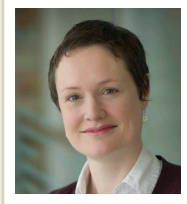


Contact Lens Update

CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Report on Experimental Models of Emmetropization and Myopia

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Troilo D et al. IMI – Report on Experimental Models of Emmetropization and Myopia. Invest Ophthalmol Vis Sci. 2019 60(3):M31-M88.

Over the course of the last forty years, animal studies have significantly advanced our knowledge of the mechanisms of visual growth, including the role of vision in postnatal eye growth, the mechanisms of emmetropization (the developmental process that matches the eyes optical power to its axial length to allow the unaccommodated eye to focus at distance) and the development of refractive errors. Information gleaned from animal models has informed, and transformed, treatment strategies for myopia.¹

Popular animal models include nonhuman primates, tree shrews, guinea pigs, mice, chickens and fish. Different animal models are used for different reasons, with each species providing advantages and disadvantages. When choosing an animal model, anatomical and physiological differences are considered, as well as the significant species differences in the mechanisms and amount of accommodation. Ocular maturation rates also differ widely, with tree shrews and mice having the shortest maturation time; guinea pigs and rhesus monkeys being around 6 times longer, but still exhibiting maturation rates approximately one-third that of a human eye.

Studies with chicks were some of the first to show that the visual experience can affect eye growth and refractive development,² with the original studies on form deprivation myopia involving macaque monkeys.^{3,4} While it was once thought that the normal growth of an eye was regulated solely by genetics, the use of animal models has changed that view to one which includes both genetics and visual (environmental) factors playing a part.

The main contributions of animal models to the understanding of the mechanisms of emmetropization and the development and control of myopia are summarized as:

- Visual signals causing retinal defocus regulate eye growth through emmetropization and the refractive development of the eye.
- Introducing a hyperopic or myopic defocus in animal models causes eye growth to compensate to reduce the imposed refractive error. The largest effects are seen in the eyes of younger animals, but change can also be induced in the eyes of older animals.
- Visual signals guiding eye growth are processed within the eye, with little if any, direct contribution of the central nervous system.
- Visual signals to the peripheral retina produce growth changes affecting axial length and central refractive state and will dominate over visual signals to the central retina.

- Changes in choroidal thickness are part of the response to imposed defocus.
- Visual signals cause an eye growth response that involves changes to scleral extracellular matrix synthesis (a slow process to alter eye size) and biomechanical properties.
- The spectral composition and intensity of light, e.g. daylight vs indoor lighting, affect eye growth.
- Atropine affects eye growth by preventing experimentally imposed myopia through cellular mechanisms.
- There are several biochemical compounds, such as retinal dopamine, retinoic acid, and nitric oxide, which are involved in the modulation of eye growth.
- Evidence suggests that the retina signals hyperopic defocus and myopic defocus for eye growth through different pathways.

Experimental animal models continue to provide a scientific basis for new clinical treatments for controlling myopia progression in humans and provide insights to inform in the identification of new avenues for drug development and treatments.

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