

Macular Carotenoids: Effects in the Eye and Beyond



Duke Eye Center

James M. Stringham, Ph.D.

Visual Performance Laboratory
Duke Eye Center
Duke University Medical School
Department of Ophthalmology

james.stringham@duke.edu



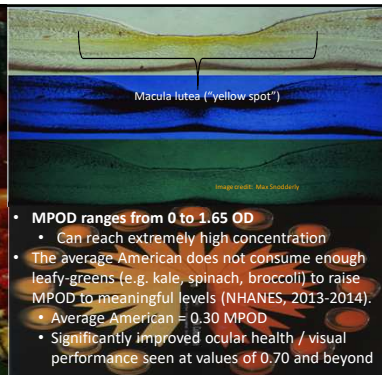
visual performance
laboratory

The Oxygen Paradox

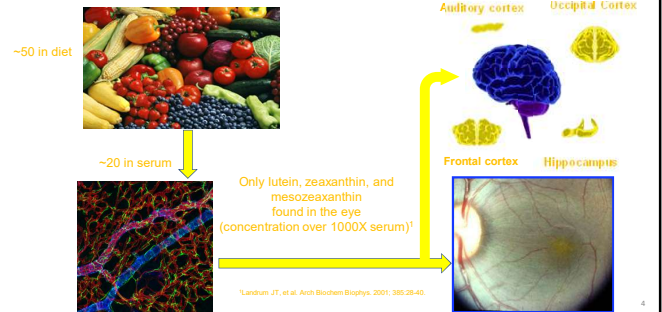


Lutein, Zeaxanthin, & Mesozeaxanthin

- Carotenoids
- Pigments that give fruits and vegetables their color
- Exceptional antioxidants
- Xanthophyll carotenoids capable of triplet excitation transfer
 - Can quench free-radical oxygen, regenerate
- Lutein, zeaxanthin, and mesozeaxanthin appear yellow-orange...absorb harmful blue light (see figure on right)
- Combine to form "macular pigment" in the retina
- Obtained from DIET ONLY (MZ also converted from L in retina [Johnson et al. 2005])



Carotenoids are in the eye and throughout the central nervous system



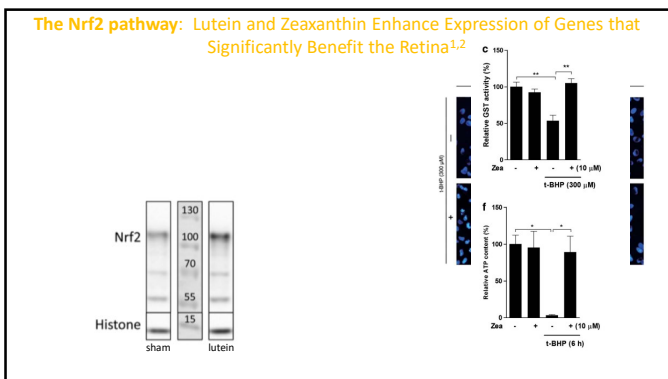


Emerging from the "Stone Age" of Macular Pigment Research

diate AMD!

Convergent new research from several disciplines indicates complex, significant benefits of high L, Z, and MZ. Across the lifespan.

