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Aging and Biological Oscillation: A Question of Geometry

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Abstract

Previous studies in different ethnic groups show changes in heart rate, respiratory rate, cortisol cycle, and sleep-wake cycle throughout life. Our purpose is to verify such changes by comparing the values of each variable before and after puberty. Puberty is associated with the end of growth and is an important point in our theoretical framework: when growth ends, changes occur in the geometry of the biological system. At the same time, this causes phase changes in the oscillatory variables, which are seen as chronodisruption. The results confirm the changes found by other authors in the evolution of the variables throughout life. Then, we can conclude that the variables studied present phase changes when growth ends, in accordance with the proposed theoretical framework.

Keywords

Chronodisruption, Phase Changes, Geometry Changes, After Puberty, Wave Function, Order-Chaos Transition, Information Density Limit

1. Introduction

Living things are complex physical systems coupled with oscillators [1] [2]. In a general way, they consist of a dissipative system, such as the enzymatic system of the Krebs cycle, associated with a self-organizing system, such as that of nucleic acids [3].

In previous works, the consideration of human beings as oscillatory systems allowed us to propose that aging is due to a change in the geometric phase. That implies considering the biological phenomenon as the expression of a vector independent of the vectors of space and time [3].

From its most basic form (the cell) to the most complex form (the whole organism), the presence of biological oscillators is notable [4]. Even at the level of

the species, the relationship between prey and predator can be described as an oscillatory system [5] [6]. Cell cycles, sleep-wake cycles, and hormonal cycles are just a few of many examples. Whichever variable we study will present oscillations and they will behave like a wave [7] [8] [9].

Suppose we observe the cell cycle of a certain type of cell and we assimilate it to a wave when another different cell type is observed, it will present another type of wave, amplitude and frequency different from that of the first cell type observed.

Aging is associated with the changes in the relationship these wave phenomenons have with each other.

Previous proposals by the authors have indicated that shortly after puberty (when growth ends) the aging process begins: the gradual decline of the capacity for homeostasis and self-organization are caused by changes in the geometry of the system [10].

Therefore, it is important to observe the behavior of the different system variables and their relationship with each other before and after puberty.

The chronodisruption process associated with aging is not a new issue and it has been studied by various authors [11] [12] [13]. The understanding and describing of chronodisruption as a decoupling of the oscillators that make up the system (of the living being), maybe a novel contribution.

We consider each variable as an oscillator, and each oscillator has its own rhythm. These are not synchronous oscillators since their rhythms, frequency and scope are different. But they are coupled because their phase differences are constant. The aging process involves a phase change that leads to the decoupling of oscillators, such as heart rate or hormonal cycles.

Our objectives are:

- Verify the existence of frequency changes in heart rate, respiratory rate, the sleep-wake cycle, and the circadian cycle of cortisol throughout life.
- Compare between each other the frequency changes of the variables studied if such changes are verified in the first objective.

2. Materials and Methods

The average frequency of the heart rate in human beings of both sexes at rest was considered. The values before and after puberty were compared (**Table 1**).

Similarly, we compared the frequency of the respiratory rate in human beings of both sexes, at rest, before and after puberty (**Table 2**).

The characteristics of the sleep-wake cycle in human beings of both sexes can be seen in the following table (**Table 3**).

We also compared the circadian cycle of cortisol before and after puberty in human beings of both sexes (**Table 4**).

A change in frequency and amplitude in a variable that describes cycles is seen in changes in the dispersion of the data. For this reason, the comparisons were evaluated by applying the standard deviation test (SD) and the coefficient of

Table 1. Shows the variation of heart rate throughout life. Sample demographic characteristics: Argentine population white (Hispanic) race. Sample size: n = 12,150.

Age	Beats per minute
1 to 12 months	80 to 160
1 to 2 years	80 to 130
2 to 4 years	80 to 120
4 to 6 years	75 to 115
6 to 8 years	70 to 110
8 to 12 years	70 to 110
12 to 17 years	60 to 100
Adults	60 to 70

Table 2. Shows the variation in respiratory rate throughout life. Sample demographic characteristics: Argentine population white (Hispanic) race. Sample size: n = 12,150.

