Non-Surgical Approaches to the Treatment of Strabismus
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Operational Definitions
• Phoria: when one eye is covered it moves away from the position it was pointing in when it was uncovered AND prior to cover it was directed towards the same object as the other eye.
• Tropia: When both eyes are open and uncovered, one of the eyes is pointed in a direction other than where the target is. The misalignment may be:
  ◦ Inward: eso  Outwards: exo
  ◦ Above: hyper  Below: hypo

More Definitions
• Strabismus: Any overt misalignment of the eye or eyes when looking at a point in space.

Optometric Referrals
• Strabismics are easy to detect and scary to many optometrists.
• Some lecturers have made these cases sound overly difficult to handle and have overemphasized the risks.

Prevalence
• 4-6% of the population have amblyopia and/or strabismus.
• “Esodeviations occur far more frequently than exodeviations, with a prevalence ratio of approximately three to one.”
• “Amblyopia has been reported to occur in 5% (Griffin et al), 7% (Dunlap), 12% (Moore), and 13% (Smith et al) of concomitant exotropes.”

Defusing the Mystique/Fear
• When taught in the past may have been shrouded in mystique and/or made to sound so difficult.
• Many got scared off, thinking that these cases are too hard.
• A whole new vocabulary seems to have been invented that needs to be mastered.

Is it really so hard?
• It is really easier than you might think!
• Because the eye is turned and these patients look different, it may seem to be more difficult than it actually is.
• The hardest part is getting to more fundamental levels of understanding of the visual process.
• This is to be contrasted against hyper-loading of activities with athletes in doing sports vision work.

Key to Helping Strabismics
• The key to being able to help a strabismic is understanding early childhood vision development.
• If we understand why the person put their eye where they put it or learned to use their eyes the way they have, then the treatment flows easily.
• This understanding flows from understanding human/child development.

9 Complexity Theory & Neural Networks

• White noise concept of behavior:
  ◦ The infant is constantly trying different ways of using their hardware.
  ◦ They constantly display a wide array of behavior patterns.
  ◦ “Transient neonatal exodeviations normally occur in the first few months of life and are consequent to developing ocular alignment and control.”

10 Hebbian Synapses

• The more a synapse is used, the easier it becomes over time to fire off that connection. 
  “Nerves that fire together wire together.”
• The less a synapse is used, the harder it becomes over time to activate that connection.
  “Use it or lose it.”

11 Building the System

• As the normally developing child interacts with the environment, there will be brief encounters that result in the short term amplification of signals in the system.
• This activates or triggers the reinforcing of the connections that were involved, thereby building the neurology that later resultant behavior will be based on.
• Follows the normal rules by which neural networks assemble themselves.

12 Why Develop an Eye Turn?

• At certain key points in development something gets in the way of a bilateral or binocular experience.
• The pattern found that “solves the environmental problem” activates the reinforcement of pathways that use the system asymmetrically.
• Over time, the person may persist in using this asymmetric pattern after the time that it benefited the person.

13 Learning/Development is Lifelong

• New synapses can be made at any at age!
• New life experiences help the person create new pathways and new patterns of the use of self from which can emerge different bilateral and binocular movement patterns.

14 Normal Development -Newborn

• Exhibits all visual behaviors that change moment to moment.
  ◦ Exotropia
  ◦ Esotropia
  ◦ Hyper/hypo-tropia
  ◦ Refractive conditions
    ◦ Hyperopia
    ◦ Myopia
    ◦ Astigmatism
    ◦ Anisometropia
• At birth the infant does not use the binocular system like an adult.
Emergence of Bilaterality

- Bilaterality in the first weeks of life can be characterized as being primarily reflexive in nature.
- Over the first few months of life more purposeful bilateral movements begin to emerge.

Early Signs of Visual Attention

- At birth, accommodation during awake and active times is fixed at +5 diopters, 20 cm - the right distance to help bond with mom. This continues until about 3 months.
- From 3 to 6 months of age the child begins to take over control of the accommodative system, moving it from the 20 cm point in space.
- By 6 months of age the child should have control of the mechanism of accommodation, at least at this point to about 2M.