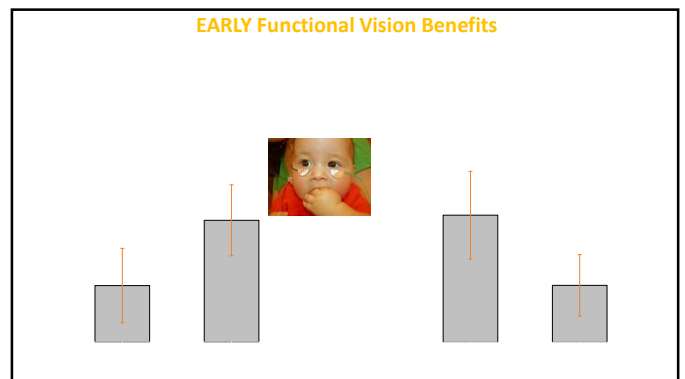
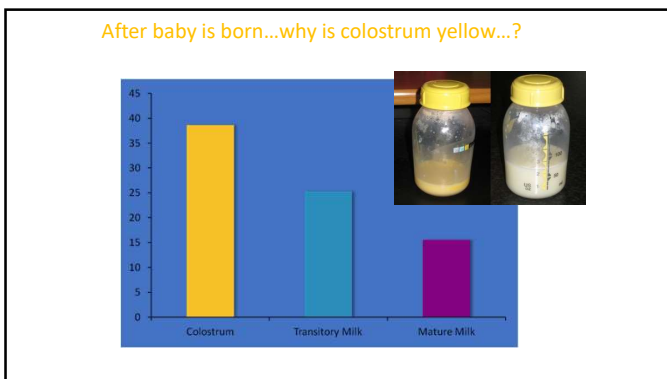
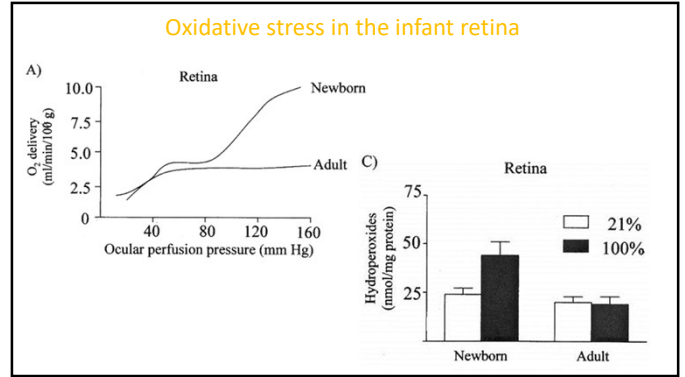
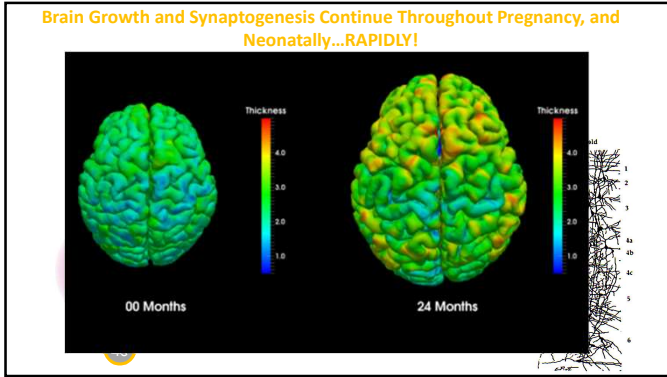
- Beyond direct antioxidant and light filtration effects

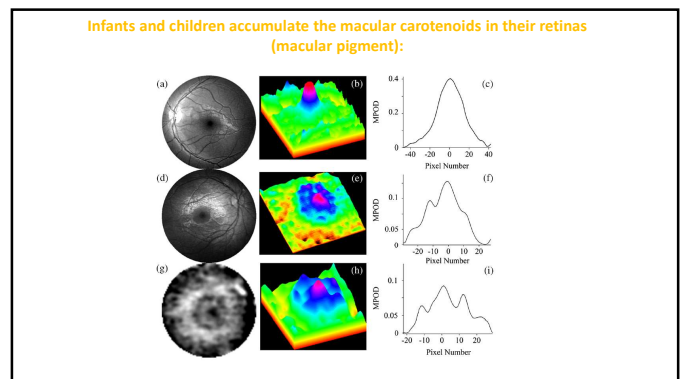
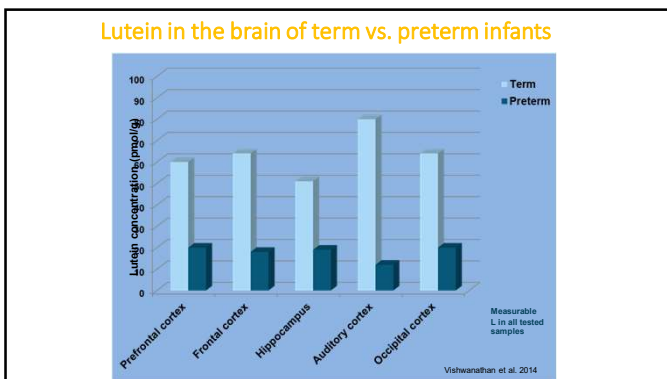
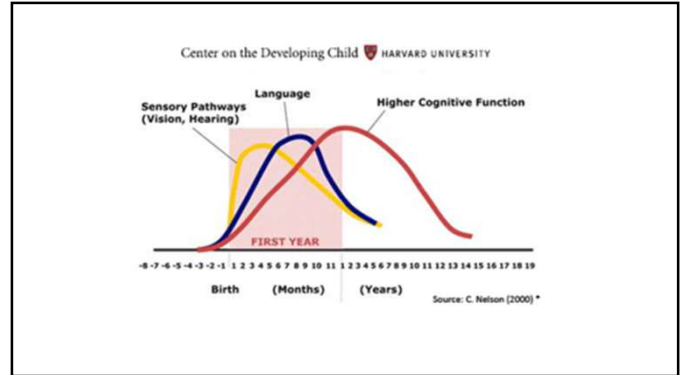
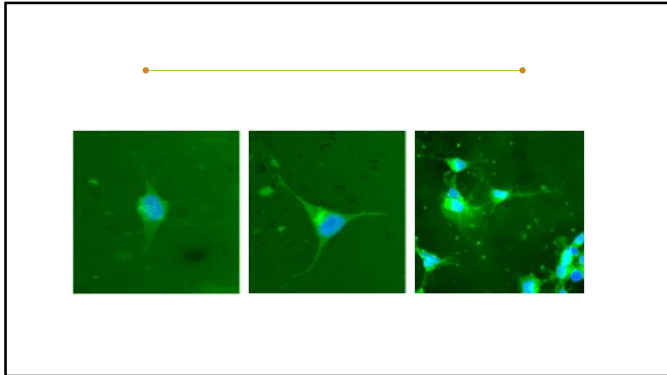


