Macular carotenoids and cognitive function

Lisa M. Renzi Hammond, Ph.D.

Behavioral and Brain Sciences Program

Human Biofactors and Vision Sciences Laboratory

Department of Psychology

The University of Georgia; Athens, GA, USA

lrenzi@uga.edu

Disclosures

- This presentation has been approved for Category “A” continuing education for eyecare professionals.
- These slides were developed solely by the speaker.
- Dr. Renzi Hammond has served as a consultant for the following eyecare businesses:
  - Johnson and Johnson Vision Care, Inc.
  - Alcon Laboratories
  - MacuHealth
  - Transitions Optical / Essilor
  - Abbott Laboratories

The natural history of vision

Other primates

Pan paniscus, (bonobos) in the DRC

Image: Wildlife Times

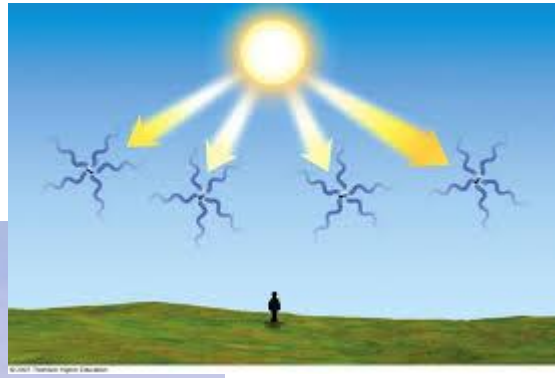
Other primates

Mountain gorilla (*Gorilla beringei beringi*)

Image: African Wildlife Foundation

Other primates

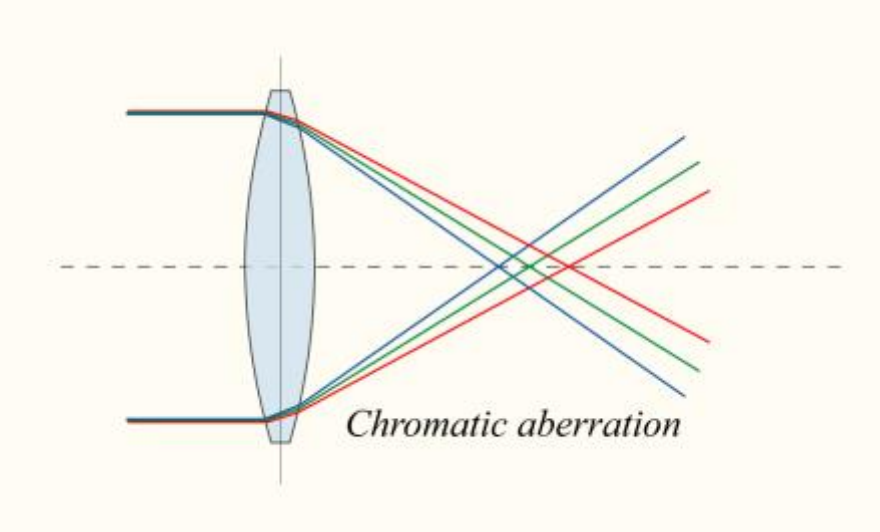
Short-wave dominant sky



Mid-wave dominant vegetation

Image: World Wildlife Fund

Chromatic aberration



Extreme ends of the visible spectrum are more than 1 diopter out of focus

Image: Wikipedia Commons

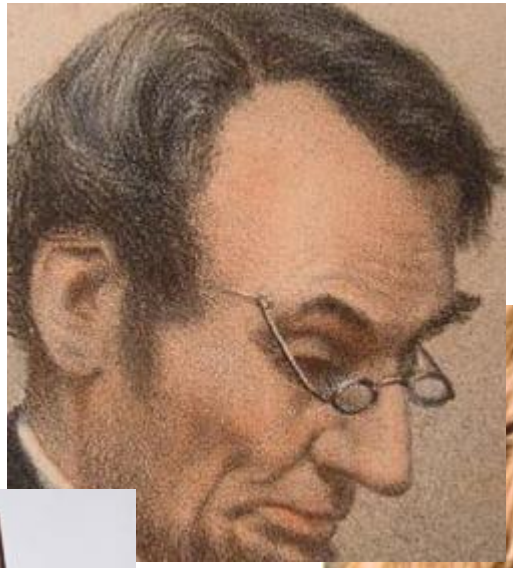
Distance vision

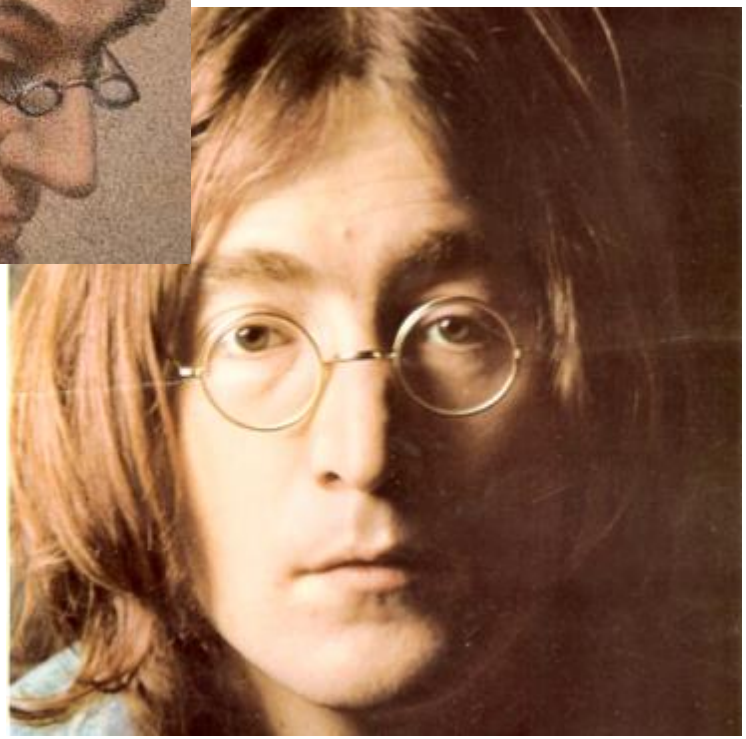
Image: Brittanica

Motion cues

Image: Harvard University

And post-Industrial Revolution?

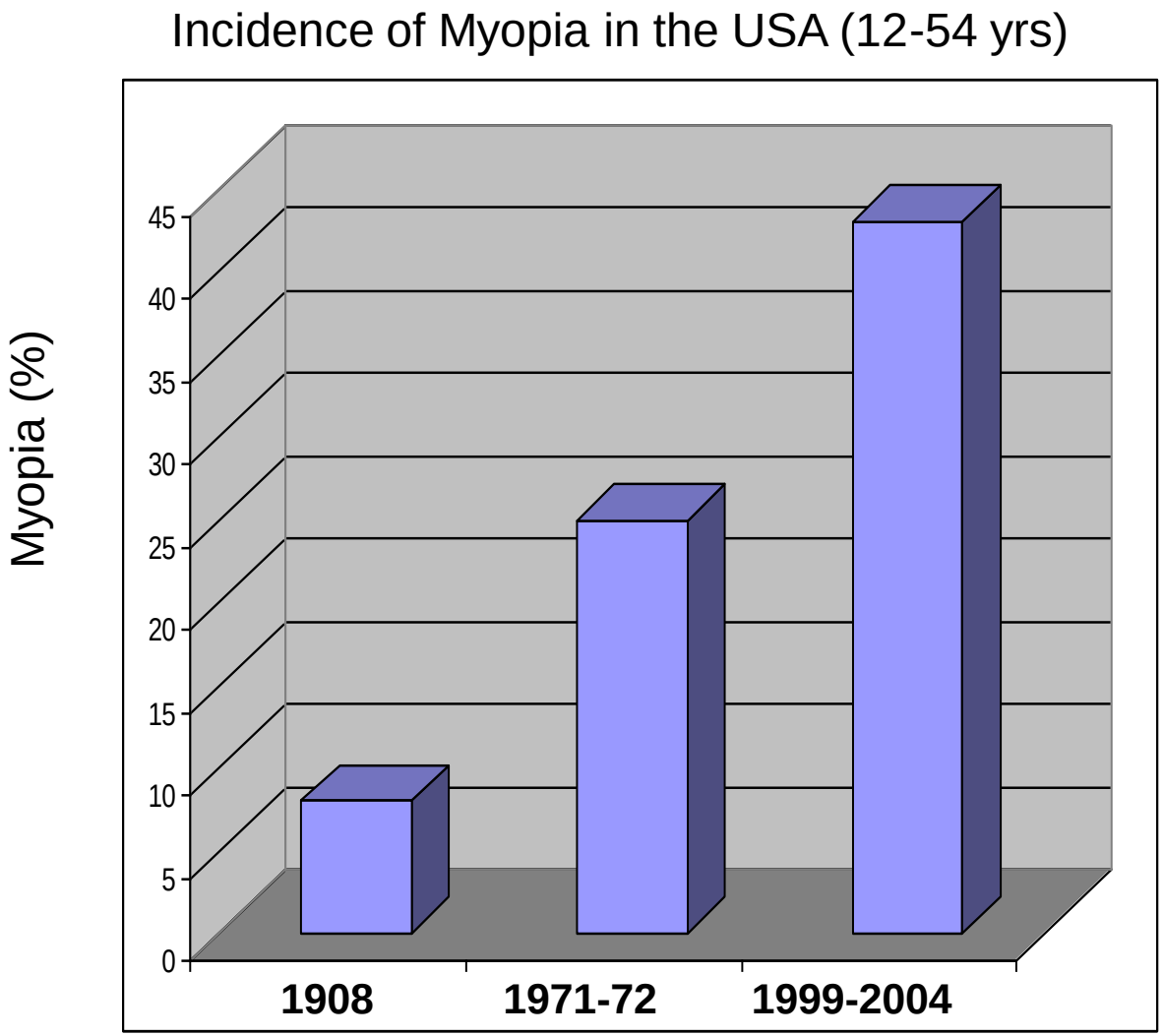




World Population, 10,000 BCE - 2000 CE

Source: J. Bradford DeLong, "Estimating World GDP, One Million B.C. - Present." http://www.j-bradford-delong.net/TCEH/1998_Draft/World_GDP/Estimating_World_GDP.html. Accessed Mar 5, 2008.

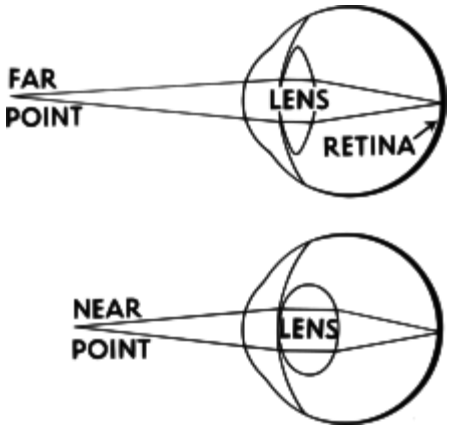
The pandemic of myopia



Vitale et al., 2009
Arch. Ophthalmol

Smoke caused massive haze

Sight distance extremely limited



PUBLIC HEALTH

Why Up to 90% of Asian Schoolchildren Are Nearsighted

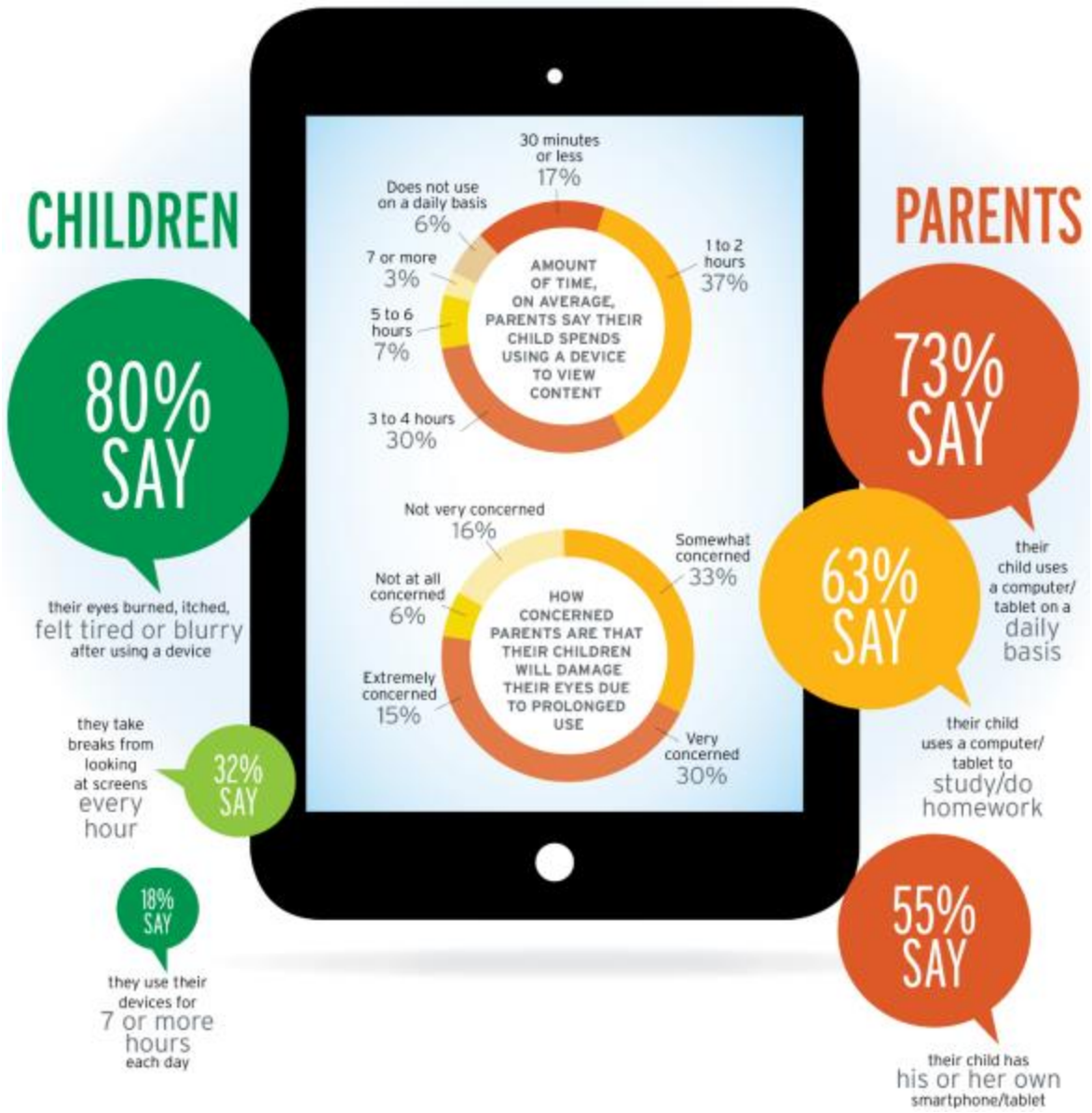
Researchers say the culprit is academic ambition: spending too much time studying indoors and not enough hours in bright sunlight is ruining kids' eyesight

By Alice Park @aliceparkny | May 07, 2012 | 2 Comments

Scientists say an epidemic of myopia, or nearsightedness, is sweeping through Asian children, and is likely due to students' spending too much time indoors studying and not enough time outside in the sunlight.

It has long been thought that nearsightedness is mostly a hereditary problem, but researchers led by Ian Morgan of Australian National University say the data suggest that environment has a lot more to do with it.

worapul chawaillphon / Getty Images



http://www.aoa.org/news/inside-optometry/screen-time-how-device-use-affects-childrens-vision?sso=y

Myopia is, in part, an example of a mismatch between lifestyle and biology.

What about other lifestyle factors and disease?

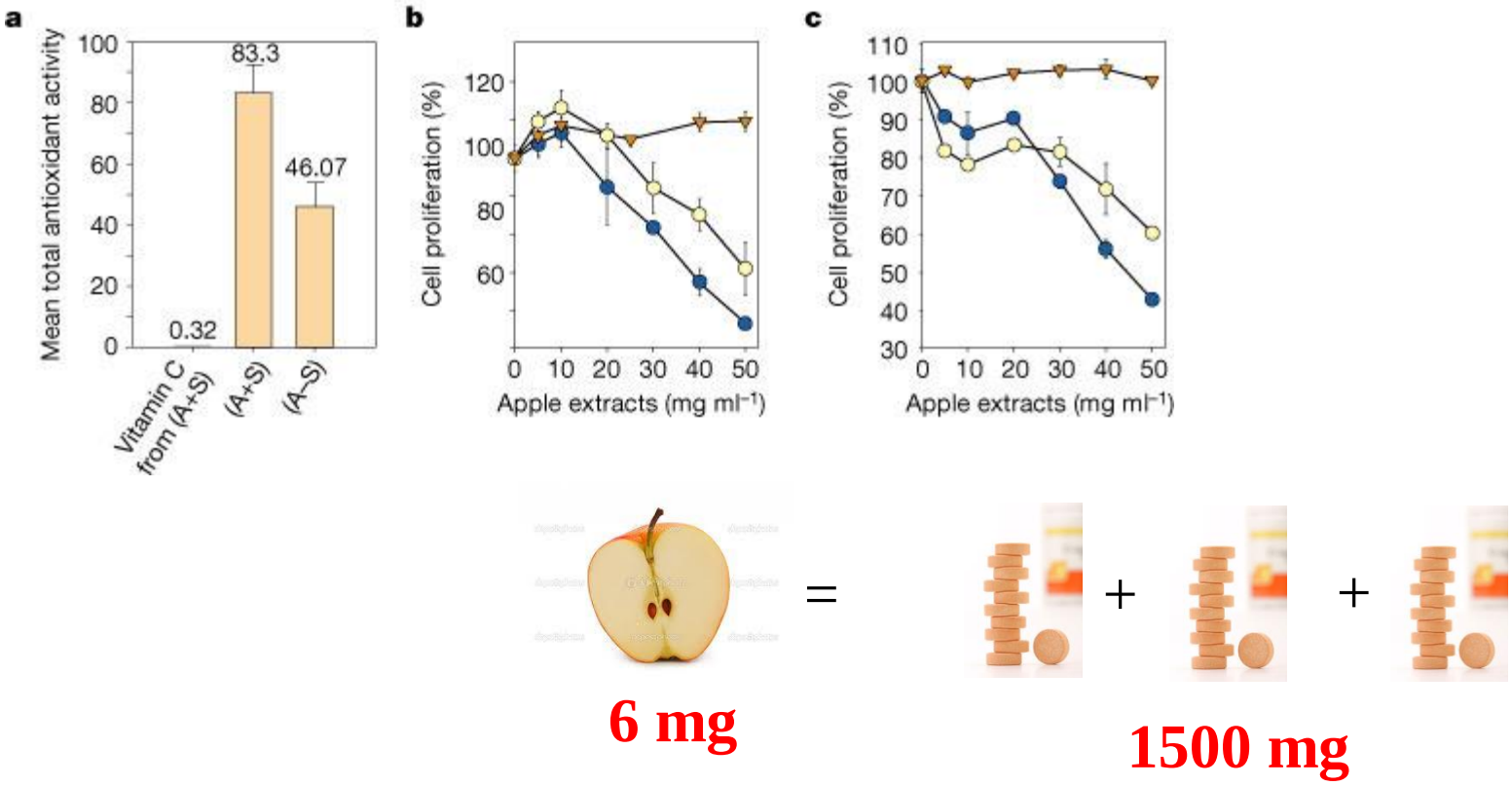
Nutrition is linked to the concept of food. What is a food?

≠

Nutrition is linked to the concept of food. What is a food?

≠

Bioavailability: Vitamin C



Eberhardt, M. V., Lee, C. Y., & Liu, R. H. (2000). Nutrition: Antioxidant activity of fresh apples. Nature, 405(6789), 903-904.

WHAT'S IN A FRESH WHOLE CLEAN APPLE?

(FROM "Handbook of Phytochemical Constituents of Generally Regarded as Safe (GRAS) Herbs")

ABSCISIC-ACID FR NAP
CIS-2, TRANS-4-ABSCISIC-ACID BK NAP
TRANS-ABSCISIC-ACID FR NAP
ACETIC-ACID
ACETIC-ACID-AMYL-ESTER
ACETALDEHYDE
ACETONE
N-ALPHA-ACETYL-AGGININE SH NAP
ADENINE RT NAP
ALPHA-ALANINE FR
BETA-ALANINE FR
ALANINE 70-435 FR USA
ALUMINUM 0.4-129 FR AAS USG
ALPHA-AMINOBUTYRIC-ACID
AMMONIA (NH3) 235-1,029 EP (FR)
AMYGDALIN 4,000-13,000 SD
AMYL-ACETATE
AMYL-BUTYRATE
AMYL-PROPIONATE
ANILINE 1.7 EP (FR) NAP
ANILINE 1.5 FR NAP
ARABINOSE
ARGININE 60-373 FR USA
ARSENIC 0.00055-0.43 FR AAS USG
ASCORBIC-ACID 20-407 FR USA
ASCORBIDASE
ASH 2,300-43,000 FR USG
ASPARAGINE 171 FR
ASPARTIC-ACID 210-2,115 FR USA
AVICULARIN FR NAP
BARIUM 0.22-8.6 FR USG
BENZOIC-ACID
3,4-BENZOPYRENE FR NAP
BENZYL-ACETATE
BENZYL-AMINE 0.6 EP (FR) NPA
BENZYLAMINE 0.3-3.0 FR NAP
BIOTIN
BORON 1-110 FR AAS BOB USG
BROMINE <1 FR AAS
BUTANOL
N-BUTANOL
1-BUTANOL
2-BUTANOL
BUTYL-ACETATE
BUTYL-BUTYRATE
BUTYL-CAPROATE
BUTYL-PROPIONATE
BUTYL-VALERIANATE
1-BUTYL-OCTANOATE
1-BUTYL-PROPIOANTE
N-BUTYL-DECANOATE
N-BUTYL-FORMATE
N-BUTYL-N-HEXANOATE
N-BUTYL-OCTANOATE
N-BUTYL-PROPIONATE
CADMIUM <0.002-0.0298 FR AAS USG
CAFFEETANNIN
CAFFEIC-ACID 85-1,270 FR CRC(FSN)
CALCIUM 40-570 (-1,376) FR AAS USG
CALCIUM-OXALATE
CAPROALDEHYDE
CAPROIC-ACID-AMYL-ESTER
CAPRYLIC-ESTER
CARBOHYDRATE 152,250-948,350 FR
BETA-CAROTENE 0-76 FR
CAROTENOIDS 0-026
CATALASE
D-CATECHIN FR NAP
CHLOROGENIC-ACID FR NAP
CHLOROPHYLL 0-1 FR
CHROMIUM 0.009-0.3 FR AAS USG
CITRIC-ACID
CITRAMALIC-ACID
COBALT <0.003-0.040 FR AAS USG
COPPER 0.24-4 FR AAS USG
COUMARIC-ACID
P-COUMARIC-ACID 15-460 FR CRC (FSN)
N-COUMARYL-QUINIC-ACID
P-COUMARYL-QUINIC-ACID FR NAP
CREATINE SH NAP
CUTIN EP(FR) NAP
CYANIDIN LF NAP
CYANIDIN-3-ARABINOSIDE
CYANIDIN-7-ARABINOSIDE
CYANIDIN-3,5 DIGLUCOSIDE CY NAP
CYANIDIN-3-GALACTOSIDE
CYSTINE 30-387
1-DECANOIC-ACID
N-DECANOL
DECENOIC-ACID
1-DECYL-ACETATE
DEHYDROASCORBIC-ACID
DIASTASE
DIETHYLAMINE 3 FR NAP
DIGALACTOSYL-DIGLYCERIDE 49-107 FR
3-BETA-19-ALPHA-DIHYDROXY-2-OXOURS-
12-EN-28-OIC-ACID 1000 WD NAP
DIHYDROXYTRICARBALLYLIC-ACID 1 FR
DIPHOSPHATIDYL-GLYCEROL 4-6 FR
DO 25-35
L-EPICATECHIN FR NAP
5,6-EPOXY-10'-APO-5, 6-DIHYDRO-
BETA-CAROTENE-3, 10'-DIOL 20,000 EP (FR) NAP

ESTRAGOLE TR EO
ESTRONE 0.10-0.13 SD NAP
ETHANOL
ETHYL-ACETATE
ETHYLAMINE 3 FR NAP
ETHYL-BUTYRATE
ETHYL-CAPROATE
ETHYL-CROTONATE
ETHYL-DECENOATE
ETHYL-DODECANOATE
ETHYL-HEXANOATE
ETHYL-ISOBUTYRATE
ETHYL-METHYLBUTYRATE
ETHYL-NONANOATE
ETHYL-OCTANOATE
ETHYL-PENTANOATE
ETHYL-PHENACETATE
ETHYL-PROPIONATE
ETHYL-VALERIANATE
FARNESENE EP(FR) NAP
FAT 3,210-34,200 FR FNP PED
FAT 180,000-230,000 SD
FERULIC-ACID 4-95 FR CRC(FSN)
FIBRE 131,000 FR PED
FIBRE 5,200-49,636 FR USA
FLUORINE <0.1-2.1 FR AAS
FOLACIN 0.02-0.2 FR USA
FORMIC-ACID
FRUCTOSE 50,130-60,900 FR
FUMARIC-ACID
GALACTANASE
GALACTARIC-ACID
D-GALACTURONIC-ACID 13-54
GERANIOL
D-GLUCITOL
GLUCOCEREBROSIDE 34-49
D-GLUCONIC-ACID
GLUCOSE 17,200-18,200 FR
GLUTAMIC-ACID 156-1,244 FR
GLUTAMINE 20
GLYCERIC-ACID
GLYCINE 80-497
GLYCOLIC-ACID
GLYOXYLIC-ACID
GUANIDINE SH NAP
GUANIDINOACETIC-ACID SH NAP
GAMMA-GUANIDINOBUTRAMIDE SH NAP
GAMMA-GUANIDINOBUYTYRIC-ACID SH NAP
GAMMA-GUANIDINOPROPIONIC-ACID SH NAP
GUANIDINOSUCCINIC-ACID SH NAP
HEMICELLULOSE
HEPTACOSANE
N-HEPTANOIC-ACID
HEPTENOIC-ACID
2-HEPTANOL
N-HEPTANOL
N-HEX-1-EN-3-OL
CIS-N-HEX-3-EN-1-OL
TRANS-N-HEX-2-EN-1-OL
TRANS-N-HEX-3-EN-1-OL
HEXACOSANOL
N-HEXANOL
7-HEXANOIC-ACID
1-HEXANOIC-ACID
HEXANOL
2-HEXENAL
TRANS-2-HEXENOIC-ACID
HEXYL-ACETATE
HEXYL-BUTYRATE
HEXYL-FORMATE
N-HEHYL-N-HEXANOATE
N-HEXYL-OCTANOATE
N-HEXYL-PROPIONATE
HISTIDINE 30-187 FR
P-HYDROXYBENZOIC-ACID FR NAP
HYDROXYCINNAMIC-ACID 1,340 FR
4-HYDROXYMETHYLPROLINE
3-HYDROXY-OCTYL-BETA-D-GLUCOSIDE FR NAP
19-HYDROXYURSOLIC-ACID PL JSG
20-HYDROXYURSOLIC-ACID PL JSG
19-HYDROXYURSONIC-ACID PL JSG
HYPERIN
HYPEROSIDE FR NAP
IDAEIN
INDOLE-3-ACETIC-ACID PL PAS
INOSITOL
IODINE
IRON 1.1-123 FR AAS USA USG
ISOAMYL-BUTYRATE
ISOAMYL-PROPIONATE
ISOBUTYL-ACETATE
ISOBUTYL-BUTYRATE
ISOBUTYL-FORMATE
ISOCHLOROGENIC-ACID PL PAS
ISOCITRIC-ACID
ISOLEUCINE 50-497 FR
ISOPROPYL-BUTYRATE
ISOQUERCITRIN FR NAP
JASMONIC-ACID FR NAP
KILOCALORIES 3,429 FR PED
LACTIC-ACID
LAURIC-ACID 10-63 FR
LEAD 0.002-64 FR AAS USG

LECITHIN
LEUCINE 120-746 FR
LINOLENIC-ACID 870-5,411 FR
ALPHA-LINOLENIC-ACID 180-1,120 FR
LITHIUM 0.044-0.172 FR USG
LUTEIN 0.4-5 FRJAF37:65
LUTEOXANTHIN FR NAP
LYSINE 20-746 FR
MAGNESIUM 48-478 (-860) FR AAS USA USG
L-MALIC-ACID
MALVIDIN-MONOGLYCOSIDE
MANGANESE 0-29 FR AAS USG
MANNOSE
MERCURY 0.00011-0.02 FR AAS USG
METHANOL
METHIONINE 20-124
METHYL-ACETATE
METHYL-2-XI-ACETOXY-20-BETA-
HYDROXY-URSONATE EP(FR)
METHYLAMINE 4.5 EP(FR) NAP
2-METHYL-BUT-2-EN-1-AL FR NAP
2-METHYL-BUT-3-EN-1-OL FR NAP
D-2-METHYLBUTAN-1-OL
2-METHYLBUTAN-2-OL
METHYL-BUTYRATE
METHYL-CAPROATE
2-METHYL-2,3-EPOXY-PENTANE FR NAP
24-METHYLENE-CHOLESTEROL PO NAP
METHYL-FORMATE
METHYL-GUANIDINE SH NAP
6-METHYL-HEPTEN-5-EN-2-ONE FR NAP
METHYL-HEXANOATE
N-METHYL-BETA-PHENETHYLAMINE 1.2 FR NAP
METHYL-PROPIONATE
METHYL-2-METHYL-BUTYRATE
METHYL-1-PENTANOATE
2-METHYLPENTAN-2-OL
N-METHYL-PHENETHYLAMINE 1.3 EP(FR)NAP
N-METHYL-PHENETHYLAMINE 1.2 FRNAP
GAMMA-METHYLA-PROLINE
2-METHYL-PROPEN-1-AL FR NAP
METHYL-VINYL-KETONE FR NAP
MEVALONIC-ACID 30-36 FR
MOLYBDENUM 0.077-0.43 FR USG
MONOGALACTOSYL-DIGLYCERIDE 12-42
1-MONO-LINOLEIN SD NAP
MUFA 150-935 FR USA
MYOINOSITOL 4,500 PO NAP
MYRISTIC-ACID 20-124 FR
NEOCHLOROGENIC-ACID
NEOXANTHIN EP(FR) NAP
NIACIN 1-7 FR
NICKEL 0.004-0.648 FR AAS USG
NITROGEN 290-4,000 FR AAS
NONACOSANE
D-L-NONACOSANOL
N-NONANOIC-ACID
N-NONANOL-2-NONANOL
NONENOIC-ACID
1-NONYL-ACETATE
OCTACOSANOL
OCTA-CIS-3-CIS-5-DIEN-1-OL EO NAP
OCTA-TRANS-3-CIS-5-DIEN-1-OL EO NAP
OCTA-CIS-3-CIS-5-DIEN-1-OL-ACETATE EO NAP
OCTA-TRANS-3-CIS-5-DIEN-1-OL-ACETATE EO NAP
N-OCTANONE
N-OCTANOL-2-OCTANOL
OCTENOIC-ACID
1-OCTYL-ACETATE
OLEIC-ACID 140-671 FR
OXALIC-ACID
OXALOACETIC-ACID
ALPHA-OXOGLUTARIC-ACID
PALMITIC-ACID 480-2,986 FR
PALMITOLEIC-ACID 10-62 FR
PANTOTHENIC-ACID 1-4 FR USA
PECTASE
PECTIN 1,4000-66,380 FR USA
PECTIN-DEMETHOXYXYLASE
N-PENTANOIC-ACID
1-PENTANOIC-ACID
PENTANOL
1-PENTANOL
2-PENTANOL
3-PENTANOL
N-PENTENOIC-ACID
N-PENTYL-AMINE 0.3 FR NAP
PENTYL-BUTYRATE
N-PENTYL-DECANOATE
N-PENTYL-FORMATE
1-PENTYL-FORMATE
PENTYL-HEXANOATE
N-PENTYL-2-METHYLBUTYRATE
1-PENTYL-1-PENTANOATE
N-PENTYL-OCTANOATE
PEROXIDASE
2-PHENETHYLACETATE
PHENOLICS 1,100-3,400
PHENYLALANINE 50-311 FR
PHLORETAMIDE FR NAP
PHLORETIN LF JAD
PHLORETIN-4'-0 BETA-D-
GLUCOPYRANOSIDE 4,486 FR NAP

