The Neurological Effect of Lenses and Puzzles on Brain Plasticity

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Overall Goals

- Describe how brain plasticity requires three main components:
  - An afferent pathway (input sensor)
  - An efferent pathway (to allow movement)
  - Intact processing pathway(s)

- Explain how patients requiring rehabilitation can recuperate more easily with the addition of individualized visual puzzles and lenses

- Discuss examples of patients who have recuperated more quickly with visual processing enhancements than traditional rehabilitation methods
Objectives

- Understand the visual components of brain plasticity:
  - Visual input sensors
  - External visual pathway(s) other than 20/20 eyesight
  - Internal visualization systems
  - Eye movement pathways

- Understand why a patient’s rehabilitation is faster with the addition of individualized visual puzzles and lenses designed for balance between peripheral and central systems
VISUAL SYSTEMS OTHER THAN 20/20 EYESIGHT
What does an itch do?

- Even though a mosquito bite is limited to a minute fraction of skin receptor cells, it can pull mental attention away from the outside environment (such as a teacher or rehab instructor).

- Having an “annoying” area on any portion of the 63 million retinal cells and/or their corresponding brain pathways can do the same thing.

- Eyeglasses can be designed to mute out the irritating pathways.
The eye connects with internal body functions as well as external eyesight.

**VISUAL** retinal pathways register external information for eyesight and perception.
- retino-geniculate tract

**NON-image forming** retinal pathways register internal information for comfort.
- retino-collicular tract
- retino-hypothalamic tract
The Retina is a TWO-WAY portal

- Seeing is one aspect of retinal function – the SLOWEST pathway.

- AFTER non-image forming pathways stabilize unconscious body functions, a person’s mind may THEN pay attention to and select objects around them.

- Eyesight is therefore NOT activated efficiently if the body isn’t balanced first.
Three components of brain plasticity

- Sensitive sensors (afferent)
- Non-damaged processing pathways
- Some mode of motor output (efferent)
Sensory/Motor Systems

- Visual input sensors
  - For movement
  - For size and shape
  - For details and color

- Eye movement pathways
  - Unconscious reflexes
  - Subconscious awareness
  - Conscious attention
Some of the Non-Eyesight Pathways

- External visual pathway(s) other than the 20/20 central eyesight pathway
  - Figure Ground
  - Spatial Perception

- Internal visualization systems
  - Metacognition
  - Deductive and Inductive Thinking
  - Analytical Perception
  - Visual Imagery
  - Mental Manipulation
  - Classification
Eye Movement Pathways

- **Unconscious reflexes**
  - Fine tuning of balance and posture
  - Neck and shoulder vs. eyes

- **Subconscious**
  - Smooth eye movements (following a moving target)
  - Jumping eye movements (shifting gaze to another location)

- **Conscious**
  - Aiming and focusing on a selected target
Patients have Individual Habits and Tolerance Ranges

- **COMFORT**
  - I Can, it’s easy, it’s fun

- **TOLERANCE**
  - It’s hard, but I’ll do it

- **GIVE UP/BREAKDOWN**
  - It’s too hard,
  - I won’t even try, or
  - I can’t anymore
CONTINUAL LOOP of:
INPUT – PROCESS – RESPONSE

● At intentional (logical) levels
  ➢ If the original sensory input is perceived as confusing, mismatched or skewed then processing and thus, motor response is also slowed or incorrect.

● At unintentional (emotional – gut) levels
  ➢ Motor responses will be awkward if unconscious biochemical systems are out of balance.
Unique Decision Making

Internal Reflexes

**HOW AM I?**
Body Rhythms, Mood & Energy

**WHERE AM I?**
Orientation

Outside World

**WHERE IS IT?**
Organization

**WHAT IS IT?**
Details

Defenses
Interest
Motivation
Energy
FIRST we stabilize internal environment

- Where am I? -- **Skeletal Body** Stability
- How am I? -- **Visceral Body** Stability

THEN deal with the external environment:

- Where is It? -- **Aiming** Object location
- What is It? -- **Focusing** Object identification
When patient is stable, Donalee’s Designs for Strong Minds’ work enhances internal systems as well as aiming and focusing.
Unique Decision Making

Internal Subconscious Decision

WHO AM I?
Past Experiences

Conscious Decision

Defenses
Interest
Motivation
Energy

What am I going to do about it?
Aiming and Focusing

WHO AM I?
Past Experiences
Each of the 2 functional levels governs a type of eye movement:

