

Applying Neuroplasticity to Optometric Care

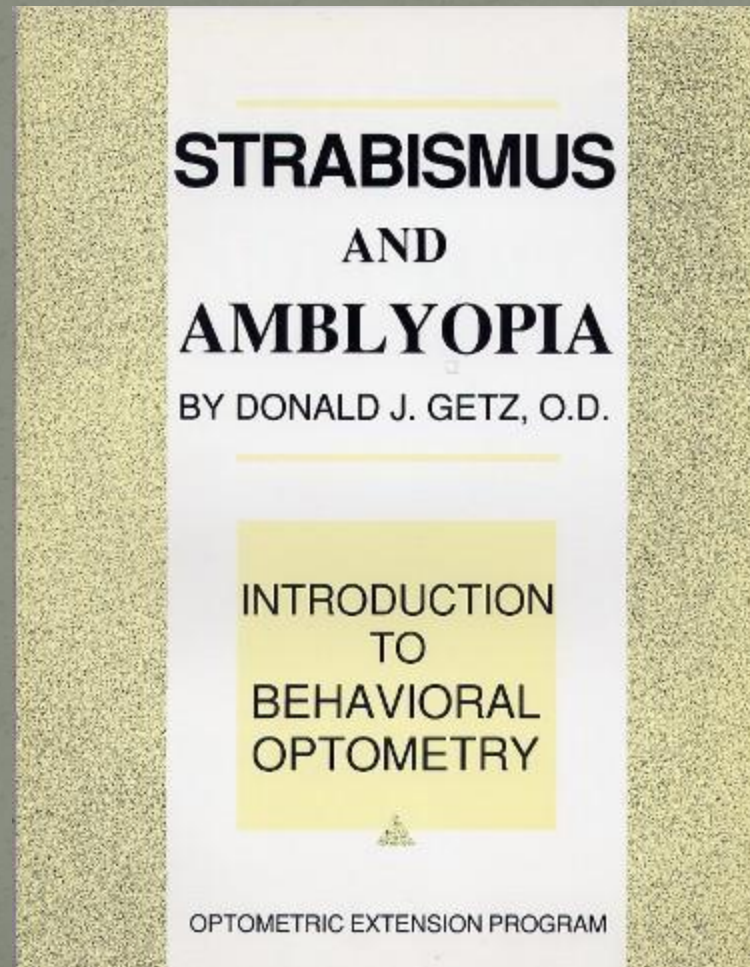
Dan L. Fortenbacher, O.D., FCOVD
Clinical Professor – Michigan College of Optometry
September 17, 2010

A turning point in the life of an impressionable optometry intern

- December 1978



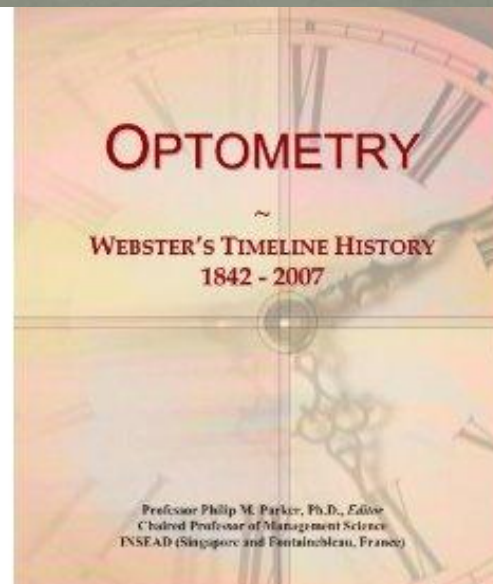
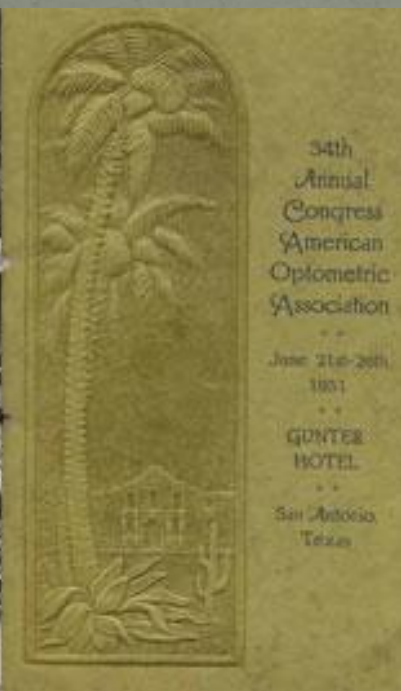
My assignment



Applying Neuroplasticity to Optometric Care



History of optometry



First Lenses

- 434 BC – “burning glass”- Aristophanes



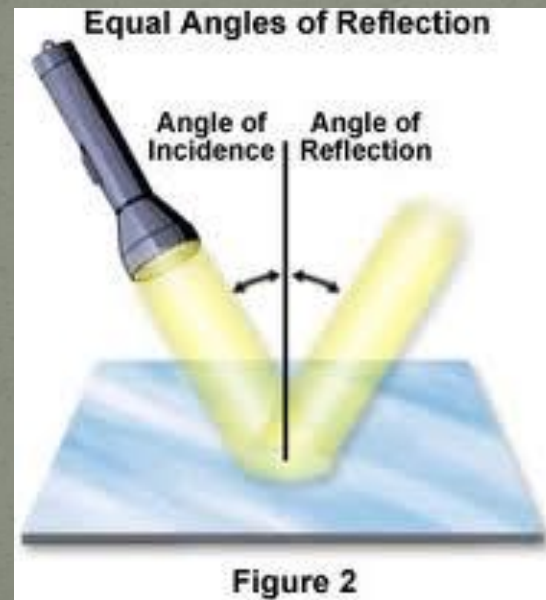
Image formation in the eye

- 450 BC – Empedocles
 - The Visual Ray “Extromission”