PHLORETIN-XYLOGLUCOSIDE FR NAP
PHLORIZIN GLYCOSURIC
PHOSPHATIDYLIC-ACID 3-6 FR
PHOSPHATIDYL-CHOLINE 149-214 FR
PHOSPHATIDYL-ETHANOLAMINE 101-124 FR
PHOSPHATIDYL-GLYCEROL 8-27 FR
PHOSPHATIDYL-INOSITOL 50-59 FR
PHOSPHATIDYL-SERINE 4 FR
PHOSPHORUS 68-925 (-1,548) FR AAS PED USG
PHYTOSTEROLS 120-745 FR USA
PIPECOLINIC-ACID
POLYGALACTOSYL-DIGLYCERIDE
POLYGALACTURONASE
POLYPHENOLASE
POMOLIC-ACID PL JSG
POMONIC-ACID PL JSG
POTASSIUM 1,150-12,140 (-17,630) FR AAS USG
PROCYANIDINS LF NAP
PROLINE 20-436
PROPANOL
2-PROPANOL
N-PROPANOL
1-PROPANOL
N-PROPIONIC-ACID
PROPYL-ACETATE
PROPYL-BUTYRATE
PROPYL-FORMATE
PROPYL-2-METHYLBUTYRATE
PROPYL-N-PENTANOATE
PROPYL-PROPIONATE
PROTEIN 1,670-12,800 FR PED
PROTOCATECHUIC-ACID FR NAP
PUFA 1,050-6,535 FR USA
PYRROLIDINE 1.5 EP(FR) NAP
PYRIDOXINE
PYRUVIC-ACID
QUERCETIN 58-263 PC PAM
QUERCETIN-ARABINOSIDE
QUERCETIN-3-O-ALPHA-
ARABINOFURANOSIDE PL JSG
QUERCETIN-3-O-ALPHA-
GALACTOSIDE EP(FR) NAP
QUERCETIN-3-O-BETA-D-GLUCOSIDE PL JSG
QUERCETIN-3-RHAMNOGLUCOSIDE
QUERCETIN-3-O-RHAMNOSIDE PL JSG
QUERCETIN-3-RUTINOSIDE
QUERCETIN-3-O-XYLOSIDE EP(FR) NAP
QUERCETIN FR NAP
L-QUINIC-ACID
REYNOUTRIN FR NAP
RIBOFLAVIN 1 FR
RUBIDIUM 0.27-10 FR AAS
RUTIN TR EP(FR) NAP
SELENIUM 0.000055-0.00043 FR USG
SERINE 80-497 FR USA
SFA 580-3,610 FR USA
SHIKIMIC-ACID
SILICON 1-70 FR AAS
SILVER 0.011-0.096 FR USG
SINAPIC-ACID FR NAP
SODIUM 0-130 FR USG
SORBITOL LF NAP
STEARIC ACID 70-426 FR
STRONTIUM 0.168-8.6 FR USG
SUCCINIC-ACID
SUCROSE 24,000-36,200 FR
SUGAR 60,100-166,000 FR
SULFUR 1.65-23 FR USG
TETRADECENYL-ACETATE LF NAP
TETRADECYL-ACETATE LF NAP
THIAMIN 1-2 FR PED
THREONINE 30-435 FR
TITANIUM 0.055-3 FR USG
ALPHA-TOCOPHEROL 2-37 FR TOT USA
TRIACONTANOL
TRIGLYCERIDE 45-90
1,3,3,-TRIMETHYL-DIOXA-2,7-
BICYCLO (2,2,1) HEPTANE FR NAP
TRYPTOPHAN 20-124 FR
TYROSINE 40-249 FR
URONIC-ACID 7-1,440 FR
URSOLIC-ACID EP(FR) NAP
VALINE 40-560 FR
VIT-B6 1-3 FR
VOMIFOLIOL-1-O-BETA-D-
XYLOPYRANOSYL-6-0-BETA-
D-GLUCOPYRANOSIDE FR NAP
WATER 809,000-896,000 FR USG
XYLOSE
ZINC 0-35 FR AAS USG
ZIRCONIUM 0.22-0.56 FR USA

Many entries derived from Hicheme
AAS=ACTA AGRIC SCAND SUPPL
22 1980 1(20-86%; ZMB=7.24 X APB

Ideal diet?

Bolivian forager-horticulturalists: Tsimane

Diet:

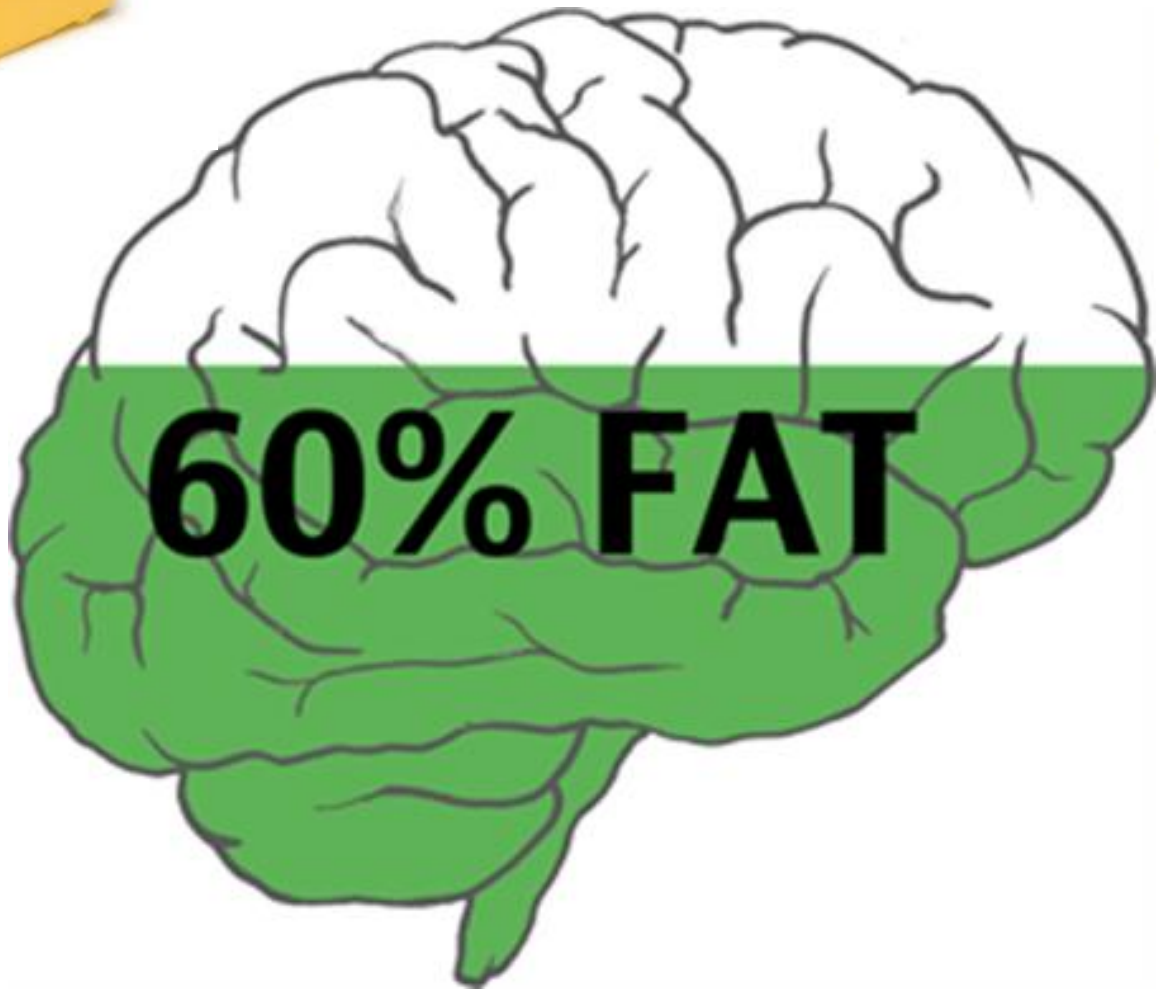
freshwater fish
hunted game
Plantains
Rice
Manioc (yuca)
fruit

Martin et al. Maternal & Child Nutrition 2012;8:404-418

United States: The Revis family of North Carolina.

Mexico: The Casales family of Cuernavaca.

Ecuador: The Ayme family of Tingo.


60% FAT

The lasting impact of diet on biology

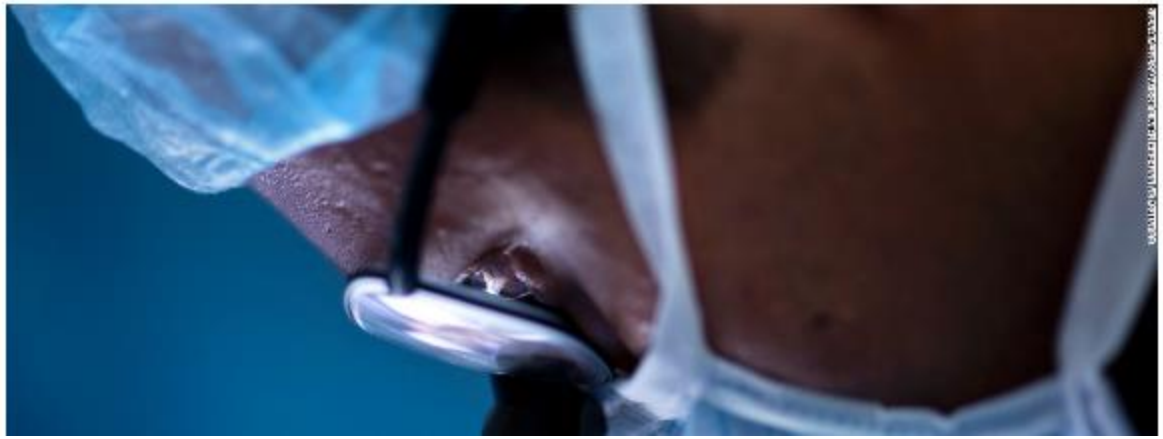
	Tsimane	US	Canada
18:1n-9	27.5±4.56	30.2±3.44	34.6
18:2n-6	10.2±4.56	18.9±5.10	13.2
20:3n-6	0.47±0.12	0.33±0.88	0.38
20:4n-6	1.06±0.33	0.55±0.09	0.42
22:5n-6	0.21±0.07	0.05±0.03	0.05
18:3n-3	1.90±0.84	1.58±0.65	1.51
20:4n-3	0.25±0.18	0.06±0.03	0.05
20:5n-3	0.20±0.12	0.06±0.04	0.08
22:5n-3	0.40±0.14	0.14±0.04	0.14
22:6n-3	0.69±0.26	0.16±0.26	0.27

All C 20 & 22 n-6 & n-3 high, DHA is not the only variable

'Bad luck' mutations increase cancer risk more than behavior, study says

By Susan Scutti, CNN

Updated 2:00 PM ET, Thu March 23, 2017

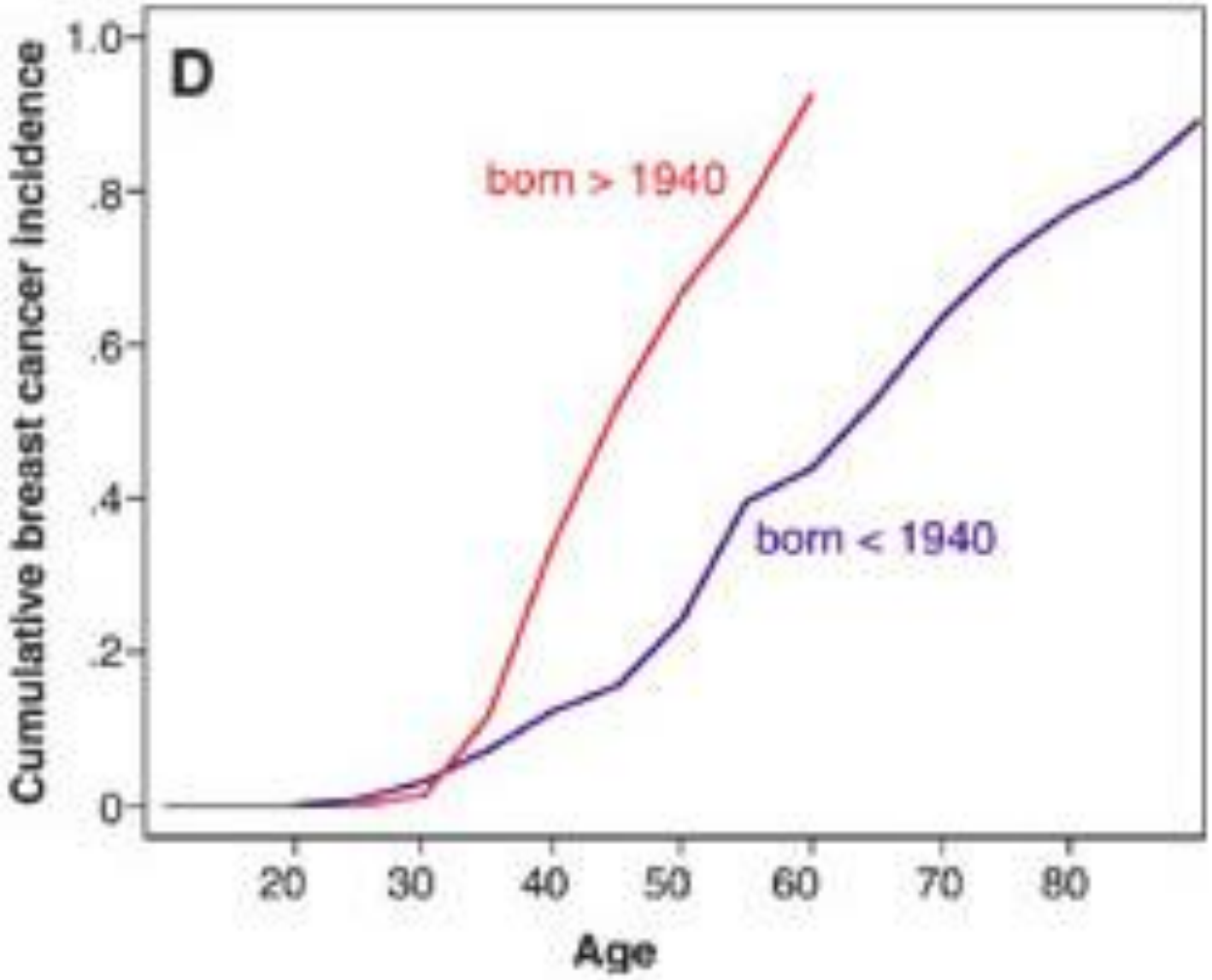


Top stories

Pharmacist convicted in fungal meningitis outbreak

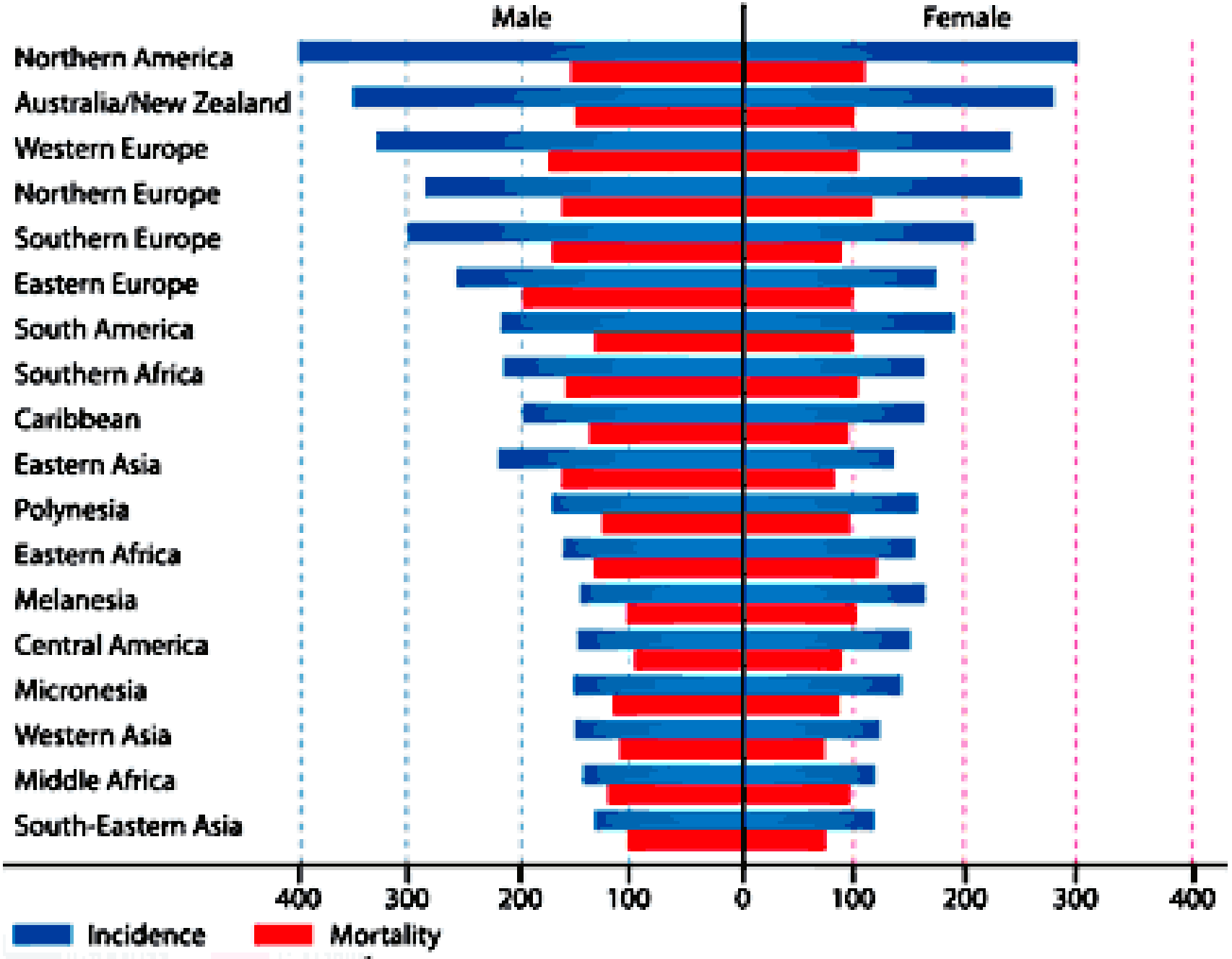
Nunes: Trump's personal communications possibly collected

The breast cancer risks for women in the study born after 1940 were significantly higher for those born in the same families before 1940.

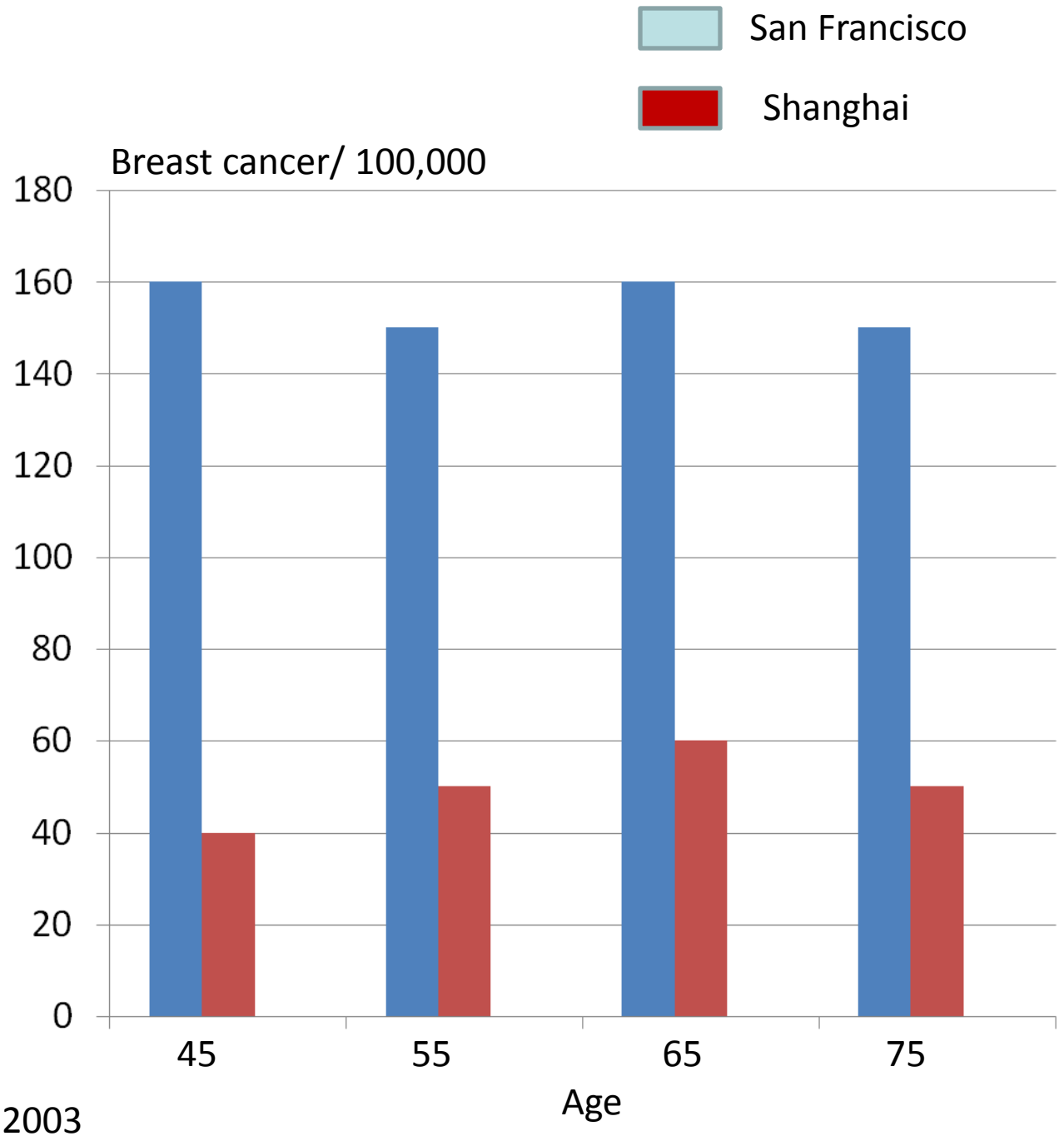


Science **302**, 643-646 (October 24, 2003).

Cancer is a disease of the Western Lifestyle



Breast cancer rates among Chinese women who moved to San Francisco compared to Chinese women who stayed in China

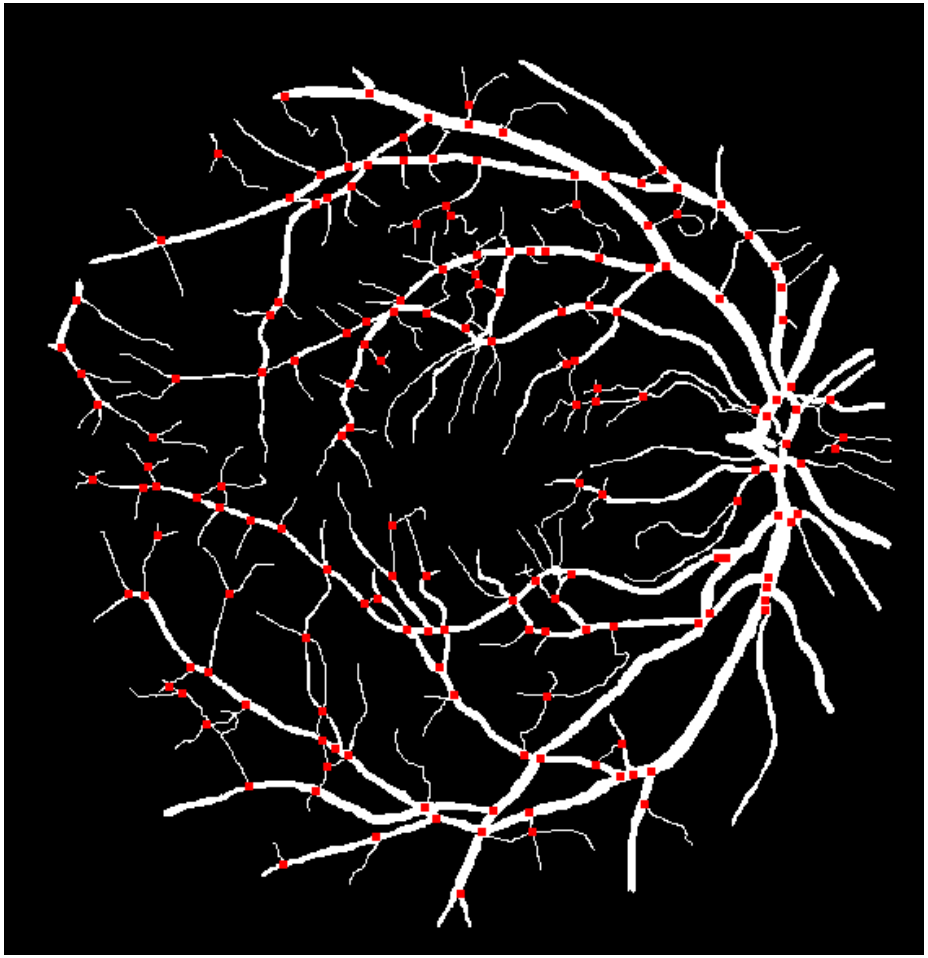


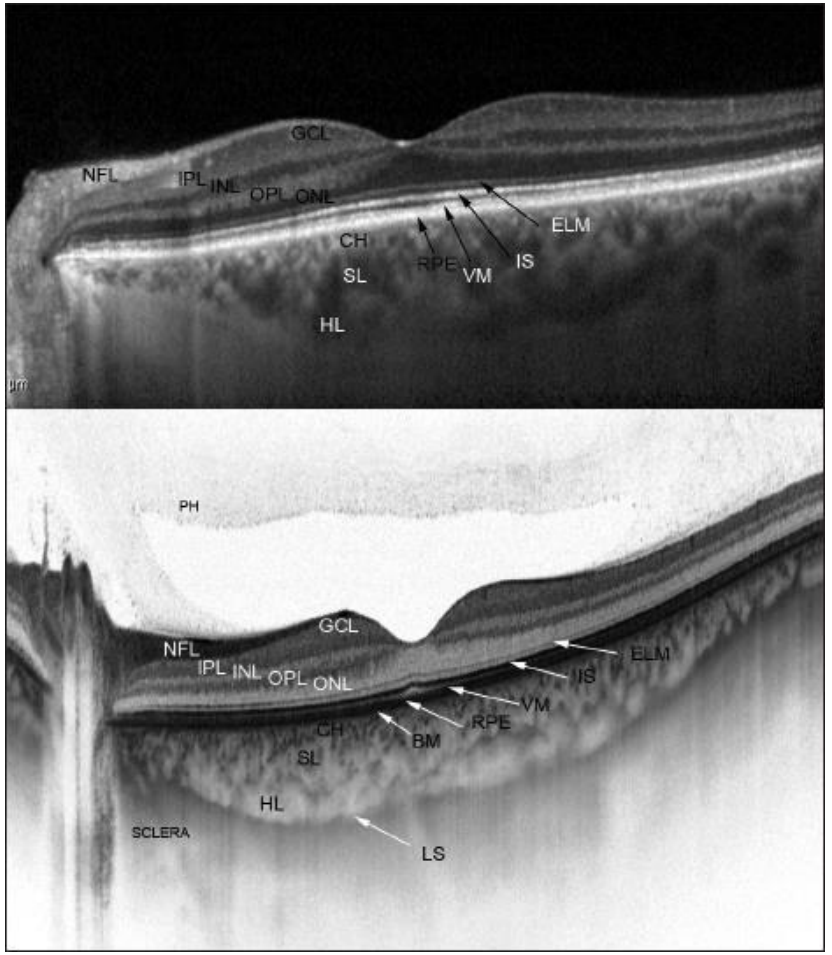
Waterhouse, Muir, et al., 2003

Many other diseases seem to be linked to Western lifestyle, rather like myopia.

At least we can treat myopia. What about AMD? Alzheimer's disease?

