What is vision?

Vision is the deriving of meaning and direction of action as triggered by light.
Vision is the Emergent

Diagram of Emergence from “Complexity, Life at the Edge of Chaos” by Roger Lewin
Vision – the dominant process in humans.

Steps of Neural Development from Gerald Edleman

Neural Networks in the Brain (Wet Mind)
Neural Networks in the Brain with feedback (Wet Mind)

Reentrant Wiring

Neural Darwinism of Gerald Edelman

Reentrant Signaling
Non-Malingering Syndrome

• A malingering question…
  – Why don’t the kids with this complain about the many abnormalities that we find when we test them?
Behavioral Model of Active Visual Perception

Object recognition in human vision is provided by the following:

• Separate processing and representation of “what” and “where” information at high levels of the visual system.
• Frame of reference is attached to the basic feature at each fixation point and includes “what” and “where” data.

• Mechanisms of visual attention use “where” information to direct sequential image processing.
• Mechanisms which provide comparison of current and expected object features in each fixation.
ADD/ADHD & Visual Attention

Why does the medical profession say that Ritalin, Adderol, etc. have paradoxical effects?

Mechanisms of Visual Attention

Vision Therapy provides the patient the opportunity to have the necessary meaningful experiences to vary the size of the attention window, the intensity of the attention, and the length of time that visual attention is maintained. Once the control of visual attention has been learned few people will still display ADD or ADHD symptoms.
Lawrence Weiskrantz

“To date, workers have identified nine branches of the optic nerve that connect with regions of the brain other than the visual cortex.”, Unconscious Vision: The Strange Phenomenon of Blindsight, The Sciences – September/October 1992

Karl Pribram

“In one set of optic nerve recordings it was shown that whereas about 8% of the nerve fibers in the optic nerve carry signals to the retina, these 8% modulate the input in 80% of the input fibers in the optic nerve.”, Brain & Perception: Holonomy and Structure in Figural Processing, Earbaum, 1991

Haglund, Ojemann, Hochman

“It has been known since the 1940’s that even isolated peripheral nerves change their reflectance when kept busy conducting impulses. Reflectance changes also occur in brain slices kept alive by an oxygenated bath without any blood supply, making it likely that reflectance changes are at least in part also a result of swelling of neurons and glia with activity.”, Optical imaging of epileptiform and functional activity in human cerebral cortex, Nature 358:668-671, 20 August 1992
What’s The Big Deal?

• Conjecture:
  – Test pattern hypothesis, similar in the auditory system.
  – Allows for a noisy system to be very sensitive
  – Acts as a primer, sending forward patterns for matching as well as sending backward to pattern activation areas in the “What is it?” area of identification.

Selected quotes from “Adult Cortical Plasticity and Reorganization”, Science & Medicine, 1997 Avi Karni

“Cortical plasticity is subserved by a slowly evolving, incremental process. …consistent exposure over several daily session is required to induce sufficiently large changes for the visual system to become highly specialized within an artificial visual environment or with a distorted visual input.” …

More Karni…

“…going higher in the visual system, plasticity increases and remains possible for longer periods.”

“Recent evidence suggest that even low-level processing areas such as primary sensory and motor cortical areas retain a behaviorally relevant degree of plasticity throughout life.”

“Adult observers can more than double the sensitivity of their visual systems by training.”

“…passive exposure to a stimulus is insufficient and a behavioral context (relevance for performance) may be critical for learning to occur.”
“Our observations suggest two stages in the acquisition of improved perception. A fast improvement, occurring early in training, can be induced by a limited number of trials, on a time scale of a few minutes or less... After this later period, large and long-lasting improvements in performance were found. Performance continued to improve over days and was maximal after 5 to 10 consecutive training sessions spaced 1 to 3 days apart. Once a maximal level was reached, most of the gain was retained over months and even years.”

Also, a stable directionality is necessary but not sufficient to guarantee accurate directions being given to perform a particular movement.

In reading, the attention window must be large enough to encompass both the current fixation point and the zone into which the next fixation will go to program the next eye movement accurately.

Understanding the Magno/Parvo cellular neurological channels in vision and how they are used in reading.
Where do good readers fixate?

A. At the beginning of the word  
B. One-third the way from the left hand side  
C. In the middle of the word  
D. Wherever the eyes just happen to fall

The question that the Breitmeyer/Lovegrove hypothesis does not answer!

If this is so, then how do we figure out where to go next with our eyes, where to saccade to next, if we are concentrating with the central part of our vision on figuring out what we are reading and using the peripheral part of our vision to blank out the previous image?
Lateral Masking

Geiger & Lettvin Statement (1)

“Dyslexia, not associated with other neurological or visual deficit, is presently unaccountable and is classified, more by default than by demonstration, as a disorder of some neurological function. But among the possibilities is a physiological explanation. ……

Geiger & Lettvin Statement (2)

…. That is, the necessary information for reading may be blunted before cognition by misuse of a normal process but the pathway to convey the information is intact as is the higher function itself. At first this sounds like a distinction without a difference and, further, makes the visual process arbitrary. ……

Geiger & Lettvin Statement (3)

…. But we propose to show that such blunting can be measured, that the measure is diagnostic, and that the blunting can be relieved by suitable designed practice.”

