

Darwin and the eye

Charles Darwin was born two centuries ago and his work still remains alive, being subject of important debates with an increasing and strong influence on philosophy, religious faith and policy in first-world countries, the European Union or the United Nations. Today there is a clear parallelism between the evolutionist-versus-creationist controversy and parallel worldwide political battles whose results often affect many millions of people. In this scenery, it turns out that the human eye plays a crucial and relevant role. On the side of creationism, it is claimed that the eye is a perfect system and, therefore, it can only be the result of the work of a “Supreme Engineer” and never the result of blind (no eyes) chance. On the contrary, evolutionists put the emphasis on short-term and long-term mechanisms of adaptation to explain the specialization of different visual systems (animals and humans) to survive in their respective environments.

Strictly speaking, scientists studying the eye should keep away from these philosophical discussions (many times biased by hidden political interests or by religious credos). Here, however, I take the opportunity to express an opinion from a perspective that is different from the rigorous point of view that a scientific paper demands, but is based on my experience of 25 years studying the optics of the human eye. On the one hand, I am still amazed by the fact that in the eye one finds (to more or less extent) most principles and tools of optical engineering (optical design, optical fibers, quantum efficiency, etc.) effectively applied, which is a serious challenge for the current state of the art of our science and technology, with intriguing and some time paradoxical evidences. On the other hand, however, it was evident for scientists and clinicians, that even healthy emmetropic eyes exhibit a large amount of optical defects (aberrations). One century ago Helmholtz wrote that if an optician sells him a lens with such defects he would complain and give it back. When one analyzes the design principles of the eye¹ one finds a puzzling sort of mixture of smart solutions and crude flaws.

A most intriguing design flaw is the contradictory optical and retinal designs. There is no doubt that the eye is a very wide-angle lens and its design seems to aim to guarantee a high homogeneity of optical quality across its wide visual field, whereas the retina is highly inhomogeneous; i.e. the

vision of details is concentrated in a small central area, the fovea, and is rapidly lost as we move towards the periphery. This severe mismatch between optical and retinal resolution (possible design flaw) can only be explained by evolution. A wide visual field is common to most species (from insects to mammals), which seems important for survival, since it allows most basic tasks such as defense and locomotion. The fovea, however, seems necessary for more specialized tasks involved in predation: remote detection, recognition, etc. The development of the fovea seems to be related to a parallel development of brain cortex, and then to higher-level perception abilities. In this context, perhaps the optics of the eye required only minor adaptations when the retina and visual cortex developed a foveated vision.

Therefore, long-term evolution and short-term adaptation seem to be present in the eye, which would add further evidences to Darwin findings, thus supporting evolutionist hypothesis. Evolution and adaptation permits us to order apparently contradictory pieces of knowledge, which explains why it is so attractive for most scientists. In science, the merit of a theory lays on the amount of facts it can explain, and the evolution hypothesis is able to explain most.

However, the “engineering” theory based on a smart, efficient and robust design cannot be totally discarded today. Even though the eye has many optical defects, modern clinical evidence shows that any attempt to modify its optical system (for instance by refractive or cataract surgery, orthokeratology, etc.) results in a deterioration of its optical quality. A few years ago, custom LASIK promised supervision, but evidence shows that the natural optics of the eye cannot be improved in general with today’s available technology...

REFERENCES

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