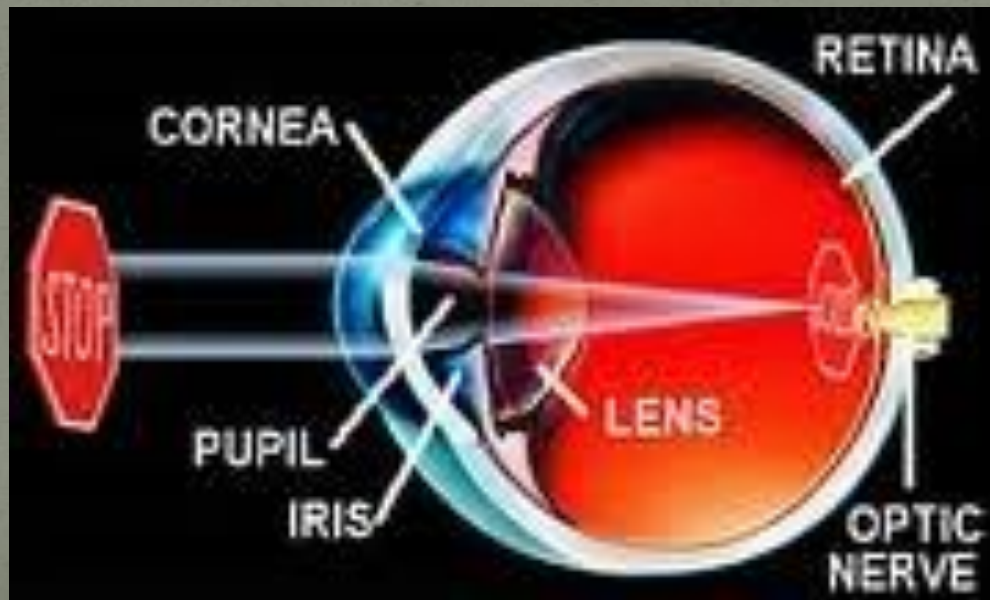
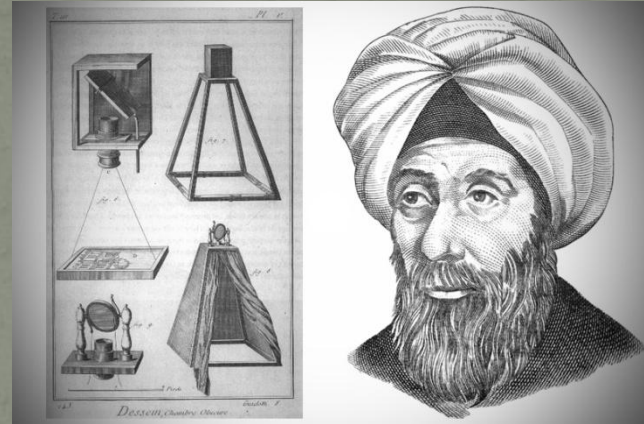
History of optics

- 280 BC – Euclid
 - Angle of incidence = reflection
 - Light travels in straight lines



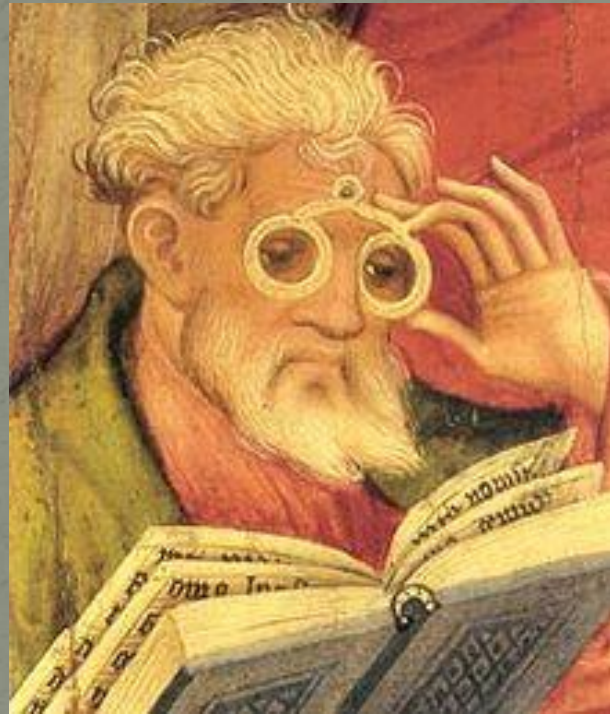
The turning point- Image formation in the eye

- 1000 AD Alhazen
 - “Intromission” proven



1st eye glasses

- 1300 AD

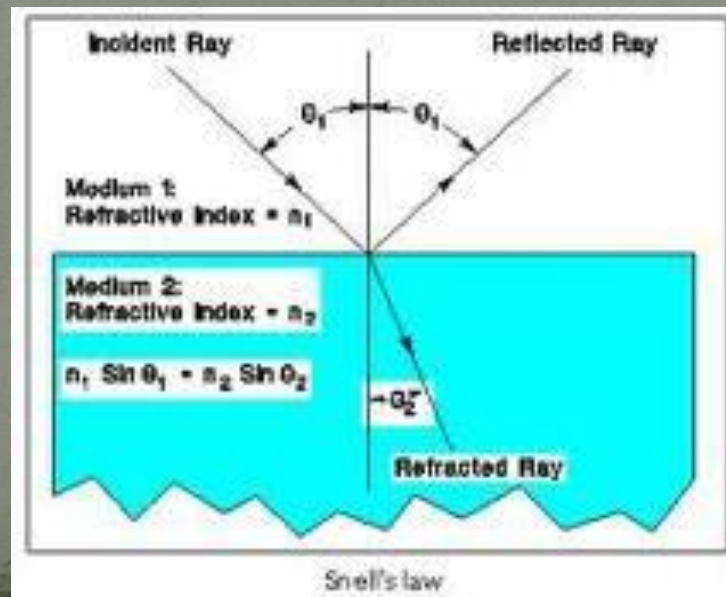


History of optics

- 1621 AD - Snell
 - Law of refraction



Willebrord Snell
(1580-1626)



History of optometry

- 1623 - Benito Daza de Valdes wrote 1st book on optometry



Then comes binocular vision

- The mathematician François d'Aguillon published one of the first significant analyses of binocular vision in 1613.
 - Aguillon was, in fact, the *first* to use the term "horopter" from the Greek words horos (boundary) and opter (observer)

Accommodation is linked to binocular

- William Porterfield made an optometer in the mid 1700s and noted the existence of a relationship of accommodation and convergence.
 - “A Treatise on the Eye, the Manner and Phaenomena of Vision.”



The discovery of stereopsis!

- Charles Wheatstone invented the mirror stereoscope and in 1838 used it to experiment on binocular vision and stereopsis.



The measurement of lenses

- 1872 – Monoyer
 - Inventor of the Diopter

$$D = \frac{1}{f \text{ (m)}}$$



Fast Forward



Modern Optometry of today

- Progressive Addition Lenses
- High Definition custom lenses using wave front technology
- Antiscratch, antireflection, antidust lenses coatings
- Light weight, nonglass photochromatic lenses

Modern eye care in the last 30 years

- Disposable contact lenses
- Refractive surgery
- Intraocular lens implants (IOLs)
 - Outpatient, no stitch procedure
 - Accommodating IOLs
- Auto refractors

- And much more...