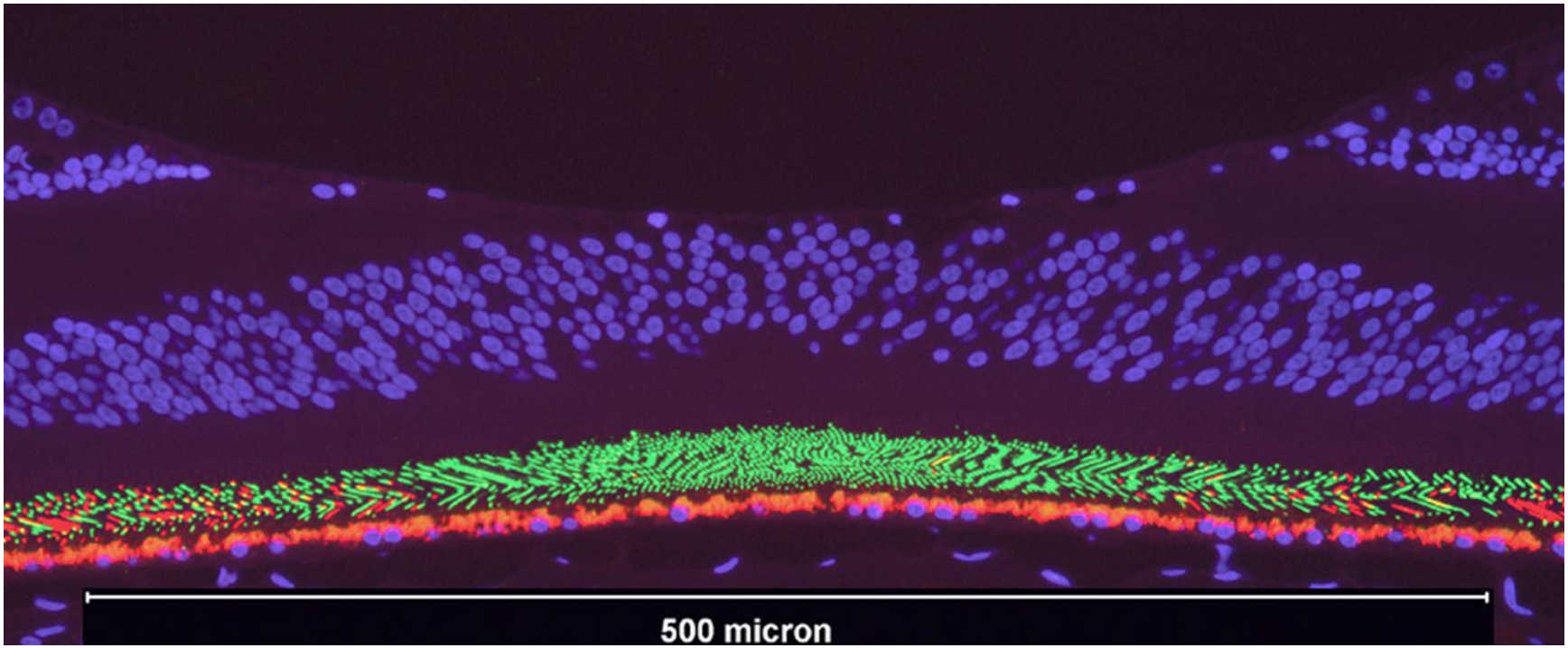
Retina is one of the most metabolically active tissues in the body





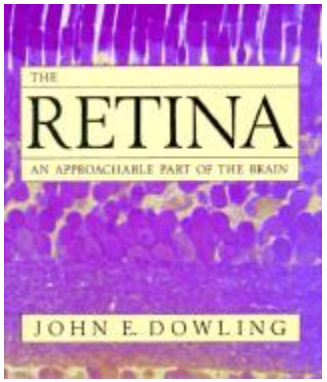
e.g., Cohen & Noell, 1965; Anderson & Satlzman, 1964; Ames, 1992.
Images: Azzopardi & Petkov, 2011; Michalewska et al, 2013

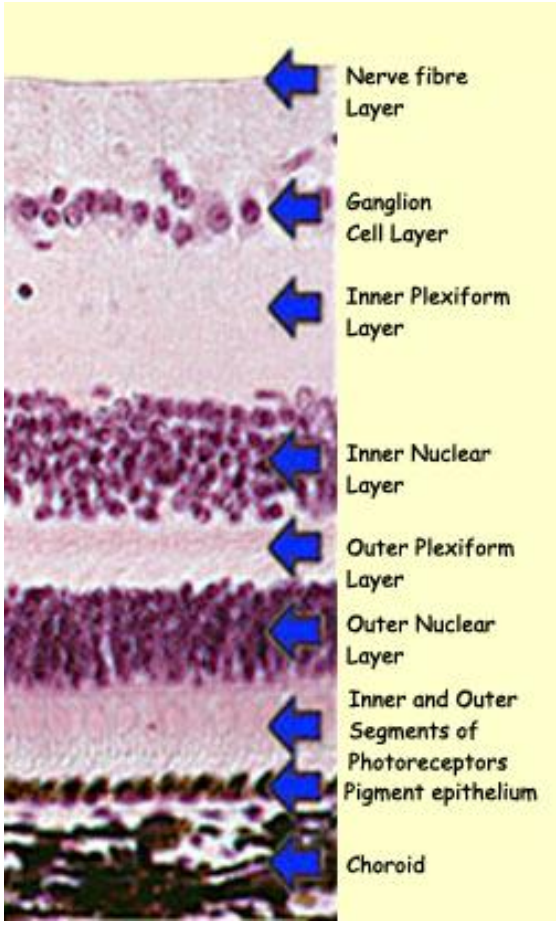
Retina is one of the most neurologically dense tissues in the body

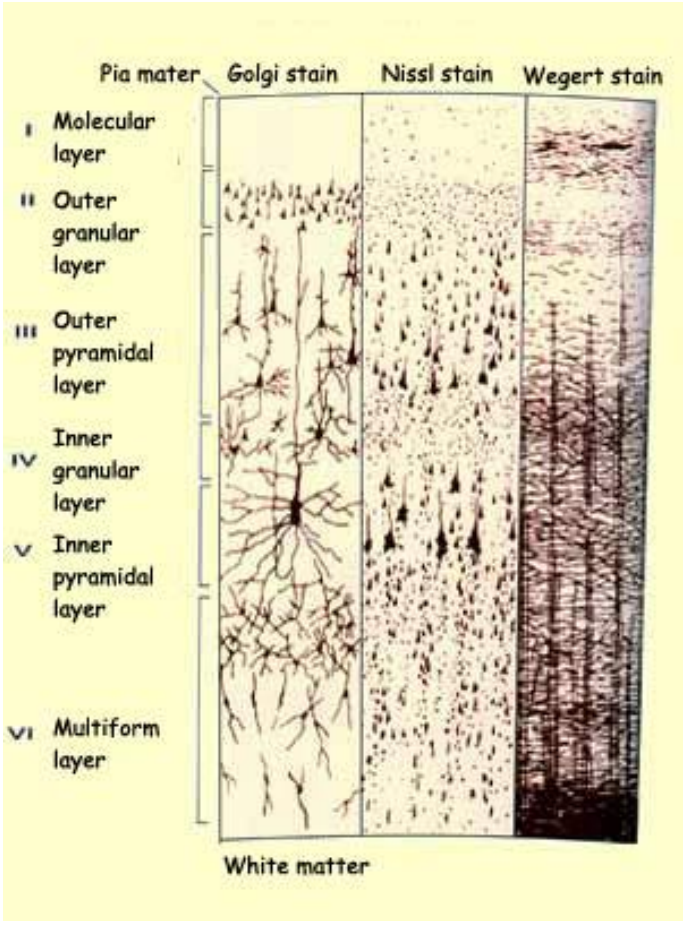


Optic nerve: 1,200,000 fibers.
Next most dense cranial nerve: 140,000 fibers (sensory root of trigeminal nerve)
2500 mm^2 area, 120 microns thick → 148.2 million receptors and ganglia

Dowling was right





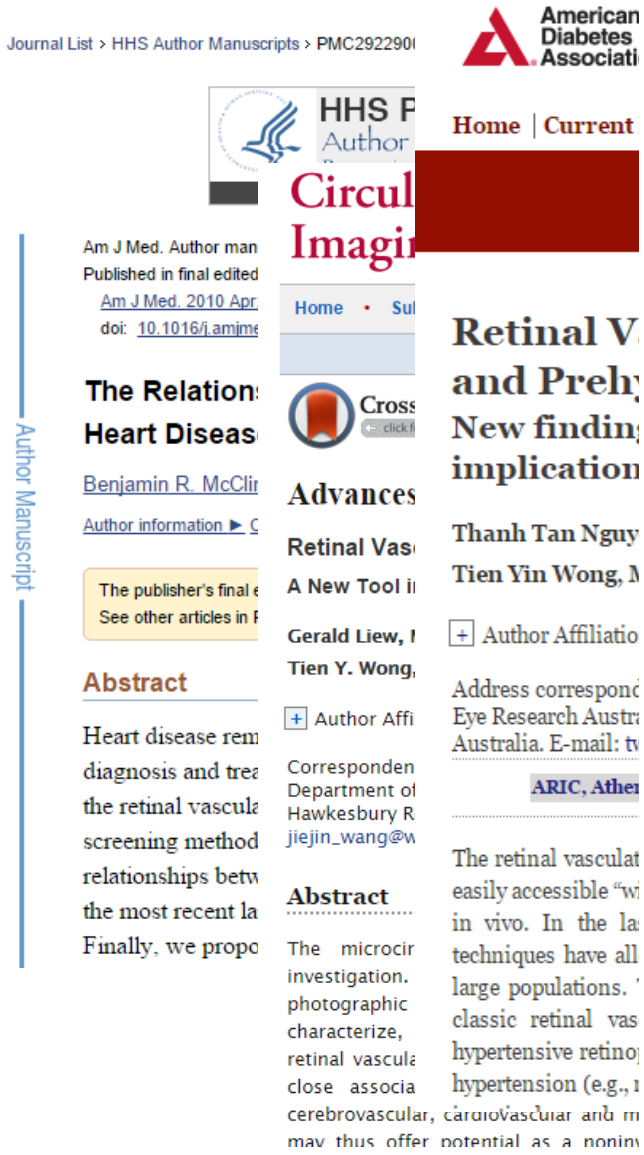


Images: University of Kansas Medical Center; McGill University

Viewing the CNS

Image: Cho et al, 2014

Retinal change as a predictor



Journal of Neurology
April 2005, Volume 252, Issue 4, pp 396-402

Date: 22 Mar 2005

Predicting the Outcome of Optic Neuritis

P. Nilsson MD, E.-M. Larsson MD, PhD, P. Maly-Sundgren MD, PhD, R. Perfekt PhD, Magnhild Sandberg-Wollheim MD, PhD

Abstract

Background

Multiple sclerosis (MS) is a common disease with considerable risk for disability. Optic neuritis (ON) is a common first symptom of MS but it can also remain an isolated episode. Therefore, predicting the outcome of ON has gained in importance, particularly in light of current discussions of early disease modifying treatments in individuals at risk of developing MS. We reported previously on our cohort of 86 patients with acute monosymptomatic unilateral ON of whom 33 had progressed to MS after up to 18 years. Three patients had died. The present study extends the observation period to 31 years.

Retinal change as a predictor

Journal of Alzheimer's Disease 24 (2011) 615–631
DOI 10.3233/JAD-2011-101908
IOS Press

Review

Age-Related Macular Degeneration (AMD): Alzheimer's Disease in the Eye?

Kai Kaarniranta[a,b,*], Antero Salminen[c,d], Annakaisa Haapasalo[c,d], Hilkka Soininen[c,d] and Mikko Hiltunen[c,d]
[a]*Department of Ophthalmology, Institute of Clinical Medicine, University of Eastern Finland, Kuopio, Finland*
[b]*Department of Ophthalmology, Kuopio University Hospital, Kuopio, Finland*
[c]*Department of Neurology, Institute of Clinical Medicine, University of Eastern Finland, Kuopio, Finland*
[d]*Department of Neurology, Kuopio University Hospital, Kuopio, Finland*

Accepted 4 January 2011

Abstract. Age-related macular degeneration (AMD) is a late-onset, neurodegenerative retinal disease that shares several clinical and pathological features with Alzheimer's disease (AD), including stress stimuli such as oxidative stress and inflammation. In both diseases, the detrimental intra- and extracellular deposits have many similarities. Aging, hypercholesterolaemia, hypertension, obesity, arteriosclerosis, and smoking are risk factors to develop AMD and AD. Cellular aging processes have similar organelle and signaling association in the retina and brain tissues. However, it seems that these diseases have a different genetic background. In this review, differences and similarities of AMD and AD are thoroughly discussed.

Keywords: Age-related macular degeneration (AMD), aggregation, aging, Alzheimer's disease, autophagy, lysosome, oxidative stress, proteasome

Similarities:

Clinical pathological features
- Oxidative stress
- Inflammation

Molecular similarities between deposits
- Drusen and amyloid plaques

Decreased capacity to degrade damaged cellular proteins

Genetic risk factors
- APOE
- Complement factors

Lifestyle risk factors

For age-related retinal and brain diseases, prevention is key

Retina. 2015 Mar;35(3):459-66. doi: 10.1097/IAE.0000000000000338.

Metabolic syndrome and risk of age-related macular degeneration.

Maralani HG[1], Tai BC, Wong TY, Tai ES, Li J, Wang JJ, Mitchell P.

Author information

Abstract

PURPOSE: To investigate the relationship between metabolic syndrome (MetS) and its components with the risk of early- and late-stage age-related macular degeneration (AMD).

METH
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RESUL
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PMID: 2

Biomed Res Int. 2014;2014:413150. doi: 10.1155/2014/413150. Epub 2014 Jul 3.

Nutritional risk factors for age-related macular degeneration.

Ersoy L[1], Ristau T[1], Lechanteur YT[2], Hahn M[3], Hoyng CB[2], Kirchhof B[1], den Hollander AI[2], Fauser S[1].

Author information

Abstract

PURPOSE: To evaluate the role of nutritional factors, serum lipids, and lipoproteins in late age-related macular degeneration (late AMD).

METHODS: Intake of red meat, fruit, fish, vegetables, and alcohol, smoking status, and body mass index (BMI) were ascertained questionnaire-based in 1147 late AMD cases and 1773 controls from the European Genetic Database. Serum levels of lipids and lipoproteins were determined. The relationship between nutritional factors and late AMD was assessed using logistic regression. Based on multivariate analysis, area-under-the-curve (AUC) was calculated by receiver-operating-characteristics (ROC).

RESULTS: In a multivariate analysis, besides age and smoking, obesity (odds ratio (OR): 1.44, P = 0.014) and red meat intake (daily: OR: 2.34, P = 8.22 × 10(-6); 2-6x/week: OR: 1.67, P = 7.98 × 10(-5)) were identified as risk factors for developing late AMD. Fruit intake showed a protective effect (daily: OR: 0.52, P = 0.005; 2-6x/week: OR: 0.58, P = 0.035). Serum lipid and lipoprotein levels showed no significant association with late AMD. ROC for nutritional factors, smoking, age, and BMI revealed an AUC of 0.781.

CONCLUSION: Red meat intake and obesity were independently associated with increased risk for late AMD, whereas fruit intake was protective. A better understanding of nutritional risk factors is necessary for the prevention of AMD.

PMID: 25101280 [PubMed - indexed for MEDLINE] PMCID: PMC4101976 Free PMC Article

How does one prescribe nutrition?

PUBLISHED
18 DEC 2013

An apple a day keeps the heart doctor away

HEALTH | SCIENCE

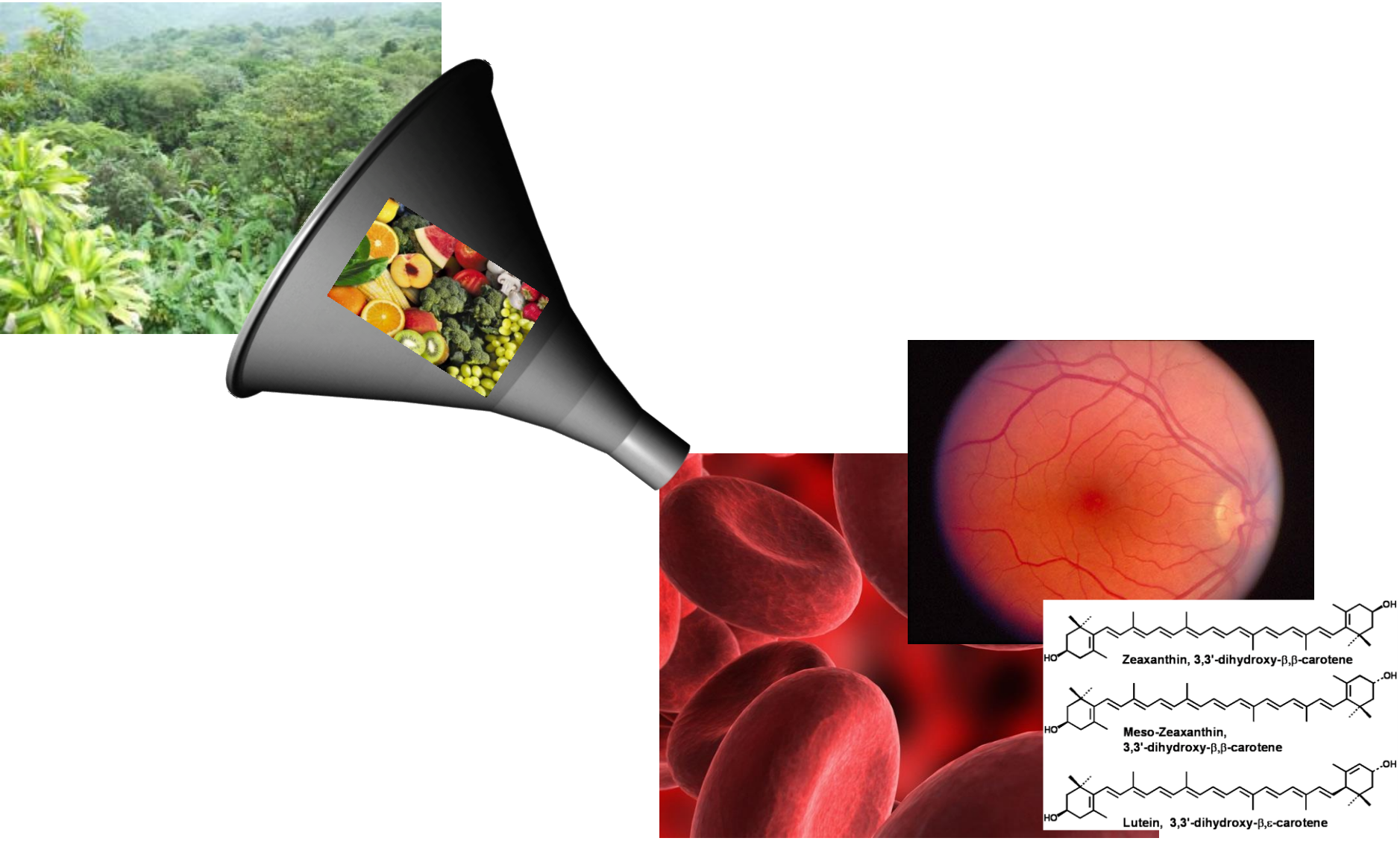
The 150-year-old proverb 'an apple a day keeps the doctor away' stands the test of time, say Oxford University researchers.

Writing in the more light-hearted Christmas edition of the *BMJ* medical journal, the scientists estimated how effective this Victorian health advice would be today in preventing heart disease among people over 50.

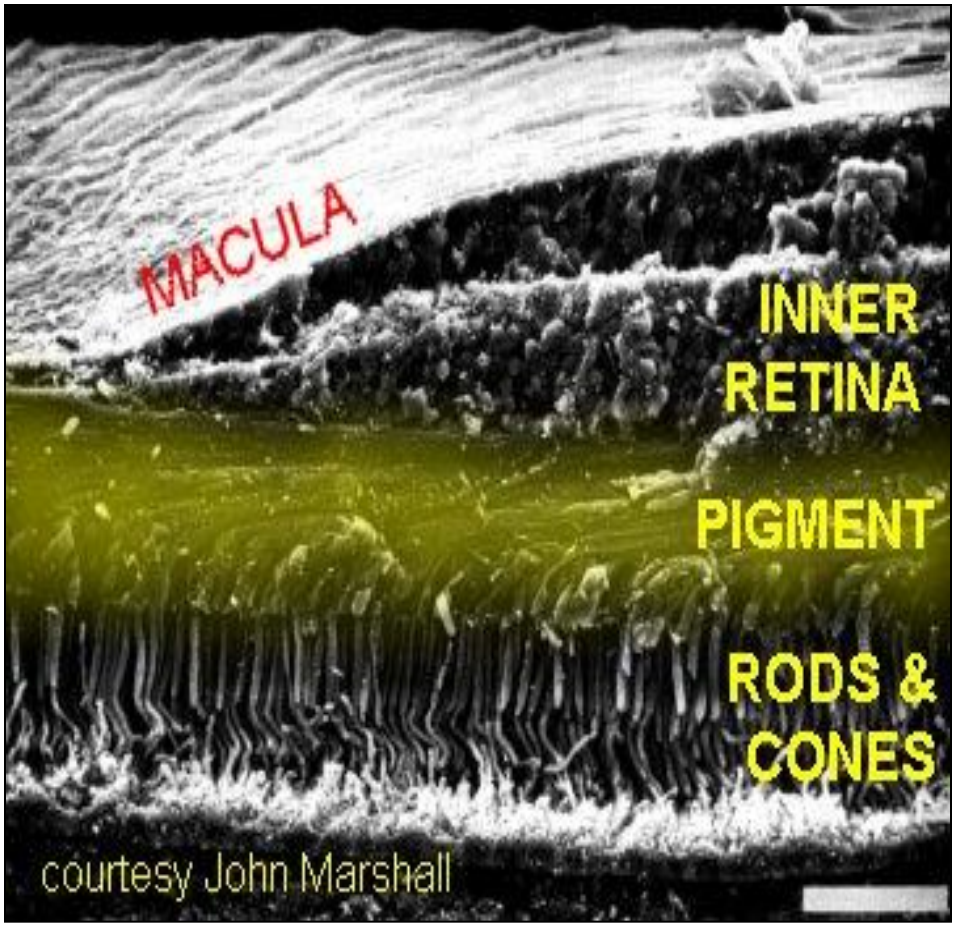
Using mathematical models, the researchers calculated that prescribing an apple a day to all adults aged 50 and over in the UK would prevent around 8,500 deaths from heart attacks and strokes every year.

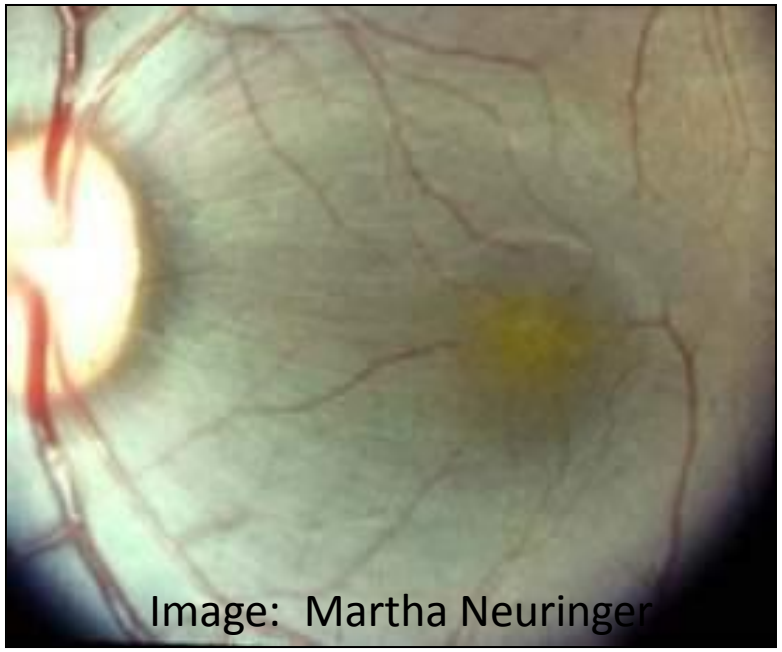
Introduction to dietary carotenoids

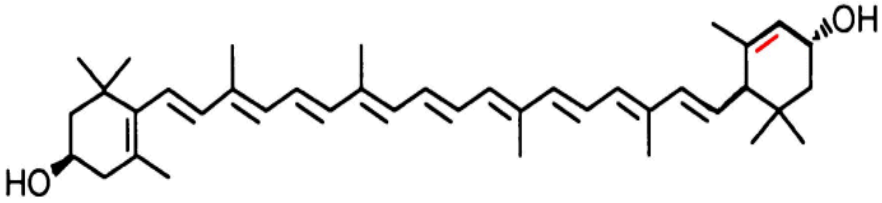
Selective absorption of carotenoids



Macular Pigment (MP)





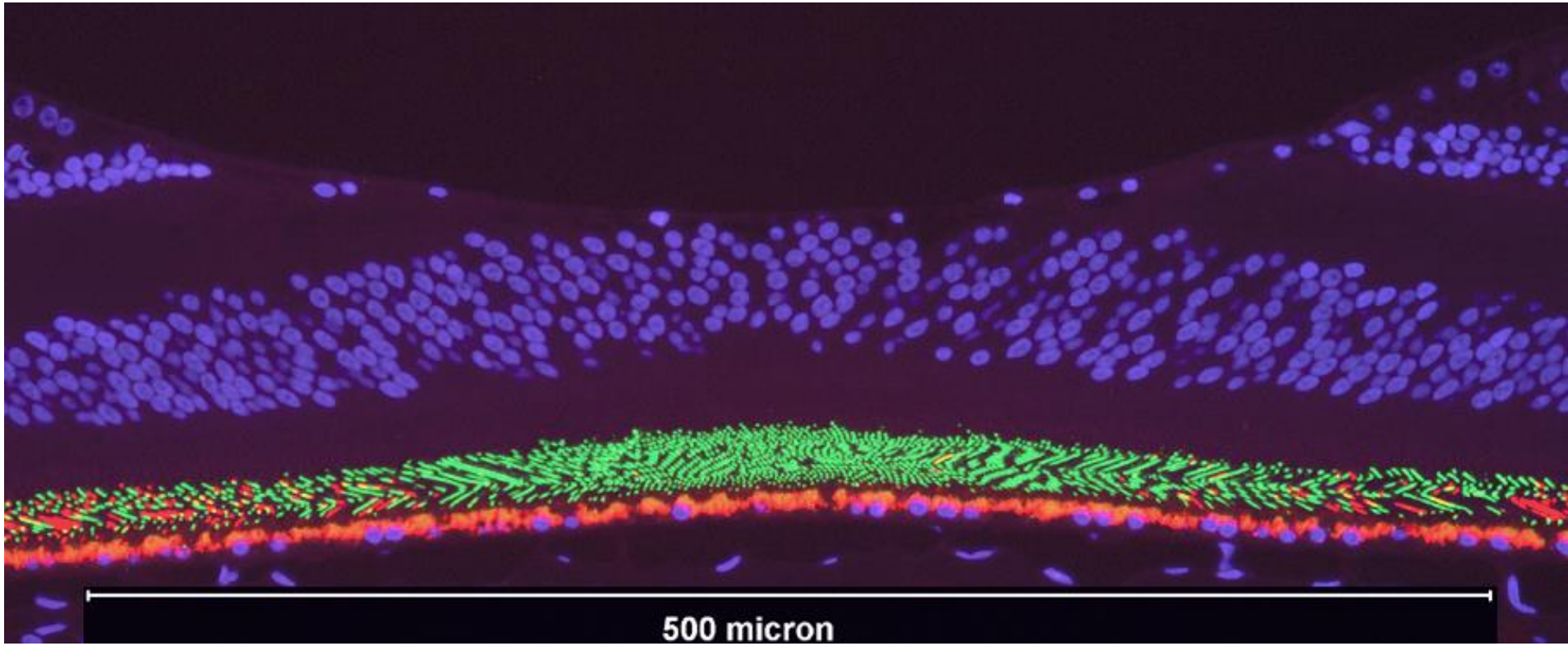


MP is comprised of lutein (L) and zeaxanthin (Z), and their isomer, meso-zeaxanthin (MZ).

MP screens central cones

Central Fovea

Cell nuclei (purple), LM cones (green), rods (red), lipofuscin (orange)



MP absorbs short-wave light

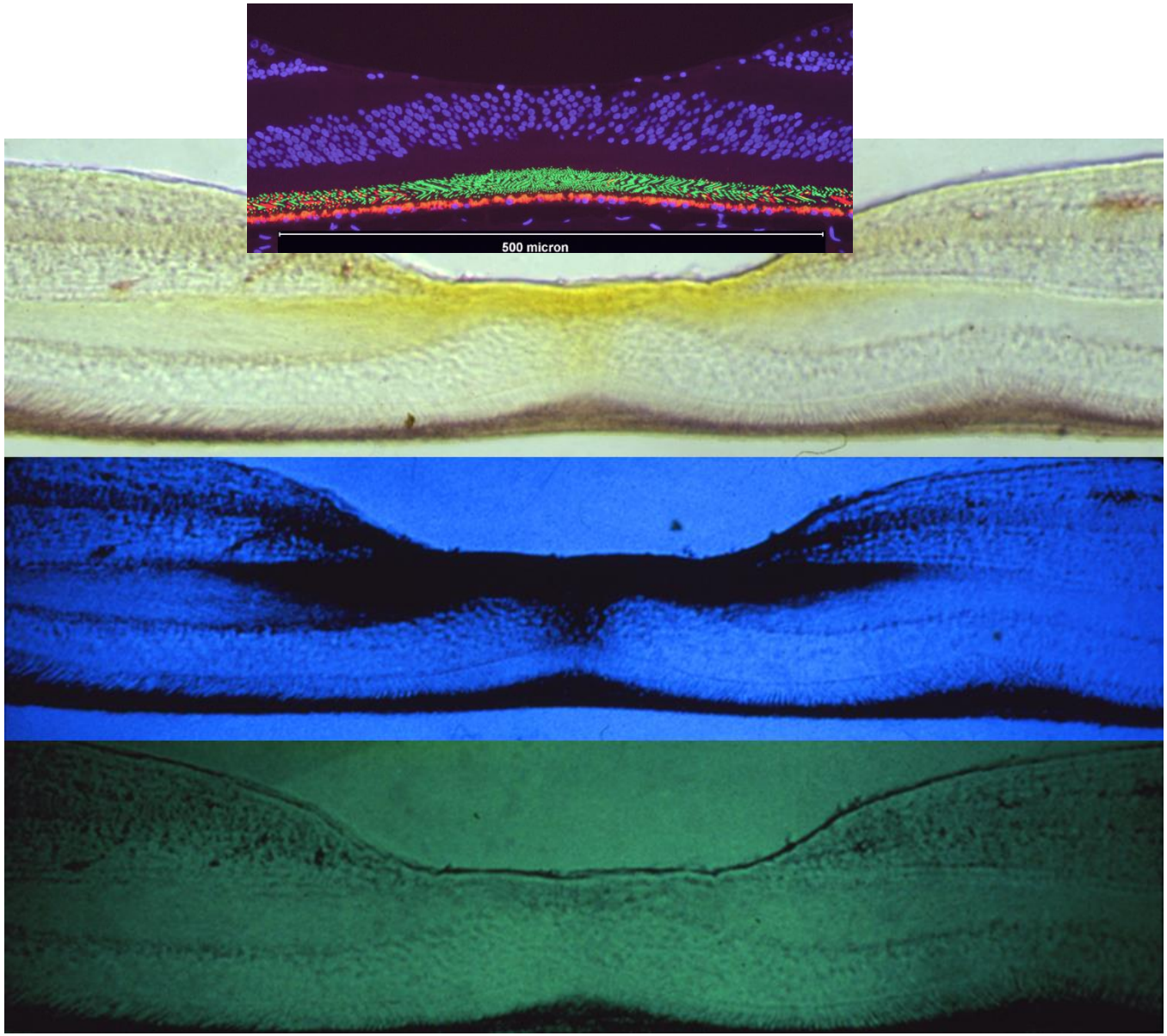


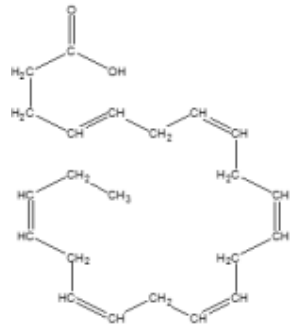
Image: D. Max Snodderly

Xanthophylls are antioxidants

Light

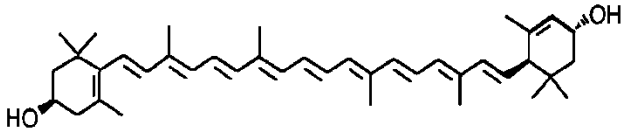
Photosensitizer + O_2

DHA



Lipid Peroxidation

$^1O_2$ $^3O_2$



Lutein

Heat

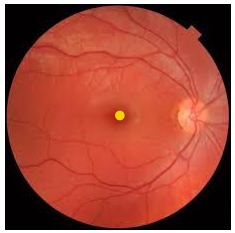
Which foods are best for L and Z?

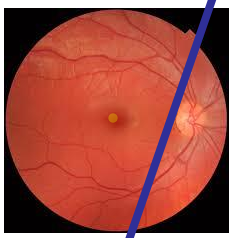
Foods with lutein and zeaxanthin

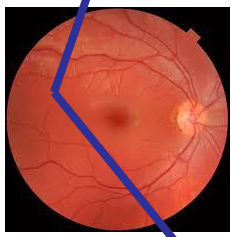
FOOD	SERVING	mg
Kale *(cooked)*	1 cup	23.8
Spinach *(cooked)*	1 cup	20.4
Collards *(cooked)*	1 cup	14.6
Turnip greens *(cooked)*	1 cup	12.2
Spinach *(raw)*	1 cup	3.8
Corn *(can or cooked)*	1 cup	2.2
Green peas *(canned)*	1 cup	2.2
Broccoli *(cooked)*	1 cup	1.6
Romaine lettuce *(raw)*	1 cup	1.3
Green beans *(cooked)*	1 cup	0.8
Eggs	2 *(large)*	0.3
Orange	1 *(medium)*	0.2

AOA.org

How do North Americans stack up?