Age	Breaths per minute
1 to 12 months	30 to 60
1 to 3 years	24 to 40
3 to 6 years	22 to 34
6 to 12 years	18 to 30
12 to 18 years	12 to 20
Adults	12 to 16

Table 3. Shows the variation in hours of sleep throughout life. Sample demographic characteristics: Argentine population white (Hispanic) race. Sample size: n = 12,150.

Age	Hours of sleep per day
1 to 12 months	12 to 16 hours
1 to 2 years	11 to 14 hours
3 to 5 years	10 to 13 hours
6 to 12 years	9 to 12 hours
13 to 18 years	8 to 10 hours
Adults	6 to 8 hours

Table 4. Shows the variation in plasma cortisol concentration throughout life. Sample demographic characteristics: Argentine population white (Hispanic) race. Sample size: n = 12,150.

Age (years)	Plasma Cortisol μg/dl
6 to 9	7 to 23
10 to 11	5 to 18
12 to 14	5 to 22
15 to 17	6 to 21
Adults	9 to 16 (average)

variation (CV). The CV is the appropriate test to verify the changes in the SD of each variable throughout life. The CV is expressed as a percentage (values of 30% or more are statistically significant), and it is a good measure of the phase change of each variable throughout life.

3. Results

Before puberty, the heart rate presents (SD) = 27.64. A value that is not consistent with a normal distribution pattern (SD ≤ 3). While after puberty, the values are (SD) = 5. Although neither is this compatible with a normal distribution pattern (SD ≤ 3), it shows five times less dispersion than before puberty. The CV is 30.22% (statistically significant) (Figure 1).

The respiratory rate before puberty presents SD = 12.93. After puberty, their values are SD = 2. These values show a reduction in dispersion and a normalization of the behavior of the variable after puberty (SD ≤ 3). The CV is 49.40% (statistically significant) (Figure 2).

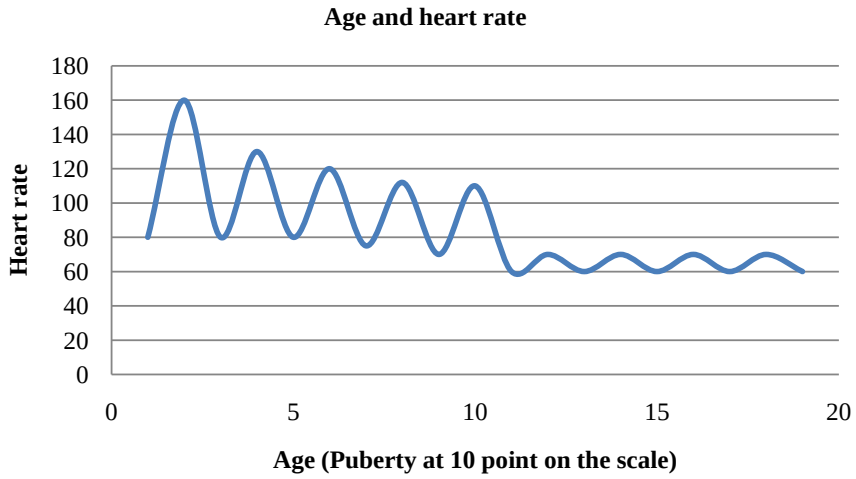

Figure 1. Heart rate variation throughout life. CV = 30.22% (significant).