But what about?

- Amblyopia
- Strabismus
- Non-strab binocular dysfunction
- Accommodative dysfunction
- Oculomotor dysfunction

Throughout Human History...
The Voyage of Discovery

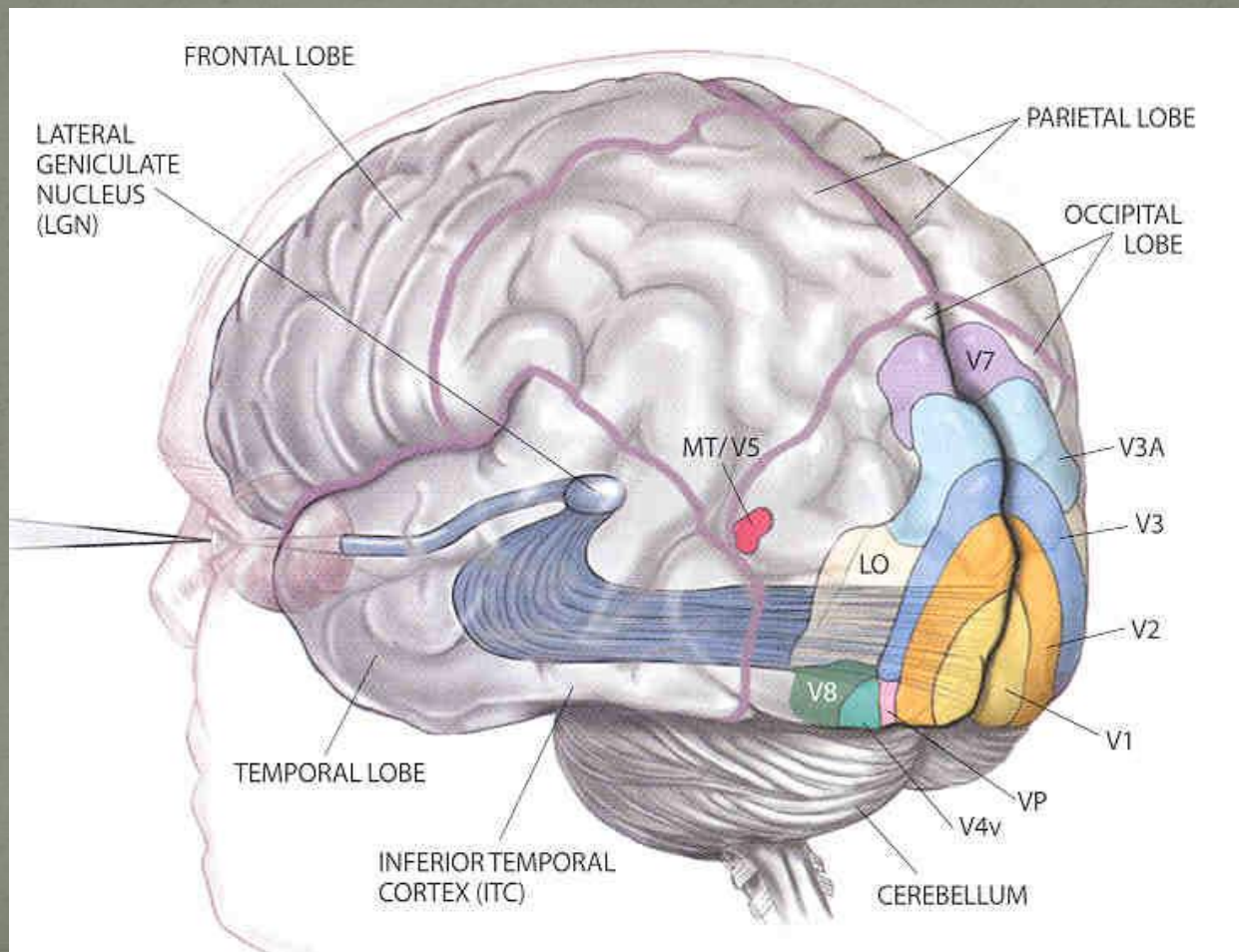


The sea...our final frontier



Applying neuroplasticity in optometry is the final frontier!

The visual brain



Turning points in Neuroscience

- Golgi and Ramón y Cajal shared the Nobel Prize in Physiology and Medicine in 1906 for their extensive observations, descriptions and categorizations of neurons throughout the brain
- The scientific study of the nervous systems underwent a significant increase in the second half of the twentieth century, principally due to revolutions in molecular biology, electrophysiology, and computational neuroscience.

20th century voices in Optometry...pioneers of neuroplasticity

- Skeffington
- Getman
- Kraskin
- Forrest

Skeffington

- Identification- “What is it?”
- Centering/Localization – “Where is it in space and time?”
- Antigravity/Orientation – “Where am I in space and time?”
- Speech/Auditory/Communication – “How do I communicate about ‘where’ and ‘what’?”
- ***Vision is the Emergent***

Getman

- Movement develops vision
- Vision substitutes for movement
- Vision is motor.

Kraskin

- Deriving meaning and directing of action through visual information processing triggered by a selected band of radiant energy (lens application)