1.0 + log units

0.3 log units

0.0 log units

20+ mg / day

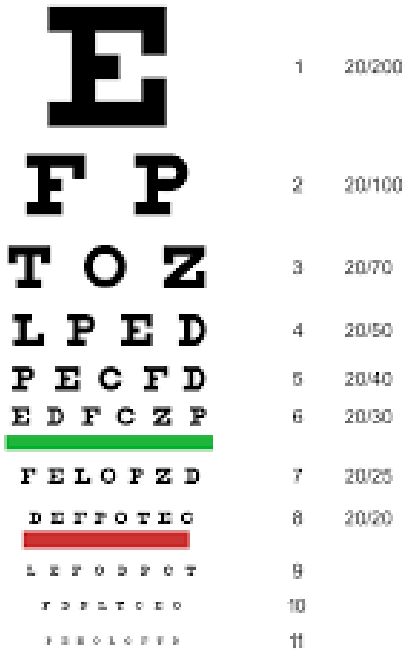
1.5 mg / day

Micrograms, if any

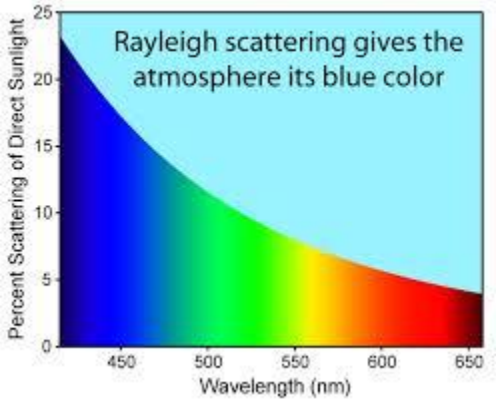
Hammond & Caruso-Avery, 2000;
Curran-Celentano et al, 2002

Carotenoids and visual function: the evidence

Visual function?

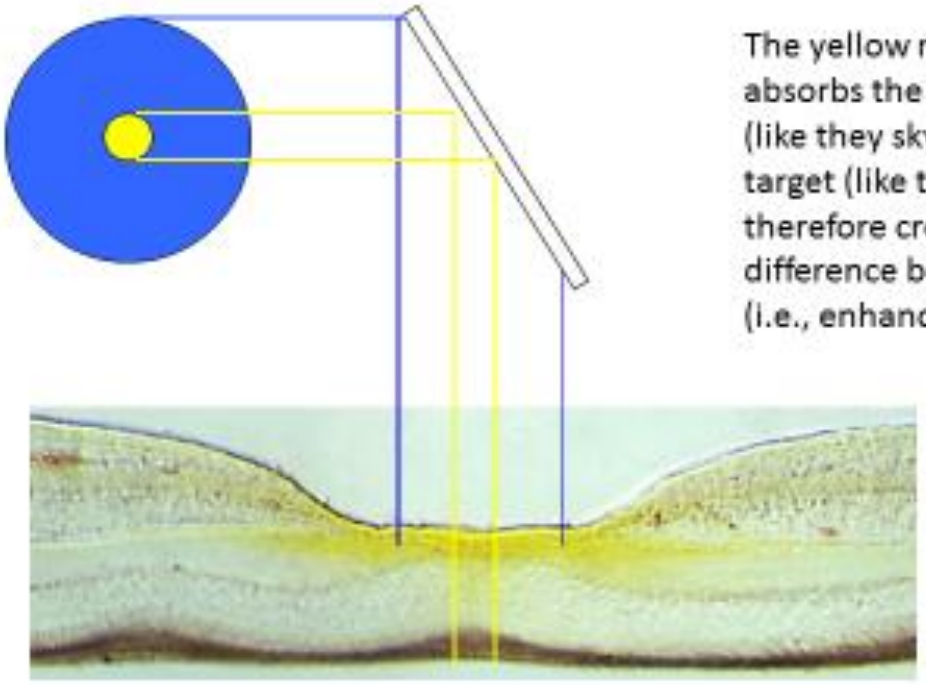


vs.



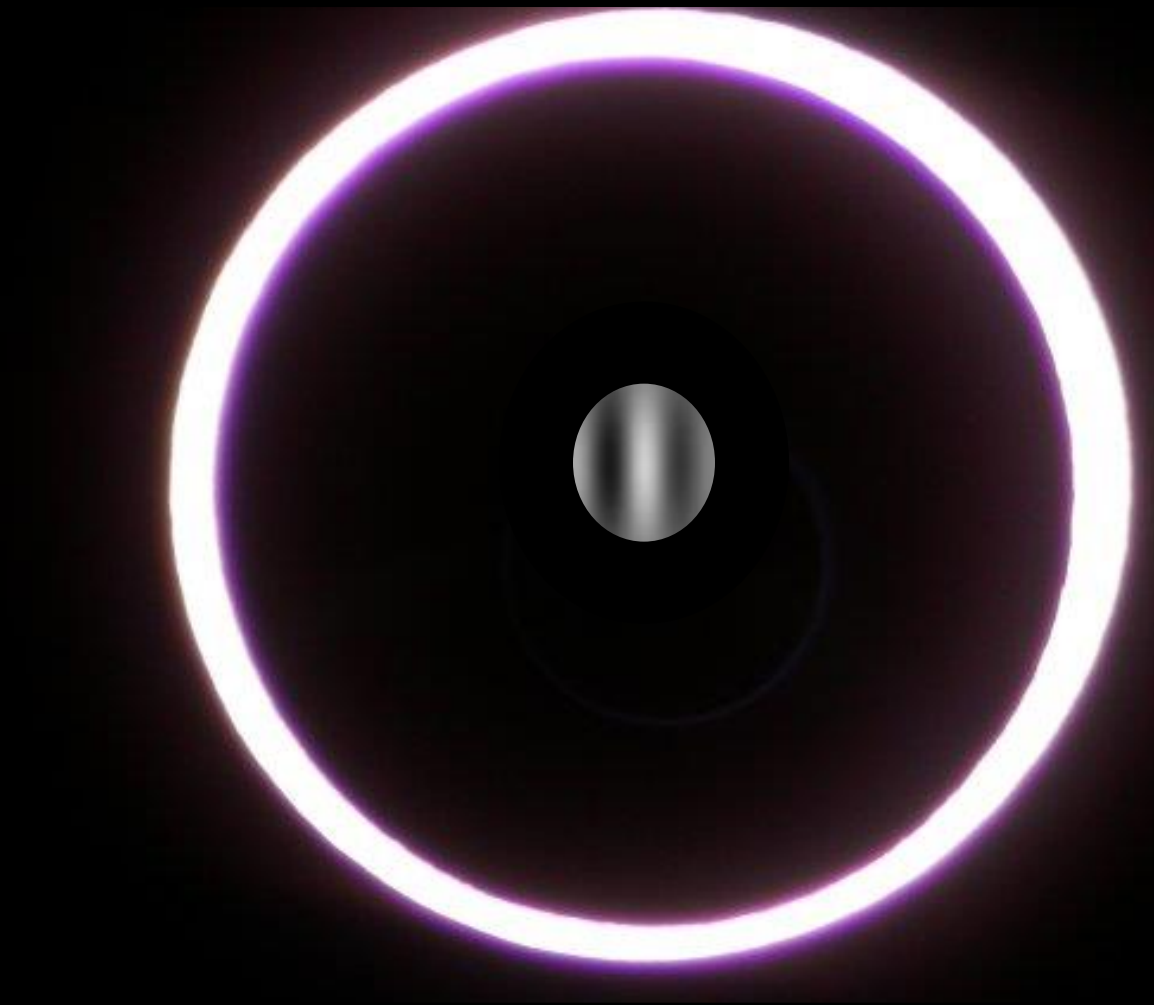
Pigments absorb short-wave light.
Tungsten sources make bad test lights.

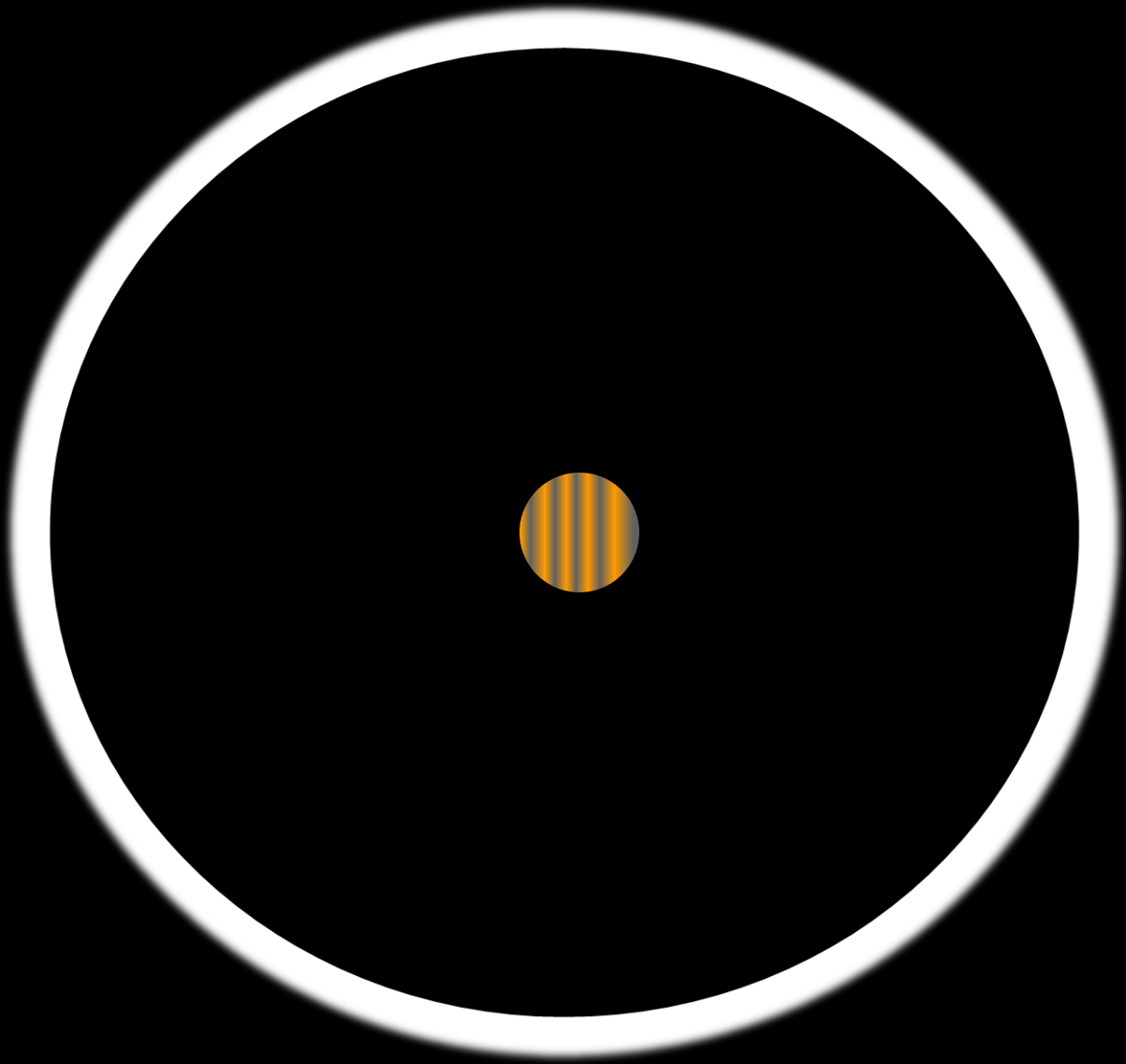
Testing visual function



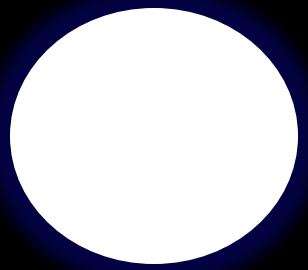
The yellow macular pigment absorbs the background (like they sky) more than the target (like the ball) and therefore creates a bigger difference between the two (i.e., enhances contrast)

Glare disability

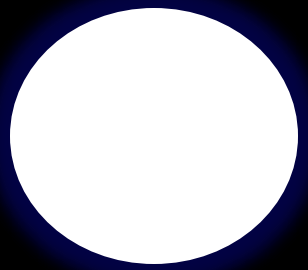




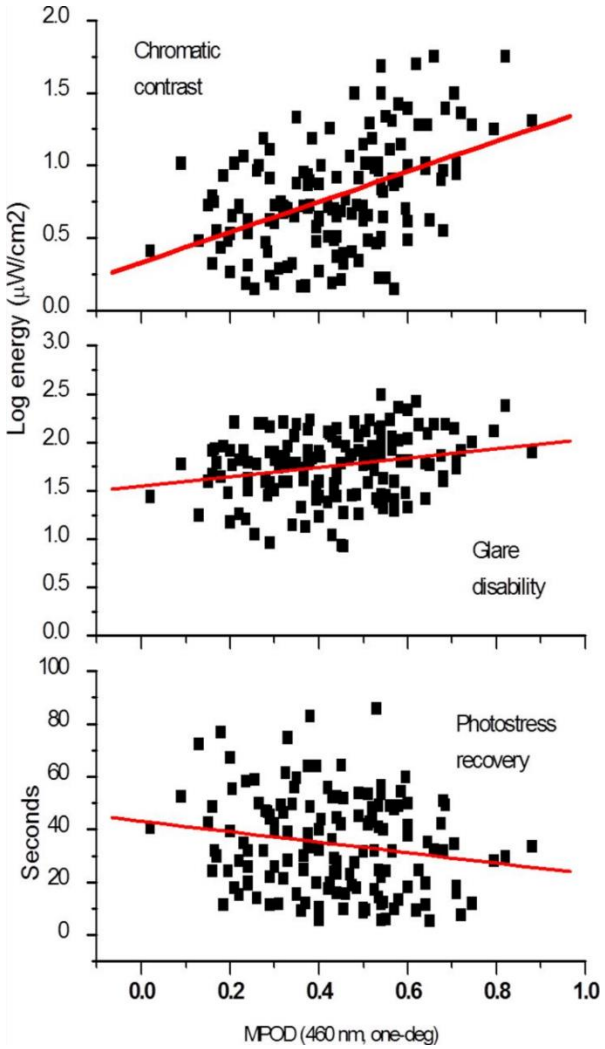
Photostress recovery

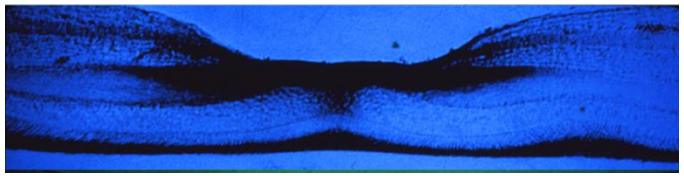


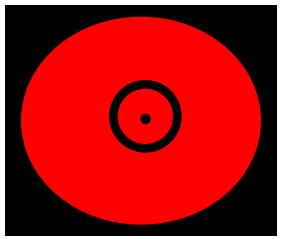
Photostress recovery



Xanthophylls improve visual function.







Renzi & Hammond, 2010; Hammond et al, 2013

Xanthophylls and AMD

JAMA The Journal of the American Medical Association

Original Contribution | May 15, 2013

ONLINE FIRST

Lutein + Zeaxanthin and Omega-3 Fatty Acids for Age-Related Macular Degeneration

The Age-Related Eye Disease Study 2 (AREDS2) Randomized Clinical Trial FREE

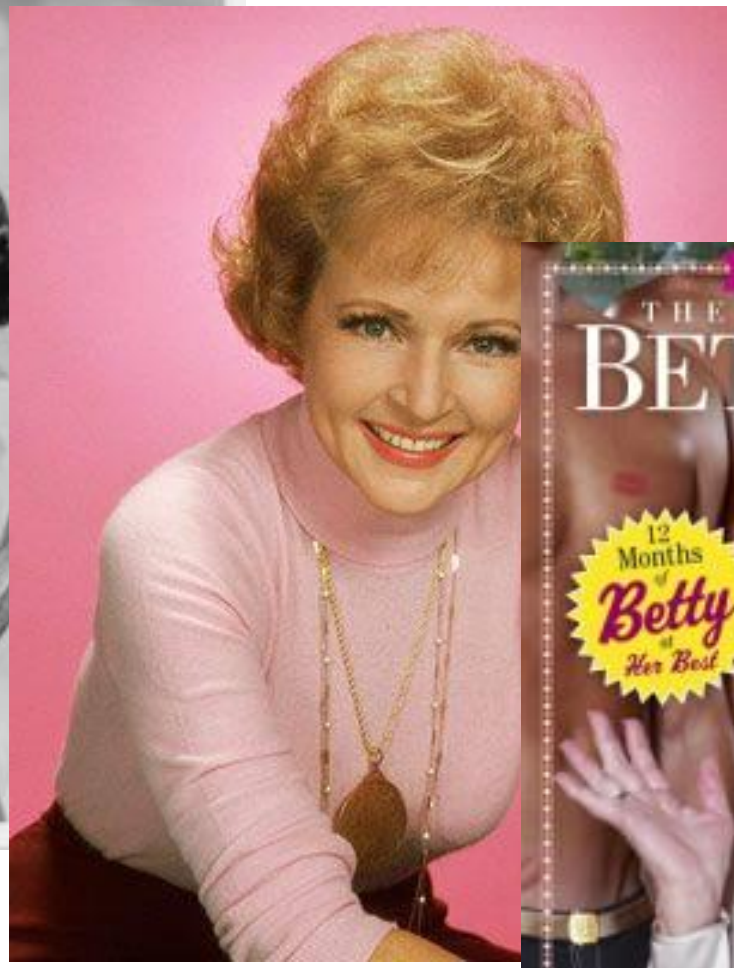
The Age-Related Eye Disease Study 2 (AREDS2) Research Group*

[+] Author Affiliations

JAMA. 2013;309(19):2005-2015. doi:10.1001/jama.2013.4997.

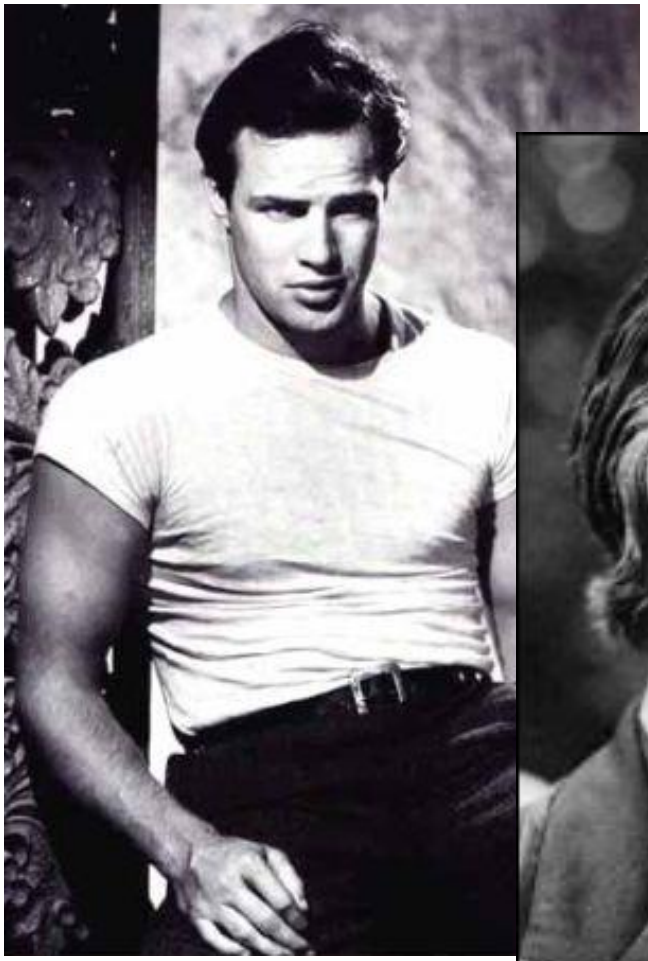
Carotenoids and cognitive function: the evidence

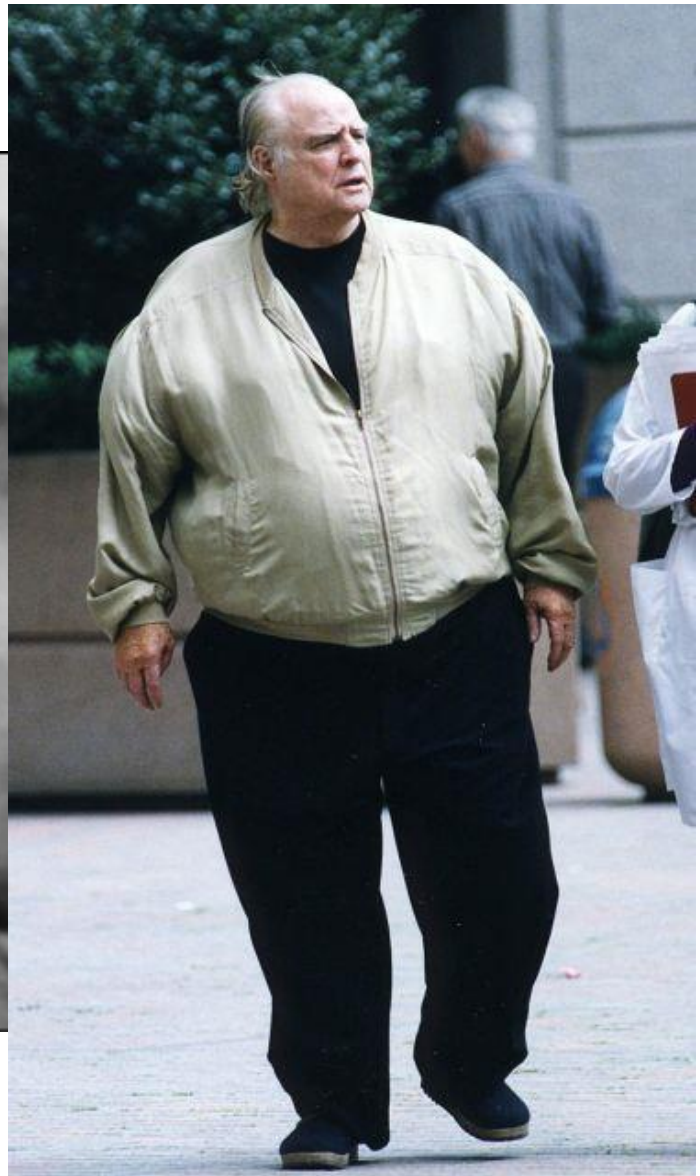
The many ways that one can age



Betty White: current age, 93

The many ways that one can age





Marlon Brando: died age 80, liver failure, congestive heart failure, obesity, diabetes, pulmonary fibrosis

The many ways that one can age

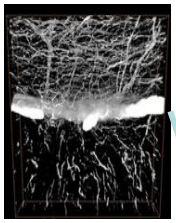
Paul Newman: died age 83, lung cancer

Successful aging?

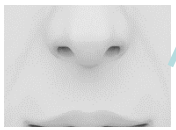
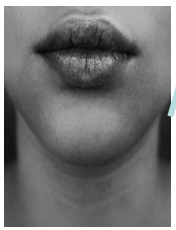
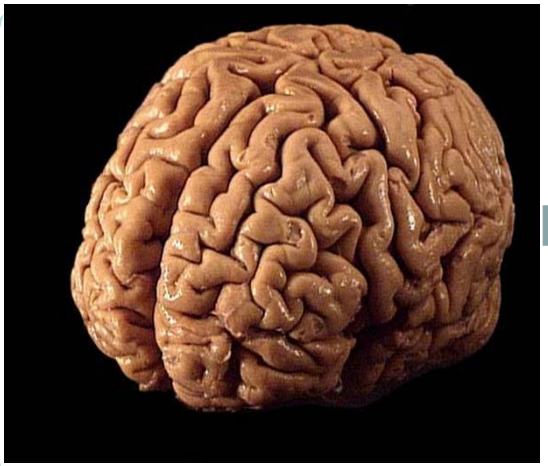
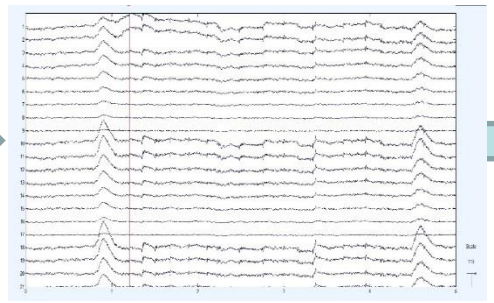
"You start to lose your memory, you start to lose your confidence, you start to lose your invention. So I think that's pretty much a closed book for me.“

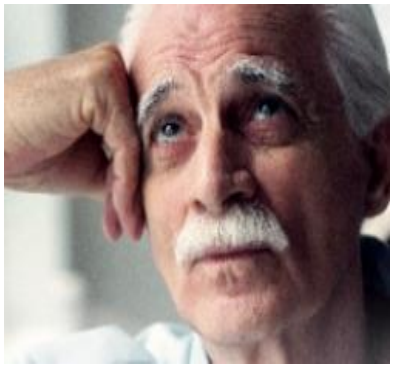
-- Paul Newman, 2007, on retiring from acting

Cognition?

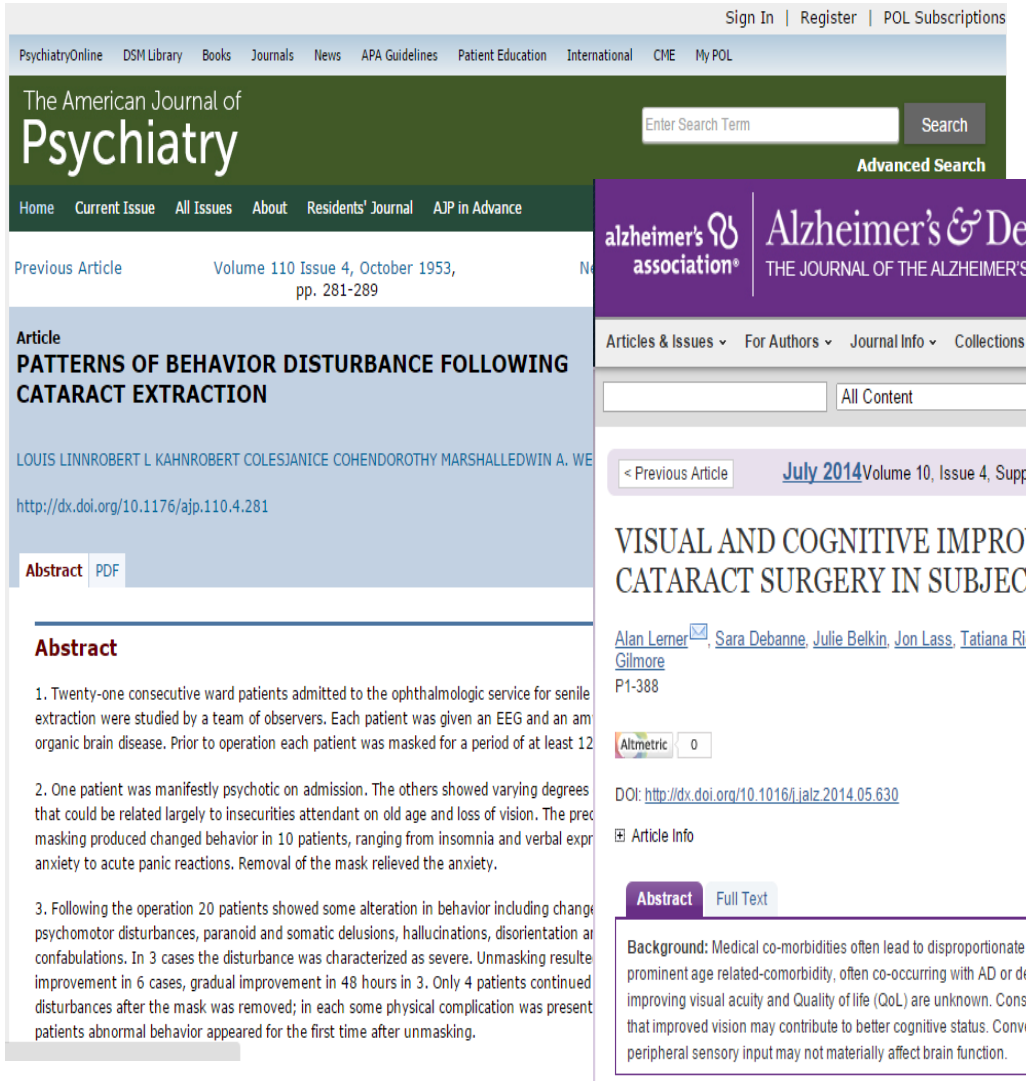





Altered sensory input with age

Cognition?



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Previous Article Volume 110 Issue 4, October 1953, pp. 281-289

Article

PATTERNS OF BEHAVIOR DISTURBANCE FOLLOWING CATARACT EXTRACTION

LOUIS LINNROBERT L KAHNROBERT COLESJANICE COHENDOROTHY MARSHALLEDWIN A. WE

http://dx.doi.org/10.1176/ajp.110.4.281

Abstract PDF

Abstract

1. Twenty-one consecutive ward patients admitted to the ophthalmologic service for senile extraction were studied by a team of observers. Each patient was given an EEG and an am organic brain disease. Prior to operation each patient was masked for a period of at least 12

2. One patient was manifestly psychotic on admission. The others showed varying degrees that could be related largely to insecurities attendant on old age and loss of vision. The prec masking produced changed behavior in 10 patients, ranging from insomnia and verbal expr anxiety to acute panic reactions. Removal of the mask relieved the anxiety.

3. Following the operation 20 patients showed some alteration in behavior including change psychomotor disturbances, paranoid and somatic delusions, hallucinations, disorientation a confabulations. In 3 cases the disturbance was characterized as severe. Unmasking resulte improvement in 6 cases, gradual improvement in 48 hours in 3. Only 4 patients continued disturbances after the mask was removed; in each some physical complication was present patients abnormal behavior appeared for the first time after unmasking.

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VISUAL AND COGNITIVE IMPROVEMENT FOLLOWING CATARACT SURGERY IN SUBJECTS WITH DEMENTIA

Alan Lerner, Sara Debanne, Julie Belkin, Jon Lass, Tatiana Riedel, Thomas Steinemann, Susie Sami, Grover Gilmore

P1-388

Altmetric 0

DOI: http://dx.doi.org/10.1016/j.jalz.2014.05.630

Article Info

Abstract Full Text

Background: Medical co-morbidities often lead to disproportionate adverse effects in dementia. Cataracts are a prominent age related-comorbidity, often co-occurring with AD or dementia. The utility of cataract removal in AD in terms of improving visual acuity and Quality of life (QoL) are unknown. Considerations for surgical removal include the possibility that improved vision may contribute to better cognitive status. Conversely, since AD is a brain disease, improving peripheral sensory input may not materially affect brain function.

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Aerobic Exercise Training Increases Brain Volume in Aging Humans

Stanley J. Colcombe, Kirk I. Erickson, Paige E. Scalf, Jenny S. Kim, Ruchika Prakash, Edward McAuley, Steriani Elavsky, David X. Marquez, Liang Hu and Arthur F. Kramer

+ Author Affiliations

Address correspondence to Arthur F. Kramer, PhD, Beckman Institute, University of Illinois, 405 N. Mathews Ave., Urbana, IL 61801. E-mail: akramer@s.psych.uiuc.edu

Received July 8, 2006.
Accepted September 21, 2006.

