THE *FUNCTIONAL PHOTOPHOBIA SYNDROME* AND BINOCULAR FUSION IN NEURO-REHABILITATION

——REVERSAL OF STAGES OF DETERIORATION IN FUNCTIONAL PHOTOPHOBIA IN NEURO-REHABILITATION

PLUS-ADD LENSES VERSUS TINTED LENSES AS THERAPY FOR BINOCULAR CONVERGENCE VARIANCE

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BACKGROUND READING:

1963: Lane BC: Functional photophobia: Preliminary observations from optometric analysis of 100 cases. *Eastern Seaboard Conference on Visual Training;* 8: 32-51.
1968: Lane BC: A report on recent research into some aspects of the problem of visual deterioration associated with reading and reading programs. *Eastern Seaboard Visual Training Conference;* 13: 47-55.
1968: Lane BC: Functional photophobia: Its phenomenology and treatment without tinted lenses. *Eastern Seaboard Visual Training Conference;* 13: 55-69b.
1969: Lane BC: Notes on functional photophobia: Its phenomenology and treatment without tinted lenses. *Southern Journal of Optometry;* 11(10): 13-14, 38, 40. (Reprint without author's authorization of lecture outline notes distributed to the Pathology Section, American Academy of Optometry, Chicago, Dec 11, 1967.)
1969: Lane BC: The phenomenology and development of functional photophobia. *American Journal of Optometry and Archives of American Academy of Optometry;* 46: 779. (Abstract)
1970: Lane BC: LSC inventory: Preliminary normative studies of a new optometric quantification scale for "spatial centering" [later re-scaled and called "Binocular Convergence Variance"]. *Eastern Seaboard Conference on Visual Training;* 15: 59-61.
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1975: Lane BC: BCL [later re-scaled and named "Binocular Convergence Variance (BCV)"] and HRA as behaviorally significant clinical indices in refractive evaluation. *Am J Optom Physiol Optics;* 52: 797. (Abstract)
1976: Lane BC: *Checklist on Photophobia (Glare Hypersensitivity).* (Folder published and distributed by the College of Optometrists in Vision Development)
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1977: Lane BC: Functional photophobia associated with daily sustained reading and closework accommodation. *General Program of the American Academy of Optometry Annual Meeting;* p. 28. (Abstract B-22).
1978: Lane BC: Lowering of functional photophobia threshold with daily, sustained closework accommodation. *Eastern Seaboard Invitational Skeffington Symposium on Visual Training;* 23: 64-78.
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1992: Lane BC: *Lowering of Functional Photophobia Threshold with Daily, Sustained Closework Accommodation.* Ann Arbor, MI: University Microfilms International. (Thesis, New York University, 1981)

Note: Harold Levinson has claimed that a nystagmoid movement [measured in the above studies as Binocular Convergence Variance] is statistically responsible for **dyslexia** in youths.

Glare sensitivity serves many useful functions. Normal glare sensitivity is a valuable protective mechanism of the eye against photic damage. What would ordinarily be considered glare ***hyper***sensitivity, a seemingly excessive, painful sensitivity to ordinarily non-damaging levels of illumination, is also a useful protective mechanism for the traumatized eye undergoing healing (Dalessio, 1972) or for the vitamin-depleted photopigments in malnourished persons and in albinos (Sorsby, 1972).

At issue in this study is ***functional*** photophobia, first described by Lane (1963) as associated with what Kaufman (1963) has called "variability [or variation] of binocular convergence." Functional photophobia is the most commonly encountered form of glare hypersensitivity in the United States, and it is an important clinical problem in ophthalmic practice. It produces discomfort more usually than pain, and much (but not all) of what is considered "discomfort glare" may be attributed to functional photophobia.

In contrast to other forms of glare hypersensitivity, the usefulness of functional photophobia has remained unclear. The results of this study point toward two plausible hypotheses on the value of functional photophobia. For example, the functional photophobe has developed aversive behaviors that have the value of protecting the individual from fusion-degrading stresses created by the large fields of high luminance that he or she cannot manage binocularly. Secondly, by reducing the retinal illuminance with severe wincing or by closing or virtually closing one eye, the functional-photophobia response enables performance under conditions beyond the individual's range of binocular wide-open-eye ability.

The distinctions between the traumatized-eye photophobia, the nutritionally deprived photophobia, and the behaviorally defined five stages of functional photophobia are important to evaluate in the neuro-rehab patient to aid in the programming of therapy.