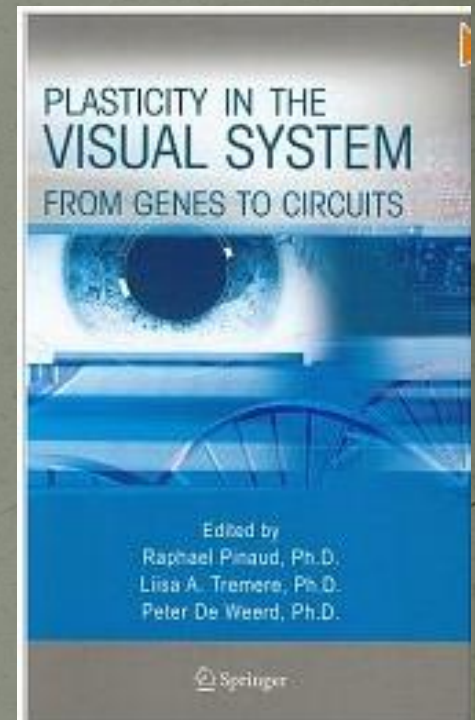
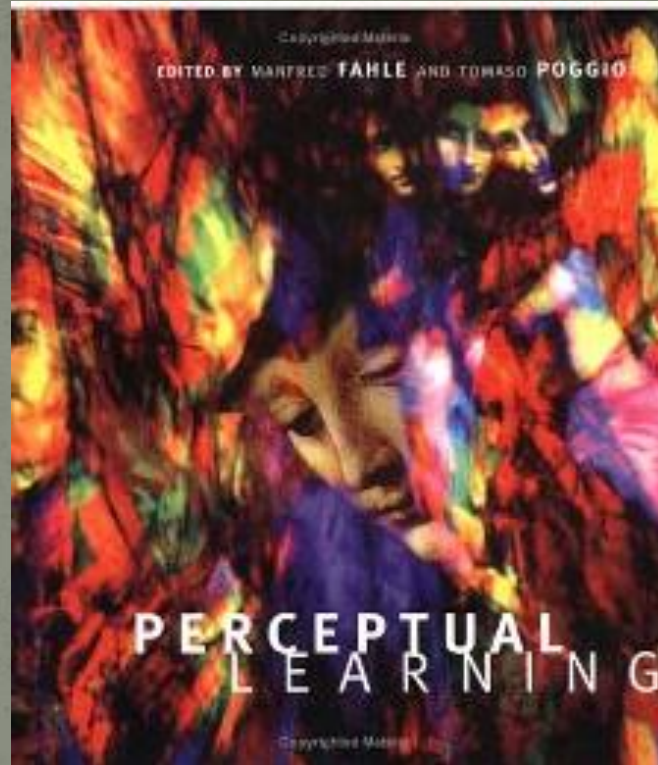
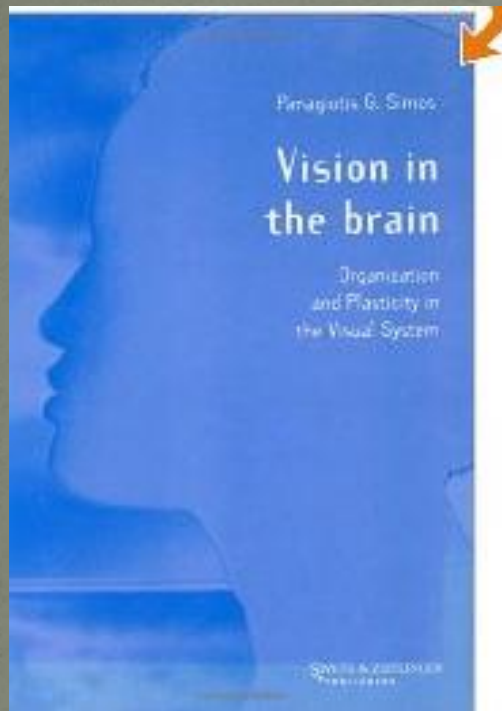
Forrest

Vision is a process that sub serves
consciousness, awareness and attention.

Who is setting the stage for applications of neuroplasticity in optometry today?

- The neuroscientists!

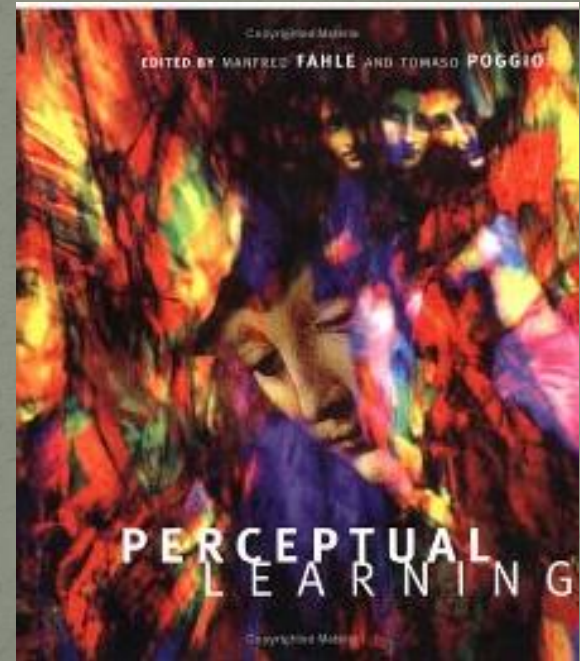
Sample Reference Texts



What is neuroplasticity?

Manfred Fahle, Tomaso Poggio – Perceptual Learning

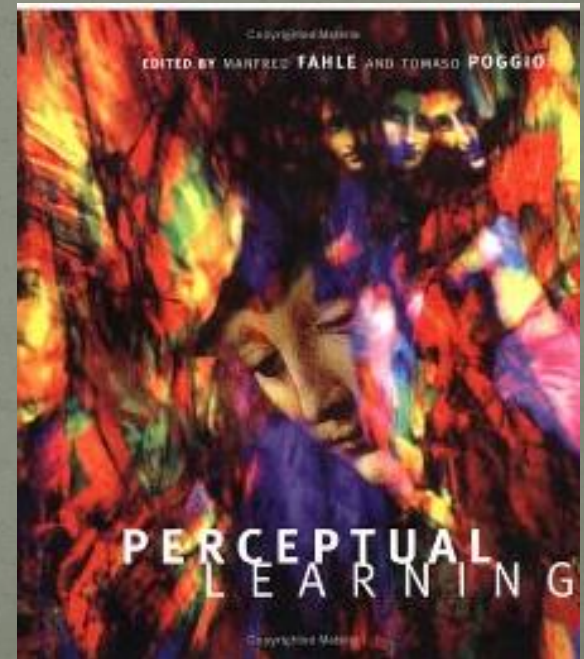
“The modifiability of the brain leading to more appropriate function”



What is neuroplasticity?

Manfred Fahle, Tomaso Poggio – Perceptual Learning

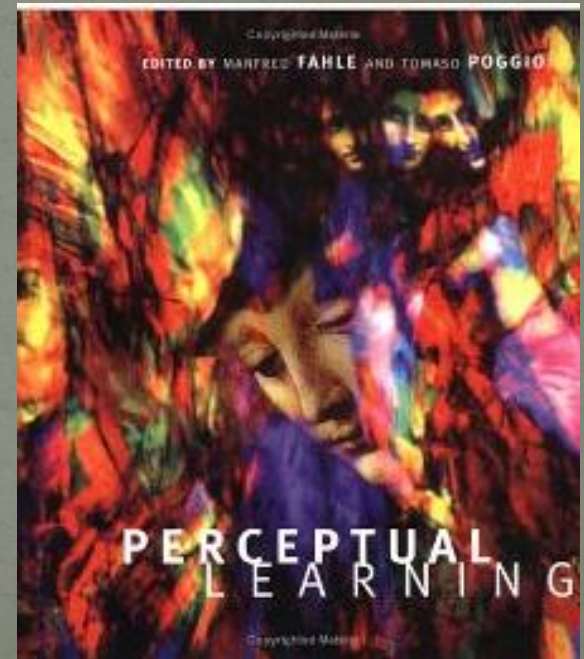
“Describes the neuronal substrate of changing behavior, such as changes in “synaptic weights” or formation of new synapses”



What is neuroplasticity?