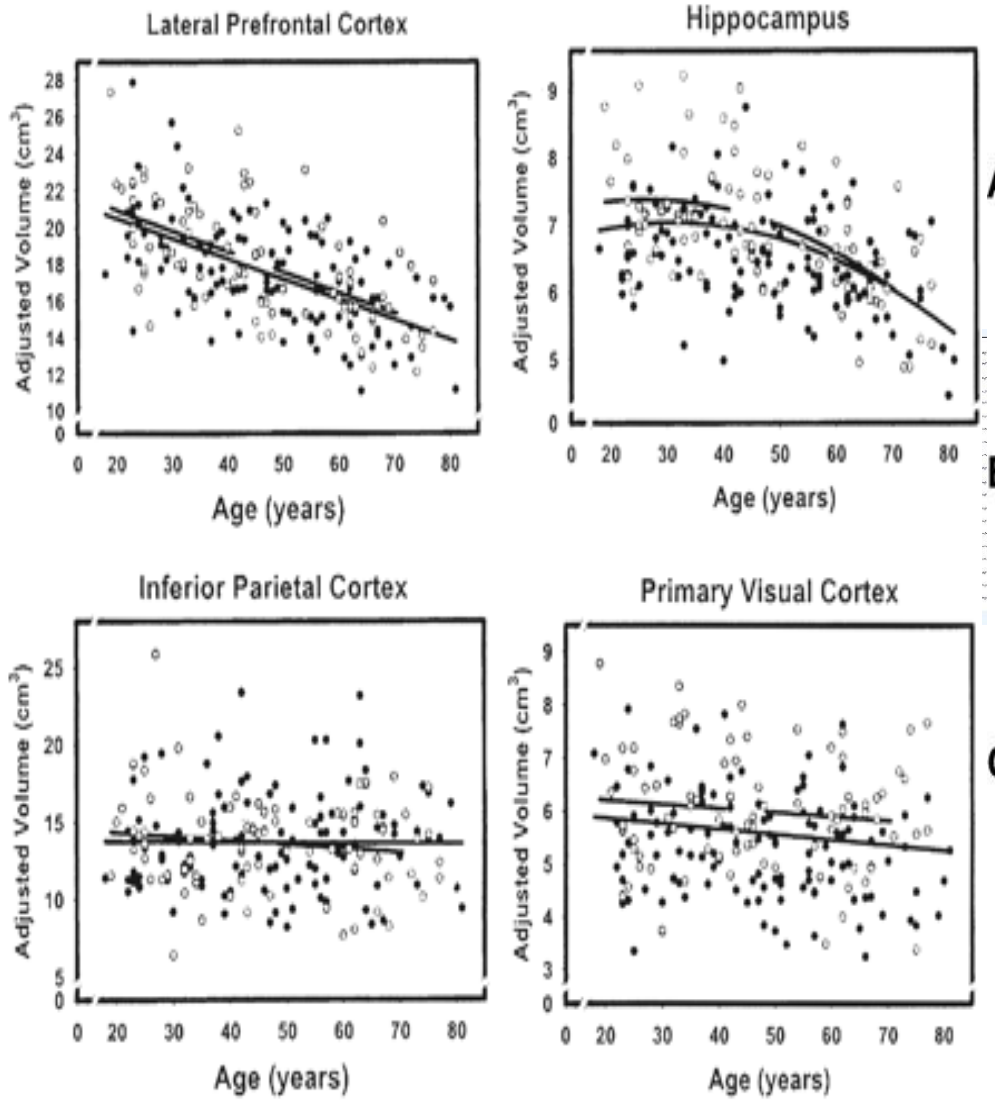
Abstract

Background. The present study examined whether aerobic fitness training of older humans can increase brain volume in regions associated with age-related decline in both brain structure and cognition.

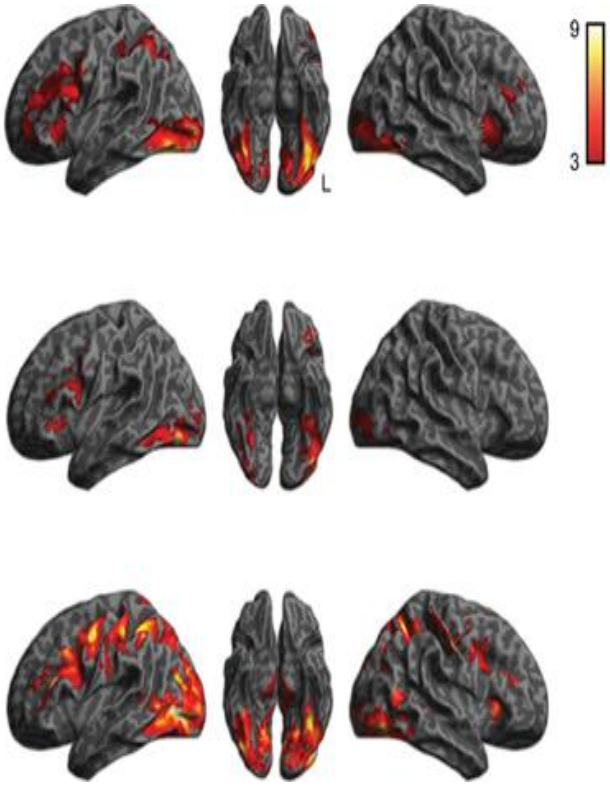
Methods. Fifty-nine healthy but sedentary community-dwelling volunteers, aged 60–79 years, participated in the 6-month randomized clinical trial. Half of the older adults served in the aerobic training group, the other half of the older adults participated in the toning and stretching

Altered sensory input with age

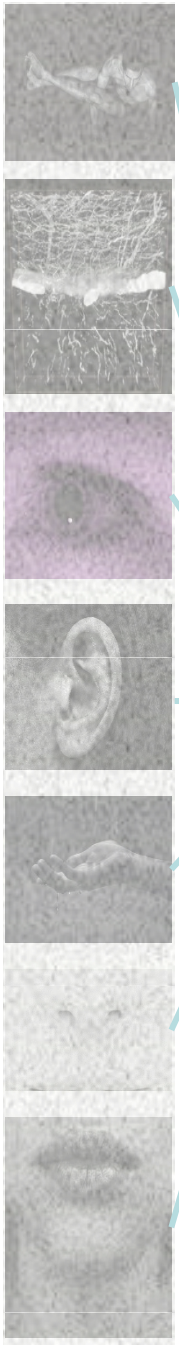
Cognition?



Raz et al, 2004

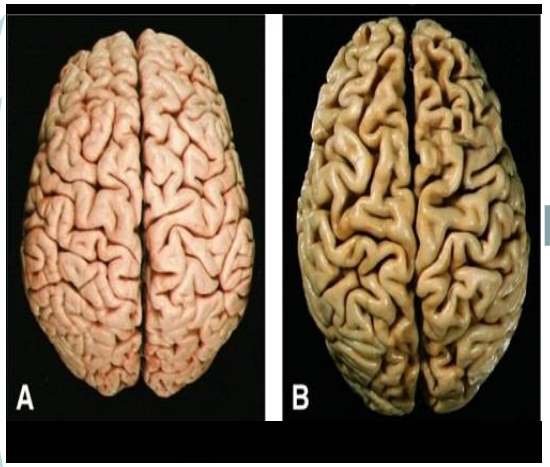


Peelle et al, 2013

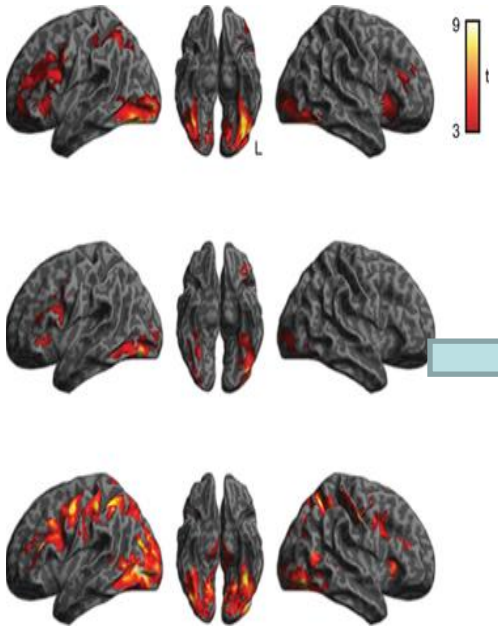


Altered sensory input with age

Cognition?



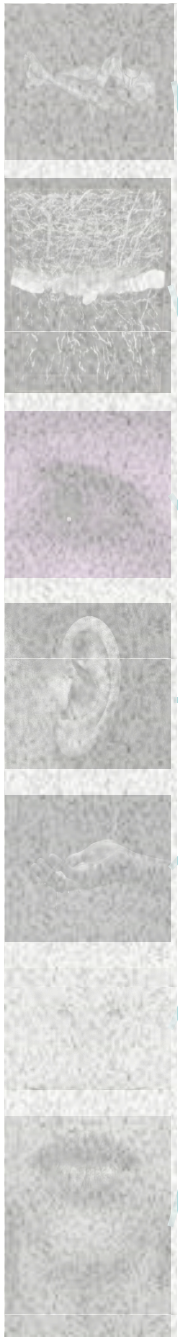
Loss of cortical volume

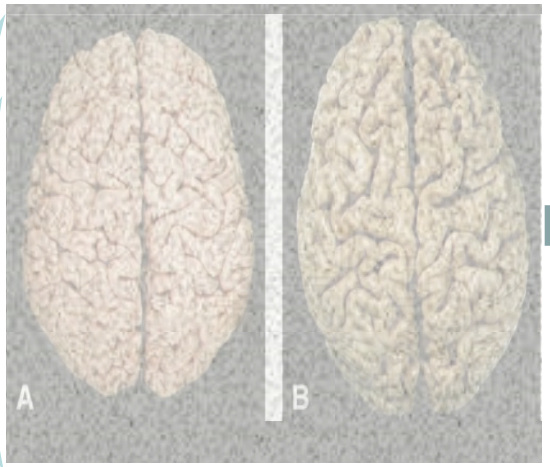


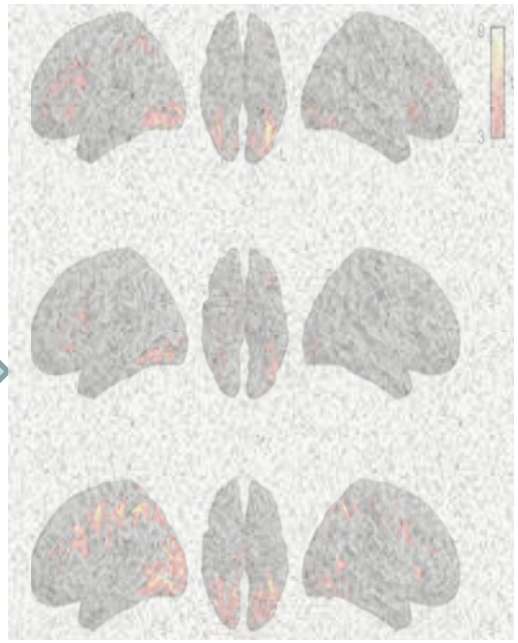
Alterations in processing strategy

More or less successful execution of behavioral tasks

Cognition?

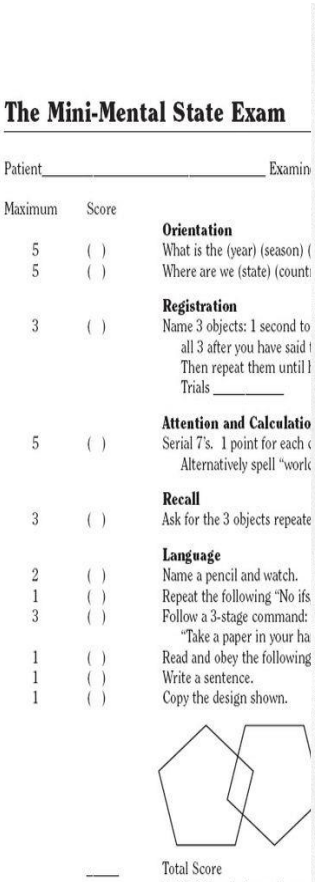






More or less successful execution of behavioral tasks

Measuring behavior



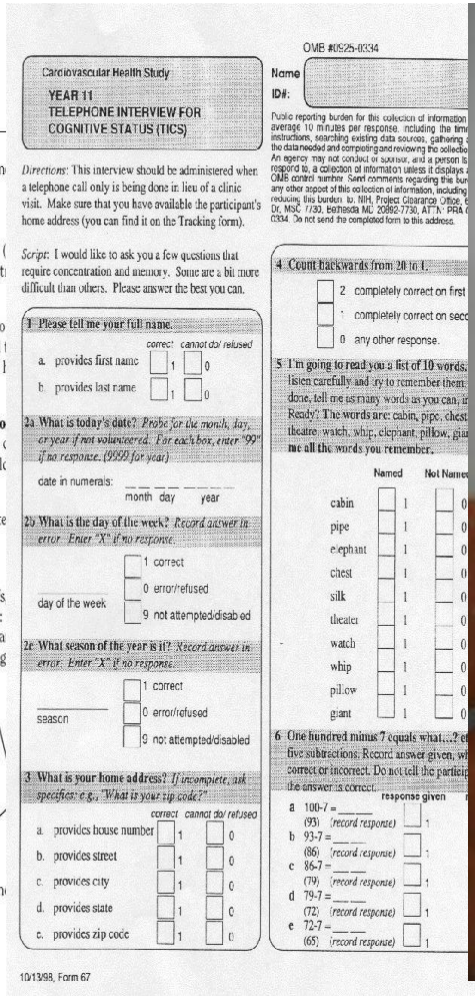
The Mini-Mental State Exam

Patient_____ Examin

Maximum	Score	
		Orientation
5	( )	What is the (year) (season) (
5	( )	Where are we (state) (count
		Registration
3	( )	Name 3 objects: 1 second to all 3 after you have said t Then repeat them until h Trials _____
		Attention and Calculatio
5	( )	Serial 7's. 1 point for each c Alternatively spell "worl
		Recall
3	( )	Ask for the 3 objects repeate
		Language
2	( )	Name a pencil and watch.
1	( )	Repeat the following "No ifs
3	( )	Follow a 3-stage command: "Take a paper in your ha
1	( )	Read and obey the following
1	( )	Write a sentence.
1	( )	Copy the design shown.

____ Total Score

ASSESS level of consciousn



Cardiovascular Health Study

YEAR 11

TELEPHONE INTERVIEW FOR COGNITIVE STATUS (TICS)

OMB #0925-0334

Name

ID#:

Directions: This interview should be administered when a telephone call only is being done in lieu of a clinic visit. Make sure that you have available the participant's home address (you can find it on the Tracking form).

Script: I would like to ask you a few questions that require concentration and memory. Some are a bit more difficult than others. Please answer the best you can.

1 Please tell me your full name.

correct cannot do/ refused

a. provides first name 1 0

b. provides last name 1 0

2a What is today's date? *Probe for the month, day, or year if not volunteered. For each box, enter "99" if no response. (9999 for year)*

date in numerals: ___ ___ ___ ___

month day year

2b What is the day of the week? *Record answer in error. Enter "X" if no response.*

1 correct

0 error/refused

day of the week

9 not attempted/disabled

2c What season of the year is it? *Record answer in error. Enter "X" if no response.*

1 correct

0 error/refused

season

9 not attempted/disabled

3 What is your home address? *If incomplete, ask specifics: e.g., "What is your zip code?"*

correct cannot do/ refused

a. provides house number 1 0

b. provides street 1 0

c. provides city 1 0

d. provides state 1 0

e. provides zip code 1 0

4 Count backwards from 20 to 1.

2 completely correct on first

1 completely correct on second

0 any other response.

5 I'm going to read you a list of 10 words. Listen carefully and try to remember them. When I'm done, tell me as many words as you can, in any order. Ready? The words are: cabin, pipe, elephant, chest, silk, theater, watch, whip, elephant, pillow, giant. Tell me all the words you remember.

	Named	Not Named
cabin	1	0
pipe	1	0
elephant	1	0
chest	1	0
silk	1	0
theater	1	0
watch	1	0
whip	1	0
pillow	1	0
giant	1	0

6 One hundred minus 7 equals what...? Continue for five subtractions. Record answer given, whether correct or incorrect. Do not tell the participant the answer is correct.

response given

a 100-7 = _____ (93) *(record response)* 1

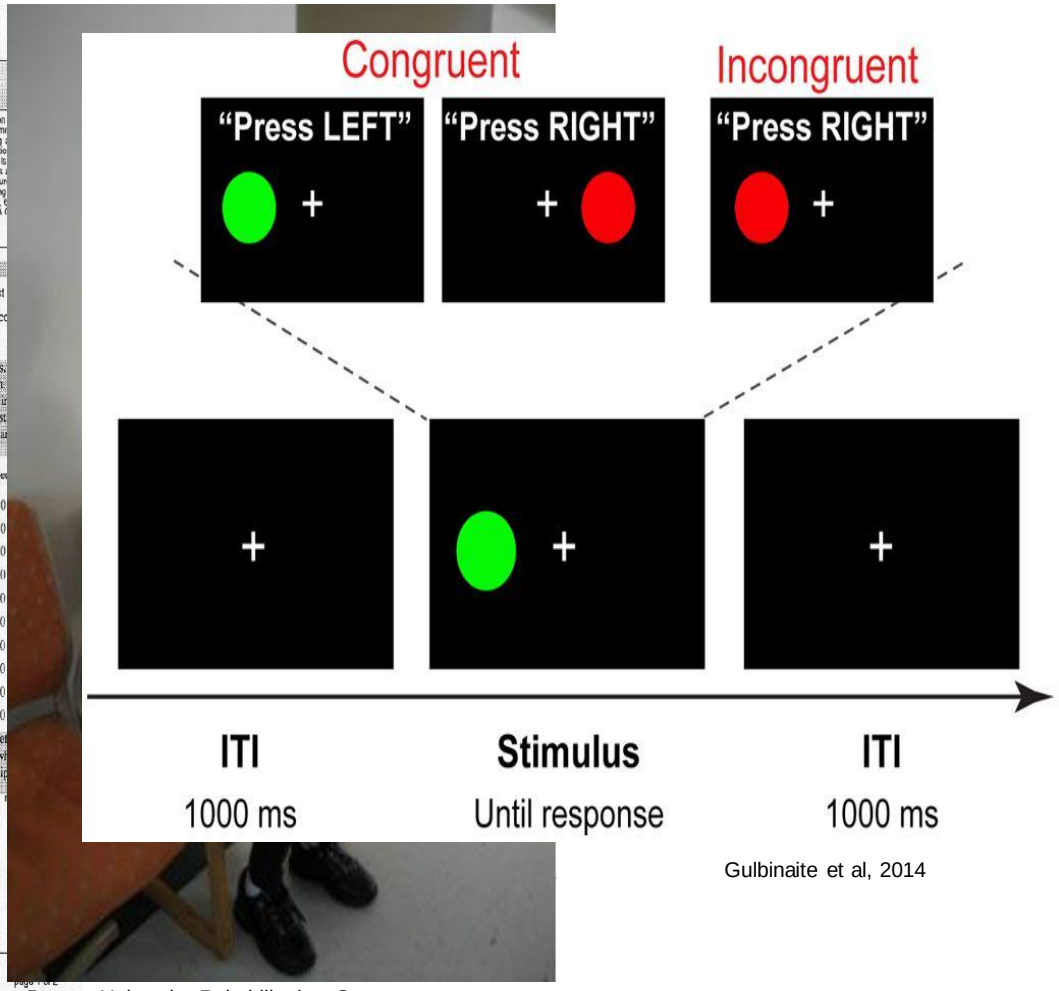
b 93-7 = _____ (86) *(record response)* 1

c 86-7 = _____ (79) *(record response)* 1

d 79-7 = _____ (72) *(record response)* 1

e 72-7 = _____ (65) *(record response)* 1

10/13/98, Form 67

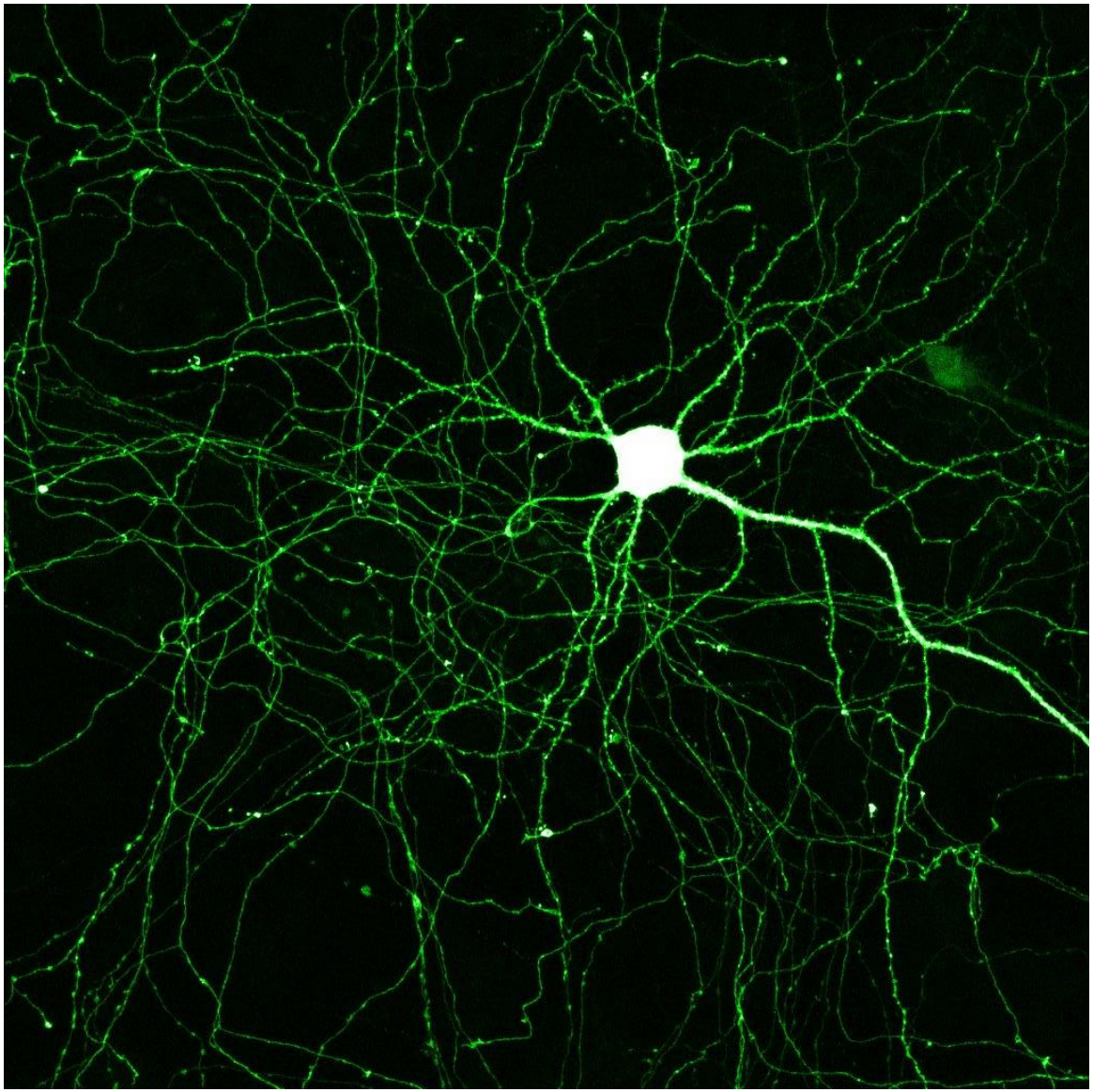


Gulbinaite et al, 2014

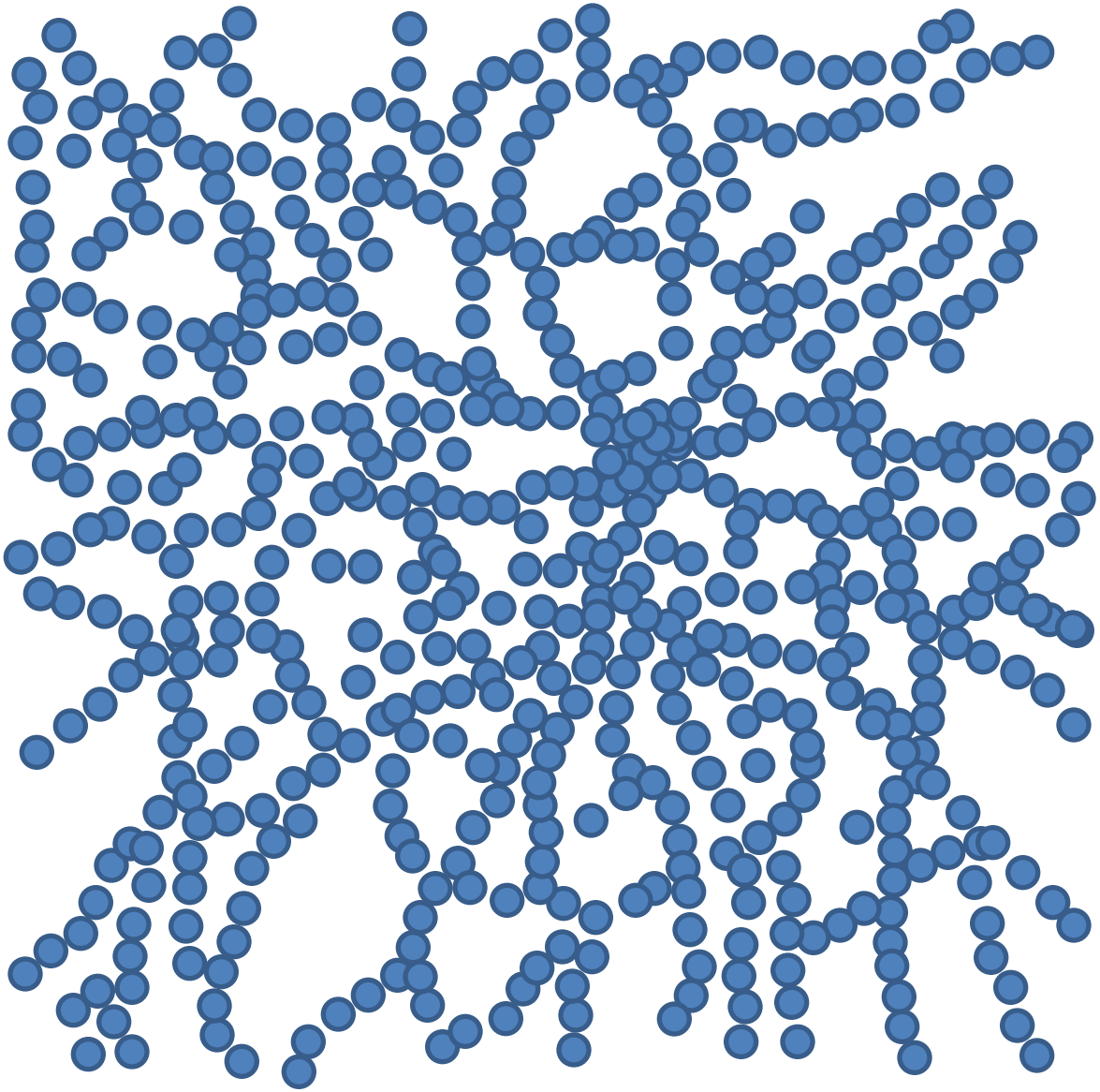
Boston University Rehabilitation Outcomes Center

Category confusion: staging decline vs. direct measures of function vs. cognitive functional reductionism

What's in a neuron?

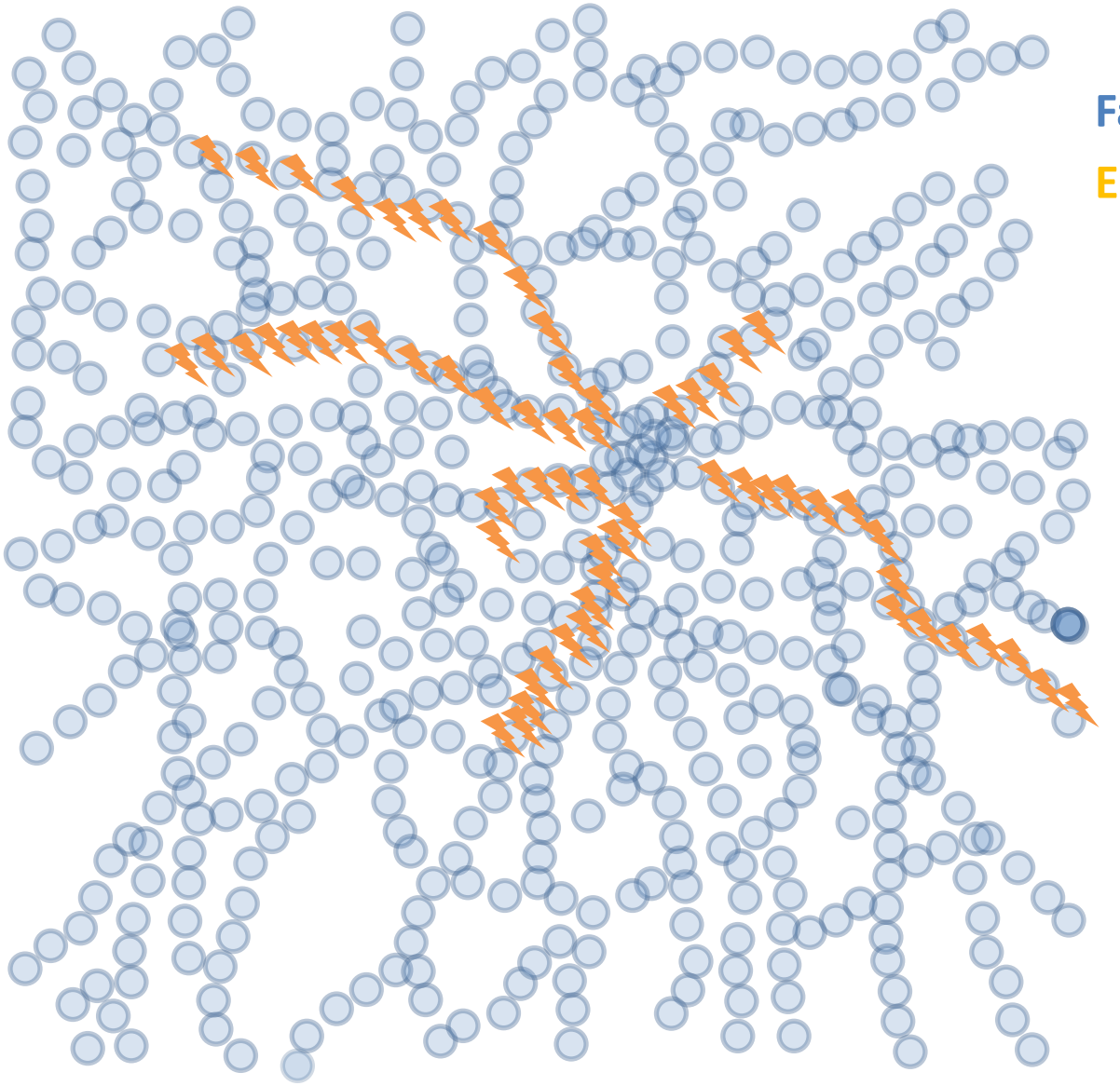


What's in a neuron?