Protection against AMD is "icing on the cake," not the cake

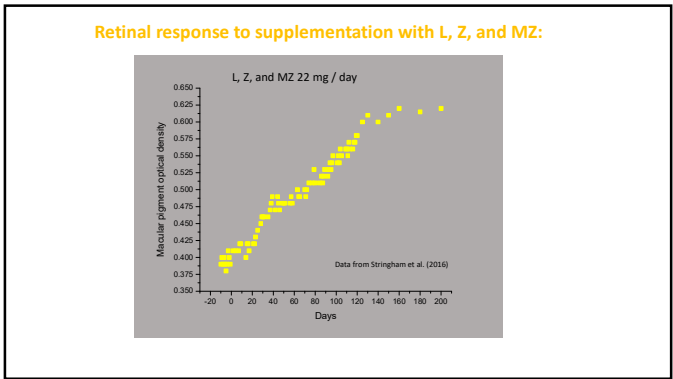
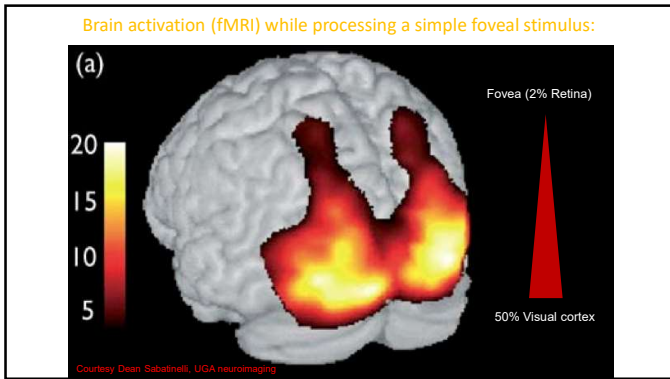
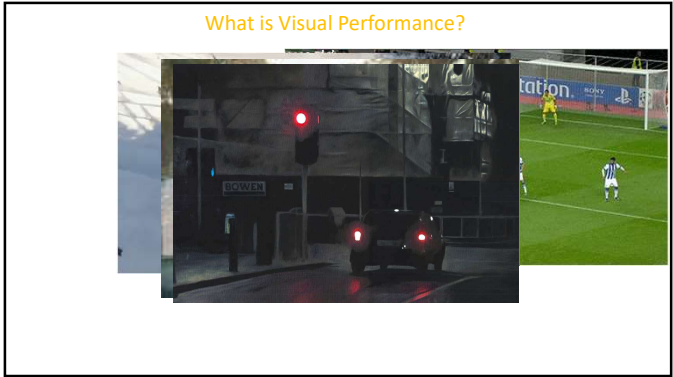
So...what is the purpose of L, Z, & MZ in the retina?

