

# **Dioptr Hours of Accommodative Stimulus, Ciliary Muscle Fuel Accession, Scleral Distension Risk Factors, and Myopiagenesis**

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## **ABSTRACT**

In 1973 Lane documented strong association of dioptr-hours and dioptr-log-hours of stimulus to accommodation to elevation of intraocular pressure. Lane's 1978 study "showed that what promotes **myopia** development is not the hours of closework per se, but the accommodative stimulus in dioptrers multiplied by the logarithm of the hours invested in the closework."

By 1980 Lane had shown that several **nutrients** (especially ascorbic acid, folate, and trace-element chromium) support effective action of the ciliary muscle in binocular accommodation, while other nutrients such as calcium apparently complex with collagen, which itself complexed with the glycosaminoglycans in the vitreum and sclera and thereby resist scleral distension and myopic progression.

*Methods.* Accommodative stimulus in dioptr hours was calculated for 200 consecutive patients over 400 visits by subtracting the working-distance dioptrics from the Habitual Relative Add.

*Results and Discussion.* Age-for-age, unless countered by vision therapy accommodative training, accommodative stimulus stress in teens and adults is a more significant risk factor for predicting myopic increase than the dietary risk factors, although controlling for the dietary risk factors more clearly reveals the powerful influence of dioptr-hours of accommodative stimulus exposure in the development and progression of myopia.

## **INTRODUCTION**

Refractive surgery is catching headlines. Exuberant myopes proclaim "At last, no more myopia!" When in fact, the eyeball is still too long, the retina is too thin, the vitreous is too liquefied and subject to detachment followed by retinal detachment and risk of the malignant myopia process if not partial or complete blindness. Before refractive surgery is contemplated, should there not be a major effort to reverse the myopiagenesis process?

Should a primary approach be through ergonomics, vision therapy, nutrition, blood exchanges, or all of the above?

In his 1973 thesis Lane documented the strong association of *dioppter hours* and *dioppter-log-hours* of stimulus to accommodation to elevation of intraocular pressure (Lane 1980a). His 1978 study and subsequent confirmatory studies and elaborations (Lane 1981a, 1981b, 1982a, 1982b, 1985) “showed that what promotes myopia development is not the hours of closework *per se*, but the *accommodative stimulus* in diopters multiplied by the logarithm of the hours invested in the closework.” Please see Figures 1 and 2 and Table 1.

In the meantime we have been able to show that difficulties in the accession of fuel for the ciliary muscle are strongly associated, age-for-age, with limited positive relative accommodation (PRA) facility—a test of binocular focusing through increasing negative dioptric lenses at a standard closework distance of 40 cm with convergence maintained constant. The effect is indexed by the chromium concentration in red blood cells, since this is strongly correlated with body stores of chromium and chromium is required as an insulin potentiator for glucose fuel uptake at insulin receptor sites. The ciliary muscles may be the one set of muscles that we use more today than ever before in recorded history while most of the other muscles we use less.

Previously we had looked at the effects of depression of dietary intake of calcium in ratio to dietary intake of phosphorus and these depressed ratios in blood and hair tissues as probable factors affecting scleral distension. The evidence is that this depression of calcium results in a lack of adequate complexing of calcium with the collagen matrix complexed with the glycosaminoglycans of the scleral tunic. On the one hand, these effects of depression of calcium intake and of storage levels of chromium are too important to disregard. On the other hand, the present study revisited the issue of the powerful effects of posture and working distance and laterally unequal accommodative stimulus, so well documented by Hermann Cohn, MD (Cohn, 1886; Cohn, 1892) in the second half of the nineteenth century and by Darell Boyd Harmon in the mid-twentieth century (Harmon, 1958).

## METHODS

Accommodative stimulus scores in dioppter hours were calculated for 200 consecutive patients over 400 visits by subtracting the working-distance dioptics from the Habitual Relative Add. These consecutive entered patient records are part of a continuing panel eye-disease epidemiology study used for cases and controls in Lane’s myopia, cataract, glaucoma, vitreopathy, tear film, and macular degeneration studies at Columbia Universities Health Sciences campus. Critical to the quality of this study was the meticulous testing and reconfirmation of each parameter analyzed for this study.

In this study we revisited the issues of working distance and Habitual Relative Add (HRA) and Age Adjusted Habitual Relative Add (AAHRA). The HRA is calculated by subtracting “the effective spherical-equivalent dioptric value of the ametropia as

calculated from the best-acuity subjective for the naked phakic or pseudophakic eye best in focal rapport with the specific closework task” from the “effective spherical equivalent dioptric power of the prosthetic lens system (spectacle lenses and/or contact lenses.(Lane 1980a). The AAHRA is arrived at by subtracting an “Age expected median add” from the HRA. The statistically “ideally compensated” ametropia AAHRA for any age by definition becomes “zero” diopters.

## **RESULTS AND DISCUSSION**

As reported in our companion paper, high myopes are biochemically different from high hyperopes, at least when the high myopia is increasing and the hyperopia is increasing, and this effect pervades this study sample.

In 1974, Glants, Katorgina, Jakovenko, and Marzhokhova reported the beneficial effects of blood exchanges on the control of high myopia (Glants et al, 1974; Marzhokhova, 1975). Kolosov and associates presented the evidence for a “phosphorocalcium” imbalance in progressing myopia, and this same argument can be made by observing Peter Gardiner’s (Gardiner, 1958) data, although the editors at that time supplied the wrong connotation for otherwise correct denotation.

Despite these measurements and our own evidence for the importance of restriction of supplemental sugar in the diet, we find that postural shifts which can and do result in unequal accommodative stimuli and even central-vision suppression can often promote larger change than the dietary factors which according to one commonly held theory should affect both eyes more or less equally. We find that in the same high myope, one eye may be found significantly progressing deeper into myopia while the companion eye is recording reduced myopia. This effect is not at all uncommon. (Table 2)

A fatigue syndrome in response to frequently repeated long-sustained stimulus to accommodation appears to be the principal trigger to myopiogenesis. Dietary factors affect both the distensibility of the globe and the ability, age-for-age, to support strong or long-sustained binocular accommodation without fatigue. Except in marasmus and in nuclear cataractogenesis, dietary factors appear to control the magnitude of the refractive change rather than initiating the change.

## **CONCLUSIONS**

The primary approach for prevention and reversal of the myopiogenesis process needs to place increased emphasis on strengthening the accommodative response ability and reducing the accommodative stimulus through ergonomics, vision therapy, appropriate use of lenses, nutrition, blood exchanges, and modified study habits.

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