Fatty acids (lipid bilayers)

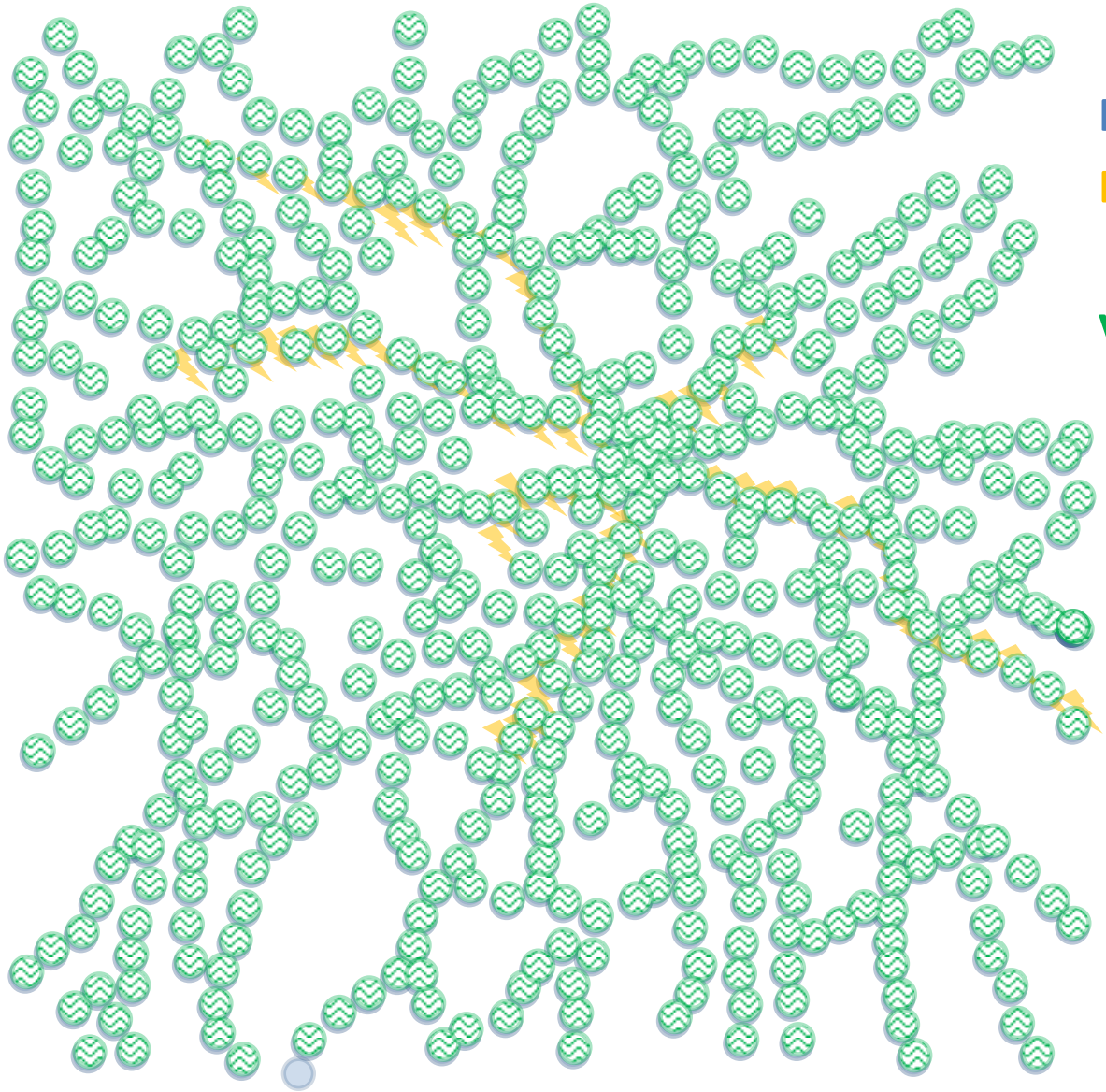
What's in a neuron?



Fatty acids (lipid bilayers)

Electrolytes (ion channels)

What's in a neuron?

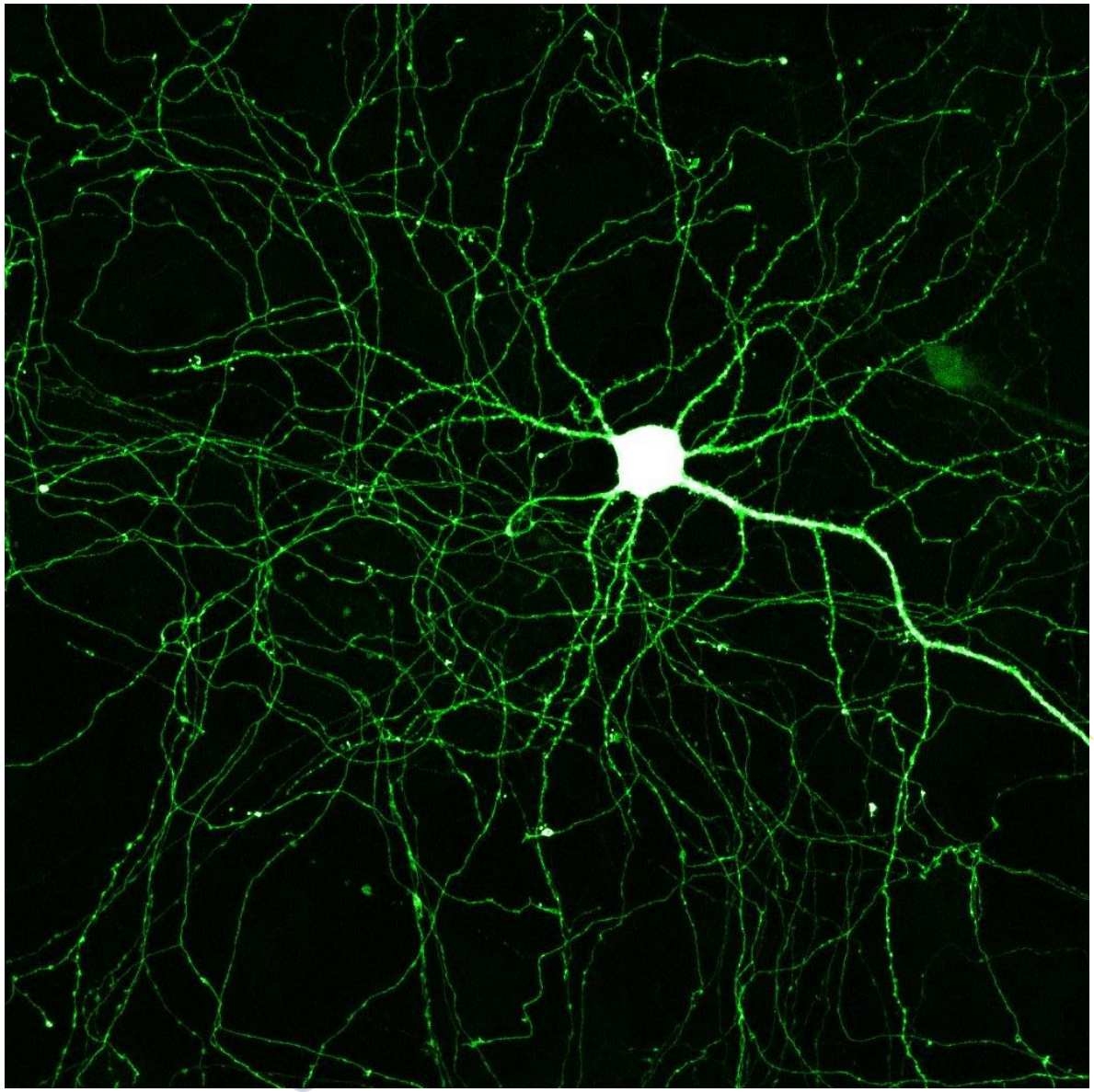


Fatty acids (lipid bilayers)

Electrolytes (ion channels)

Vitamins (fat and water soluble)

What's in a neuron?



Fatty acids (lipid bilayers)

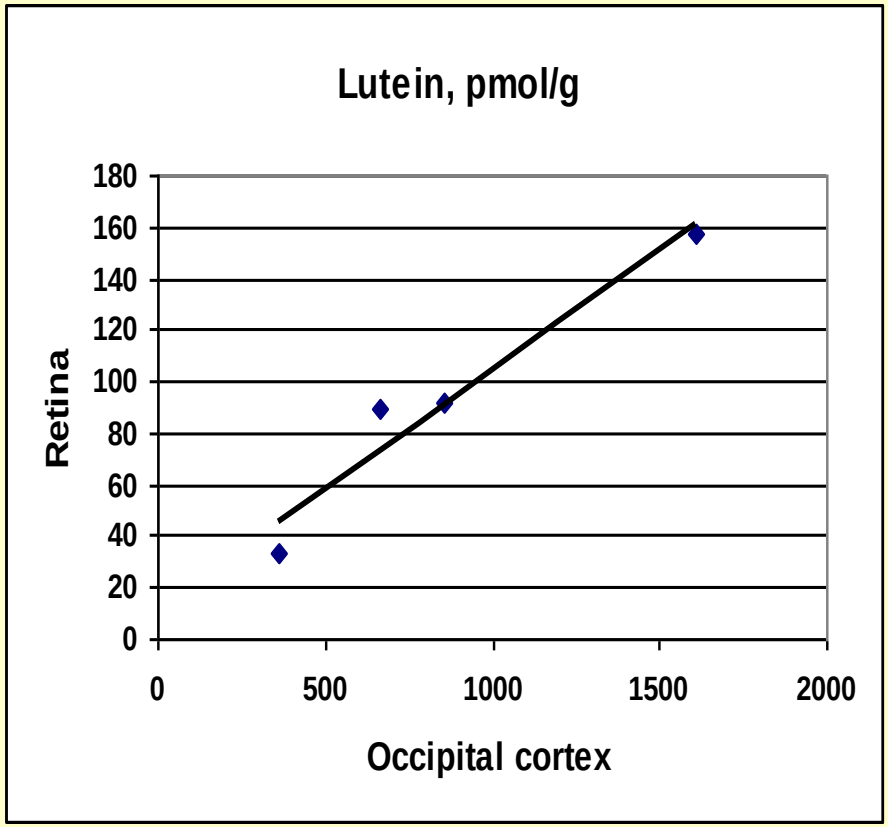
Electrolytes (ion channels)

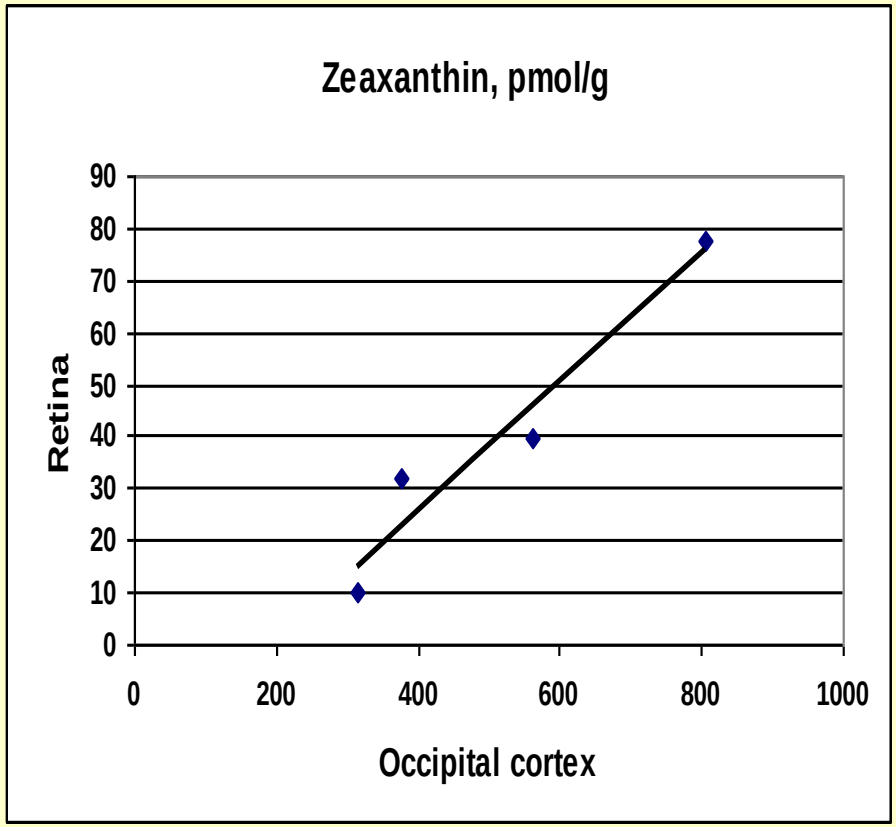
Vitamins (fat and water soluble, aqueous and lipid compartments)

Proteins and carbohydrates (cytoskeleton, receptors)

Carotenoids?

Retinal L and Z concentrations relate to cortical concentrations





Vishwanathan et al, 2013

Processing speed underlies cognition

35,197 students

27,547 undergraduates

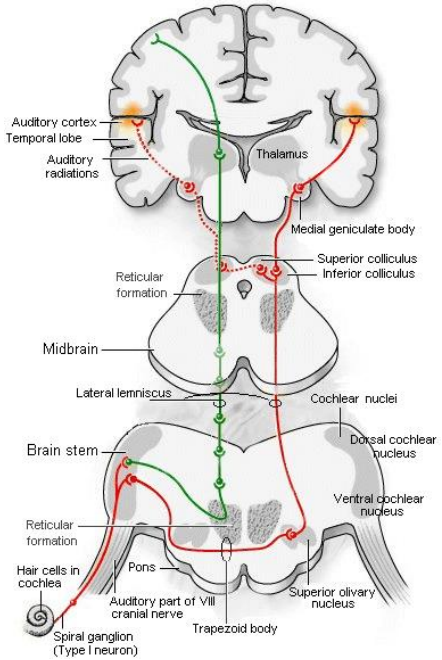
1,752 graduating

How many rows of 50 would be needed to accommodate all 1,752 undergraduates?

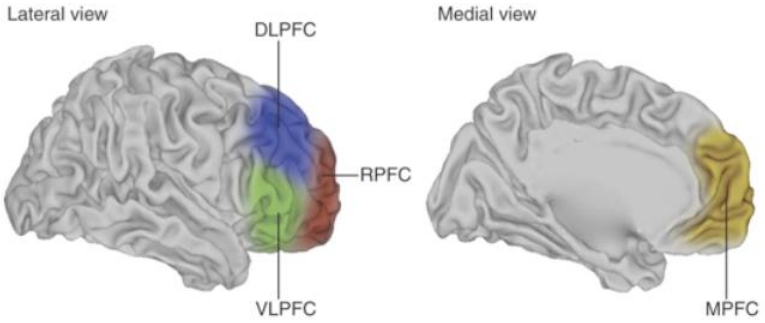
~35

And what if I read that out loud?

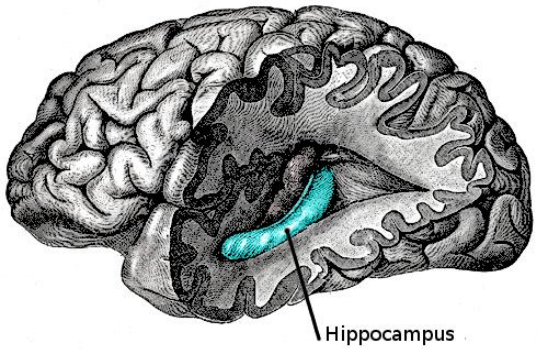
1. Hearing



2. Sensory processing



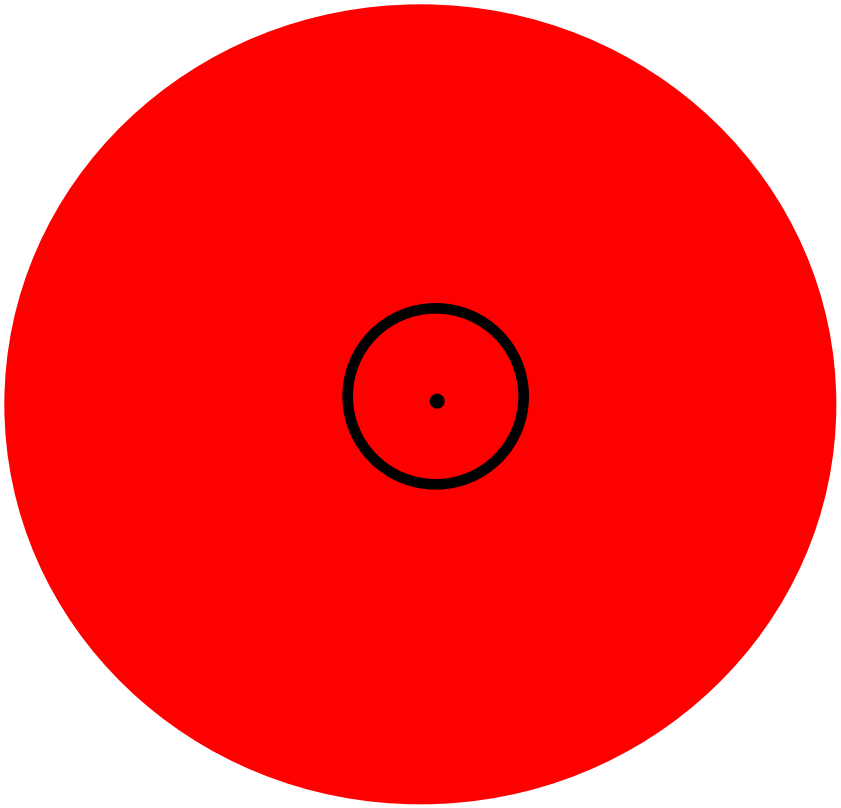
3. Working memory



4. Conversion to long-term storage

5. Permanence

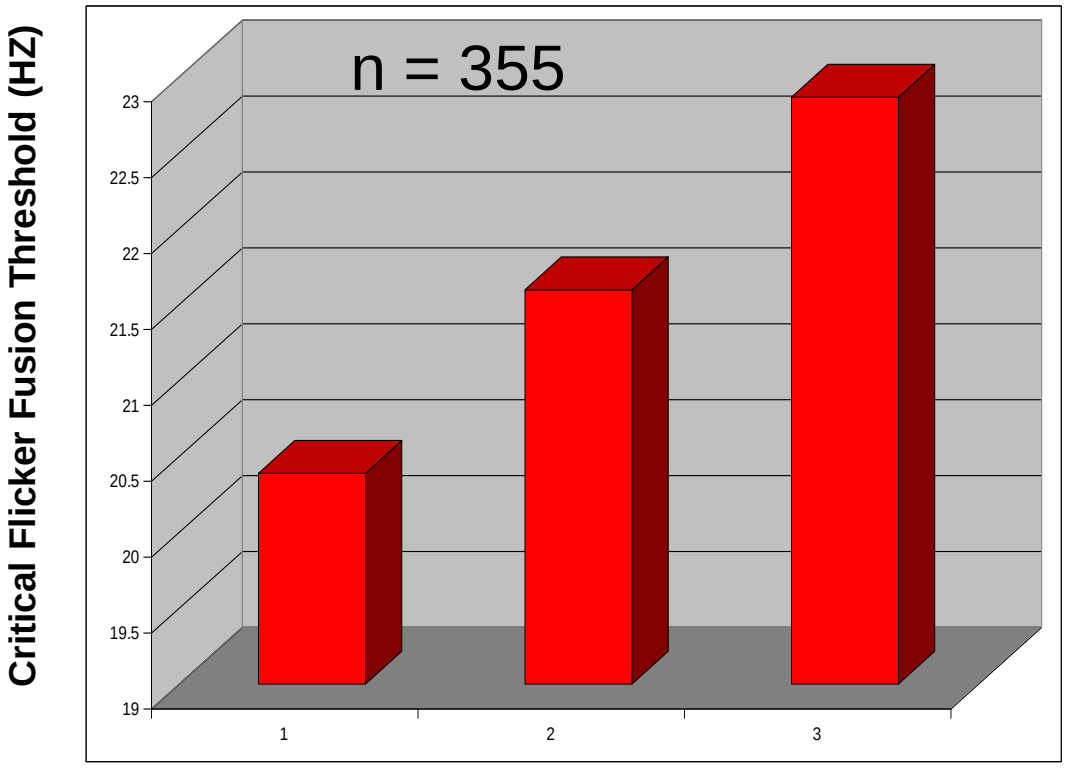
Measuring processing speed



Critical Flicker Fusion Frequency (CFF)

Processing speed is the pace at which a person takes in information from the world.

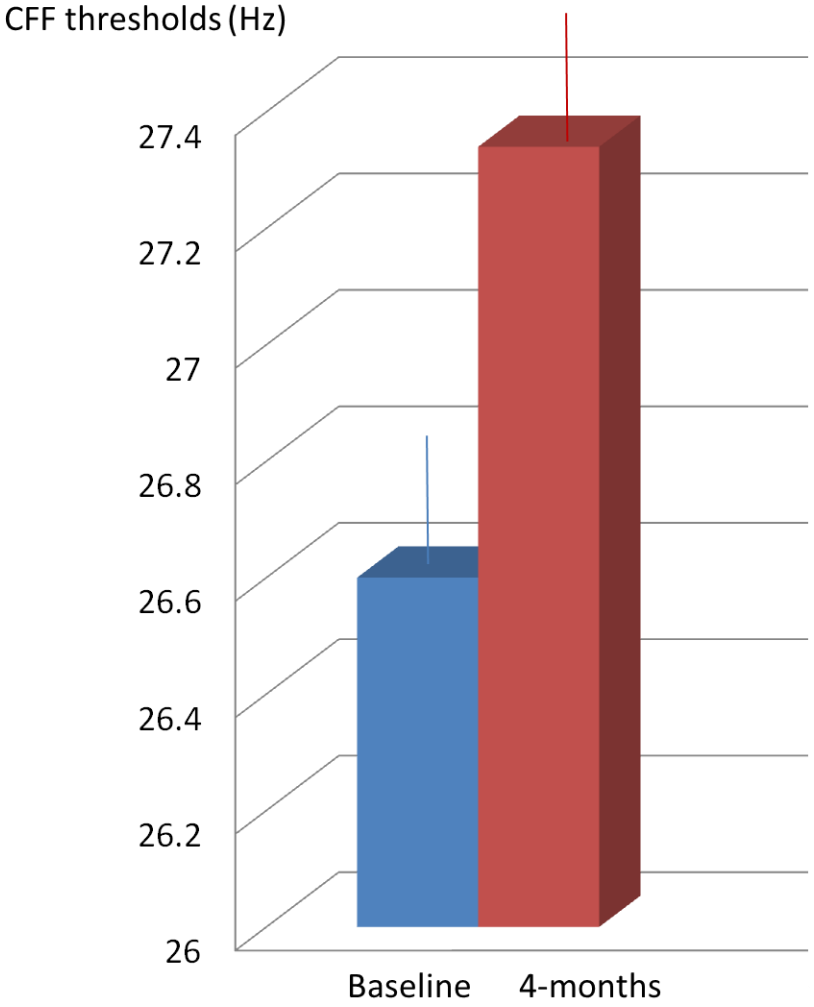
Lutein levels relate to processing speed



Hammond & Wooten, 2005

Renzi & Hammond, 2010

Supplementation with lutein and zeaxanthin improves CFF



When young people supplement lutein and zeaxanthin, CFF improves significantly.

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PLOS ONE

A Double-Blind, Placebo-Controlled Study on the Effects of Lutein and Zeaxanthin on Neural Processing Speed and Efficiency

Emily R. Bovier[1], Lisa M. Renzi[1,2], Billy R. Hammond[1]*

1 Vision Sciences and Human Biofactors Laboratories, Department of Psychology, The University of Georgia, Athens, Georgia, United States of America, 2 Abbott Nutrition, Columbus, Ohio, United States of America

Abstract

Lutein and zeaxanthin are major carotenoids in the eye but are also found in post-receptoral visual pathways. It has been hypothesized that these pigments influence the processing of visual signals within and post-retina, and that increasing lutein and zeaxanthin levels within the visual system will lead to increased visual processing speeds. To test this, we measured macular pigment density (as a biomarker of lutein and zeaxanthin levels in brain), critical flicker fusion (CFF) thresholds, and visual motor reaction time in young healthy subjects (n = 92). Changes in these outcome variables were also assessed after four months of supplementation with either placebo (n = 10), zeaxanthin only (20 mg/day; n = 29) or a mixed formulation containing 26 mg/day zeaxanthin, 8 mg/day lutein, and 190 mg/day mixed omega-3 fatty acids (n = 25). Significant correlations were found between retinal lutein and zeaxanthin (macular pigment) and CFF thresholds ($p<0.01$) and visual motor performance (overall $p<0.01$). Supplementation with zeaxanthin and the mixed formulation (considered together) produced significant ($p<0.01$) increases in CFF thresholds (~12%) and visual motor reaction time (~10%) compared to placebo. In general, increasing macular pigment density through supplementation (average increase of about 0.09 log units) resulted in significant improvements in visual processing speed, even when testing young, healthy individuals who tend to be at peak efficiency.

Citation: Bovier ER, Renzi LM, Hammond BR (2014) A Double-Blind, Placebo-Controlled Study on the Effects of Lutein and Zeaxanthin on Neural Processing Speed and Efficiency. PLoS ONE 9(9): e108178. doi:10.1371/journal.pone.0108178

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Data Availability: The authors confirm that all data underlying the findings are fully available without restriction. All data underlying the findings in the study are freely available in the manuscript (averages and standard deviations are listed in the tables). Individual raw data points for each participant are available upon request by contacting the corresponding author.

Funding: This study was funded by ZeaVision, LLC. http://www.zeavision.com/. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have read the journal's policy and the authors of this manuscript have the following competing interests: ERB, none; BRH has received speaker fees from ZeaVision, LLC, and LMR is currently an employee of Abbott Nutrition. Abbott Nutrition did not contribute to this study in any way. At the time the work was completed, LMR was solely an employee of the University of Georgia. Information listed in the "Competing Interests" section of this submission does not alter the authors' adherence to all PLOS ONE policies on sharing data and materials.

* Email: bhammond@uga.edu

Supplementation also improves reaction times

OPEN ACCESS Freely available online

PLOS ONE

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Emily R. Bovier[1], Lisa M. Renzi[1,2], Billy R. Hammond[1]*

1 Vision Sciences and Human Biofactors Laboratories, Department of Psychology, The University of Georgia, Athens, Georgia, United States of America, **2** Abbott Nutrition, Columbus, Ohio, United States of America

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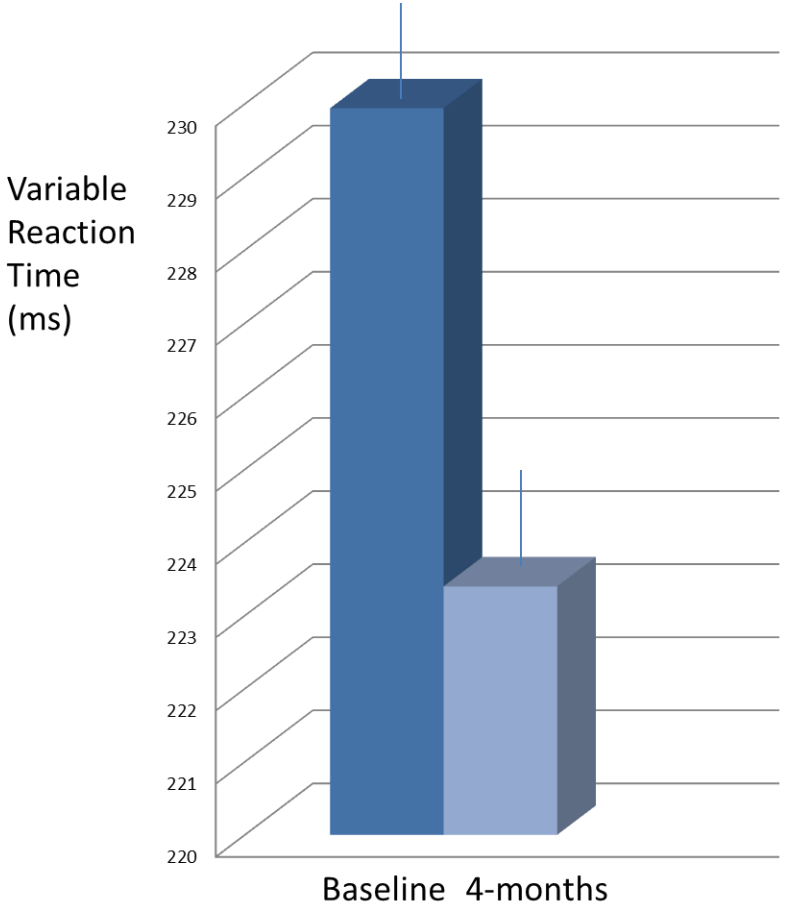
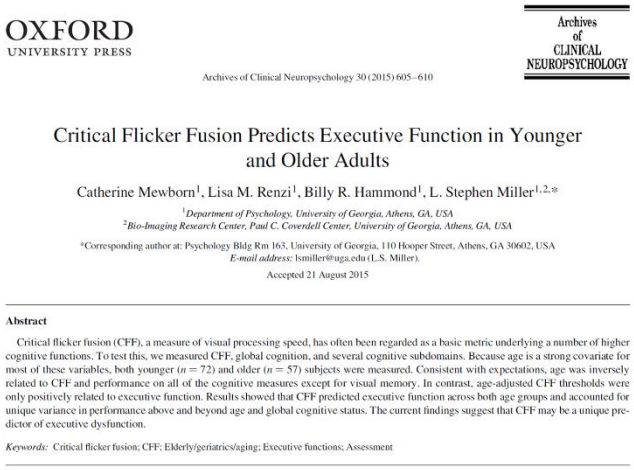
* Email: bhammond@uga.edu

As CFF improves, reaction times also improve.



CFF is the “gateway” to higher cognition



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Archives of Clinical Neuropsychology 30 (2015) 605–610

Archives of CLINICAL NEUROPSYCHOLOGY

Critical Flicker Fusion Predicts Executive Function in Younger and Older Adults

Catherine Mewborn[1], Lisa M. Renzi[1], Billy R. Hammond[1], L. Stephen Miller[1,2,*]

[1]*Department of Psychology, University of Georgia, Athens, GA, USA*
[2]*Bio-Imaging Research Center, Paul C. Coverdell Center, University of Georgia, Athens, GA, USA*

*Corresponding author at: Psychology Bldg Rm 163, University of Georgia, 110 Hooper Street, Athens, GA 30602, USA
E-mail address: lsmiller@uga.edu (L.S. Miller).

Accepted 21 August 2015

Abstract

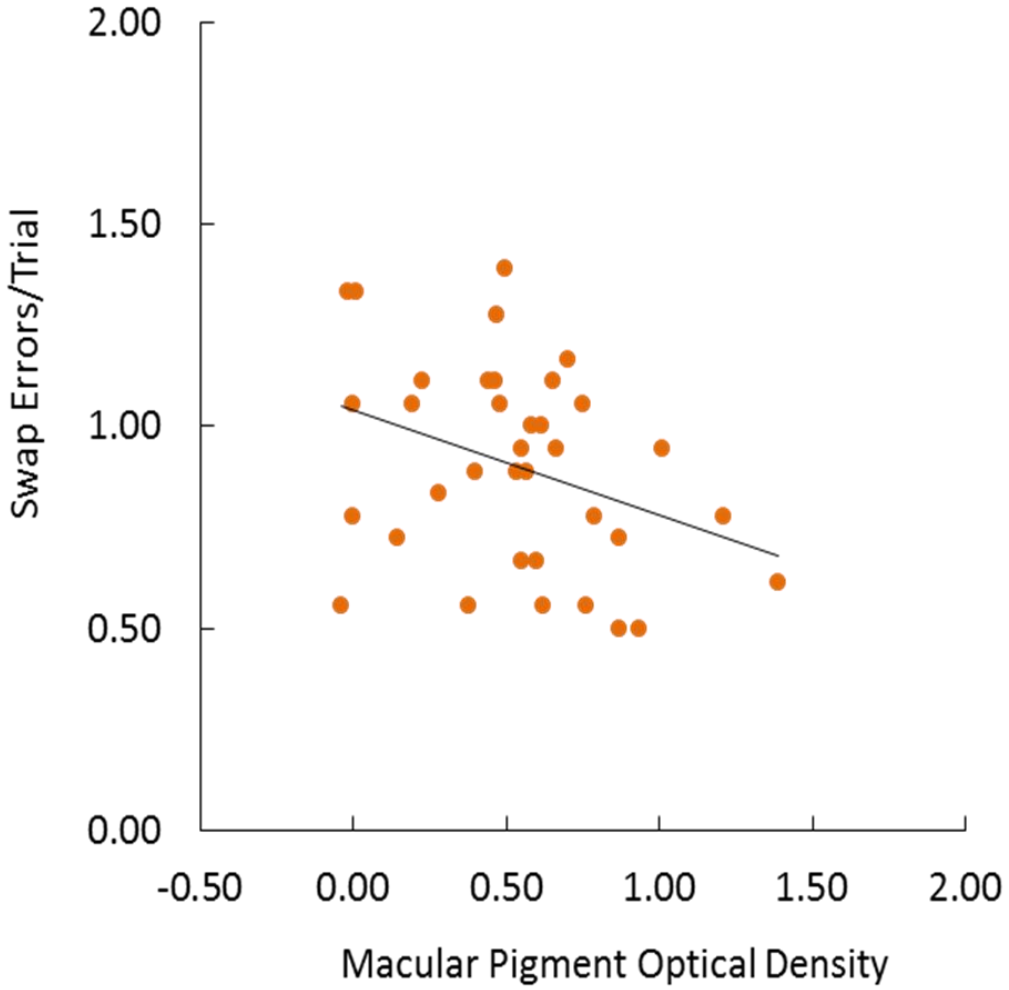
Critical flicker fusion (CFF), a measure of visual processing speed, has often been regarded as a basic metric underlying a number of higher cognitive functions. To test this, we measured CFF, global cognition, and several cognitive subdomains. Because age is a strong covariate for most of these variables, both younger ($n = 72$) and older ($n = 57$) subjects were measured. Consistent with expectations, age was inversely related to CFF and performance on all of the cognitive measures except for visual memory. In contrast, age-adjusted CFF thresholds were only positively related to executive function. Results showed that CFF predicted executive function across both age groups and accounted for unique variance in performance above and beyond age and global cognitive status. The current findings suggest that CFF may be a unique predictor of executive dysfunction.