Geiger Lettvin Testing Protocol

<table>
<thead>
<tr>
<th>Fixation</th>
<th>Stimulus</th>
<th>Black</th>
<th>All White</th>
<th>Fixation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;40 mm</td>
<td>&lt;40 mm</td>
<td>40 mm</td>
<td>23 months</td>
<td>Fixation</td>
</tr>
</tbody>
</table>

Targets used: S H Y E N W C I T O
-20 to +20 degrees in 2.5 degree increments.
Contrast 10:1, each letter 35 minutes of angle wide.

Geiger & Lettvin Research on Lateral Masking

Asymmetry in English Reader

Asymmetry in Hebrew Reader
Learning effects change the curve from abnormal to normal!

![Graph showing lateral sensitivity data](image1)

Danish Data

![Graph showing lateral sensitivity data](image2)

Lateral Sensitivity: Normal Subjects & Combined Data

- Fixation Points (degrees of eccentricity)
- Percentage Correct Responses

<table>
<thead>
<tr>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Combined Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixation Points (degrees)</td>
<td>Percentage Correct Responses</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lateral Sensitivity: Poor Readers vs. Controls

- Fixation Points (degrees of eccentricity)
- Percentage Correct Responses

<table>
<thead>
<tr>
<th>Female Subject</th>
<th>Male Subject</th>
<th>Combined Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixation Points (degrees)</td>
<td>Percentage Correct Responses</td>
<td></td>
</tr>
</tbody>
</table>

Geiger & Lettvin's Data

- Normal
- Dyslexic
- Severe Dyslexic

Our Combined Data

- Dyslexic
- Severe Dyslexic

![Graph showing lateral sensitivity data](image3)

![Graph showing lateral sensitivity data](image4)
What’s Going On?

- Incomplete or improper study replication?
- Something else?
- Something significant?
- Are we on to something?

Possible Explanations

- Random trials
- Luminance & contrast differences
- Letter unfamiliarity
- Different working distance
- Unknown reading levels
- Computer flicker
- Letter jaggedness

Who cares?

- We all should!
  - M-Cell pathway DEFECT is THE currently in-vogue term, but is it a defect?
  - Rather than being a neurological problem might it be something else?

Visual Attention Shifting

Subsections

- Shape Shift
- Disengage
- Move
- Engage
- Visual Attention Shifting
The Harris Hypothesis

Understanding reversals and their relationship to ocular motor dysfunctions.
Reversals

• Does a person actually see a “b” as a “d”?  
• Does a person actually see things backwards?  
• Does a person actually read the letters from right to left when reading “saw” for “was”?  

Feature Detection

When a young developing reader looks at individuals letters they may still be at the stage of looking at the features of each letter and assembling these features into the letter rather than seeing the letter as single entity.  The letters “b” and “d” both have the feature of a line and a loop.  The only difference between the two is the spatial orientation of the two features one to another.  

Laterality

Laterality is the knowledge that a person has of the two halves of their body being different.  At first they have no awareness of this and use each side of the body interchangeably. Later they begin to use the body asymmetrically with one assuming more of the lead and the other the support roles.  Over time this becomes more stable and eventually they associate the labels of “left” and “right” with these two sides.  

Directionality

Directionality is laterality projected out into space onto other objects.  In this way the person can know if one object is to the right of left of them, then in reference to other objects as well as in reference to another person.  At higher levels this extends to all kinds of more complex spatial relationships.
Is there a relationship between ocular motor control and laterality/directionality?

To give directions to a person or to a system one must simultaneously know where both the beginning and ending points are in a journey. If you only know where you are and you have only a general sense of where you are going, you cannot give accurate instructions to get from point A to point B.

Yoked Prisms and Neurology

- Many people use prisms in different manners.
- Yoked prisms have been prescribed following two major theories. Both are dependent on the person looking and interacting with the environment to a nearly equal degree with and without the prisms.
- In patients in the autism spectrum this is not so. They seem to go from being non-connected to connected to the visual world.
- How? Why? What’s the mechanism?

Autism, PDD, Asperger’s Syndrome

- Kaplan performed a study which demonstrated a 78% improvement in the children making eye contact with the lenses on.

Autism, How do they work?

- Mechanism must be different than the space shifting or body mechanic shifting going on in the Kaplan or Kraskin approaches discussed earlier.
- How to take the person from apparently not being connected to the outside world to being about to attend, fixate, and make eye contact in the outside world?
Hypothesis

- It's related to the “binding” problem.
  - Local areas of the brain process different aspects of the sensory input; where, what, color, size, name, uses, etc.
  - Where does it all come back together to get unified as a single percept?
    - Is there a homunculus?
  - Cytowic, “The Man Who Tasted Shapes” gives us a potential mechanism mediated by attention mechanisms in the midbrain.

If the energy of activation is too low then the separate aspects of stimuli do not get bound together.

- The child may then act as if stimuli from some areas are too intense: tactile defensiveness, hyper-ocusis, etc.
- The prisms may function to alter blood flow to the mechanisms of attention to increase the energy of activation thus allowing the proper “binding” for the object.