Manfred Fahle, Tomaso Poggio – Perceptual Learning

“...serves to adjust the functional and anatomical organization of the central nervous system as a result of sensory experiences...”



Huang JC. Neuroplasticity as a Proposed Mechanism for the efficacy of optometric therapy & rehabilitation. J Behav Optom 2009; 20(4):9-99.

1. The scientific community is gradually embracing the notion that rehabilitation of motor, sensory and cognitive impairments can alter brain reorganization and result in functional recovery.

Huang JC. Neuroplasticity as a Proposed Mechanism for the efficacy of optometric therapy & rehabilitation. J Behav Optom 2009; 20(4):9-99.

2. The training and rehabilitation of functional visual disorders through repetitive, targeted visual rehabilitative techniques should not be a foreign concept.

Huang JC. Neuroplasticity as a Proposed Mechanism for the efficacy of optometric therapy & rehabilitation. J Behav Optom 2009; 20(4):9-99.

3. Based on what is now known about neuroplasticity, the mechanism for the efficacy of VT and rehabilitation is likely through strengthening synaptic connections and inducing cortical reorganization to maximize visual efficiency.

Press LJ. Vision therapy as perceptual learning:
Insights from the Vision Sciences Society.
J Behav Optom 2007;18(4):96-99.

- An essay showing that perceptual learning was a widespread term vision scientists were using to describe many activities in vision therapy, not just amblyopia and strabismus.

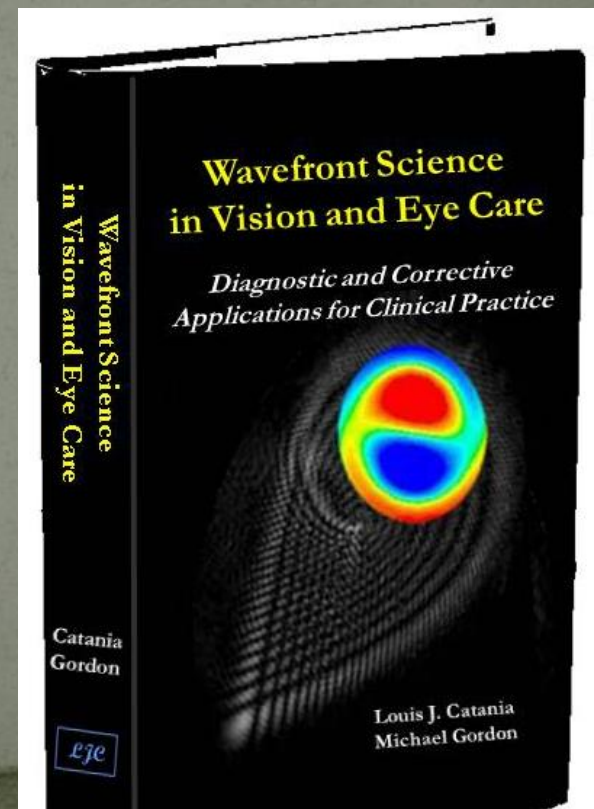


Insights from the Vision Sciences Society.

- Plasticity in human blindsight
- Improving global motion perception in the blind field of adult humans with V₁ damage
- Improving vision in adult amblyopia by perceptual learning
- Reactivation of juvenile-like ocular dominance plasticity in the adult visual cortex
- Primate area V₁ reorganization following retinal lesions

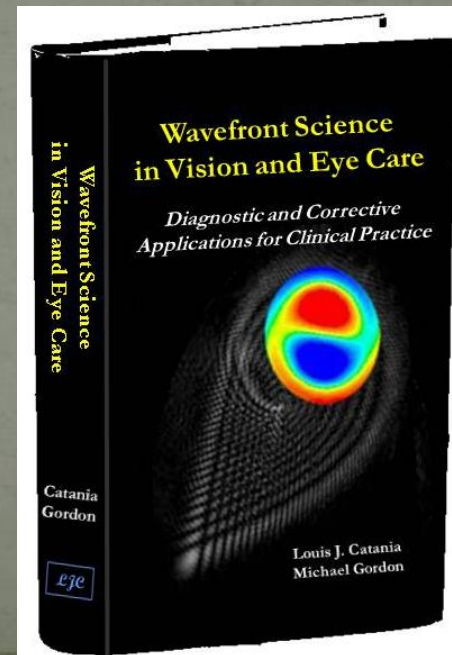
When Visual Performance Doesn't Match the Optics of the Eye

- Adaptive Optics goes beyond sphere, cylinder and axis
- Includes concepts of Zernike Polynomials & Point Spread Function
- Introduced to deal with complaints about vision related to LASIK
- Now extended to “wavefront” CLs, spex, and IOLs
- Contrast sensitivity/MTF “interpreted” by visual cortex
- How do we handle cortical aberrations?



When Visual Performance Doesn't Match the Optics of the Eye

- Neural Adaptation
- Training the visual brain
- Neuroplasticity in the visual system
- Neurorehabilitation for accommodating IOLs
- NEUROVISION via LEVI & POLAT applied to REVITALVISION