Keywords: Critical flicker fusion; CFF; Elderly/geriatrics/aging; Executive functions; Assessment

CFF is one of the best predictors of cognitive function young, healthy people and older adults. People who can process information quickly tend also to be better at other cognitively challenging tasks.

Measure	Relationship to CFF (r)
Global cognition	0.377
Processing speed	0.344
Reasoning	0.386
Executive functioning	0.465

Early life influences on cognition



Hassevoort et al, 2017,
Journal of Pediatrics

N = 40
p = 0.007

Early life influences on cognition

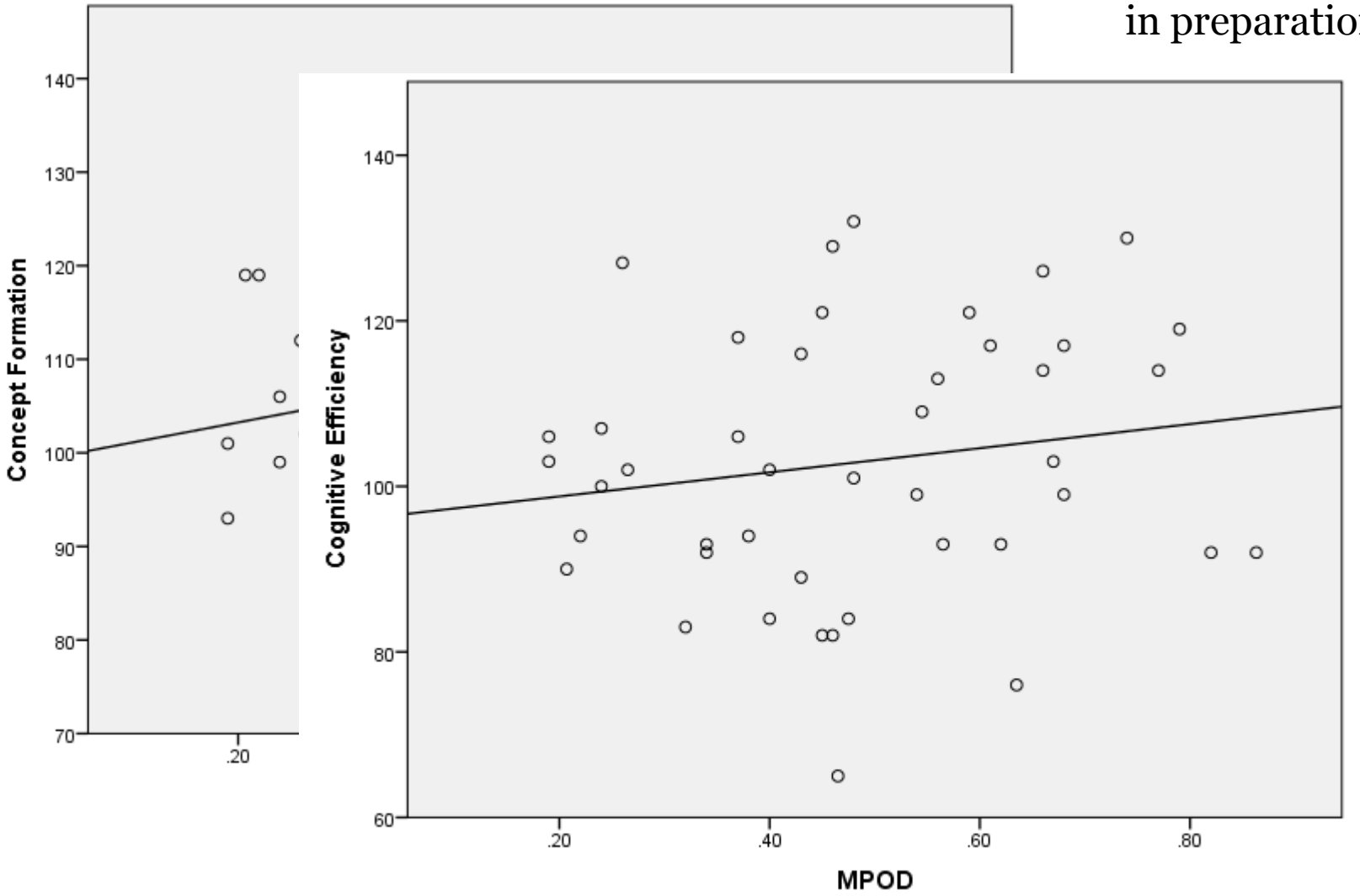
	Children, aged 7-12 years	
	Relation to Macular Pigment (r)	Statistical Significance (p≤)
Achievement	0.40	0.01*
Reading	0.28	0.05*
Math	0.35	0.01*
Written Language	0.41	0.01*
Reading fluency	0.22	0.09†

Kaufman Test of Academic and Educational Achievement II

Barnett et al, *in press*, *Nutritional Neuroscience*

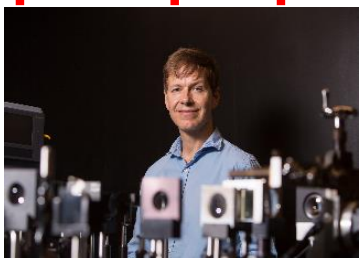
Does it work?

Saint, Renzi-Hammond, Hammond et al, in preparation



Measuring cognition at multiple levels of analysis, in multiple populations

- Randomized, double masked placebo-controlled trial
- N = 102 completers
  - n = 51 young, healthy adults
  - n = 51 community dwelling elders
- 12 mg L+Z vs. placebo






optisharp Zeaxanthin Simply more for your eyes

FloraGLO LUTEIN

UNH WILDCATS

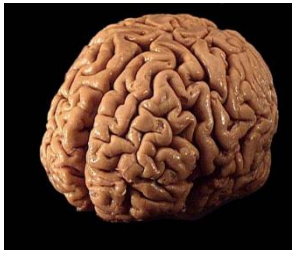
DSM MacularMetrics Abbott Nutrition

Measuring “cognition” at multiple levels of analysis, in multiple populations

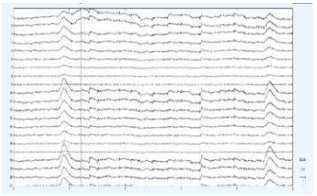
Level 1: anthropo-, metrics, diet, serum, MPOD

Level 2: sensory input level

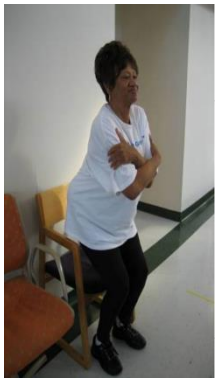
Level 3: structural integrity of the nervous system



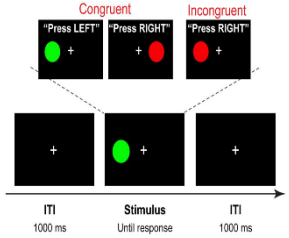
Level 4: processing strategy, passive and active processing

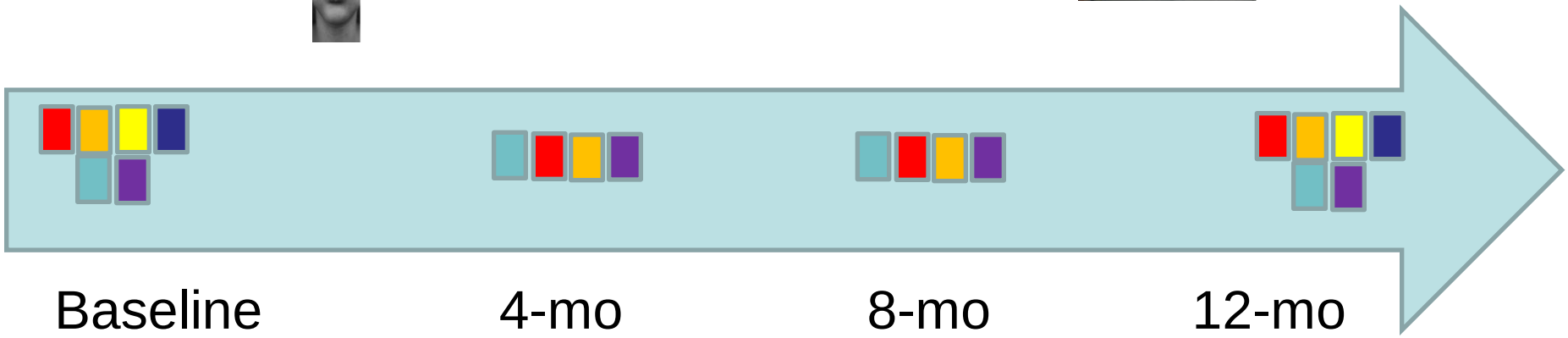


Level 5: functional behavioral tasks

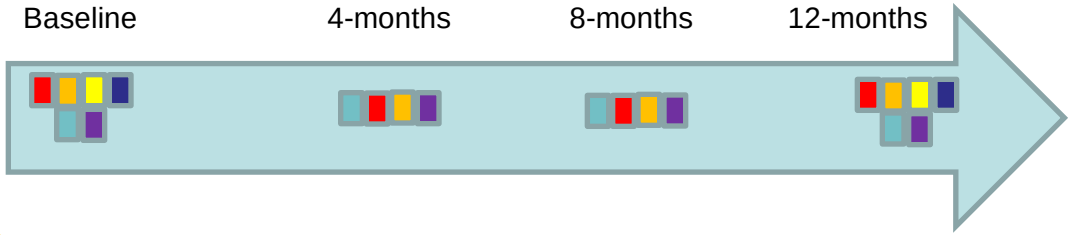


Level 6: functionally reductionist and diagnostic tasks





Baseline 4-mo 8-mo 12-mo



Level 1

Basic anthropometrics

Health screen

MPOD

Presence of / degree of cognitive impairment (clinical interview)

Family Hx

Serum carotenoids

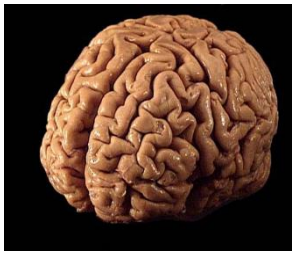
Level 2

Visual acuity

Temporal contrast sensitivity

Critical Flicker Fusion Frequency (CFF)

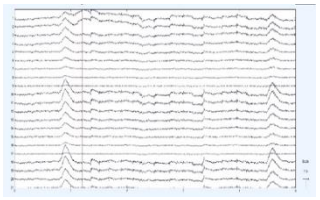
Level 3



Structural magnetic resonance imaging (MRI)

Voxel based morphometry

Level 4



Resting state electro-encephalography (EEG)

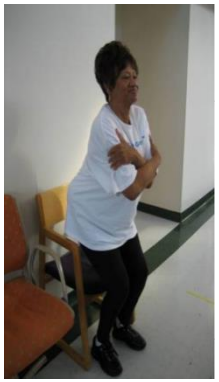
EEG in visual attention / target detection task

EEG in simple flicker paradigm

Functional MRI (fMRI) in operation span and memory tasks

Diffusion tensor imaging (DTI)

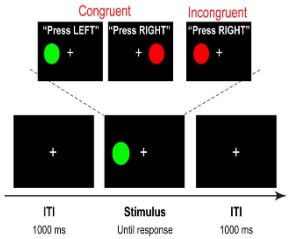
Level 5



Short physical performance battery (SPPB)

Reaction time and coincidence anticipation testing

Level 6



Attention

Visual Memory

Verbal Memory

Processing Speed

Psychomotor Speed

Reasoning

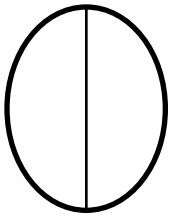
Executive Function

Mood

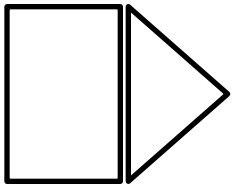
Social Function

Testing cognitive function

Visual Memory



Remember this image



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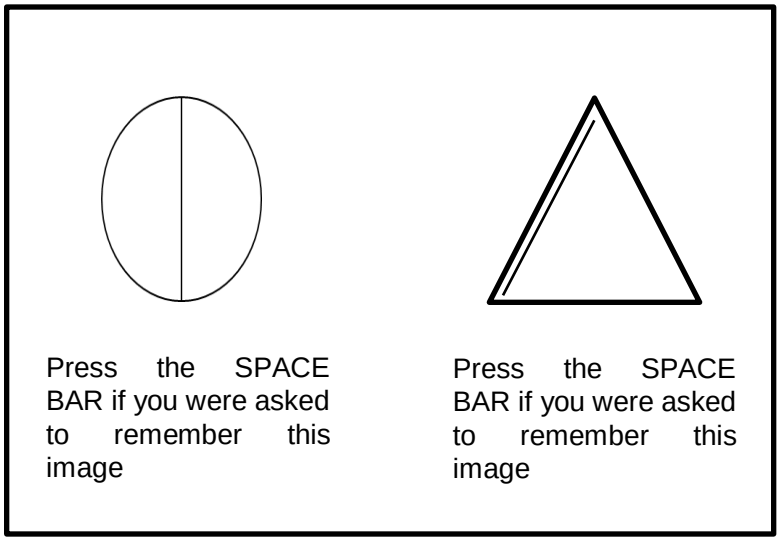
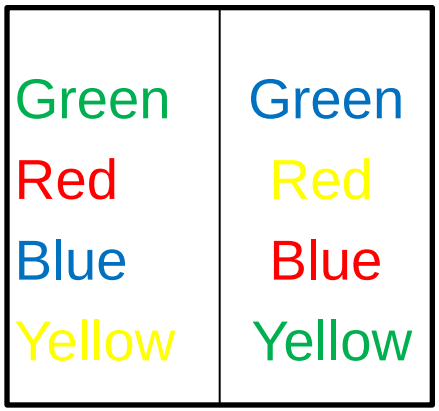
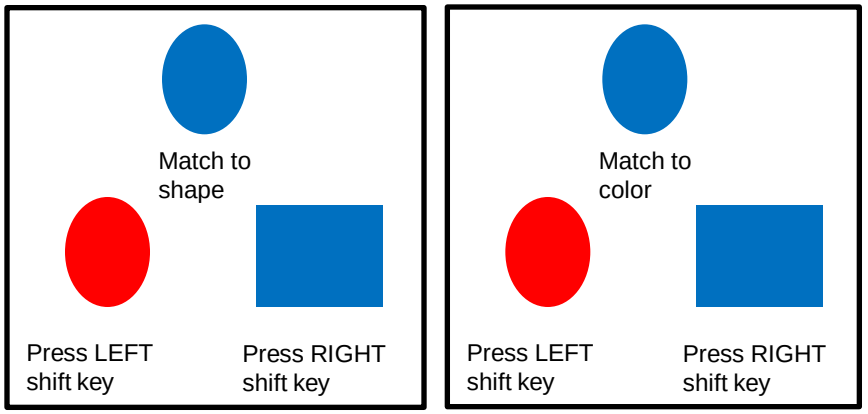


Testing cognitive function

Complex Attention



Stroop Task

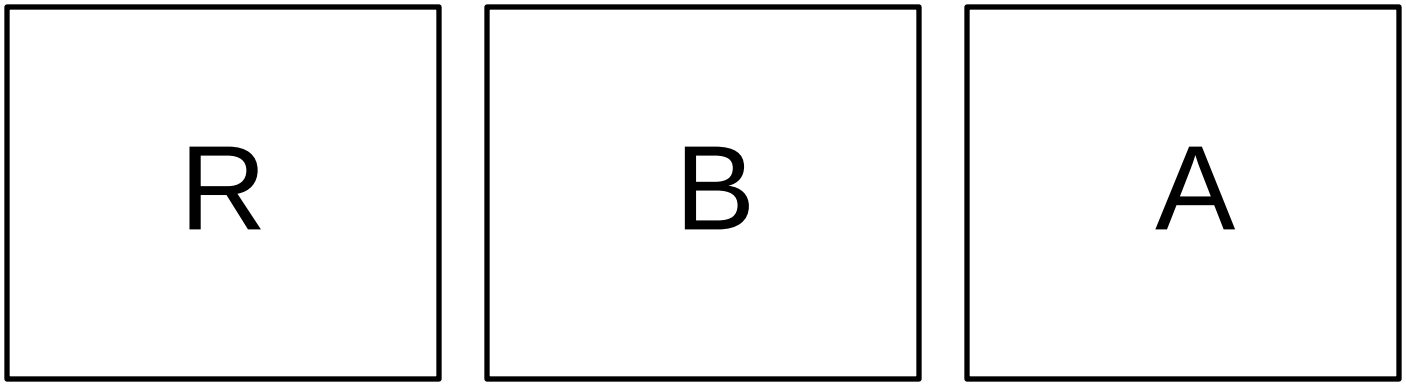


Shifting Attention Task

Testing cognitive function

Complex Attention

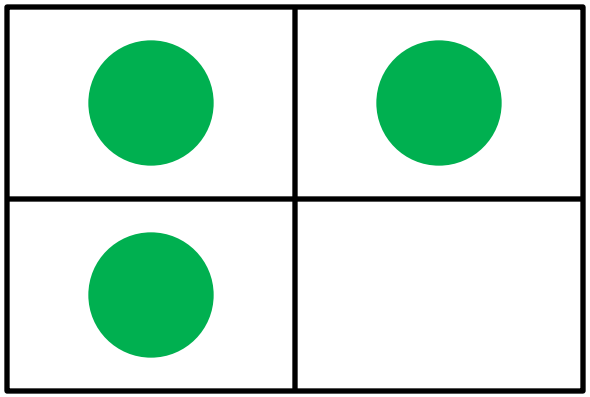
Press the SPACE bar when you see the letter “B.”

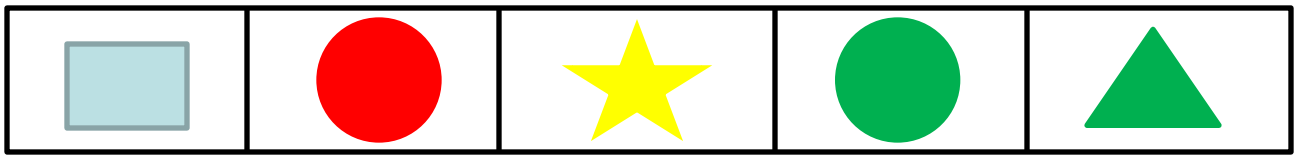


Continuous Performance Task

Testing cognitive function

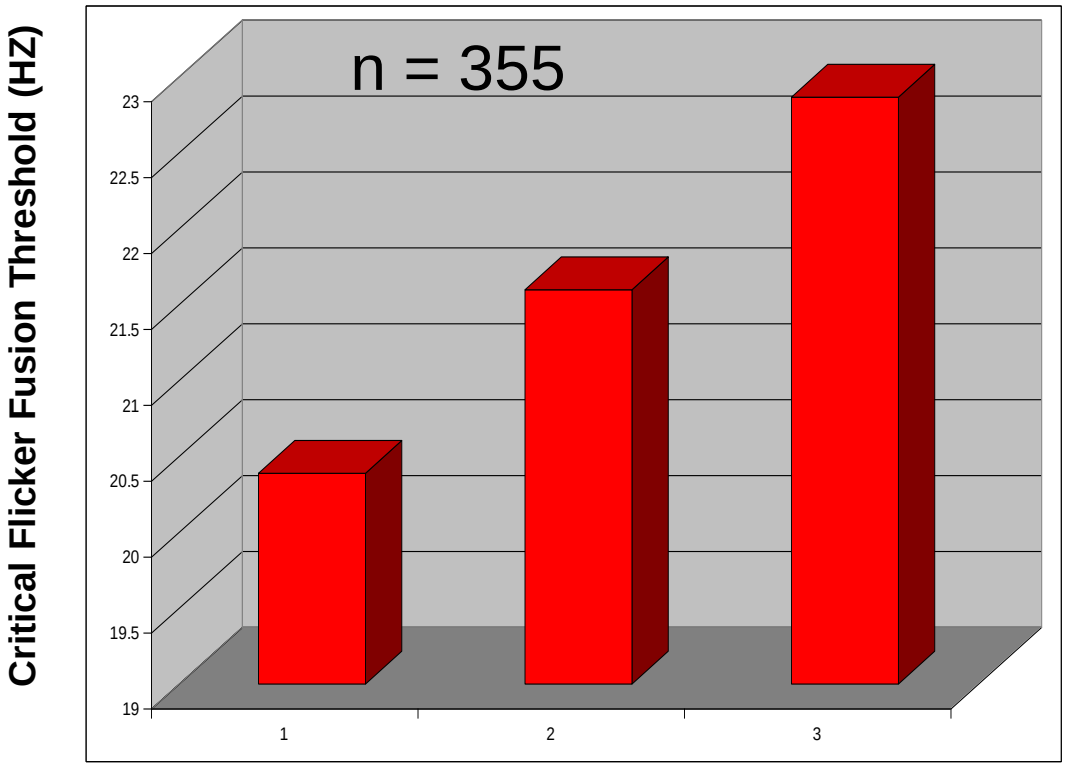
Reasoning ability: choose the option that best completes the pattern.





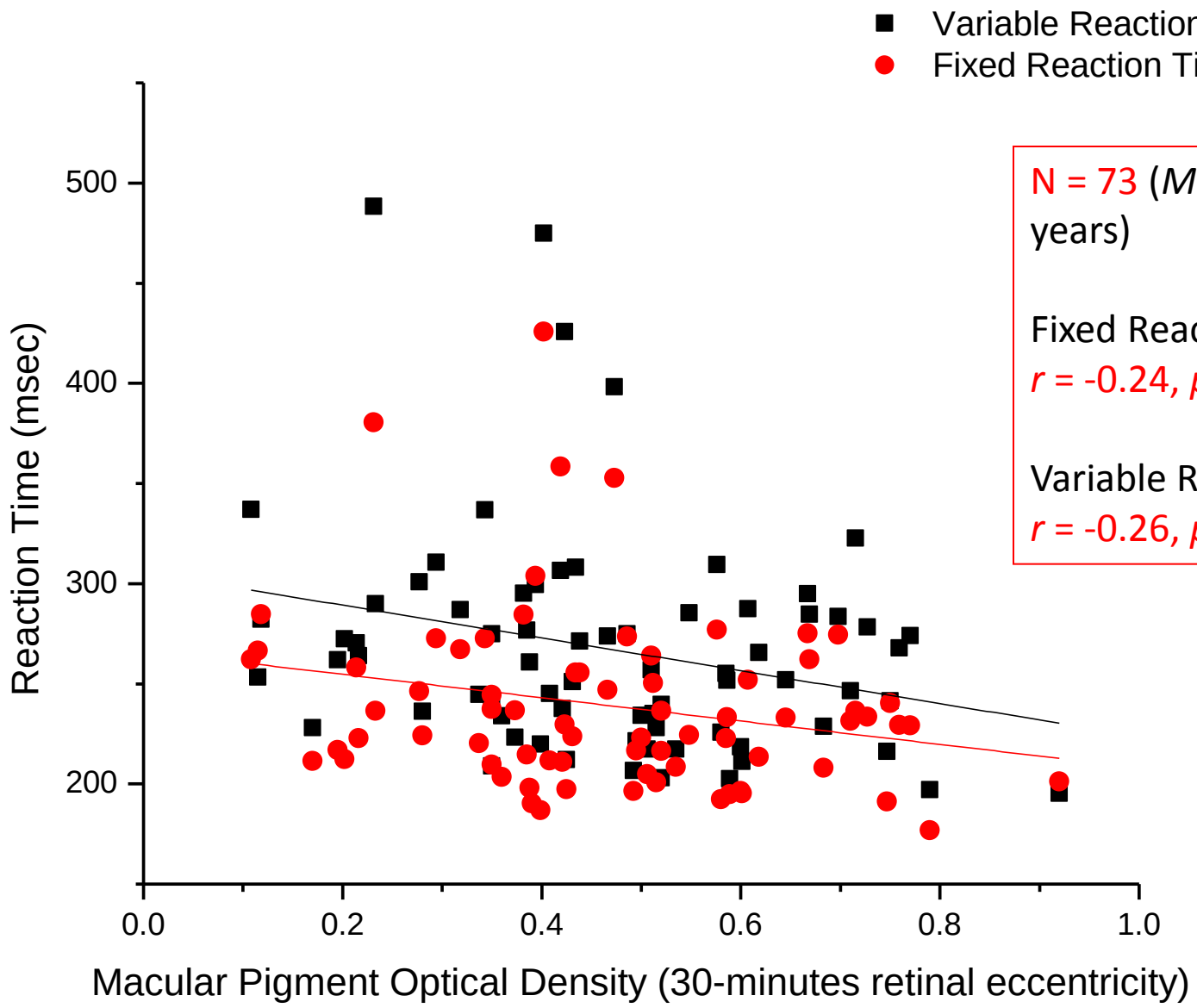
1 . 2 . 3 . **4 .** 5 .