Bilaterality – Who Cares?

- We are a bilateral binocular organism.
- Asymmetries in bilaterality are reflected in asymmetries in binocularity.
- Generally, the direction of flow of development is from the asymmetric use of the body to the asymmetric use of the visual system.

Development and Etiology

- As binocularity emerges, challenges at key points in time will lead to the development of specific types of strabismus.
- 3-6 months of age: high angle (>40-45 diopters) unilateral esotropia with deep amblyopia
- Around or just after 6 months: high angle (>40-45 diopters) esotropia, if amblyopia is present it is not deep

Development and Etiology (2)

- 18-30 months: Moderate esotropia, or exotropia, unilateral refractive amblyopia.
- 3-5 years of age: accommodative esotropia, high plus (+4.00 – +7.00).
  - Has not been shown to be hyperopic to this degree prior to the development of the turn.

Exotropia

- "Exotropia had a positive correlation with: an onset prior to age two, alternating deviation, hypoxia at birth, delayed developmental milestones, and neurological involvement."
- "Age of onset of exodeviations in the pediatric population less than six years of age appears to cluster around birth to two years of age, with a limited incidence beyond five years of age."
- "56% of our constant exotropes presented with neurological or ocular pathology."
- "Our intermittent exotropes revealed 19% had a history of neurological or ocular disease."

How much testing do you need to do?

- H. Ward Ewalt, “What else do you need to know about a strabismic other than what you see when you meet them in the reception area?”
- Can we help them?
- Most testing is related to being able to tell the patient how long the treatment will take and what the probable outcome will be.
Some more terms

- Concomitant: when the person looks in different directions of space the eyes stay in the same relative position to each other. All movements are yoked.
- Non-concomitant: when the person looks in different directions of space the eyes change their relative positions to each other.
  - Most surgeries produce scar tissue.
  - Prognosis is better if they have not had any surgery, even if post-op the amount of turn is small.

Causes 1 – Ear Aches

- The VIth nerve travels close to some structures that are prone to infection and inflammation, which may cause a temporary decrease in nerve conduction to the muscle causing an under-action of the muscle.
- Solutions: face turn, send out more signal, suppress the eye, let the eye go in.

Causes 2 – Earaches

- The earache could be sub-clinical.
- It is more significant if it occurs at critical points in visual development and the development of bilaterality and binocularity.
  - Birth to age 6 months – prone posture
  - Age 6 – 18 months beginning to be in upright posture
- The same problem occurring after these critical points might not, and probably wouldn’t, have the same effect.

Diplopia & Confusion

- Diplopia – the conscious awareness of seeing two images of a single object, which appear in two different areas of space at the same time.
- Confusion – each eye is directed towards a different object. Confusion occurs when the images of the two different objects compete to be represented on the internal representation of reality for the same location in space at the same time.

Diplopia

Picture courtesy of Griffin

Confusion

Picture Courtesy of Griffin

Diplopia & Confusion

- Diplopia – Traditionally taught as THE main symptom that drives the development of strabismus.
- Confusion – Traditionally not addressed as a significant causative factor.

Confusion – The Driving Force

- Nat Flax, “The need to resolve the confusion is what drives the process of adaptation.” It is analogous to how sustained near-centered demands drive the process of building myopia.

Resolving Confusion
- The person can resolve confusion in several ways:
  - Tune one channel out. Suppression (generally only portions of one channel of flow is tuned out). NOTE: Suppression occurs early in the neurology and costs a good deal of energy to shut down the flow through one channel.
  - Physically cover an eye.
  - Blur one channel. Develop single sided refractive condition.

### Resolving Confusion
- The person can resolve confusion in several ways:
  - Shift the relative positions of the two images. Make the eye turn more or less
    - Exotropia – may develop two areas of space that can perceptually be used simultaneously. (Flax hypothesis)
    - Esotropia
      - Micro ET (5-8) PD usually with AP and/or EF. Use 4 BO prism test
      - Medium ET (18-25) PD, finds the blind spot. Usually no amblyopia.
      - Large ET (40+) PD, uses the nose as occluder, missed the blind spot and kept on going.

