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EDITORIAL

Fractal geometry: A consolidated tool for imagination

Geometría fractal: Una herramienta consolidada para la imaginación

Since the very first attempts performed by the human brain for acquiring information about the surrounding world, priority is usually given to the information received by visual channels, i.e. by the eyes (1). It is interesting the proportion of human cerebral cortex destined for processing the stimuli captured by the photo-sensors contained in the retina, ranging 55% (1-3). According to several authors (1-4), the human learning process involves the association of each stimulus received by the different transduction assemblies composing the five senses to an image or, even, to a specific intricate memory. This has derived in formulating research works about how the brain develops the processes of creation and imagination (2-4). Therefore, the complexity of the well-known capacity of children for drawing in the mind (or in a piece of paper) a picture of an imaginary creature, and defining how it smells, hears, tastes, and touches, is astonishing. Having fun making an imaginary creature does not necessarily imply an easy task for the human brain, especially if the thinker of such an imaginary creature goes deeper into deciding if the creature becomes an opponent or a friend. In turn, the learning process may result affected when the visual channels do not work properly. Some studies have shown that lack of visual experience delays the physiological development of cognitive, social and linguistic skills in blind children (2, 5, 6). Although this might signify a serious disadvantage for an adequate brain development, there exist reports indicating that cerebral processing of shapes (2), spatial perception and imagery occurs in the same way and in the same highly-specialised visual areas, despite the sensory channels through which the information is acquired, in both blind and non-blind individuals. Furthermore, it is possible to mention many examples of blind persons noticing some aspects that the non-blind ones do not recognise (2, 5-7).

Trying to reproduce, describe and or communicate the so-varied shapes seen everywhere, e.g. by painting a landscape, might be started by considering as an obvious choice the use of the elementary patterns of the Euclidean geometry such as circles, squares, spheres, pyramids, etc. This procedure seems to be sufficient for several fields or activities; however, if the purpose is to obtain an accurate representation of the natural shapes and objects, the Euclidean patterns may result not enough. Additionally, when observing a common object like a tree or a cloud, their magnification reveals the details in their surface or contour; nevertheless, the magnification of standard geometrical patterns does not produce the same effect. Hence, any classical pattern used to represent the contour of a natural object remains very far from the aim of illustrating all the information enclosed by such a level of details (8).

Numerous questions may emerge from above, for instance: How can we represent in a more realistic way the objects seen in nature?, How can we condense the information acquired by different sensorial channels into a single descriptor that allowed us to build and/or associate in our mind a corresponding image of the complex natural objects?, How can we communicate and help someone else, blind or non-blind person, to comprehend the so-detailed natural shapes?, How can we express in quantitative terms the differences in morphology and texture, which sometimes are easily detected and sometimes even not recognised?

In 1982, Benoit Mandelbrot, published “The fractal geometry of nature” (8), coining the term ‘fractal’ from the Latin word *fractus,* which means fractured, broken, irregular. Mandelbrot called as fractals to all mathematical (theoretical) figures derived from an iterative process, and from this, fractals have a property called self-similarity; because of such property, fractals show a high level of details and, very importantly, fractals are characterised by a fractional (non-integer) dimension, the renowned 'fractal dimension'. Since that year, uncountable works concerning almost every field in science and technology have incorporated fractal geometry as a tool for quantitatively describing morphology and texture attributes, as well as changes, trends and differences along time/space of biological and non-biological structures, phenomena and processes, with or without direct implications for industry. Some references related to biological phenomena/processes are listed here (9-14). The research article included in the present number of this journal is another example of the application of fractal geometry for describing and quantifying changes in morphology and texture of biological matrices subjected to a chemical process (15). The development of fractal geometry as a widely useful tool, however, has depended on essential computational techniques, mainly the digital image analysis. Expressed in terms of fractal dimension, this tool has allowed also for deriving mathematical models for systems in which complexity is fundamental (16), such as those related to the chaos theory. Thus, by denoting objects, shapes, structures, contours, surfaces, behaviours, phenomena or processes through a single quantitative descriptor called as fractal dimension, complemented by data on lacunarity and multifractality (8, 17), it has been possible to suggest an answer for the questions formulated above.

Along the most recent decades, then, fractal geometry has become a consolidated tool for integrating the information acquired by visual channels, in order to increase our understanding of nature by helping to evoke a more accurate landscape of the Universe in our imagination.

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