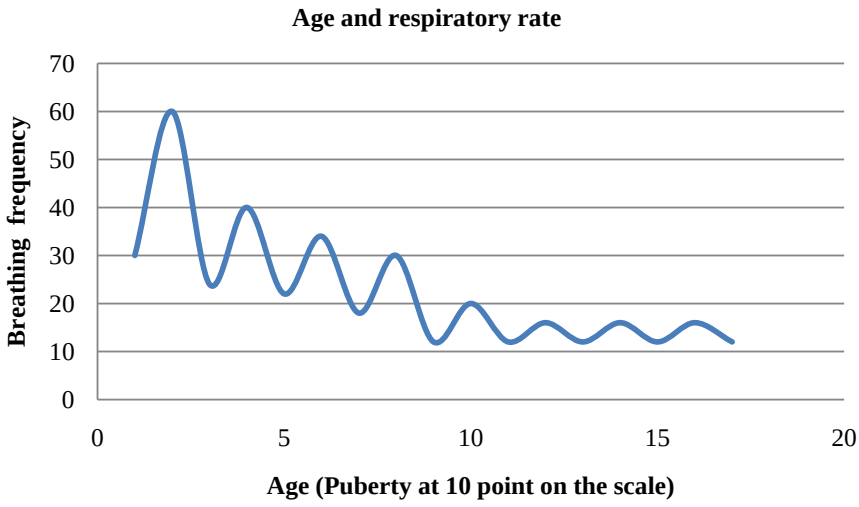

Figure 2. Variation in respiratory rate throughout life. CV = 49.40% (significant).

Regarding the hours of sleep per 24 hours, the results before puberty SD = 2.29; and after puberty SD = 1. It can be seen that the spread is halved after puberty. The CV is 25.21% (no significant) (Figure 3).

In the case of the cortisol cycle, before puberty, it is SD = 7.76. While after puberty, it is SD = 3. This implies the normalization of the variable (SD = 3) after puberty and a reduction of the dispersion to half its value before puberty. The CV is 53.94% (statistically significant) (Figure 4).

4. Discussion

It is noteworthy that, in all the variables studied changes occur that are stabilized, decreasing the dispersion and frequency of the oscillations at the end of growth. Such changes occur across gender and ethnicity. Previous papers on populations of different ethnic groups showed results similar to those we found [14] [15] [16].

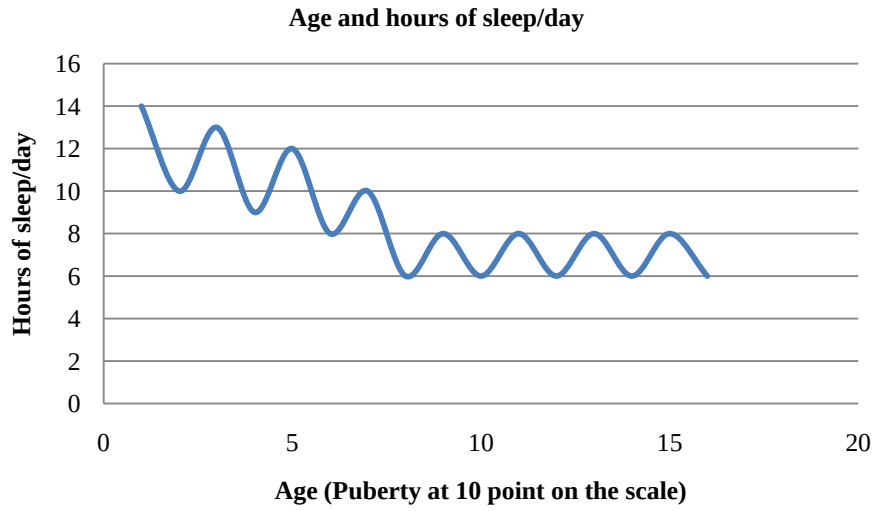

Figure 3. Variation in hours of sleep throughout life. CV = 25.21% (no significant).

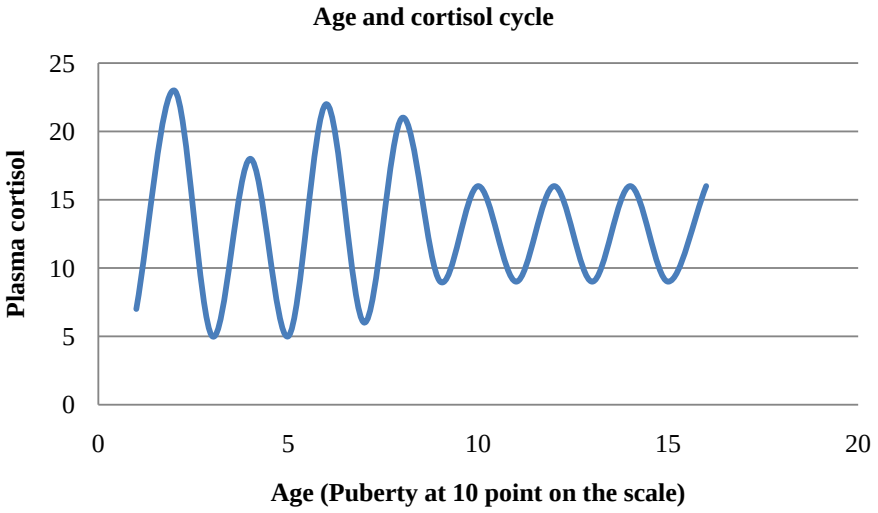

Figure 4. Variation in plasma cortisol throughout life. CV = 53.94% (significant).