### Resolving Confusion
- The person can resolve confusion in several ways:
  - Reprogram the directional sense of one eye. This may emerge and be seen in some testing as anomalous retinal correspondence (ARC) or anomalous projection (AP).
  - Traditionally – the whole eye gets reprogrammed. Is a wiring problem!
  - Cheap energy solution.
  - Not a wiring problem.

### Therapeutically Reducing Confusion
- Remove confusion and you remove the forces driving them to continue mal-adapting.
  - HOW???
- One way is to use some form of occlusion
  - Binasal
  - Single nasal
  - Direct
  - Indirect

### Anomalous Retinal Correspondence
- Anomalous – abnormal, not usual, out of the ordinary.
- Retinal – occurring at the level of the retina.
- Correspondence – spatial match between the “images” or “pictures” from the two eyes.

### Right Eye Esotropia with
Normal Projection

### Right Eye Esotropia Harmonious
Anomalous Projection
Some Myths of AP

- The “image” from the whole eye is reprogrammed.
- Once the reprogramming is done, it is permanent.
- Once established, this new software is always used.

Characteristics of AP

- The volume of space shifted may vary moment to moment.
- The areas of space shifted may be islands around the fovea (to deal with confusion) and around the new pseudo-fovea (to deal with diplopia).
- These islands may remain separate or may link together into a larger island.
- The shape of the shifted areas is amorphous and may change depending upon how it is tested.
- Outside the shifted areas NP is usually still seen.

Characteristics of AP

- The more natural the testing situation (the more like real life) is, the more likely AP will be measured.
- The less natural the testing situation (the less likely the person has ever encountered this situation) is, the less likely they will show AP on testing.
- It is not an all or nothing thing!

Accommodative Esotropia

- Age 3-5 sudden onset esotropia associated with high degree of hyperopia and a high AC/A ratio.
- Traditional Treatment:
  - Prescribe full cycloplegic plus at far with +3.00 add in a high bifocal.
  - Some may even prescribe more plus than measured to decrease the angle as much as possible.
  - Take accommodation out of play to reduce the factors that are driving the eye inwards.

Accommodative Esotropia

- Etiology
  - Do the eyes all of a sudden change size?
  - Is the change anatomical or physiological?
  - What actually changes or was it there all along?
  - Seem to be associated with a precipitating event
    - High fever
    - Febrile (fever related) seizure
    - Acute severe illness
    - Acute emotional event
    - Near Drowning

Active vs. Passive

- A continuum exists between the two poles of active and passive ways of interacting with the visual environment.
• Active: Most attention is directed into the visual process and its direct here-and-now connection to the real object in space. It is done with a higher degree of concentration into a smaller volume of space. Overall indicators of physiological stress would be elevated.

45  Active vs. Passive
• Passive: Most attention resources are diverted to other sensory modalities and/or are directed towards internal cognitive thought and are not directed out to the real objects in space. This is done in a highly dispersed manner, with small portions of attention distributed unevenly throughout large volumes of space. Overall indicators of physiological stress would be depressed.

46  Active vs. Passive
• In hyperopia in general, the more of the hyperopia compensated for, the more passive the use of vision and visual attention.
• The less of the hyperopia that is compensated for, the more active the use of vision and visual attention, unless there is too much hyperopia for the person to manage.

47  Active vs. Passive
• The patient who is too passive does not take control of how they see.
• If a person is placed in a situation where in order to "see" they need to be too active, this can drive them to turn an eye to suspend having to use both channels together or they can avoid the environmental demands altogether.

48  Accommodative ET a New Approach
• Viewed through the active-passive filter the use of lenses from the traditional is modified.
• Our goal is to maintain enough activeness in the visual system to facilitate the person taking control of what they see and how they use their visual system.
• We do not want them too passive. Then they expect us to do the VT to them.

49  Accommodative ET a New Approach
• Plus lenses then are used to modify the position along the active – passive continuum. As the person becomes more passive they also react more slowly to new challenges and react to fewer environmental demands, and this may include more often choosing flight than fight. (degrees/ranges of freedom)

50  Plus Lenses and the Accommodative ET
• Paraphrasing Bill Ludlam; The plus is the scaffold we erect to build the house of binocularity.
• One should build the weakest scaffold necessary to get the job done.
• Once the house is built you can remove the scaffold. It is important to do this step-by-step to not risk damaging the house of binocularity.