Newborn

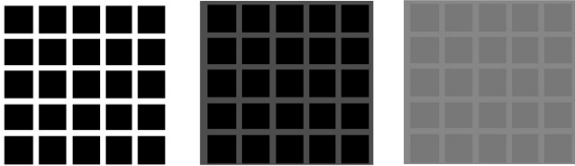




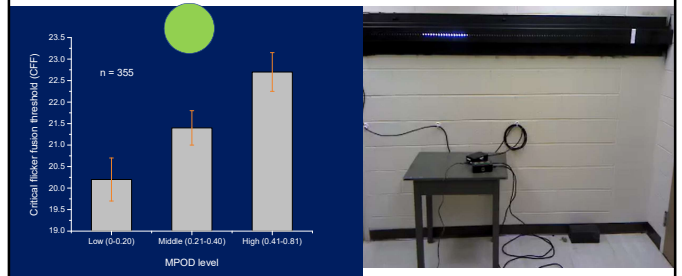
MPOD and Visual Performance



High MPOD leads to enhanced neurophysiology, improved contrast sensitivity:



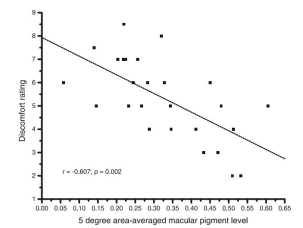
Visual Performance: MPOD is related to faster visual processing



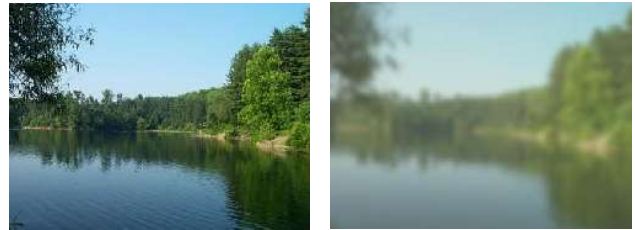
Effects in Glare: Higher MPOD = Lower Visual Discomfort



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High vs. Low MPOD: Glare Disability Reduced



Photostress recovery and the "fatigue function"

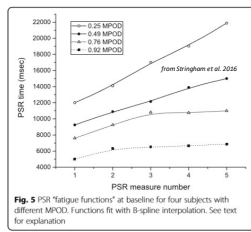
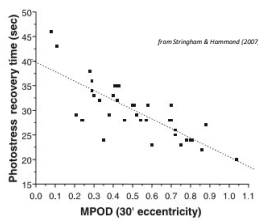
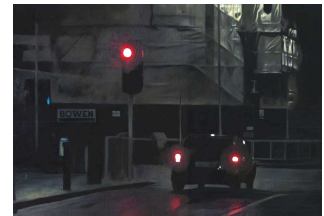
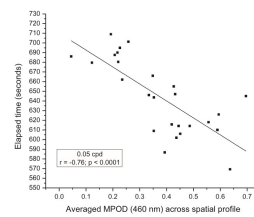
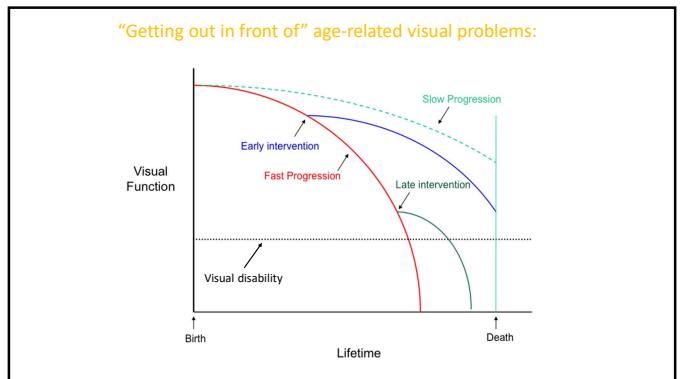
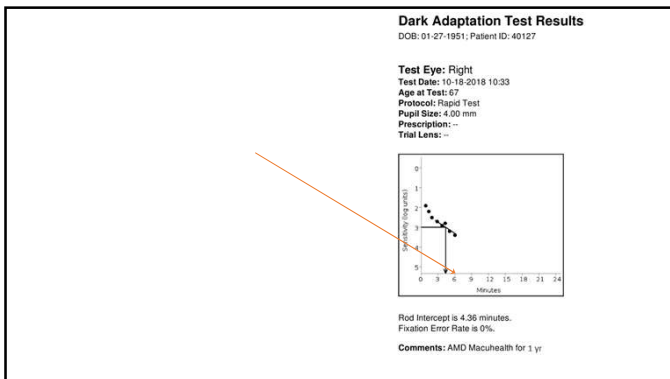
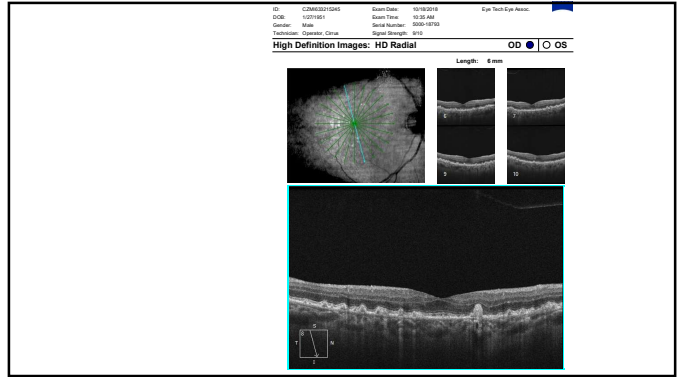
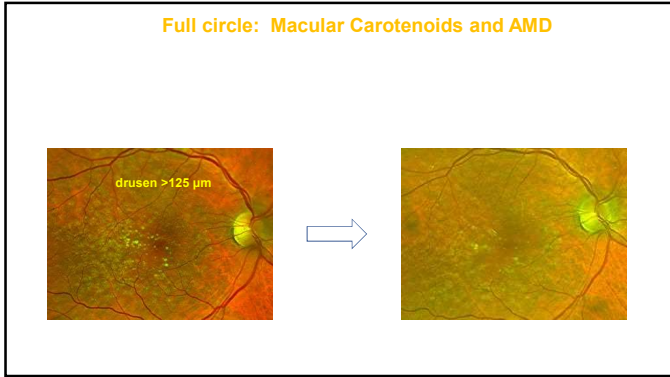


