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Letter to the Editor

Degree of myelination (g-Ratio), Divine proportion and *Fibonacci sequence* – A mathematical relationship

Dear Sir,

The g-Ratio (degree of myelination) [*estimated by dividing the axon diameter by the myelinated fiber diameter*] is widely utilized as a functional and structural index of optimal axonal myelination. This concept is supported by the observations that during the recovery process from demyelinating disease, central axons undergo an initial period of hyper-remyelination and increased diameters which then eventually revert to the normal g-Ratio.[1]

In addition, the g-Ratio can be useful to the evaluation of the relationship between nerve conduction velocity and fiber morphology during peripheral nerve regeneration.[2] Rushton was the first to derive an optimal theoretical g-Ratio of 0.6. In this classic study the calculation of g-Ratio is based on the speed of fiber conduction.[1] It is known that some peripheral axon g-Ratio values tend to be lower than central axon g-Ratio values.[3] It is possible that in the peripheral system the space constraint is less of a limiting factor than in the brain, as axonal myelination in the peripheral nervous system tends to be optimized for maximizing conduction velocity so that long projection axons can ensure rapid sensory and motor responses.

This means that the thickness of the myelin sheath varies according to the diameter of the axon: bigger axons have thicker myelin, and vice versa. The exception to the constant g-Ratio rule is seen in axons that have been remyelinated – for example, after peripheral damage and regeneration – in which the sheaths are typically thinner than expected.[4]

Most myelinated axons in any given animal have the same g-Ratio and this value is usually between 0.6 and 0.7.[1] In fact, recently some author's[4] have demonstrated that the g-Ratio of 0.6 is optimum for normal conduction velocity of neural impulses. This fact is of great significance since other studies show that the nerve fibers that exhibit the g-Ratio with values of about 0.6, tend to have greater functionality.[1]

Thus, the g-Ratio may be considered a reflection of the set-point at which the structural and functional organization of individual fibers has achieved a high degree of balance and optimization. Additionally, to obtain a value of 0.6 for the g-Ratio, is necessary to make a 40% difference between the ratio of axonal diameter and the diameter of the myelinated fiber; which corresponds exactly to the same difference required to achieve a famous *Divine proportion* ($\Phi = 1.6$), which is classically associated with greater structural efficiency.[5]

Similarly, when we examine the *Fibonacci sequence*: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89..., we see that as we move forward in the sequence, the ratio between the two successive numbers oscillates around of the ratio 1.6 corresponding to a difference between the highest and lowest number in the order of 40%, as follows[5]:

$1/1 = 1.0$
$2/1 = 2.0$
$3/2 = 1.5$
$5/3 = 1.6$
$8/5 = 1.6$
$13/8 = 1.6$
$21/13 = 1.6$
$34/21 = 1.6$
$55/34 = 1.6$
$89/55 = 1.6$

Therefore, all data here presented are compelling evidence that the g-Ratio of the nervous fibers really have a strong relationship with the *Divine proportion* and the *Fibonacci sequence*, which are classically found in numerous biological structures.[5]

REFERENCES

1. Chomiak T, Hu B. What is the optimal value of the g-ratio for myelinated fibers in the rat CNS? A theoretical approach. *PLos One*. 2009;4:e7754.
2. Ikeda M, Oka Y. The relationship between nerve conduction velocity and fiber morphology during peripheral nerve regeneration. *Brain Behav*. 2012;2:382–390.

3. Chau WK, So KF, Tay D, Dockery P. A morphometric study of optic axons regenerated in a sciatic nerve graft of adult rats. *Restor Neurol Neurosci*. 2000;16:105–116.
4. Soltanpour N, Asghari Vostacolaee Y, Pourghasem M. Comparison of morphometric aspects of light and electron microscopy of the hypoglossal nerve between young and aged male wistar rats. *Cell J*. 2012;13:229–236.
5. Livio M. *The Golden Ratio: The Story of Phi, The World's Most Astonishing Number*. New York: Broadway Books; 2002.

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