Applying Neuroplasticity to Optometric Care

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A turning point in the life of an impressionable optometry intern

- December 1978
My assignment

STRABISMUS
AND
AMBLYOPIA
BY DONALD J. GETZ, O.D.

INTRODUCTION TO BEHAVIORAL OPTOMETRY

OPTOMETRIC EXTENSION PROGRAM
Applying Neuroplasticity to Optometric Care
History of optometry
First Lenses

- 434 BC – “burning glass” - Aristophanies
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
History of optometry

- 1623 - Benito Daza de Valdes wrote 1st book on optometry
The mathematician François d’Aguilllon 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 works 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

\[ D = \frac{1}{f (m)} \]
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*
• Movement develops vision
• Vision substitutes for movement
• Vision is motor.
Deriving meaning and directing of action through visual information processing triggered by a selected band of radiant energy (lens application)
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

   - Author: Panagiotis G. Simos

2. Perceptual Learning
   - Author: Edited by Manfred Fahle and Tomaso Poggio

3. Plasticity in the Visual System: From Genes to Circuits
   - Edited by Raphael Pinard, Ph.D., Liisa A. Tremere, Ph.D., Peter De Weerd, Ph.D.
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...”
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.
2. The training and rehabilitation of functional visual disorders through repetitive, targeted visual rehabilitative techniques should not be a foreign concept.


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.

- 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?
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”
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.
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

- 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”

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Mean age of subjects = 70

* Patients’ baseline VA = 20/15 — no room to improve
For Doctors

RevitaVision™ 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

RevitaVision 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 anything invasive."

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
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 performed monocularly or monocularly in a binocular field.
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

- Visual Acuity
- Accommodation
- Eye Movements
- Binocular Integration
- Peripheral Awareness
- Motion Sensitivity
- Spatial Vision
- Visual Cognition
- Inter-sensory Integration
Intra-Optometric Collaboration

Primary Care OD

Patient’s Performance Optimized

Identify Visual Need

Collaborate with VT Doc

Visual Brain Requires Training
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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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