Fig. 5 PSR "fatigue functions" at baseline for four subjects with different MPOD. Functions fit with B-spline interpolation. See text for explanation

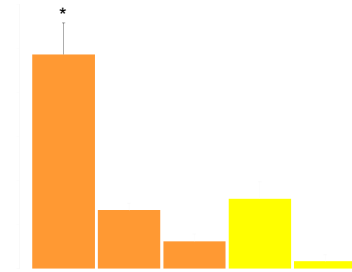
MPOD Associated With Better Vision in Dim Light, Faster Dark Adaptation



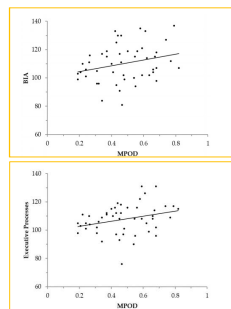


L, Z, MZ, MPOD, & Cognitive Status in Young, Healthy Individuals

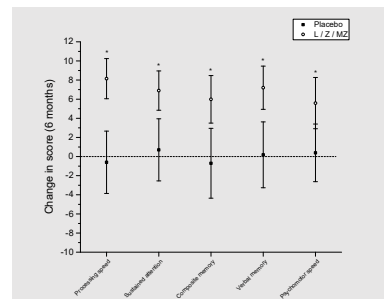
Carotenoid concentration in the brain (mean of 4 brain regions; age 0-1 yrs)



New Data: Pre-adolescent children (7-13 yrs.), Ocular Lutein, and Intellectual Ability / Executive Processes



Cognitive Effects in Healthy, Young Adults (18-25 yrs.)



Additional results from Stringham et al. 2019

Pooled active supplement groups				
Serum marker	Mean (baseline)	SD	Mean (6 months)	SD
TNF- α	5.39 pg / mL	2.21	5.66 pg / mL	2.44
IL-6	4.6 pg / mL	1.87	4.452 pg / mL	1.96
IL-1 β	0.659 pg / mL	0.54	0.498 pg / mL*	0.46
AOC	0.552 μ g / mL	0.103	0.663 μ g / mL*	0.111
Lutein	0.21 μ g / mL	0.111	1.25 μ g / mL*	0.684
Zeaxanthin isomers	0.04 μ g / mL	0.025	0.292 μ g / mL*	0.131