- **Reflexive (Unconscious, Involuntary)**
  - Head Movement
    - Triggered by head position
    - Develops in utero

- **Developed (Subconscious & Conscious)**
  - Aiming
    - Triggered by environmental stimuli
    - Develops after birth
  - Focusing
    - Triggered by convergence
    - Develops after macula (central eyesight) evolves
Traditional Eye Tests Emphasize Central, not Peripheral Vision

- But, the integration of periphery with the central is critical
- For example, imagine a mouse running across a room
  - Peripheral vision catches a moving blob, and initiates a reaction
  - This is all done before central focusing occurs.
Peripheral eyesight is useful

- I cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg. The phaonmneal pweor of the hmuan mnid, aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it deosn't mtttaer in waht oredr the ltteers in a wrod are, the olny iprmoatnt tihng is taht the frist and lsat ltteer be in the rghit pclae. The rset can be a taotl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Amzanig huh? yaeh
Stimulation of peripheral vision affects:

- Adrenaline
- Body Posture
- Head Position
- Attention
- Thinking Process
Neuro-Optometrists Think:

Physical

Health
Muscle Reflexes
and Control

Physiological

Energy
Mood
Behavior

Psychological

Attention
Awareness
Judgment
Developmental Building Blocks

Body and Gravity
- Reflexes
- Isolated Control Movement

Surroundings
- Awareness
- Organization
- Judgment
- In TIME & SPACE

Mind and Attention
- Thinking
- Conceptualization
- Planning
- CONCEPTS & DETAILS
Typical Concerns

Academic
- Writing
- Reading
- Concentration

Social
- Behavior Awareness of Surroundings

Sports
- Speed
- Fatigue
- Judgment
- Coordination
Neuro-optometrists can influence behavior:

- By evaluating and suggesting optimal ways of organizing a person’s surroundings, to stay within their comfort ranges.
  
  Thus, when organization and cognition are more automatic, the internal world is calmer.
Cortical vs. Subcortical

- **MIND:**
  - conscious
  - subconscious

- **BODY**
  - unconscious/reflex

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Difficulty with understanding what is seen, heard, smelled or felt from the other person’s perspective.
Difficulty with communicating to others what is seen, heard, smelled or felt so that another person can clearly understand.

Can range from:

“I can’t write essays well” to

“Non-verbal and non-responsive”
Subconscious – Peripheral Awareness

**Cues:** Learned habits beneath conscious levels

- In visual systems, this is measured by testing:
  - OKN (optokinetic reflex)
  - Convergence
  - Pursuits
  - Saccades
Central eyesight is a SLOW pathway

Chemical Circuitry
Neurological Circuitry
Peripheral Eyesight
Central Eyesight
Neurological Circuitry – intertwined with eyesight centers

Fig. 6. Retinal projections to the primary visual centers (white arrows) and their major links with homolateral secondary subcortical areas. Double arrows indicate reciprocal connectivity.
Scientific American magazine showed a “non-visual” pathway to the hypothalamus.
OPTOMETRY encompasses many pathways

NEURO-OPTOMETRY

SYNTONIC OPTOMETRY

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The eye is connected to a LOT!
Cognitive Restructuring involve mediation and context free games.

Context free games utilize visual puzzles that require bottom up thinking to solve the problem. DSM puzzles organize the tools into various logical structures.

- Comparisons - Analogies
- Progressions
- Analytical Perception
- Classification
Cognitive Restructuring involve mediation and context free games.

Participation in DSM programs habituate analytic and critical thinking

- Recognize similarities in diverse situations
- Formulate a plan
- Solve the problem
- Analyze the success of the solution
- Gain insights for change
Cognitive Restructuring involves mediation and context free games.

**Mediation** makes the thought process explicit so that the individual can control problem solving and decision making.

- **Intention**
  - Understanding the specific goals of the game
- **Attention**
  - Slow down to recognize details and organize them in new ways
- **Deliberate Rehearsal**
  - Practice with a focus
- **Transference**
  - Generalize behavior to other situations
HOUR 2
DONALEE MARKUS’ WORK
Professor Clark Elliot gives a voice to concussion and TBI patients worldwide.
Cognitive Restructuring involves mediation and context free games.