51  Clinical Gem

"Start where they got it and work towards where they ain’t got it!"

52  Vertical Deviations
• Most vertical misalignments are secondary to other problems and are not primary problems in their own right.
Postural asymmetries
- Horizontal problems
- Hardware related problems
- Those verticals that cannot be related to any of the above may need special attention.

Vertical Deviations

Postural Asymmetries
- Functional leg length difference
- Actual leg length difference
- Scoliosis
- Torticollis

Secondary to Horizontal Problems
- If the eyes are not locked together by fusion or the coordinated use of both channels simultaneously, then there is freedom for vertical slippage in the system.
- This is not and should not be considered a separate problem, rather it is a secondary symptom of the underlying strabismus.
- In most cases we go through our standard VT for strabismus and without paying any direct attention to the vertical, the patient will take care of it.

Hardware Problems
- Hardware problems that affect muscles, ligaments, blow-out fractures, secondary to EOM surgeries.
- Generally hard to eliminate.
- Work to help the person use the system to the fullest possible within the limitations of the system.

In cases where the problem is secondary to a recent trauma or disease:
- VT can speed up the healing process:
  - Avoid the development of secondary co-contractures
  - Medical model: Wait 6 months!!
  - PT/OT literature full of papers that show that the sooner VT is begun, the better the cure level attained and the faster the better quality of life issues are resolved.

Treating Verticals
- Classically it was thought that one should work vertical fusion ranges using things like vectograms in holders that allow the vectograms to be slid up and down rather than right to left.
- The goal was a bigger fusion range and the direction of work was nearly all in one direction.

Ludlam states that to change the underlying phoric/tropic posture the patient needs to work with jump duction procedures.
- Instead of compensating, this is truly helping the patient fix the underlying problem.
Special Activity for Treatment of Verticals

Where does surgery fit in with binocular anomalies?
- There are some cases that require surgery.
- However, in nearly every instance there should be some vision therapy prior to the surgery and then additional therapy should be done after the surgery. Often after the surgery, even if things are all right in primary gaze, they will need work to help:
  - Solidify (embed) the gains
  - Work to expand the volume of space where they easily use both channels together.
  - Improve the quality of seeing in all areas of space.

Cover Testing – Translucent Occluder

Cover Testing – Translucent Occluder

Keystone Basic Binocular Test

Brock Posture Board

Brock Posture Board

VEP/VER
- 2 different spatial frequencies
  - 8x8
  - 16x16

VEP/VER
- 2 higher spatial frequencies
  - 32 x 32
  - 64 x 64

Bagolini Striated Glasses

Bagolini Striated Glasses

Classical VT for Strabismus/Amblyopia
- Equalize monocular skills
- Biocular (monocular work in a binocular field)
- 1st degree fusion – simultaneous perception
4. 2nd degree fusion – flat fusion
5. 3rd degree fusion – fusion with depth/stereo
6. Build ranges

OEP Clinical Curriculum Behavioral Objectives

A series of behavioral objectives were derived from the sequencing of VT activities for amblyopia and strabismus.

VT - Strabismus

Behavioral Objectives

1. I am in charge of my eyes and how I see.
2. I have two eyes in my head. I can feel them both at the same time.
3. I can cross my eyes on demand totally voluntarily.

Once these three behavioral objectives have been reached then the therapy proceeds in a more linear way working on helping to provide the patient with the necessary meaningful experiences to acquire skills/abilities to meet the following behavioral objectives.

VT - Strabismus

Behavioral Objectives

1. I can see two images and move them – one in reference to another myself.
2. There is a place in space where I can use my eyes together as equal partners.
3. I am increasing the volume of space within which I can use both eyes together as equal partners.
4. I am now able to work through all the activities that are part of the VT programs for people who use their eyes as equal partners throughout space.

Sample Grid of Activities

Thank you.

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