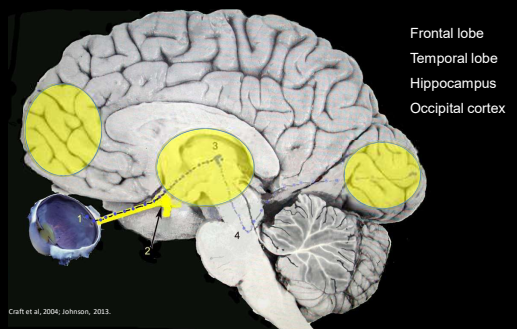
Placebo group				
Serum marker	Mean (baseline)	SD	Mean (6 months)	SD
TNF- α	4.99 pg / mL	1.89	5.64 pg / mL*	2.1
IL-6	5.53 pg / mL	2.17	5.64 pg / mL	2.42
IL-1 β	0.529 pg / mL	0.44	0.476 pg / mL	0.71
AOC	0.577 μ g / mL	0.174	0.568 μ g / mL	0.166
Lutein	0.237 μ g / mL	0.141	0.222 μ g / mL	0.132
Zeaxanthin isomers	0.052 μ g / mL	0.034	0.050 μ g / mL	0.055

Additional results from Stringham et al. 2019 (continued) – Brain-derived neurotrophic factor (BDNF)

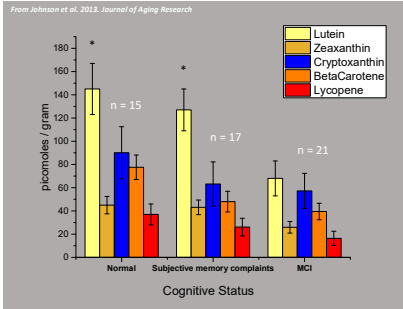
Measure	BDNF	IL-6	IL-1 β	TNF- α	AOC	Lutein	Zeaxanthin	MPOD
BDNF	1	-	-	-	-	-	-	-
IL-6	-0.094	1	-	-	-	-	-	-
IL-1β	-0.47*	0.26*	1	-	-	-	-	-
TNF-α	.11	-0.138	-0.084	1	-	-	-	-
AOC	0.31*	-0.199	-0.283*	-0.116	1	-	-	-
Lutein	0.38*	-0.188	-0.51*	-0.204	0.79*	1	-	-
Zeaxanthin	0.33*	-0.167	-0.412*	-0.187	0.61*	0.81*	1	-
MPOD	0.44*	-0.077	-0.37*	0.121	0.43*	.62*	.66*	1

L, Z, MZ, DHA, MPOD, & Cognitive Status in the Elderly, Including Early Alzheimer's Disease

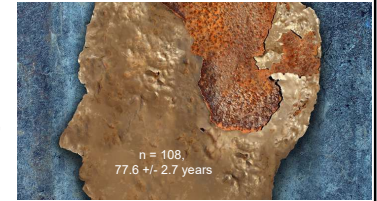
L, Z, & MZ: Found Throughout Brain Tissue, in areas requiring high performance



Carotenoid concentrations in the brain, for those 80 – 100 years old, as a function of cognitive status:



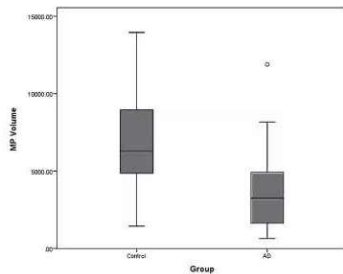
Carotenoids in the Brain Preserve Cognitive Performance



Cognitive function measure	Serum L + Z	MPOD
SMS	-0.111	0.209*
SRT learn	0.007	0.263*
SRT delayed recall	0.062	0.239*
Reaction time	0.062	-0.059
Verbal fluency	-0.2*	0.249*
Digit-symbol substitution task	-0.016	0.249*
Block design task	-0.097	0.154
Pattern comparison task	-0.127	0.195*

SMS, Teng Modified Mini-Mental State Examination; SRT, Sustained Selective Reminder Test. *P < 0.05.