> (Stage PP-Zero = no apparent hypersensitivy; Stage PP-1 = Newly experienceed, usually short-lived hypersensitivity to extremely bright outdoors sun illuminating large, bright peripheral-field walls and pavements and other surfaces; Stage PP-2 = Chronic hypersensitivity even and especially to hazy-bright skies; Stage PP3 = Usually many years of hypersensitivity resulting in great discomfort in supermarkets where the whole ceiling is brightly illuminated; Stage PP4: The final stage of a long chain of decreasing binocular vision skills or a degenerative chain institued by trauma, characterized by intolerance even to usual relatively low levels of illumination used in home lighting.)

Further, we have evidence at the 0.001 level that the most functionally photophobic students are the ones experiencing the greatest number of *diopter-hours* of daily detailed closework accommodation, and that they are caught up in an **accommodative fatigue syndrome** including **increase in diameter and depth of suppression** and **increasing variability of binocular convergence.** [Lane's 1963 study of 79 findings for 100 patients had revealed that the depth of photophobia was

positively **time indexed** and strongly associated with Skeffington and associates **seven stage syndrome of binocular deterioration**.]

It is easy to demonstrate that this is a functional photophobia—a dramatic manifestation of binocularity, strikingly relieved by covering one eye.

ABSTRACT of Lane's NYU Thesis

As part of this study a functional binocular facilitation syndrome of photophobic response was documented using simultaneous video-recording, electro oculography (EOG), galvanic skin response (GSR) and tests of binocular and accommodative function, correlated with subjective report and a 141-item preliminary questionnaire. Functional photophobia was elicited in 87.5% of students, ages 18-35, by confronting them with a 120°-wide peripheral vision field of high luminance, averaging 3.2 x 104 cd/m2 over a large area, surrounding a 34° dark-appearing center—producing photophobia when viewed binocularly and no photophobia when viewed monocularly. Three basic relations were discovered for the functional-photophobia responding subjects in this study:

(1) An "**accommodative stress index**," (Log DCH) X (Log CAS), is predictive of high *vs.* low functional photophobia threshold level, significant at better than 0.001, where DCH = average daily detailed closework hours, and CAS = individually averaged closework sustained accommodative stimulus. **[*Accommodative Stress Index* correlates strongly with functional photophobia threshold in log cd/m2, *r* = -0.92.]**

(2) {Log (**central suppression zone diameter**)} **X {variation of binocular convergence** [in minutes of arc]} is predictive of high *vs.* low "accommodative stress index" at 0.001 probability.

(3) Low ratios of **Palpebral Fissure-to-Corneal Diameter** (PF:CD) are associated with high scores on the "accommodative-stress index," and high ratios of PF:CD are associated with low levels of accommodative stress, with the difference in distributions significant at the 0.010 level by the Mann Whitney test for small samples, where the PF:CD is measured for the smaller PF eye shortly after 5 minutes of adaptation to 3.2 x 104 cd/m2 average peripheral-field glare.

COMMENT

The earlier studies by Lane cited above documented the **reversibility** of this deteriorative syndrome with **low plus adds** (+0.25 to +1.25 in young adults) and occasionally low-plus fitover (clip-on) therapy lenses, but especially with the use of **VT**. **Tinted lenses enable performance in persons with otherwise fragile binocular fusion and especially in periodic or intermittent exotropes, but may not be treating the underlying accommodative fatigue syndrome, except when the tint creates the effect of a small plus add.**

APPENDIX

Skeffington and Associates' Stages of Deterioration

1) 7+ (5) 14A 16A - 21 19
(9 - 11 - 16B) 15A 17A-20

2) 7+ (5) 16A - 21 - 19
(9 - 11 - 16B) 14A-15A 17A-20

3) 7+ (5) 15A 16A - 21 - 19
(9 - 11 - 16B) 14A 17A - 20

4) 7+ (5) 15A 16A - 20 - 19
(9 - 11 - 16B) 14A 17A - 21

5) 7+ (5) 15A 16A - 21
(9 - 11 - 16B) 14A 17A - 20 - 19

6) 7+ (5) 15A 16A - 21
(9 - 10 - 16B) 14A 17A - 20 - 19

7) 7+ ( ) 15A 16A - 21
(5 - 9 - 10 - 16B) 14A 17A - 20 - 19