

EDITORIAL

DARWIN VS. SKEFFINGTON

No matter what type of practice, refractive conditions are a major aspect of optometric care. The argument concerning the genesis and progression of refractive conditions has long been the subject of debate, I presume from the time refractive conditions have been recognized, measured and compensated.¹ The argument that the environment somehow impacts the refractive condition has deep roots in behavioral optometry and the philosophy of the Optometric Extension Program.¹⁻⁴ Skeffington's philosophy explained how the complex interaction of the identification and centering systems interacted to cause the organism to become myopic. There were others who argued that myopia was genetic.¹ I must confess that I see both positive and negative arguments for both sides. As with most things, the cause probably is a marriage of several variables.

When I began my optometric education career at Northeastern State University-Oklahoma College of Optometry (NSU-OCO), a colleague, Dr. David Goss, was (and still is) seriously pursuing the study of myopia.⁵⁻⁸ Under the influence of Dr. Goss, I began to search the literature concerning refractive conditions. One of the most dramatic studies was with the Inuits (Eskimos) of Alaska⁹⁻¹¹ and Greenland.^{12,13} In the Alaskan study a group of scientists went to the Arctic Circle to study an entire community of Inuits before mandatory education was initiated. It was found that pre-presbyopic Inuits were not myopic. (There were 1.5 to 2.0% of myopes, 41 years of age or older.) When the children began school, a dramatic increase in myopia was measured (44.7%).¹⁰ Other studies from Greenland have shown that Inuits living a traditional lifestyle did not

measure myopia. Myopia was defined as -1.5D under cycloplegia. However, those Inuits who were in school showed similar prevalences of myopia that were found in Alaskan Inuit children. The increase in myopia correlated with the academic experience.¹³

The phenomenon of the increased incidence of myopia happened in one generation. This one generation increase in the prevalence of myopia could not be explained by Darwin's theory since natural selection requires time for the "desired" characteristics to be developed. Darwin's concept is succinctly described below.

*The concept was simple but powerful: individuals best adapted to their environments are more likely to survive and reproduce. As long as there is some variation between them, there will be an inevitable selection of individuals with the most advantageous variations. If the variations are inherited, then differential reproductive success will lead to a progressive evolution of particular populations of a species, and populations that evolve to be sufficiently different eventually become different species.*¹⁴

Darwin clearly argued that the change in the characteristics of a species group would be by natural selection over many generations. The myopic change with the Inuits happened instantly in evolutionary terms. These Inuit studies offered strong evidence for environmental influences.^{9, 10, 12,13}

Another interesting refractive phenomenon that soon became apparent at NSU-OCO was the propensity of Native Americans to measure significant amounts of with-the-rule astigmatism. Optometrists

began to publish papers on the epidemiology of Native American refractive conditions.¹⁵⁻²⁰ From a clinical perspective, when examining primarily Cherokees, Goss reported that the greater the documented Native American blood quantum, the more likely the occurrence of with-the-rule astigmatism.^{19, 20} The prevalence and amounts however, did not approach the refractive amounts documented in the Western tribes.^{15-18, 21, 22}

Garber and Hughes published a paper showing that in the Navajo tribe, only those birth cohorts born after 1935 measured significant with-the-rule astigmatism.²¹ They state in their summary:

The relatively small incidence of this refractive anomaly in the population born before 1936 emphasizes the importance of the question, 'Why do the Indian children have such a large percentage of high astigmatism?'

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...might be an environmental change of recent origin that has altered the visual status of a race of people.

This prevalence of with-the-rule astigmatism was again verified by Hughes and myself when we evaluated over 6,000 records of Navajos examined in the Indian Health Hospital in Shiprock, New Mexico.²² If the with-the-rule astigmatism in Native Americans was somehow being caused by near work, as myopia appeared to be in the Inuits, then it was reasoned that the preschool Navajo would not exhibit the condition. To study this, keratometric measures were obtained on preschool Navajo children.²³ The conclusion of this study was that with-the-rule astigmatism is corneal **and is present before entering school**. This finding argued that with-the-rule astigmatism in Navajos was genetic; this presumed that there had not been a significant environmental or Skeffington type near stress influence with the Head Start children.

Thus, if the change were from a Darwinian, natural selection function this would require that the predilection for with-the-rule astigmatism took place through natural selection and over generations. On the other hand, in the case of myopia these changes were instantaneous, one generation. Was there an environmental trauma that, in one generation, was expressed in the genes of the offspring? It is as if there was a genetic predisposition for Navajos to be susceptible to some unknown influence. However, once the change is noted in the parent it is transmitted to the offspring (preschool Navajos).

While scanning a recent issue of *Time* magazine, I came across an article on epigenetics.²⁴ The concept of epigenetics might be an explanation for the “instantaneous” expression of myopia in Inuits and with-the-rule astigmatism in Native Americans. A recent definition of epigenetics is:

*Epigenetics is the study of heritable changes in gene expression that do not involve changes in the DNA sequence. Epigenetic mechanisms play important roles in our development.... topics such as DNA methylation, histone modification, RNAi, cancer epigenetics, stem cells, and the environment (e.g., nutrition and stress) as a potential modifier of our own epigenome.*²⁵

I certainly do not suggest that I fully understand this proposed mechanism. Neither do I know if epigenetics is a “player” in the development of myopia in Inuits or with-the-rule astigmatism in Native Americans. My limited understanding of epigenetics is that chemicals (epigenetic markers) outside the gene, but in close proximity to the gene, are able to influence the gene. These epigenetic markers are presumably influenced by the environment and one’s lifestyle. Once environmental factors have impacted, epigenetic factors influence the continued manifestation of the characteristic. Epigenetics could have a dramatic influence on health care; not just for our understanding of refractive conditions but for a host of conditions, loosely defined as “lifestyle” diseases or “diseases of civilization.”²⁶ Diet, drugs, tobacco, alcohol, lack of exercise and, yes, stress, are suggested to be factors that work together in a complex way to impact epigenetic markers for an individual. Some conditions that have been linked to lifestyle are: Alzheimer’s Disease, atherosclerosis, asthma, cancer, cirrhosis, diabetes, heart disease, acne, stroke, depression, obesity, the list goes on.²⁵ The future will reveal if epigenetics is a viable explanation for refractive changes, and if it offers a mechanism to help explain how stress may actually impact human genetics.

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