. And if you measure, count the breaths a human being takes, you find that he takes exactly that number of breaths in a day. Someone who lives a normal life span thus has as many days in life as breaths in a day." (20 July 1923)

Such a clear statement does, of course, ask to be checked, especially as the normal respiratory rate given for adults in physiology textbooks does not agree with this at all, probably for methodological reasons, as the usual methods of measuring the respiratory rate either change respiratory flow resistance or may result in respiratory changes due to psychological reasons.

Investigations of the diurnal rhythms of respiratory rate have already shown that the required norm of 18 breaths/min. is possible (Hildebrandt 1953). Later determinations of the regulatory optimum frequency as a criterion for the norm have substantiated this (Hildebrandt 1960). Another finding in support of this is that the minimum energy expenditure in spontaneous breathing is in the range of this normal frequency (Comroe 1968) (Fig. 7).

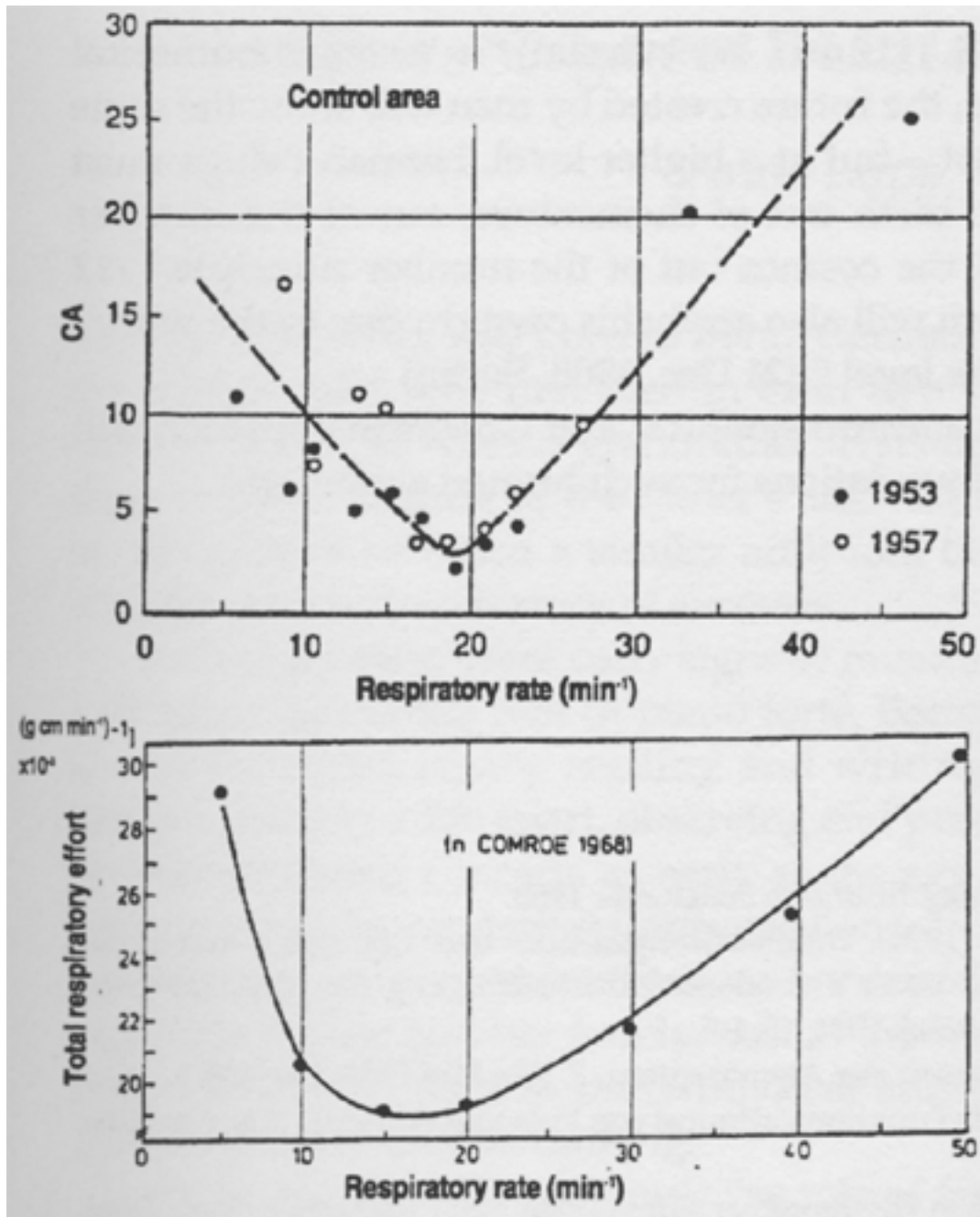


Fig. 7. Above. Control area (CA) of respiratory frequency control following graded stepping effort in relation to respiratory rate at rest prior to effort. Two sets of data (after Hildebrandt 1960). Below. Total respiratory effort in relation to respiratory rate (after Comroe 1968.)

In connection with the clearly demonstrable normal pulse/respiration ratio of 4:1 and numerous other frequency relations with whole-figure harmony (Fig. 3), we have definite, empirical proof of a relationship between the human autonomic time organism and the cosmos.

There are, however, variable degrees of freedom in this system which developed in the course of evolution: "In the past, up to about the middle of our earth evolution, man was much more in accord with the rhythms in the outside world in all his parts. ... In Lemurian times, it was perfectly normal for human beings to have their internal rhythm based on the external rhythm... Since that time things have come to overlap. The inner human being has grown independent of the external rhythm. He has kept his old rhythm inwardly. It is exactly because the rhythms no longer coincide that man has gained independence and freedom." (21 Dec. 1908, Berlin, and 20 July 1923, Dornach).

Numerous experimental studies in modern chronobiology, eliminating all environmental factors, have substantiated this non-agreement between the inherent frequencies of biorhythms of plants, animals and humans and corresponding environmental rhythms in many respects. These findings have not, however, been evaluated from the evolutionary aspect of developing autonomy.