Participation in DSM programs habituate analytic and critical thinking

- Recognize similarities in diverse situations
- Formulate a plan
- Solve the problem
- Analyze the success of the solution
- Gain insights for change
Some of the Many topics Covered:

- Metacognition
- Deductive and Inductive Thinking
- Visual Imagery
- Figure/Ground
- Spatial Perception
- Mental Manipulation
- Analytical Perception
Metacognition

Create visual imagery with internal dialogue
Find the mistakes.

Using the variable checked on the right, compare the images that have been circled to the sample in the center square.

Put an X on the circled images that do not fit the required variable.

Circle any additional images that do fit the requirement.

Fill in the blank: I am looking for _____________ images.

(shape)
Find the mistakes.

Using the variable checked on the right, compare the images that have been circled to the sample in the center square.

Put an X on the circled images that do not fit the required variable.

Circle any additional images that do fit the requirement.

Fill in the blanks: I am looking for images that are ___________ and ___________.

(size) (color)

Same:

- Size
- Shape
- Color
- Direction

Different:

- Size
- Shape
- Color
- Direction
Deductive Thinking

Find the mistakes.

Using the variable checked on the right, compare the images that have been circled to the sample in the center square.

Put an X on the circled images that do not fit the required variable.

Circle any additional images that do fit the requirement.

Fill in the blank: I am looking for images that are not ______________. (color)
Find the mistakes.

Using the variables checked on the right, compare the images that have been circled to the sample in the center square.

Put an X on the circled images that do not fit the required variables.

Circle any additional images that do fit the requirements.

Fill in the blanks: I am looking for ___________ images that are not rotated ___________.

(color) (direction)
Strong Mind Puzzles App

Challenge your mind to reach your greatest potential.

Designs for Strong Minds®
Clinically Applied Neuroscience Since 1982
US Pat. No. 6,755,419
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Strong Mind Puzzles Variations

- Strong Mind Puzzles
  - Inductive/Deductive reasoning
- Introductory
  - Inductive reasoning
- Special Needs
  - Builds thinking skills
- Brain Injury
  - Improve concentration
- Aging Brain
  - Enhance memory
- Preschool
  - Develop comparative behavior
Seven Variable Mazes
Strong Mind Mazes

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Visual Imagery

Visual imagery is the foundation of abstract thinking and mathematics.
Visualization allows the individual to rehearse a skill in their mind.
Mindful meditation restructures the brain through visualization
Object and Spatial Visual System

Dorsal or "where" stream

Spatial processing

Frontal
Parietal
Occipital
Temporal

Object processing

Ventral or "what" stream

location
movement
spatial transformations
spatial relations

color
texture
pictorial detail
shape
size

http://www.nmr.mgh.harvard.edu/mkozhevnlab/?page_id=618
The Artist’s Brain
Visual Imagery games develop abstract thinking because they

➢ Strengthen the visual cortex
➢ Create logical structures for complex analysis
➢ Establish pattern recognition
➢ Enhance abstract thinking
➢ Develop mental imagery
Figure Ground
Draw the figure in Column A on the grid in Column B
Circle the view that shows how the object would look to the person pictured.

**Example**

- **Your view of the object**
- **View 1**
- **View 2**
- **View 3**
- **View 4**
Spatial Relationship Between Objects

Put an X on the box(es) in which the figures do not have the same relationship to each other as shown in the center box.
Mental Manipulations

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>![Diagram 1]</td>
<td>![Diagram 2]</td>
<td>![Diagram 3]</td>
</tr>
<tr>
<td>![Diagram 4]</td>
<td>![Diagram 5]</td>
<td>![Diagram 6]</td>
</tr>
<tr>
<td>![Diagram 7]</td>
<td>![Diagram 8]</td>
<td>![Diagram 9]</td>
</tr>
</tbody>
</table>
Find My Mistake
Part-whole Relationships

Put an X on the shape below that you do not see in the figure on the left.
Complex Analytical Perception

Fill in the blank. Complete the "equations" by selecting the best answers from the choices below.

A B C D E
BYOPuzzles

Build Your Own Puzzles for iPad

Rehearse complex visual imagery skills

Shape perception
Shape consistency
Spatial relations
Part-whole relationships
Detail discrimination
Figure-ground differentiation
Pattern recognition
Connecting the Dots helps the individual make sense of isolated pockets of information.