Lutein levels relate to processing speed



Hammond & Wooten, 2005

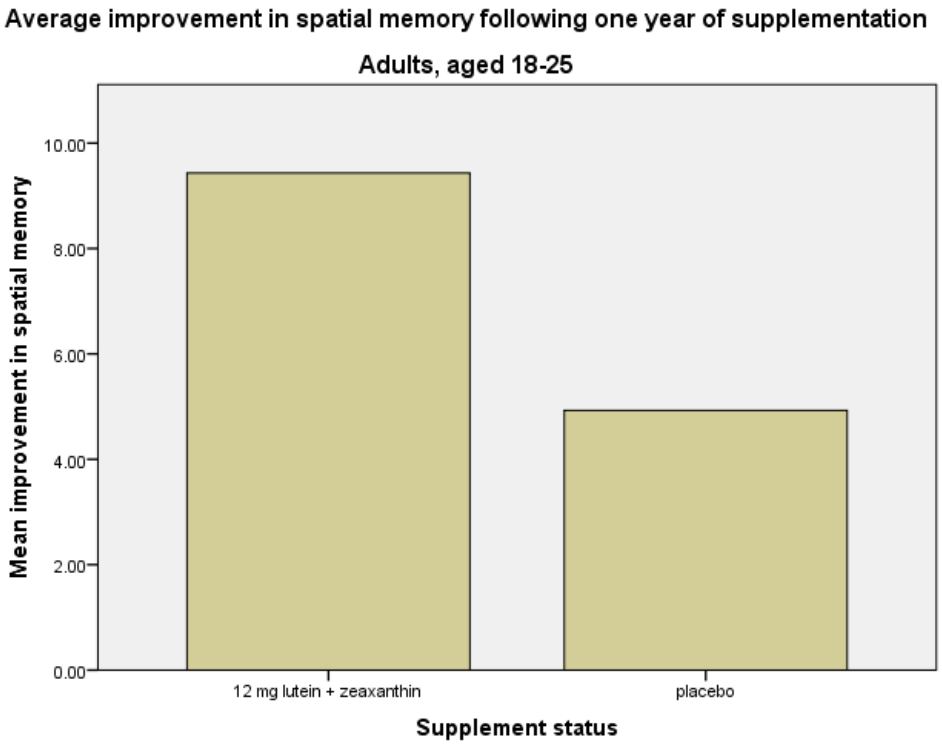
Renzi & Hammond, 2010



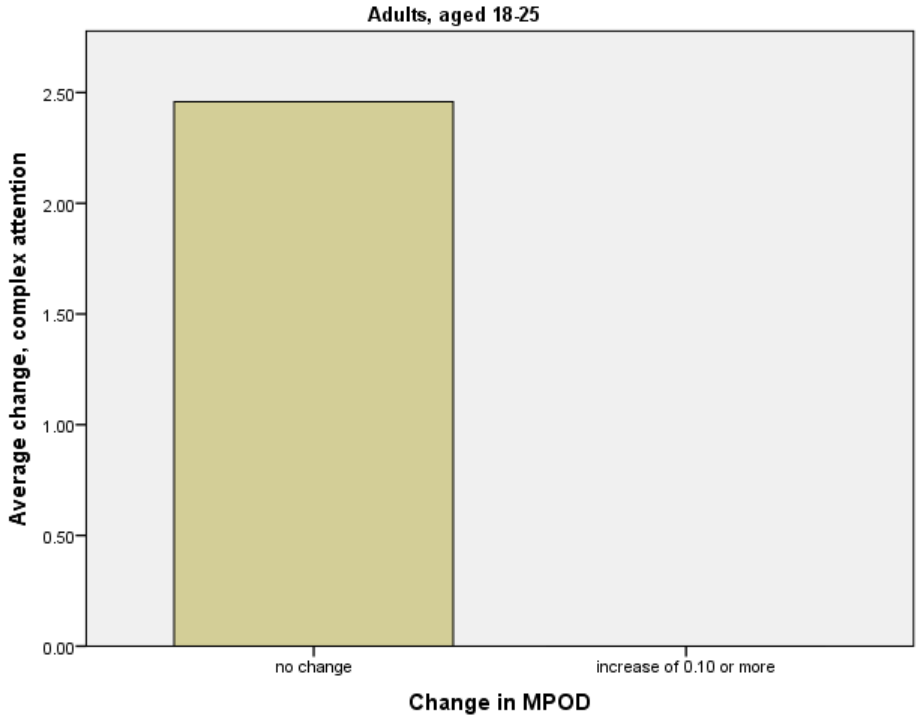
Renzi et al, 2013

Lutein levels relate to reaction time

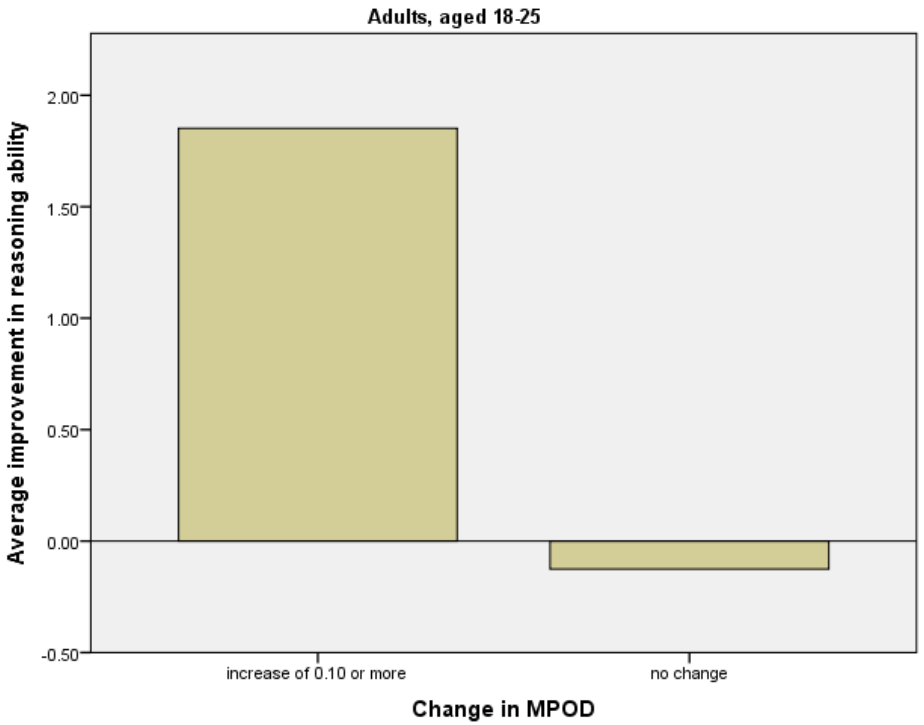
Younger adults, by supplement



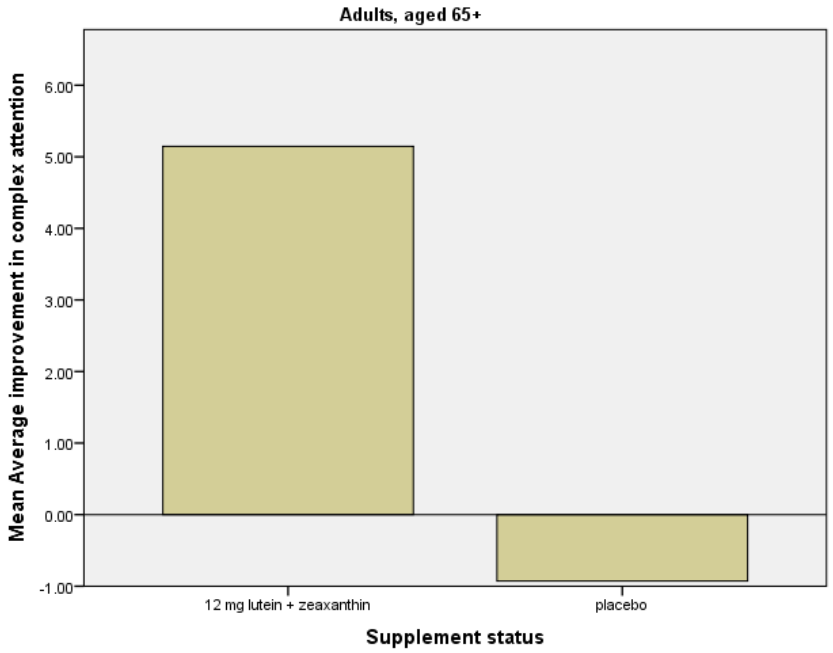
Younger adults, by improvement



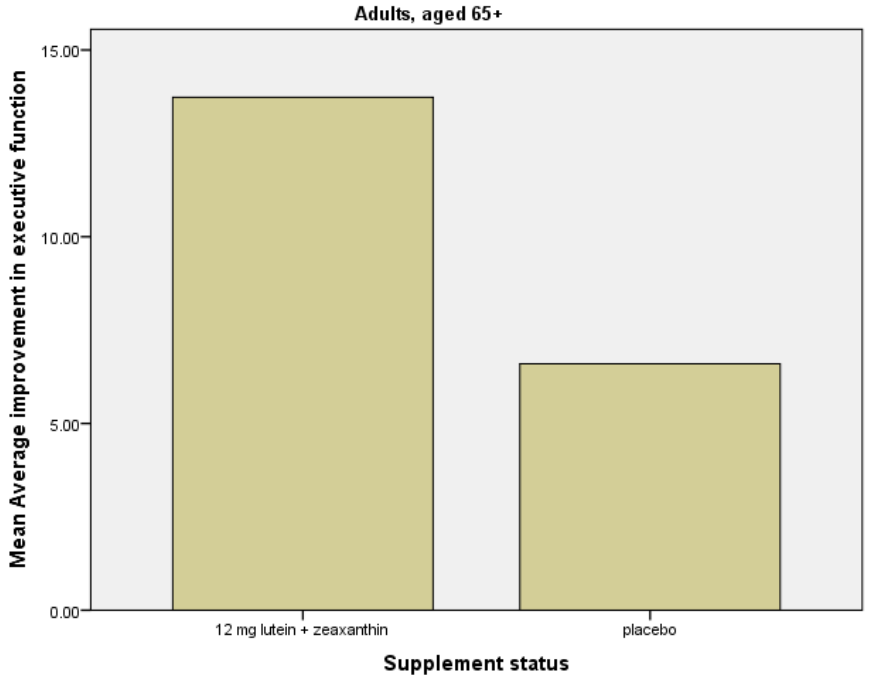
Younger adults, by improvement



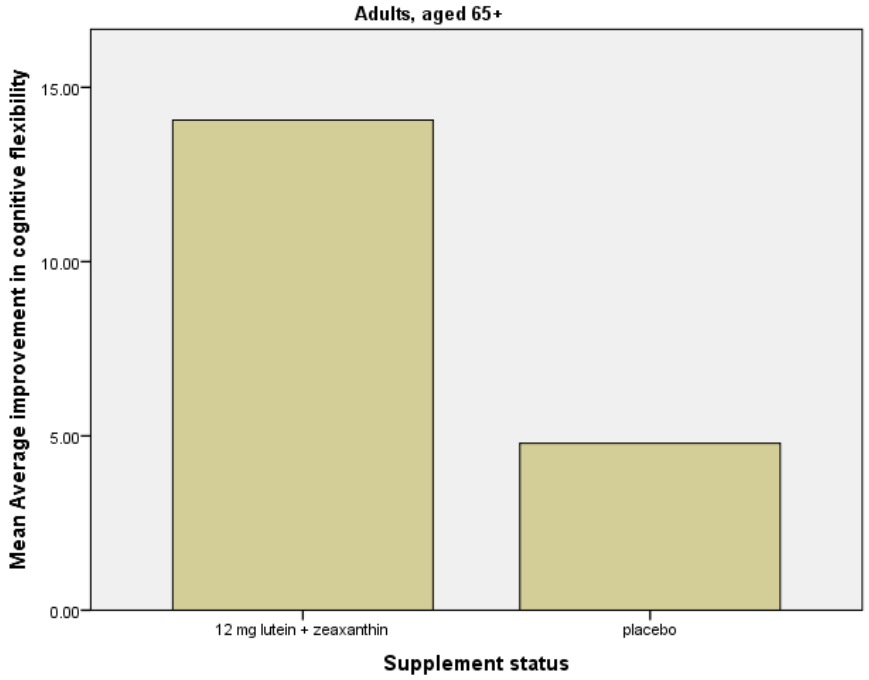
Older adults, by supplement



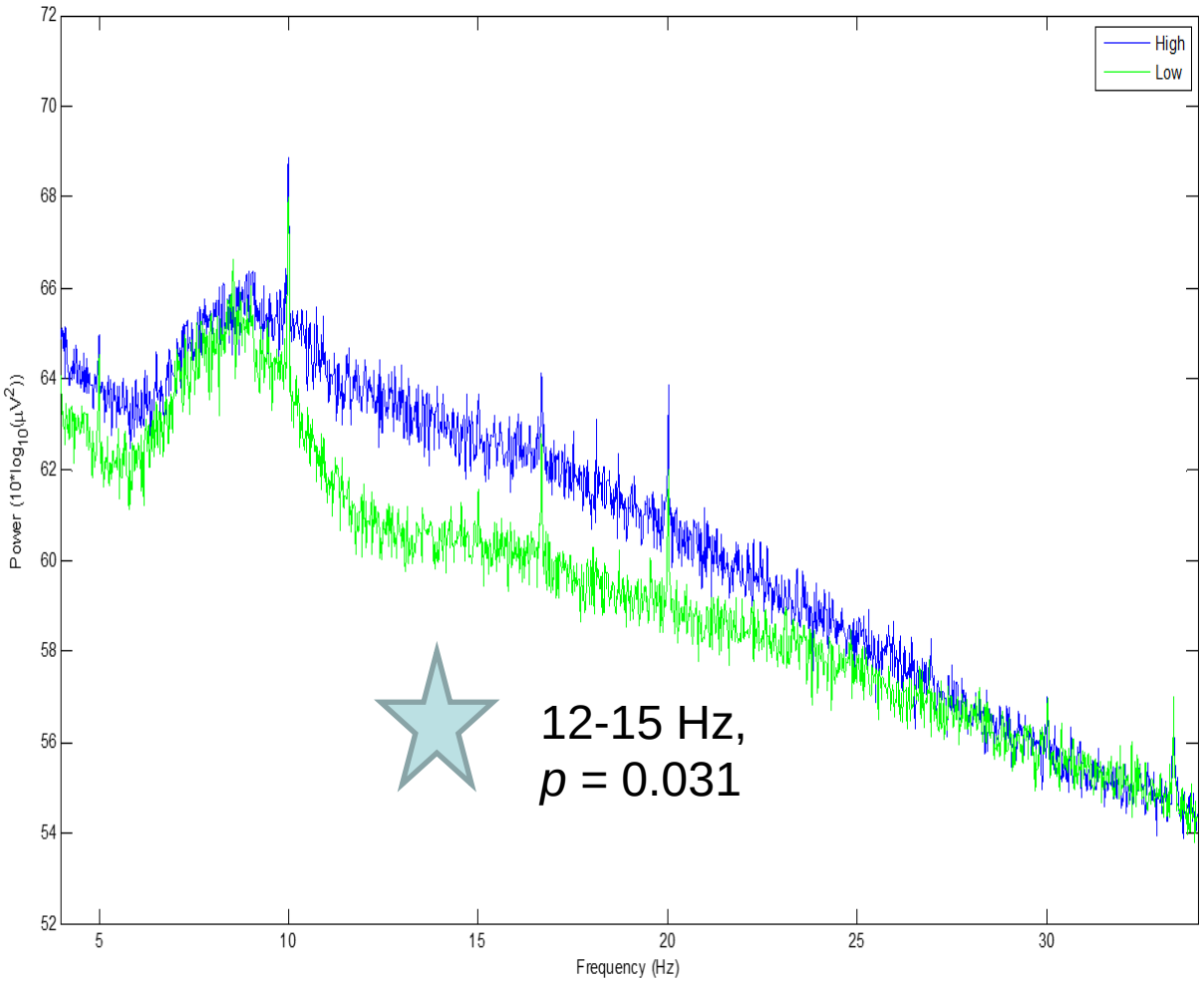
Older adults, by supplement



Older adults, by supplement

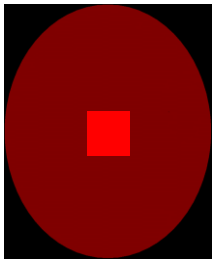


Brain activation, at rest



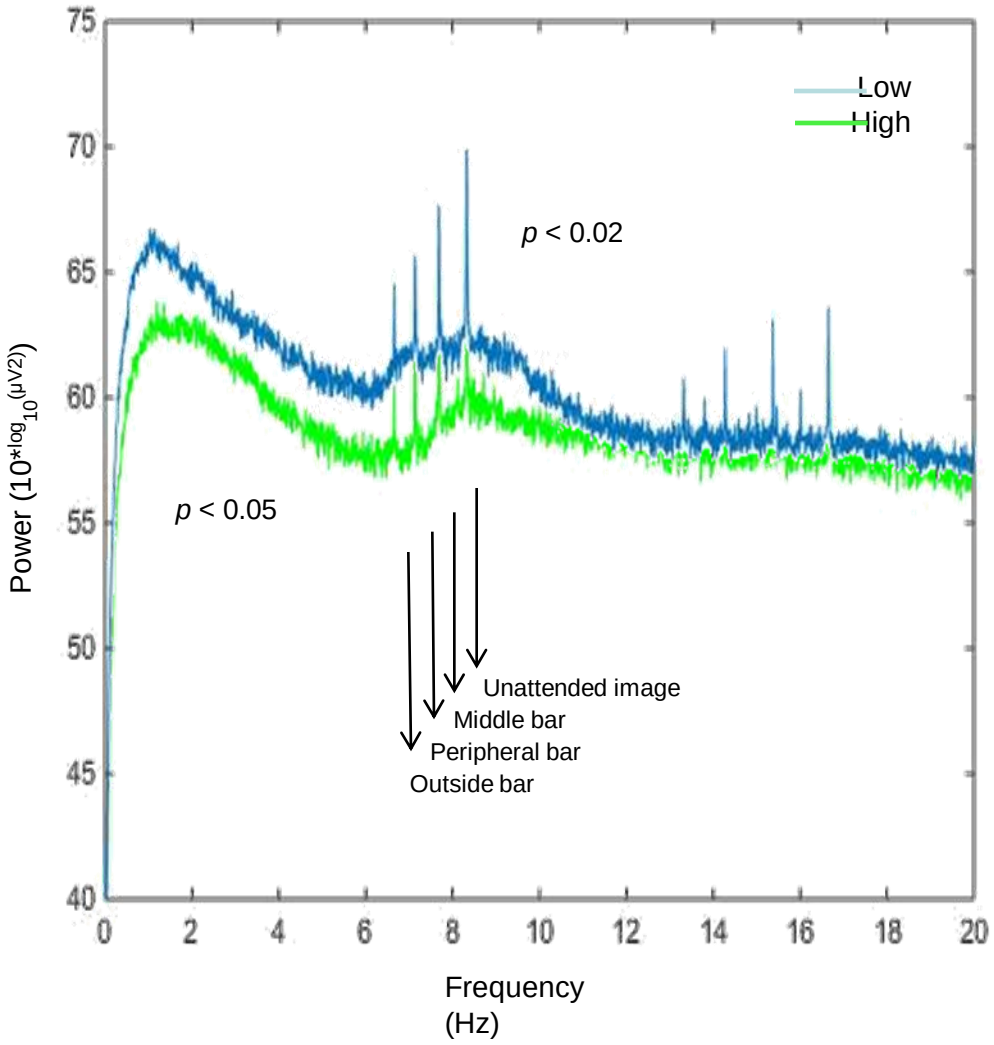
High MPOD = 0.69 average

Low MPOD = 0.28 average



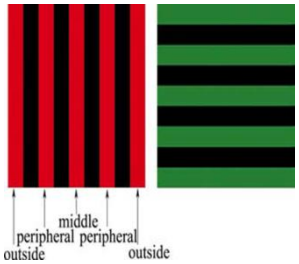
Thorne et al, 2015

Brain activation, with noise



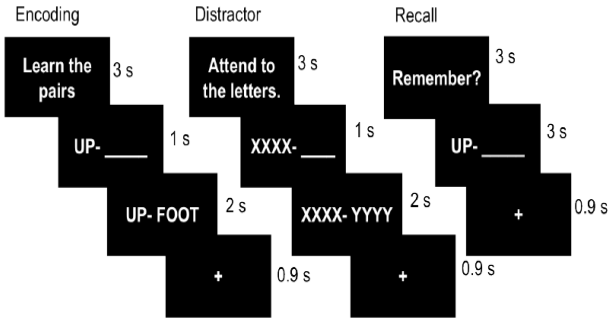
High MPOD = 0.69 average

Low MPOD = 0.28 average



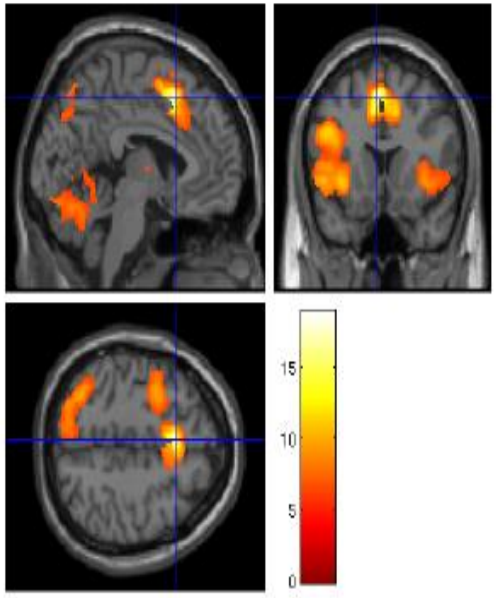
Oliver et al, 2015

Functional scans, verbal domain



Demographics	Mean (SD)
Age	71.8 (6.2)
Education	16.3 (3.8)
Gender (% female)	5%
Race	100% Caucasian
Estimated IQ	114.2 (8.6)
Subjective Accuracy (%)	74.1 (15.3)
Verbal Recall (%)	48.1 (20.1)
Verbal Recognition (%)	75.3 (20.0)

RECALL:



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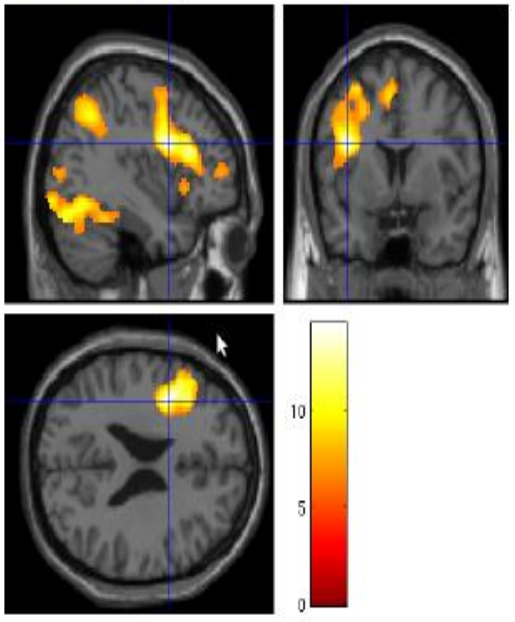
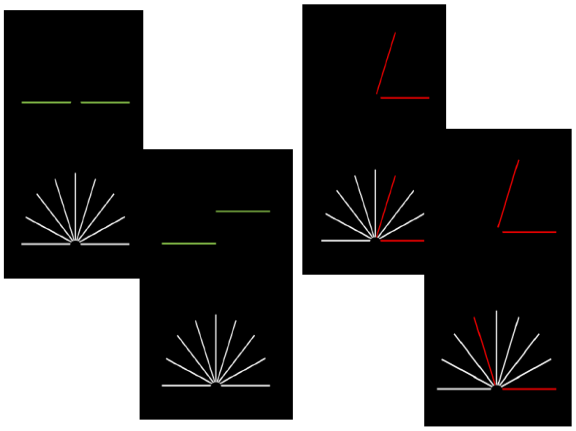


N = 35

Low levels of macular xanthophylls relate to increased utilization of compensatory processing mechanisms.

Terry et al, 2014

Functional scans, visual domain

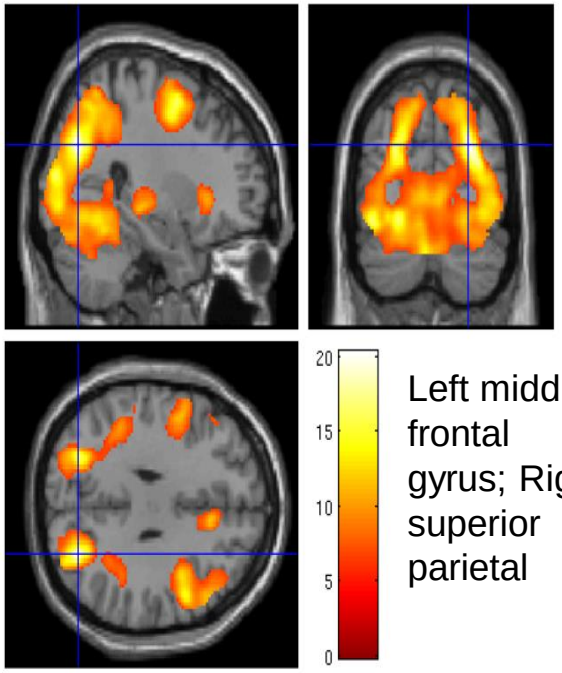


Press RIGHT if even, LEFT if uneven

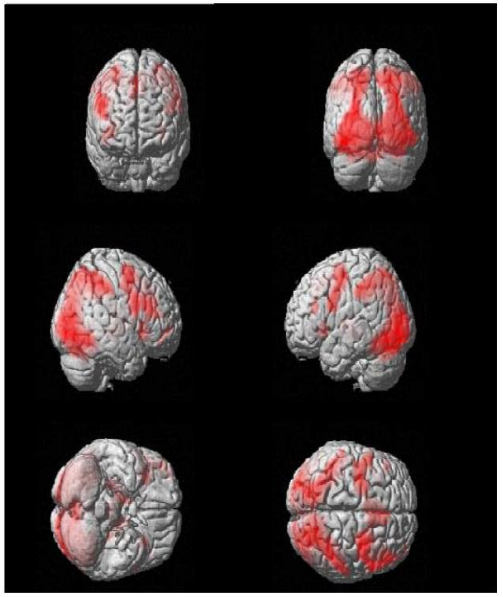
Press RIGHT if top and bottom match, LEFT if no match

Demographics	Mean (SD)
Age	73 (7.0)
Education	15.9 (2.69)
Gender (% female)	53%
Race	100% Caucasian
Estimated IQ	114.0 (8.4)
JLO easy (% correct)	98.2 (2.3)
JLO hard (% correct)	88.1 (6.5)

N = 36



Left middle frontal gyrus; Right superior parietal



Terry et al, 2014

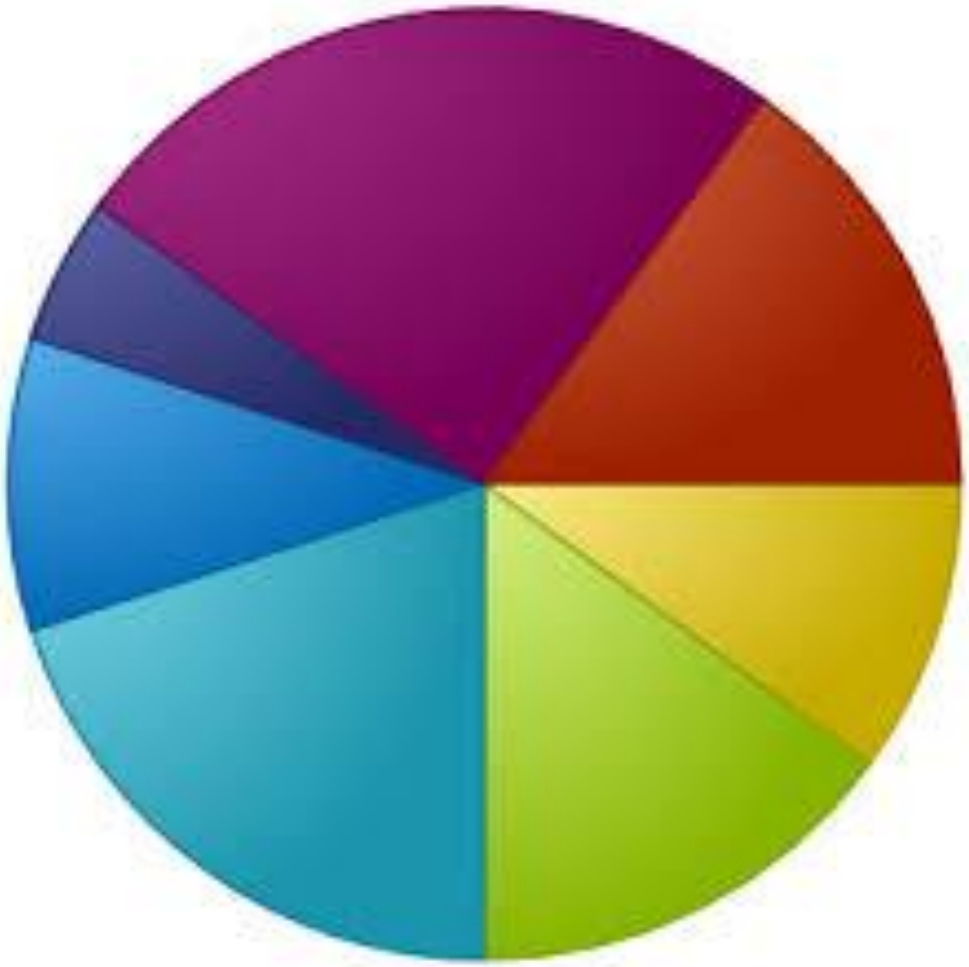
Left middle frontal gyrus and right superior parietal lobe show activation differences in adults with high macular xanthophylls.

Cognitively impaired older adults

Cognitive Status	RBANS Cognitive Domain	Relation to MPOD (*r* value)	*p* value
All participants	Attentional	0.024	0.441
	Visuospatial	0.251	0.057
Unimpaired participants	Attentional	-0.088	0.334
	Visuospatial	0.091	0.329
Impaired participants	Attentional	0.466	0.04
	Visuospatial	0.429	0.056

Renzi et al, 2013

Conclusions and recommendations for patient care



Having the hard conversation

- Asking about diet is awkward
- Patients have selective memories
- Modeling good behavior
- Track lifestyle
- Practice expansion / value add
  - OD is the new GP
- Nutrition is (needlessly) confusing

Eggs are good, eggs are bad… might as well eat a donut

Importance Observational data have suggested that high dietary intake of saturated fat and low intake of vegetables may be associated with increased risk of Alzheimer disease.

Objective To test the effects of oral supplementation with nutrients on cognitive function.

Design, Setting, and Participants In a double-masked randomized clinical trial (the Age-Related Eye Disease Study 2 [AREDS2]), retinal specialists in 82 US academic and community medical centers enrolled and observed participants who were at risk for developing late age-related macular degeneration (AMD) from October 2006 to December 2012. In addition to annual eye examinations, several validated cognitive function tests were administered via telephone by trained personnel at baseline and every 2 years during the 5-year study.

Interventions Long-chain polyunsaturated fatty acids (LCPUFAs) (1 g) and/or lutein (10 mg)/zeaxanthin (2 mg) vs placebo were tested in a factorial design. All participants were also given varying combinations of vitamins C, E, beta carotene, and zinc.

Main Outcomes and Measures The main outcome was the yearly change in composite scores determined from a battery of cognitive function tests from baseline. The analyses, which were adjusted for baseline age, sex, race, history of hypertension, education, cognitive score, and depression score, evaluated the differences in the composite score between the treated vs untreated groups. The composite score provided an overall score for the battery, ranging from −22 to 17, with higher scores representing better function.

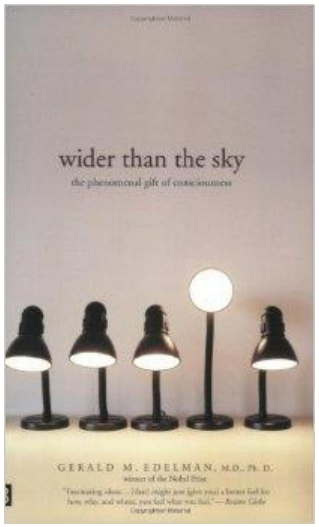
Results A total of 89% (3741/4203) of AREDS2 participants consented to the ancillary cognitive function study and 93.6% (3501/3741) underwent cognitive function testing. The mean (SD) age of the participants was 72.7 (7.7) years and 57.5% were women. There were no statistically significant differences in change of scores for participants randomized to receive supplements vs those who were not. The yearly change in the composite cognitive function score was −0.19 (99% CI, −0.25 to −0.13) for participants randomized to receive LCPUFAs vs −0.18 (99% CI, −0.24 to −0.12) for those randomized to no LCPUFAs (difference in yearly change, −0.03 [99% CI, −0.20 to 0.13]; $P = .63$). Similarly, the yearly change in the composite cognitive function score was −0.18 (99% CI, −0.24 to −0.11) for participants randomized to receive lutein/zeaxanthin vs −0.19 (99% CI, −0.25 to −0.13) for those randomized to not receive lutein/zeaxanthin (difference in yearly change, 0.03 [99% CI, −0.14 to 0.19]; $P = .66$). Analyses were also conducted to assess for potential interactions between LCPUFAs and lutein/zeaxanthin and none were found to be significant.

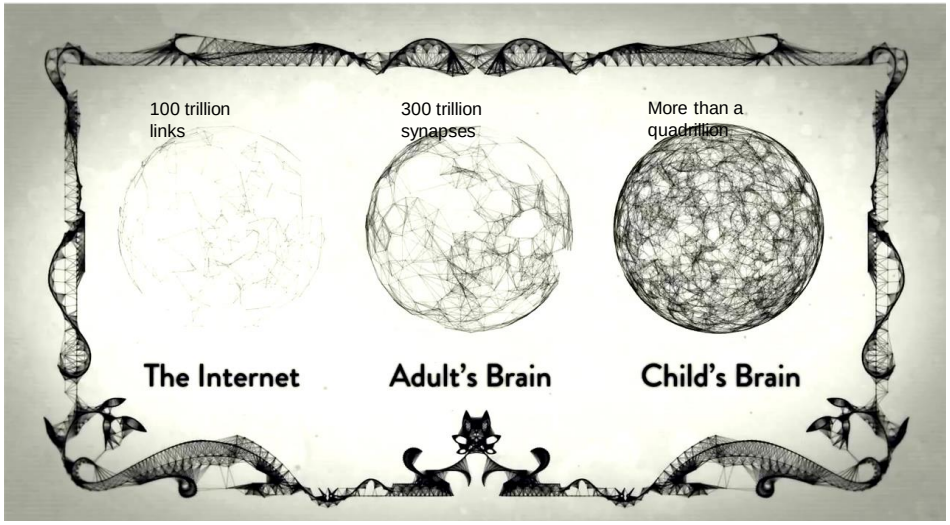
Conclusions and Relevance Among older persons with AMD, oral supplementation with LCPUFAs or lutein/zeaxanthin had no statistically significant effect on cognitive function.

Zeaxanthin, or
gnitive

er, PhD[3];
e Disease Study 2 (AREDS2)

Understanding null results, and consequences of category confusion

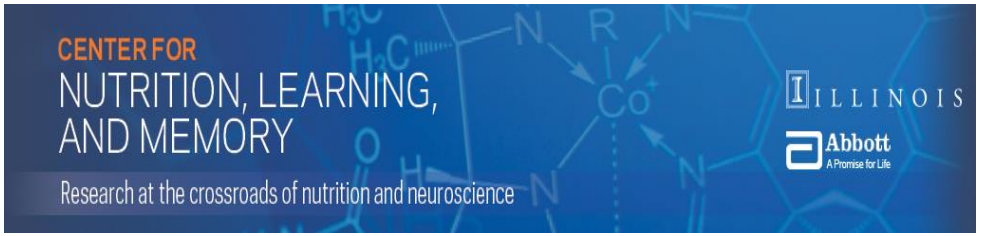




TED: Brain Power: From Neurons to Networks

- Test, function, population all align.
- Appropriate level of analysis for the question.
- There is power in "nothing happening."

Acknowledgements



- Collaborators
  - UGA: Billy Hammond, L. Stephen Miller, Brett Clementz, Janet Frick
  - Macular Metrics: Billy WootenUNH: Joanne Curran-Celentano
  - UIUC: Naiman Khan, Arthur Kramer, Neal Cohen
  - Northwestern University: Chuck Hillman
  - SUNY Oneonta: Emily Bovier
- Current and former graduate students
  - S. Anna Thorne, William Oliver, Cutter Lindbergh, Douglas Terry, Catherine Mewborn, Kevin O'Brien, Laura Fletcher, Sarah Saint
- Laboratory Employees and Research Assistants
  - Medina Bello, Samy Gabriel, David Cromer, Kodiak Sauer, Jason Champ, Craig Brown, Harrison Cloud, Jacob Beckham, Eli Chlan, Haleigh Randazzo, Stephanie Nguyen, Frances Kittle, Stephen White
- Abbott Nutrition
- DSM
- ZeaVision