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Commentary

Hologram: Beyond Biological Aging

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Abstract

Keeping in mind the relationship between the basal metabolic rate and the change in weight in the aging process, we propose to verify the holographic description of the same. For this we set ourselves the following objectives: Verify the correlation between total energy dissipation and energy dissipation per unit body mass, and verify the correlation between the total energy dissipation and the body mass. As a result of the data analysis, we obtained a coherent representation of our proposal. A high degree of correlation between the total energy dissipation in an organism and the basal metabolic rate / dry kg was found. Such a condition implies that the stated biological system satisfies the Holographic Principle.

Keywords: Basal metabolic rate; Body weight; Energy dissipation; Geometric phase; Information density; Relative surface; Structural geometry

The Theoretical Framework

In previous works, we have tried to understand the biological aging process as a consequence of the relationship between Basal Metabolism Rate (BMR) and the body mass of an organism. Specifically, we study the evolution of the values of the Basal Metabolism Rate BMR/unit of Dry Weight (BMR/dry weight), and the evolution of the values of the total body mass throughout a lifespan [1,2]. This consideration is not a whim, but it derives from the following concept: the metabolic activity of a cell depends on its exchange of matter and energy within the environment, and this occurs through its surface [3-5]. More precisely, the metabolic activity depends on its relative surface area or the surface area per volume unit [6-9].

For these purposes, body mass is assimilable to volume, since there is a direct relationship between body mass and volume (the changes in the density are not enough to invalidate this relationship), so considering the values of the TMB/unit of body mass, they are consistent with the original concept of area per unit volume or relative area [10-13]. If we look at a cell, we can say that the energy it dissipates has a direct relationship with its relative surface area or the surface area per unit volume. The information of a human being is "encoded" in its DNA and "expressed" in its structure. But the information is not expressed if it is not mediated before a process of dissipation of energy. This is related to the boundary of the human being (which in the case of the cell is its surface), rather than its body mass or volume [14-16]. This characteristic of the biological phenomenon bears a remarkable similarity to the holographic principle: in every limited spatial region, the information contained in that region is related to its surface and not to its volume [17-19].

This has interesting consequences, such as the fact considering that there is an informational density limit for the spatial region in question (called the Bekenstein Boundary in the theoretical framework of the Holographic Principle), and that stated limit is related to the surface that limits the stated region and not with its volume [20-22]. If we reduce the problem to its simplest form in biology, we must consider that a cell has a limit to its size and that this expresses its limit for informational density. A high degree of correlation between the total energy dissipation in an organism and the BMR / dry kg (consistent with the concept of relative-surface), implies that the stated biological system satisfies the Holographic Principle. On the other hand, a low degree of correlation implies that the total energy dissipation is more related to its mass or total volume than to its BMR / dry kg. In such case, the system does not satisfy the Holographic Principle.

Analyzing Data

Data on the evolution of the BMR/dry kg, the total energy dissipation expressed in Kcal/ day, and the total body mass expressed in kg throughout the lifespan in human beings is from tables of previous works [23]. When we refer to a unit of body mass, we take the values of the unit of body mass free of water (dry weight), to consider the metabolically active body mass as a reference. When comparing the total BMR /day with the dry BMR /Kg, R^2 (correlation test) has a value of 0.96 ($p < 0.02$), which is statistically significant. But when comparing the total BMR/day with the total body mass, R^2 has a value of 0.84 (NS), showing that there is no statistically significant association.

We know it seems too simple. However it's a concrete evaluation of a simple and novelty idea: information is proportional to energy dissipated, and energy dissipated is proportional to surface area rather than volume. Then the information is proportional to the surface rather than the volume (Holographic Principle). The principles and relationships that support the results are easy to explain: According to the holographic principle, in every limited spatial region, the information contained in that region is related to its surface and not to its volume. In the case of living beings, the information is related to the dissipated energy. So, if the dissipated energy is more related to its relative surface than to its volume, it is possible to apply the holographic principle to living beings. In the particular case of humans, this implies that

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the total energy dissipation is more related to the BMR / dry weight (consistent with the concept of relative-surface) than to the total mass or volume of the organism.

A Self-Organizing Hologram

In the proposed theoretical framework, we can consider that the results obtained confirm that human beings satisfy the holographic principle since the total dissipation of energy is related to the dissipation values per unit of body mass, and not to the values of the total body mass. This is the novelty point of our contribution. In previous paragraphs, we have mentioned the concept of informational density limits, and we must specify that this depends on the quantity of information. The case of fertilization and segmentation is eloquent. The oocyte is a large cell with little relative surface area. This implies a low metabolic rate, and a high informational density, to which is added the genetic information of the sperm. Soon it reaches the informational density limit and segmentation begins.

With this, the amount of information in each cell does not vary, but its density decreases because the size is reduced and the relative surface area increases. The metabolic rate shoots up and the differentiation processes begin [24,25]. There is a minimum amount of information to support the identity of the human being. The limit of the least retainable complexity is named by Stephen Gould as "the left wall of minimal complexity" [26]. There is also a maximum limit, or limit of informational density, which is reached when the system no longer supports additional information. This occurs in a cell when its relative surface area decreases and its metabolic capacity declines. In a human being we can observe the same change when, after puberty, growth ceases. The system does not increase in size but increases the informational density until it reaches its limit. This will have two consequences: one is the decline in the BMR per body mass unit, and the other is the appearance of geometric phase changes that will be seen as aging [1].

This is directly linked to the complexity and size of living things [27]. A cell cannot indefinitely increase in size. Once the informational density limit is reached, cells divide and associate, forming complex multicellular structures [28]. Therefore, the system that results from this association has more information. But the most remarkable fact is that each of its parts, and its cells, contains information regarding the entire system. Having the same DNA in all cells is an effective way of observing it. This condition also satisfies another characteristic of holograms: each of their parts contains information about the entire system [29]. This complexity is not the result of chance, but of the existence of an informational density limit. This in turn influences the geometry of the system. When a cell reaches its limit, it generates multicellular structures called tissues. These do not have the shape of their cells, in the same way that a human being does not have the shape of its organs, its tissues or its cells [30].

However, all levels of the biological organization have one characteristic in common: their geometry is determined by the density of their information. This can be seen in biological aging, and in the consistency of physical-biological systems using the holographic principle. Within the same framework, it is worth highlighting the primary role of the concept of the informational density limit: wherever it occurs, that is the boundary for human beings, beyond which organisms age, generate a new level of organization, or simply die.

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