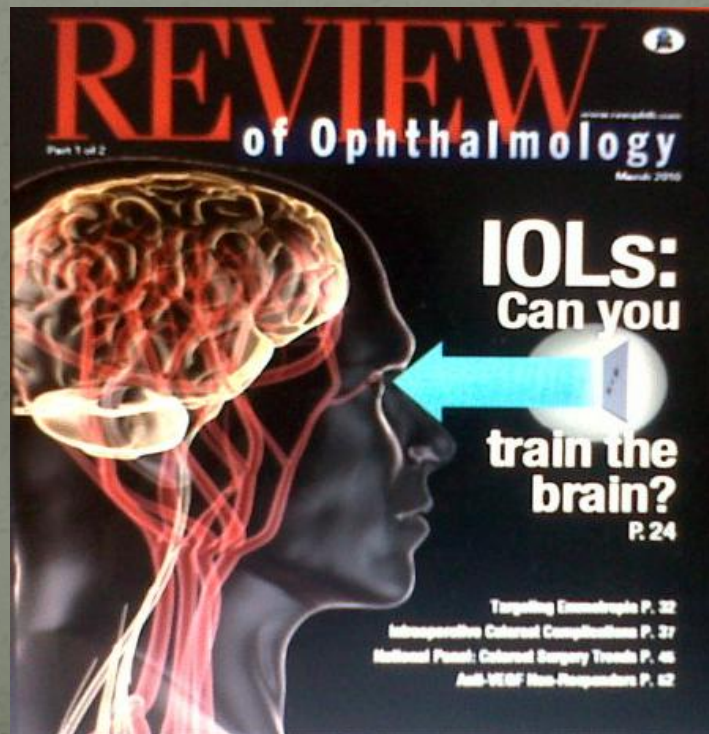


2010...the emergence of another turning point in eye care history??



WHEN IS A VISUAL PROBLEM A BRAIN PROBLEM?

- Review of Ophthalmology March 2010: Can you train the brain?
- http://www.revophth.com/index.asp?page=1_14594.htm



Key Brain Training Players in Ophthalmology – Optometry Clinical Practice

- Richard Lindstrom, MD

- Primary Care Optometry News Editorial Board
- Refractive Surgeon heading large group practice in MN



- Marlane Brown, OD

- Practices with Lindstrom
- Former Pres. MN Optometric Association



- Robert Kershner, MD

- Refractive surgeon in FL and UT
- Practices with Jeryl Kershner, MD



Ophthalmologists are becoming enthusiastic about training the visual brain

- Richard L. Lindstrom, MD, notes:
 - “We now know the brain is plastic and can ‘learn,’ even in the elderly,”
 - IOLs are an important indication for this technology, as are post-corneal refractive surgery patients with a small residual refractive error and patients with low levels of naturally occurring ametropia and early presbyopia
 - The treatment also works for amblyopia, and appears to be able to enhance sports performance...

According to Dr. Kershner - "Neuroadaptation is an issue we've always had to deal with"

The Quandary for Ophthalmology

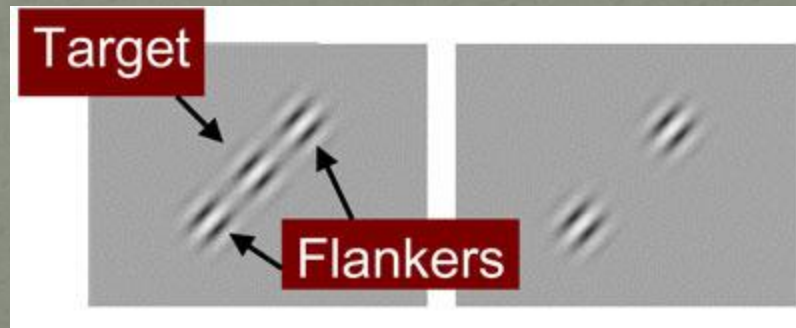
- An intraocular lens is a prosthetic implanted in a neural network for accommodative responses
- The typical IOL patient has not actively accommodated in many years
- The multifocal IOL patient often lacks the visual ability to actively use accommodation
- Most patients are unprepared for this process of neuroadaptation and are left to learn for themselves when in reality they often benefit from rehabilitative therapy

From Review of Ophthalmology, March 2010: Visual Neuroadaptation

- **The Neuroadaptation Process**
 - One of the things highlighted by the adaptation problems associated with multifocal lenses is the reality that our visual system has two distinct components: the optical system that alters light before it reaches the retina, and the neurological system (including both the retina and brain) that processes the information.
 - Many ophthalmologists haven't had to devote too much time to worrying about the neurological half of the visual system—until now.

RevitalVision Cited in Review of Ophthalmology Article

- <http://www.revitalvision.com/Doctors/ScientificBackground/>
- Same program as “Neurovision” using Gabor patches (circular gratings) to treat amblyopia through perceptual learning



From Review of Ophthalmology, March 2010

“Our training system is designed to enhance neuroadaptation by making the visual system analyze information presented using Gabor patches”

Efficacy of Gabor Patch Training After IOL Implantation

	No. of Eyes	Distance VA Improvement	Near VA Improvement	Distance CSF Improvement	Near CSF Improvement
ReZoom	24	1.5 Lines	0.6 Lines	157%	160%
Restor	6	1.6 Lines	1.2 Lines	135%	143%
Crystalens	6	0 Lines*	1.8 Lines	370%	227%
Alcon					
Monofocal	10	1.3 Lines	0.6 Lines	250%	238%
AMO					
Monofocal	10	1.3 Lines	1.7 Lines	354%	263%
Total	56	1.3 Lines	0.9 Lines	223%	197%

Mean age of subjects = 70

** Patients' baseline VA = 20/15 — no room to improve*



HOME

PROGRAMS

THE SCIENCE

FOR DOCTORS

CONTACT US

Reading Glasses:

Vision Improvement Program

Post-LASIK Therapy

Post-Cataract Therapy

Amblyopia Therapy

For Doctors

About RevitalVision™

History of the Company & Technology

Scientific Background

The RevitalVision™ Training System

Medical Research and Press

Products

Download Brochure

Pricing for Professionals

Marketing Material Request

RevitalVision™ neural vision therapy improves communication between the eyes and the visual cortex

- Improve Vision Two Lines on an Eye Chart on Average
- 100% Increase in Contrast Sensitivity

RevitalVision is:

- [Clinically Proven](#) And Tested Worldwide
- [Published in Peer Reviewed Medical Journals](#)
- Supported by a World Renowned [Medical Advisory Board](#)

"I went into this very skeptical, but I did see a positive effect for the patients in the clinical studies. I was impressed that we could improve vision without doing

Revitalvision Providers

- 69 MDs
- 20 ODs

Dr. Kershner concludes

- “If you train as many patients as possible *both beforehand and afterwards*, you’ll have a much lower number of failures and much greater number of successful outcomes.”

