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EDITORS CHOICE

Is the peripheral retina an important site for myopic development? [Liu Y, Wildsoet C (2011) The effect of two-zone concentric bifocal spectacle lenses on refractive error development and eye growth in young chicks. Invest Ophthalmol Vis Sci 52(2):1078–1086]

Henry Ho-lung Chan

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Myopia is now the most common refractive error in the world. It is reported that the prevalence of myopia ranges from 52% to 82% for Asian teenagers [1]. Emmetropization is a process which adjusts the axial length of the eye to match its refractive power in order to achieve clear vision. However, depending on the situation, this process of adjusting the axial length can induce different refractive conditions, i.e., myopia or hyperopia. Different studies have demonstrated that ocular growth is regulated by visual stimuli, and animal models have been used to show the effect of experimentally induced defocus on the axial growth of the eye. In addition, optical defocus with different signs (i.e., hyperopic and myopic) and different degrees can regulate ocular growth to produce different refractive errors. This visually guided ocular growth is not related to the visual cortex, because emmetropization is still effective after section of the optic nerve and all ciliary nerves. An interesting question of how the eye responds to different degrees of defocus is raised.

Liu and Wildsoet recently reported an interesting finding in two-zone defocus stimulations in refractive development of young chicks [2]. They used a two-zone concentric spectacle lens with five different central zone diameters (from 2.5 to 6.5 mm) and with four combinations of refractive power (plano of central zone with −5 D or +5D of peripheral zone, and plano of peripheral zone with −5 D or +5D of central zone). They found that the peripheral defocus had a greater effect than the central defocus in refractive development for both myopic and hyperopic defocus. The influence of peripheral defocus was greater than that induced by single vision lenses. These findings show that peripheral defocus is very important in ocular growth during emmetropization, and that peripheral defocus outweighs the effects of central defocus on ocular growth.

The central zone diameter of a two-zone lens system influences the effect of defocusing power in refractive development; the interaction of effective viewing size between the central and peripheral zones is an important factor in refractive error development. Moreover, the interaction between myopic and hyperopic defocus is also another important issue in emmetropization. Tse and co-workers have reported a new concept to demonstrate how integration of defocus signals affects emmetropization [3]. Simultaneous integration of competing myopic and hyperopic defocus in terms of dioptric magnitude and relative contribution guides growth of the developing chick eye to develop a particular refractive error. It is believed that our retina can differentiate defocus signals of opposite signs simultaneously, and the relative contribution and dosage of these signals provide the stimulation to guide ocular growth. Liu and Wildsoet have shown that these signals compete simultaneously, and the peripheral aspect of the signal provides a major contribution to emmetropization. Hence, it is likely that there is a specific zone in the retina of the chick effectively responding to the defocus.

Does the human eye have a particular zone of the retina which guides refractive development? A very recent study from Ho and co-workers may provide some hints [4]. They applied the electroretinogram to study retinal function in myopic human eyes. The retinal adaptive circuitry located in the inner retina was found to be impaired in myopic adults. However,

H. H.-l. Chan (✉)
School of Optometry, The Hong Kong Polytechnic University,
Hung Hom,
Kowloon, Hong Kong SAR, PRC
e-mail: henryhl.chan@polyu.edu.hk

the impaired retinal region was found in the paracentral to peripheral retina rather than in the central retina. The involved region was from 10° to 26° of the visual field. Although Liu and Wildsoet used the chick as their model for myopia development, they demonstrated that the effective visual field which starts to alter refractive changes was about 12° or more from the visual axis. Smith and co-workers found that an image with hyperopic defocus at the location of 10.3° from the visual axis would also induce myopic development in monkey eyes [5]. It is very interesting to show that the sensitive zone in the eye for refractive development is the paracentral to peripheral retina, and the most impaired retinal region in myopia is also the same retinal region.

Those interesting findings showed that the paracentral to peripheral retina is an important area for refractive development. However, there is no information showing how the paracentral to peripheral retina is sensitive to the optical defocus, or why this region shows functional change in myopia. Further investigation of the physiological activities at this particular retinal region may help to understand the mechanism of refractive development and to develop new approaches in myopia control.

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