- Select relevant information amid chaos
- Project desired results over ambiguity
- Manipulate information mentally
- Plan behavior
- Confirm inferences before taking action
- Verify results
- Change strategies
Connect the dots so that the figures in the right box look like the figures in the left box.
Connect the dots so that the figures in the right box look like the figures in the left box.
Developing the Visual Filter

Connect the dots to make 4 of each of the figures shown in the square.
The Dr. Dots app is designed to:

- Reduce impulsivity
- Strengthen pattern recognition
- Develop variation and perspective
- Plan behavior
- Take action
- Develop new strategies
- Recognize novel relationships
All DSM programs use visual puzzles to shake participants out of their routines.

- Opportunity to discover
- Create disequilibrium
- Offer alternate perspectives
- Strengthen cognitive weaknesses
The puzzles are designed to provide you with additional tools for problem solving.

**Mental agility allows us to:**

- Create novel strategies for problem-solving
- Tolerate ambiguity and uncertainty
- Be vigilant to routine behaviors that may narrow thinking
- Build effective relationships
- Adapt easily to change
- Express ideas logically
“Man’s mind, stretched to a new idea, never goes back to its original dimension.”

- Oliver Wendell Holmes
HOUR 3

MIND AND BODY REACT TO THE ENVIRONMENT
All babies have PRIMITIVE REFLEXES for survival.

During normal development, these become integrated.

After a brain injury, they often re-emerge.
Example of Reflexes:

- Sitting up straight with both legs and arms flexed is too uncomfortable.
- Reading and writing are easier on the floor with legs extended.
Mind is influenced by Body
Each must adapt to EXTERNAL Change

- Mind’s adaptation to external changes
- Body’s adaptation to external changes
The **mind** is influenced by **body** & each must adapt to **INTERNAL** Change

- Mind’s adaptation to internal changes
- Body’s adaptation to internal changes
Visual circuitry is not necessarily eyesight related.

- The review of systems that we address for each patient tells us where their weak areas are.

- Optometrists can (indirectly) affect all of the body systems, because the retina is part of the central nervous system.

- Rather than simply using lenses for central eyesight, we can determine which combinations of treatments (lenses, prisms and/or filters) is optimal for each patient.
SAMPLE PATIENTS

- Mild TBI patients
- Moderate TBI patients
- Severe TBI patients
HOUR 4

PUTTING IT TOGETHER AND QUESTIONS
They were too close to the door to close it.

- Did you notice how your mouth said “S” for the first “close” and “Z” for the second?
  - Peripheral eyesight is involved.
People select when to expend effort.

- The roller skate was patented in 1819.
- The modern suitcase was patented in 1970.
Eye/Ear Connections involve Attention

eyesight + hearing ≠ watching and listening
20/20 ISN’T ENOUGH
Healthcare Set-Up: 4 Types of Eye Care

Using visual pathways to induce changes in physical and physiological functions, via sensory integration.

Identifying and diagnosing physical and physiological conditions that manifest in visual impairments.

Identifying structural and functional problems in the eye and visual pathways, with emphasis on structures.

Identifying structural and functional problems in the eye and visual pathways, with emphasis on function.

See with Your Ears! ©2014 Mind-Eye Connection
Three Different Sensory Inputs

See with Your Ears!  ©2016  Mind-Eye Connection
Were Goals Achieved?

- Describe how brain plasticity requires three main components:
  - An afferent pathway (input sensor)
  - An efferent pathway (to allow movement)
  - Intact processing pathway(s)

- Explain how patients requiring rehabilitation can recuperate more easily with the addition of individualized visual puzzles and lenses

- Discuss examples of patients who have recuperated more quickly with visual processing enhancements than traditional rehabilitation methods
Were Objectives Met?

- Understand why a patient’s rehabilitation is faster with the addition of visual puzzles and individualized lenses

- Understand the visual components of brain plasticity:
  - Visual input sensors
    - For movement
    - For size and shape
    - For details and color
Were Objectives Met?

- External visual pathway(s) other than the 20/20 central eyesight pathway
  - Figure Ground
  - Spatial Perception

- Internal visualization systems
  - Metacognition
  - Deductive and Inductive Thinking
  - Analytical perception
  - Visual imagery and Mental Manipulation
Were Objectives Met?

○ Eye movement pathways
  ● Unconscious reflexes
    • Fine tuning of balance and posture
    • Neck and shoulder vs. eyes
  ● Subconscious
    • smooth eye movements (following a moving target)
    • Jumping eye movements (shifting gaze to another location)
  ● Conscious
    • Aiming and Focusing on a selected target
Mind-Eye Connection

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Time for a Break!