Dr. Kershner concludes

- neuroadaptive training can be very effective as a screening tool
- helps people succeed postop who otherwise might not
- cuts 30 or 40 percent off of the adaptation time

Applying neuroplasticity in optometric care

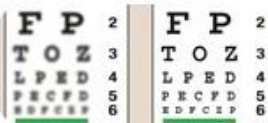
- Optometry...The Primary Eye Care profession
- Optometry...The Primary “Vision Care” profession

Optometry – The Vision Care Profession

Helping Patients of All Ages Train Their Visual Brain

- Amblyopia
 - Developmental abnormality of spatial vision
- Strabismus
 - Developmental abnormality of spatial localization
- Academic
 - Learning based vision problems/information processing
- Post-Surgical
 - Multifocal IOL with problems in simultaneous multiple foci
 - Accommodating IOL with problems in accommodative facility

- Optometry uses applications of neuroplasticity to treat visual brain problems more comprehensively with interactive office-based vision therapy

[In-Home Therapy](#)[HTS iNet](#)[PTS II iNet](#)[AmbP iNet](#)[ADR iNet](#)[Sub iNet](#)[PVT iNet](#)[In-Office Therapy](#)[Computer Orthoptics](#)[CPT](#)[Screening Programs](#)[BVA](#)[PTS II](#)

AmbP iNet Amblyopia iNet

[Intro](#) | [Total Control](#) | [Provides Motivation](#) | [Instant Review](#) | [Easy Monitoring](#) | [More Info](#) | [Free Trial Software](#)

Amblyopia iNet Program

Friday, September 8, 2006 12:12 PM Version: 1.00

[Follow the Letter](#)[Letter Blocks](#)[Letter Jump](#)[Catch the Target](#)[Find the Target](#)[Dinosaur Hunt](#)[Bingo](#)[Concentration](#)[Snowflake](#)[Penguin Peek](#)[Chipmunk Chase](#)[Amblyopia Arcade](#)[Help](#)[Return to Main Menu](#)

12 Entertaining Home-based Near Vision Activities Designed for The Treatment of Amblyopia

HTS has created an amblyopia hand-eye coordination program which uses principles of operant conditioning and behavior modification to appropriately alter stimuli characteristics to improve visual acuity. Patients begin therapy with targets that are easily seen and become progressively smaller as therapy progresses. Correct responses are reinforced with subsequent reduction in the size of the stimuli. Therapy is directed to improve resolving ability with concomitant use of hand-eye coordination tasks. Therapy can be preformed monocularly or monocularly in a binocular field.

[Next »](#)

Activities to Train the Visual Brain Beyond Computerized Programs



Intermittent
Photic
Stimulation



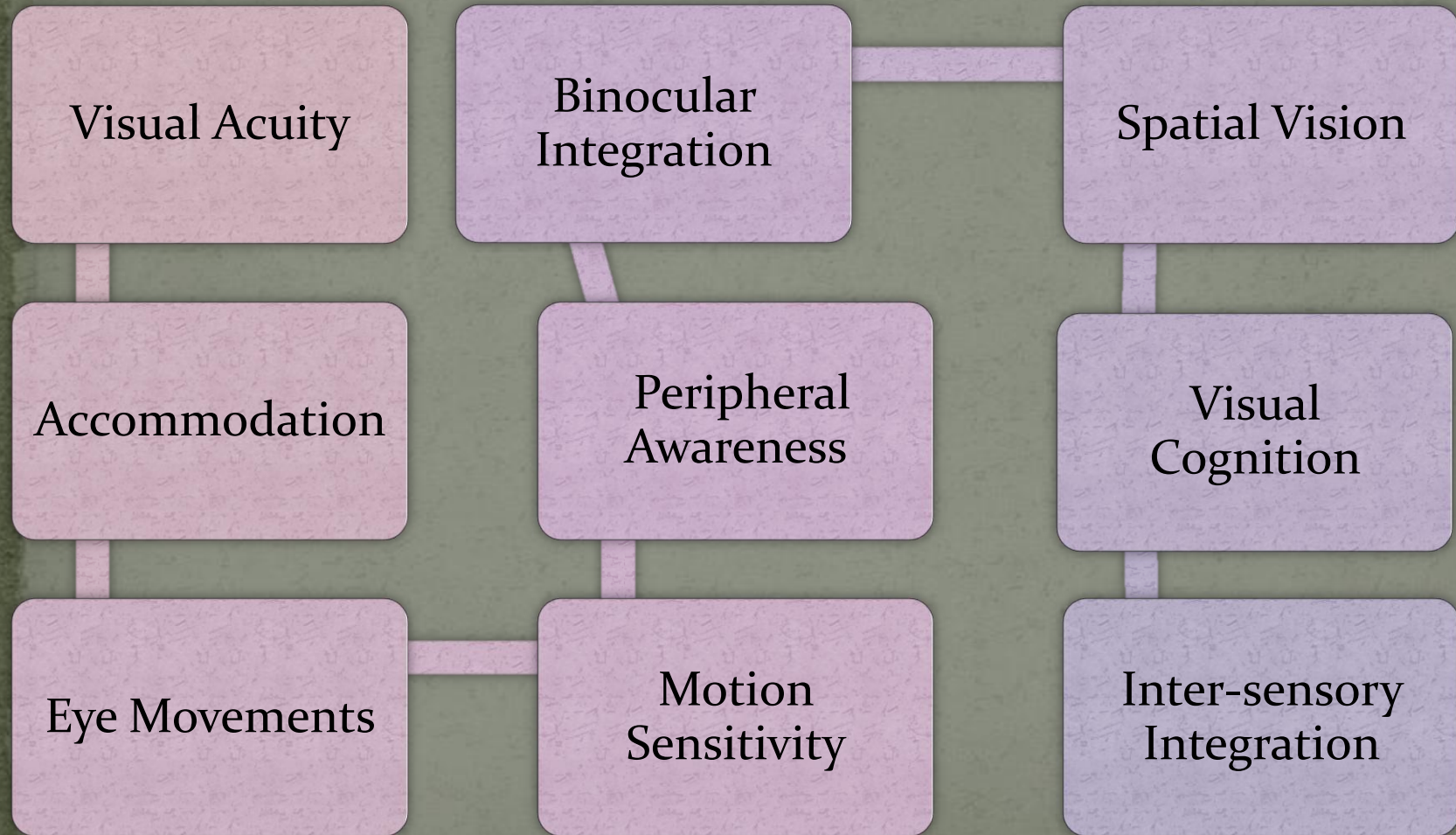
Neurophysiologic
Diplopia with
Divided
Attention