Rhythm research and human evolution

As Steiner stated on many occasions from 1908 onward, the work to be done in anthroposophically oriented rhythm research goes well beyond our understanding of the present situation for it will have to provide a basis for the future task of humanity, which will be connected with the whole cosmos, as Rudolf Steiner stated most emphatically on many occasions from 1908 onwards. "Man has grown more free of the cosmic influences in his environment." (21 Dec. 1908, Berlin) "Man would never have gained independence if everything he did had been on the leading reins of cosmic conditions. He gained his freedom because he retained his inner rhythm, getting free of the external rhythm. He has developed and become like a clock." (12 Jan. 1909, Berlin) "The least of it is that people turn night into day in our cities. What is much more important is that humanity has inwardly torn itself away from the great cosmic rhythms in its way of thinking." (12 Jan. 1909, Berlin) "We thus see that in order to gain his freedom, man had to come free of the original rhythm. But he must find the laws again in himself, so that he may regulate the clock, regulate his astral body." (12 Jan. 1909, Berlin) "It is also important that people should not think they can live without rhythm. Having developed their own inwardness separate from the outside, they must recreate themselves in their rhythms from the inside." (12 Jan. 1909, Berlin) "Man must develop inwardly to the point where he lets his own rhythm go out into the world again" (12 Jan. 1909, Berlin) "Human beings have emancipated from the outside rhythm. With the science of the spirit, in its true sense, they go back to having rhythm again. Out of our own inner resources we build a world that has the rhythm in it." (12 Jan. 1909, Berlin) "In terms of numerical relationships in large numbers, the future created by man will show the same - as the cosmos did in the past - but at a higher level. Human beings must therefore bring the future to birth out of themselves, out of the number principle, as the gods created the cosmos out of the number principle." (12 Jan. 1909, Berlin) "One day man will also apply his own rhythm to the world, when he has reached the divine level." (21 Dec. 1908, Berlin)

Rhythm studies using the anthroposophical and Goethean approach will have a role in developing the foundations for such human evolution.

Gunther Hildebrandt, MD

Calvinstr. 13
D-35037 Marburg/Latin
Germany

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