What meaning can this finding have in the theoretical framework proposed by the authors?

A geometric phase change implies that all the variables will present changes as it is the geometry of the system itself that is changing. Although all variables are not equally sensitive to system geometry changes [3] [17].

Then we must take into account the following: when a biological system in a human being consists of a single cell, or an early embryonic formation like the morula, its geometry is that of a sphere. The Gaussian curvature of its surface is positive and of equal value at all its points. In later stages of development, such as the blastula stage or the gastrula stage, the embryoblast acquires a flat shape, and its curvature is null. During the fourth week, its curvature is neutral, since the embryo develops a cylindrical shape [18] [19].

In any of these cases, a curvature of positive, null or neutral the system presents a transition in its order [20] [21] [22]. The system grows. But its size has its limits. [10] When it stops growing, shortly after puberty, its geometry will also change. The curvature is no longer the same at all points of its surface, and a system with such characteristic loses its tendency to its order [20].

Now, if we assimilate each variable to a point on the surface of its system, when a geometric phase change occurs, all the variables change value.

We must emphasize that although the variables configure a virtual space of parameters, they are defined in a real physical space. For example, the heart rate is not defined in a dispersed way throughout the system, nor in any part of it, but in a specific region of it.

In a way, the event is similar to taking an uninflated balloon (a birthday balloon) in your hands, placing it on a flat surface of a table and observing the face of a clown drawn on the surface of the balloon. After blowing up the balloon, you look at the clown's face again. You fix your attention on a pair of white crosses that represent its eyes. You will see that the location, the distance and their relationships are no longer the same. We insist again: not all variables are equally sensitive to changes in the geometry of the system. For example, the crosses on the balloon surface remain white even though their size and relationships change.

The phase shift of wave phenomena within different periods is of great importance in the case of biological physical systems: the chronodisruption that we observe in aging [21] [23] is the result of the changes that occur in the geometry of the system.

Another inevitable reflection is the following: the different living beings that exist have different genetic information. However, all of them present the same geometry guidelines in the early stages of their development, because the geometry of the system does not depend on its information, but on its information density. It is the density of information that determines the geometry of the system, and not the information itself. Genes are not the engine of evolution but an evolutionary way of encoding information [24], so it is necessary to pay attention to the density of information more than to the information itself [10] [25].

Finally, we want to emphasize that if living beings can be assimilated into oscillatory systems and their variables behave like waves, it is likely that there is a wave function that describes their position in space in the following terms:

$$\Psi\ (x, y, z, t, l) = \text{scope of probability.}$$

$\Psi^{*}\Psi$ = probability;

Ψ = wave function;

x, y, z = space axises;

t = time axis;

l = life axis.

In our theoretical framework, the biological phenomenon is the expression of a vector other than the vectors x, y, z, t.

And since the probability of locating a particle in a certain region of space must be equal to one, its wave function must be normalized. [26] It must correspond to the sum of the probabilities for the entire space of reference:

$$\int^{\Psi^{*}\Psi} \mathrm{d}r = 1$$

We know that it may seem like mere theoretical speculation, but it could help explain our deepest nature.

5. Conclusions

The results allow us to conclude that the variables studied decrease their oscillation frequency until shortly after puberty when growth stops.

These oscillations reduce their frequency and their scope. Their periods lengthen (increase their duration) and there are gaps that can be seen as chronodisruptions. The verification of these changes allows us to certify the fulfillment of the objectives of our work.

The meaning in the theoretical framework proposed by the authors can be summarized as follows: changes in the geometry of the system that occur shortly after puberty cause a lag in the behavior of the variables. Little by little, the system exhausts its ability to oscillate.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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