Macular Carotenoid Status in Early-Stage Alzheimer's Disease Patients:

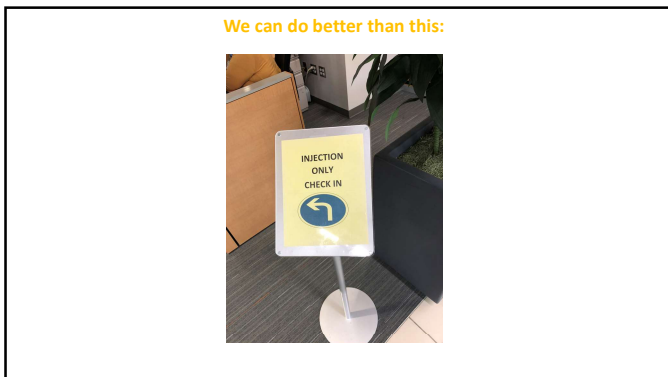
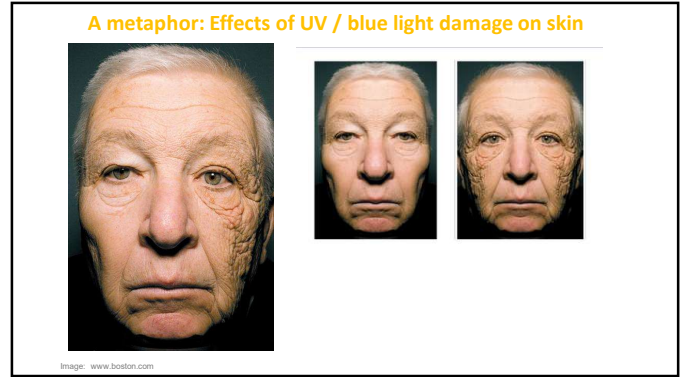
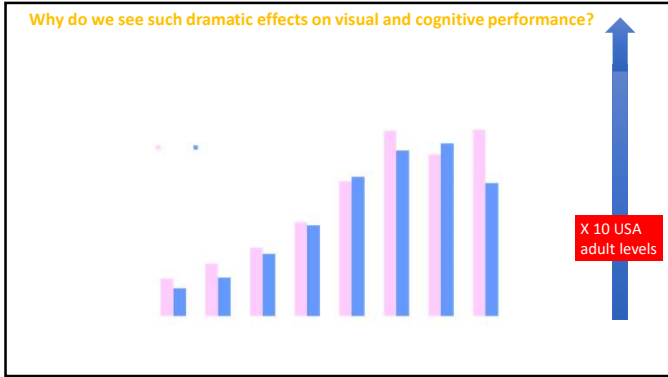


Nutritional Intervention to Prevent Alzheimer's Disease: Potential Benefits of Xanthophyll Carotenoids and Omega-3 Fatty Acids Combined

Abstract
Background: A growing body of evidence suggests the contribution of certain essential components to the brain may reduce the risk of developing Alzheimer's disease (AD).
Methods: Data from 2 randomized, open, parallel, 18-week, 1 and 2 parallel on patients with AD over an 18-month period. Patients were randomized to 1) 22 mg total L, Z (Formulation 1) or 2) 22 mg total L, Z combined with 1 g fish oil (430 mg DHA; Formulation 2).
Results: Xanthophyll carotenoid concentrations were significantly greater for Formulation 2 compared to Formulation 1 (p < 0.05).
Conclusions: The primary goal of this study was to determine if the combination of xanthophyll carotenoids and omega-3 fatty acids could be used to reduce the risk of developing AD.

New trial shows promise for limiting progression of AD

- 18-month study
- Patients with mild, moderate, and severe AD were supplemented daily with:
 - 22 mg total L, Z (Formulation 1) or
 - 22 mg total L, Z combined with 1 g fish oil (430 mg DHA; Formulation 2)
- Serum carotenoid concentration increases were significantly greater for Formulation 2 compared to Formulation 1 (p < 0.05)
 - DHA promotes enhanced absorption
- Progression of AD was less for this group (p = 0.003)
 - Caregivers reported functional benefits in memory, sight, and mood



Conclusions
The macular carotenoids have benefits for:

- Ocular / visual development
- Visual health and performance
- Phase II (epigenetic) effects
- Cognitive health and performance
 - Across the lifespan
 - May prolong onset of age-related cognitive decline
 - May preserve function in midst of disease

...oh, and relatively high MPOD can help reduce the risk of / slow the progression of AMD!

All of these effects can facilitate a conversation about nutrition with patients

Acknowledgments

Collaborators