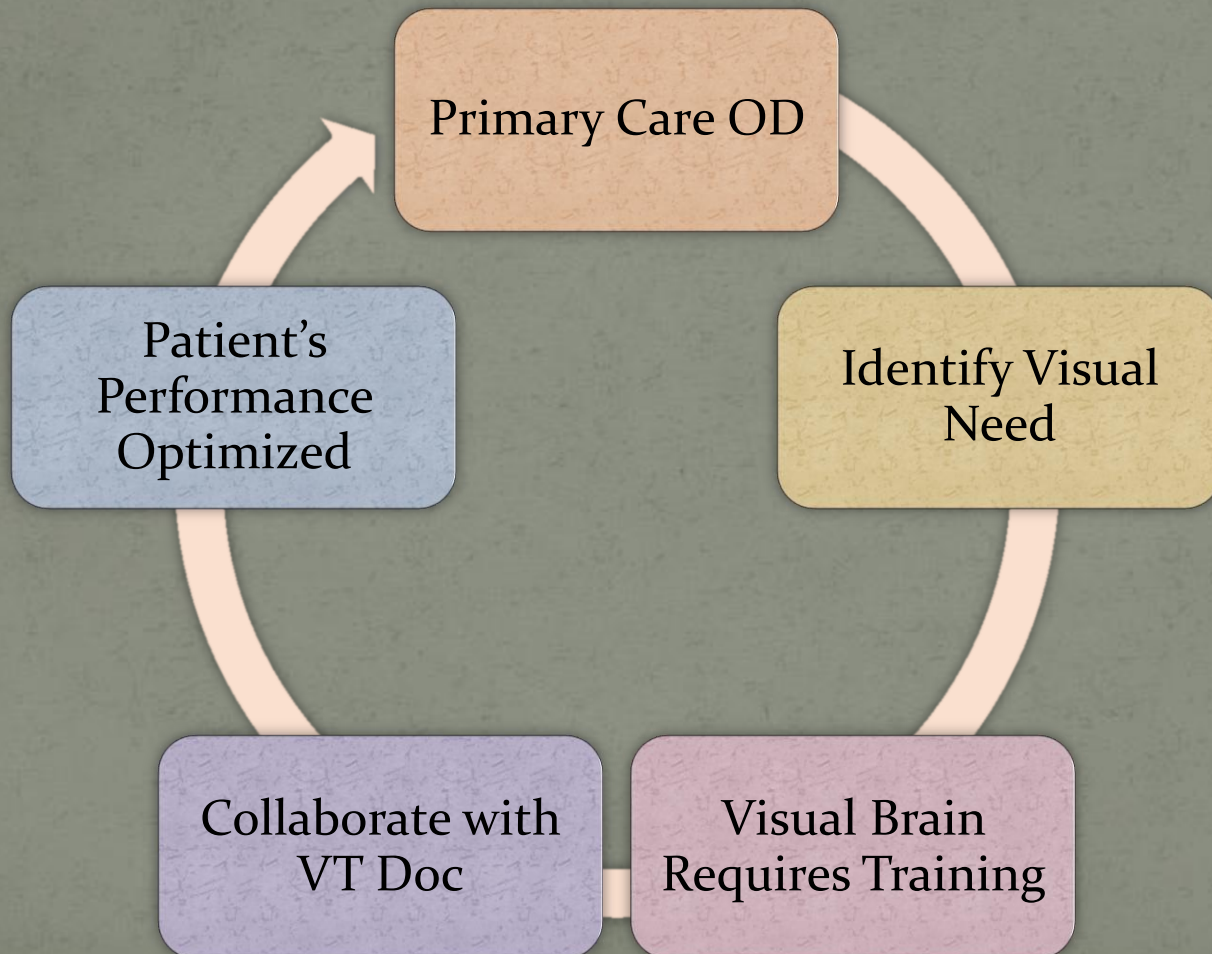
Spatial Fusion
with Optic Flow



Some Components of the Visual Brain Amenable to Neuroadaptive Training



Intra-Optometric Collaboration



What about this?

New Paradigm in Vision Care and Therapy

Ophthalmology

Neuroprosthetic
Implants/Refractive
Surgery (eg
Accommodating
IOLs)

Collaborate with OD
on Pre-Op
Assessment/Post-Op
Therapy

Optometry

Perceptual Learning
Procedures

Neuroadaptive
Training

The real voyage of discovery is not in seeking new
landscapes but in having new eyes -
Marcel Proust



The real voyage of discovery will be
landscaping new brains to provide new
eyes



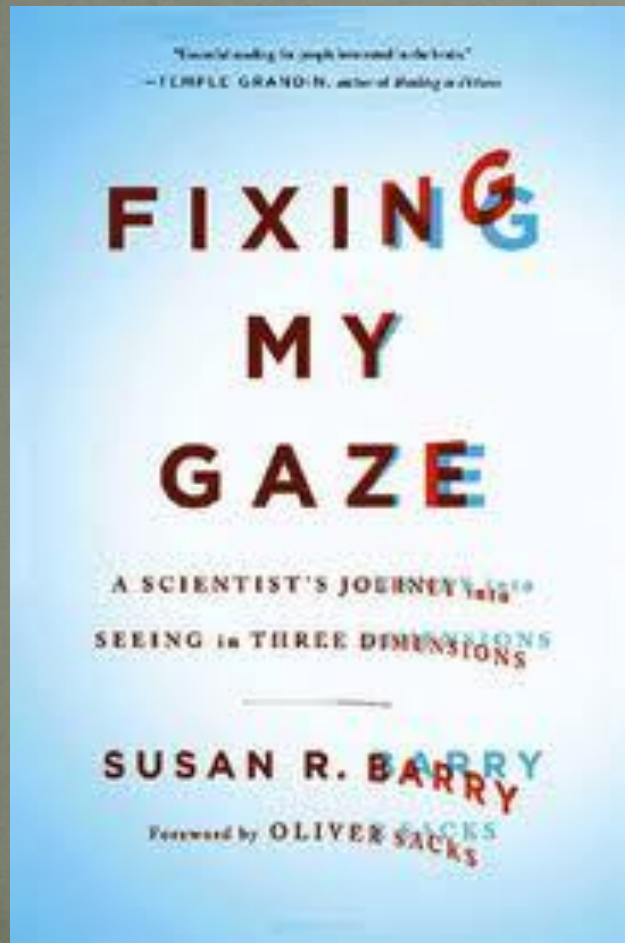
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landscaping new brains to provide new eyes



Thank you

Your assignment...

- Come to the Michigan Vision Therapy Study Group
 - January 2011
- Join COVD
- Attend VT CE
- Develop referral relationships with ODs who provide office-based Vision Therapy
- Expand services in your own office to include office-based VT
 - Hire an associate who is interested in peds/binocular vision